Water Transformation:
Infrastructure for a Livable Future

Joe Peznola, PE, Hancock Associates

and

Bob Zimmerman, Charles River Watershed Association

HANCOCK ASSOCIATES

CRWA

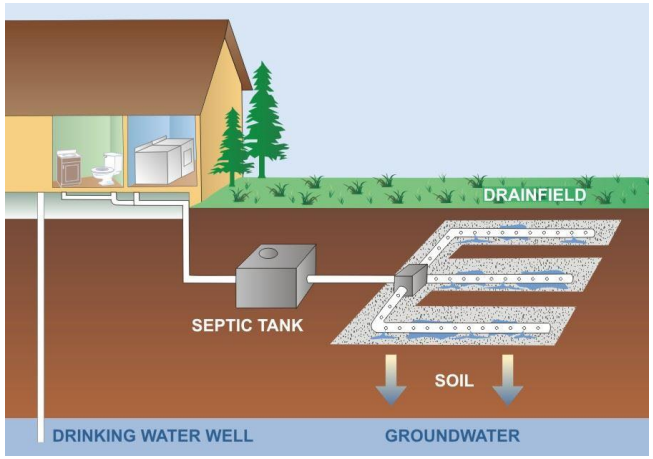
Wanted: Affordable Housing

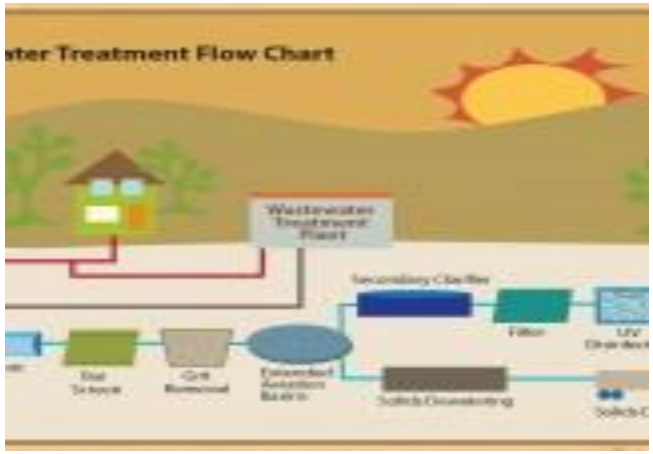
- *In 2012, Governor Duval Patrick unveiled a plan to produce 10,000 multifamily housing units a year through 2020 in an effort to keep young professionals from leaving Massachusetts.*
- *Only 12% on Massachusetts communities have greater than 10% of their housing stock deemed affordable by the Massachusetts Department of Housing and Community Development*
- *Only about 50% of Massachusetts'351 communities have some sort of maniple sewer.*

HANCOCK ASSOCIATES

CRWA

Septic Systems vs. Waste Water Treatment





- Septic Systems administered through local Boards of Health in accordance with State Sanitary Code (Title 5).
- Title 5 septic systems limited to less than 10,000 gallons per day, which equates to 90 bedrooms.
- Above 10,000 gallons per day Massachusetts requires installation of a wastewater treatment facility with effluent discharge to the ground in accordance with 314 CMR 5.0.

HANCOCK ASSOCIATES

CRWA

Installation Costs

Large Share Septic Systems

Town	Project	No. of Bedrooms	Design Flow gpd	System Cost	Cost per Bedroom
Oxford	Pinewood on the Green	46	5060	$160,000	$3,478.00
Littleton	Littleton Ridge	54	5090	$200,000	$3703.00
Sudbury	Coolidge at Sudbury	67	7370	$220,000	$3,283.00
Wayland	89 Oxbow	37	4070	$182,500	$4,932.00

Small Privately Owned Wastewater Treatment Facilities

Town	Project	No. of Bedrooms	Design Flow gpd	System Cost	Cost per Bedroom
Westford	Graniteville Woods	396	43,560	$1.8M	$4,545.00
Littleton	Village Green	498	55,000	$1.75M	$3,514.00
Westford	Princeton	352	39,000	$1.6M	$4,545
Sterling	Choksett Crossing	90	9,900	$1.1M	$12,200
Holliston	Crest View	118	13,000	$1.2M	$10,170
Westport	Edgewater	72	11,000	$1.1 M	$15,277

Maintenance and Operation Costs

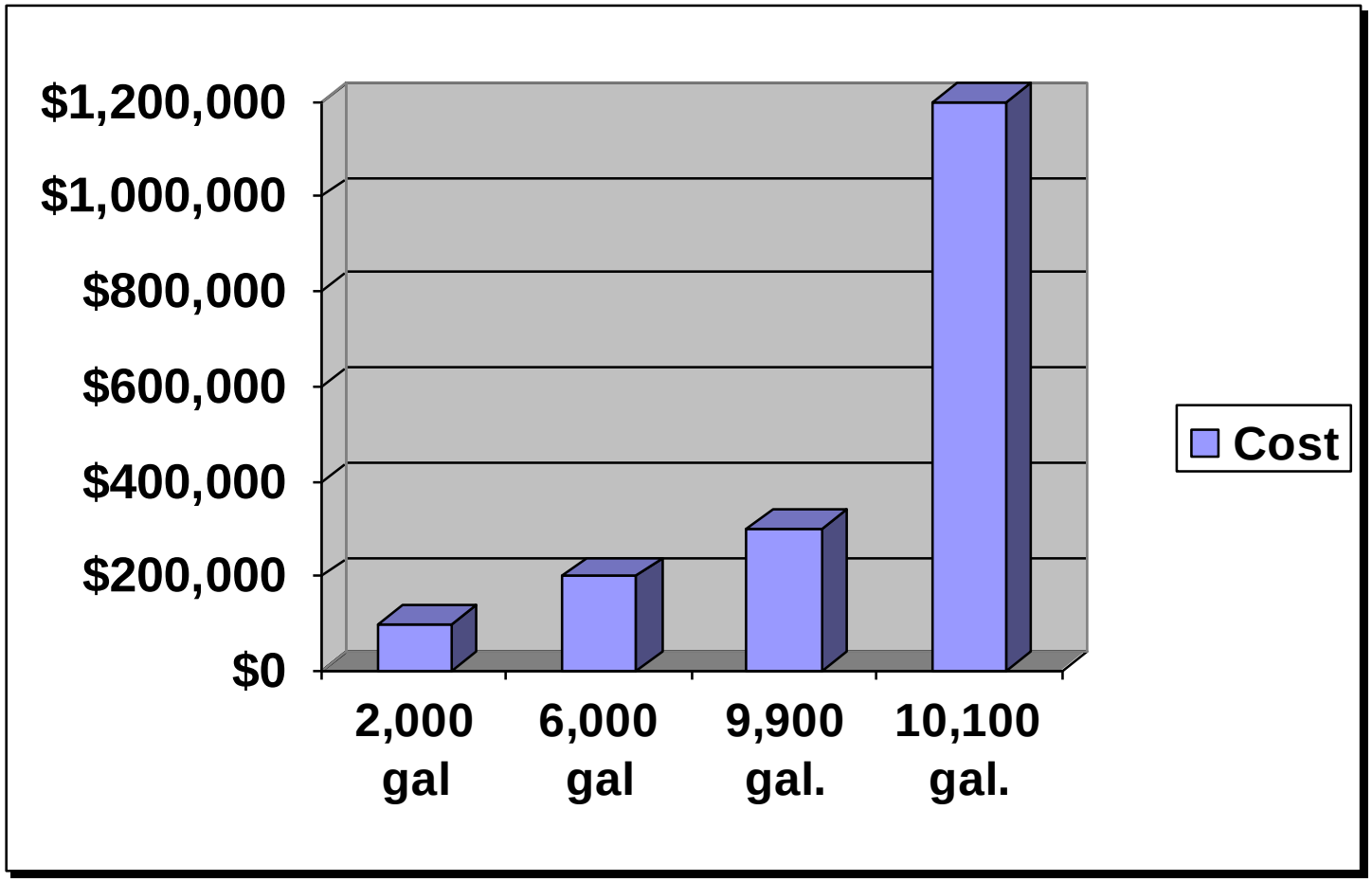
Large Share Septic Systems

Town	Project	No. of Bedrooms	Design Flow gpd	Annual Budget	Cost per Bedroom
Oxford	Pinewood on the Green	46	5060	$3,700	$81.00
Littleton	Littleton Ridge	54	5090	$4,900	$91.00
Sudbury	Coolidge at Sudbury	67	7370	$4,500	$67.00
Wayland	89 Oxbow	37	4070	$5,000	$135.00

Small Privately Owned Wastewater Treatment Facilities

Town	Project	No. of Bedrooms	Design Flow gpd	Annual Budget	Cost per Bedroom
Westford	Graniteville Woods	396	43,560	$125,000	$315.00
Littleton	Village Green	498	55,000	$125,000	$251.00
Westford	Princeton	352	39,000	$115,000	$326.00
Sterling	Choksett Crossing	90	9,900	$102,000	$1,133.00
Holliston	Crest View	118	13,000	$100,000	$847.00
Westport	Edgewater	72	11,000	$125,000	$1,500.00

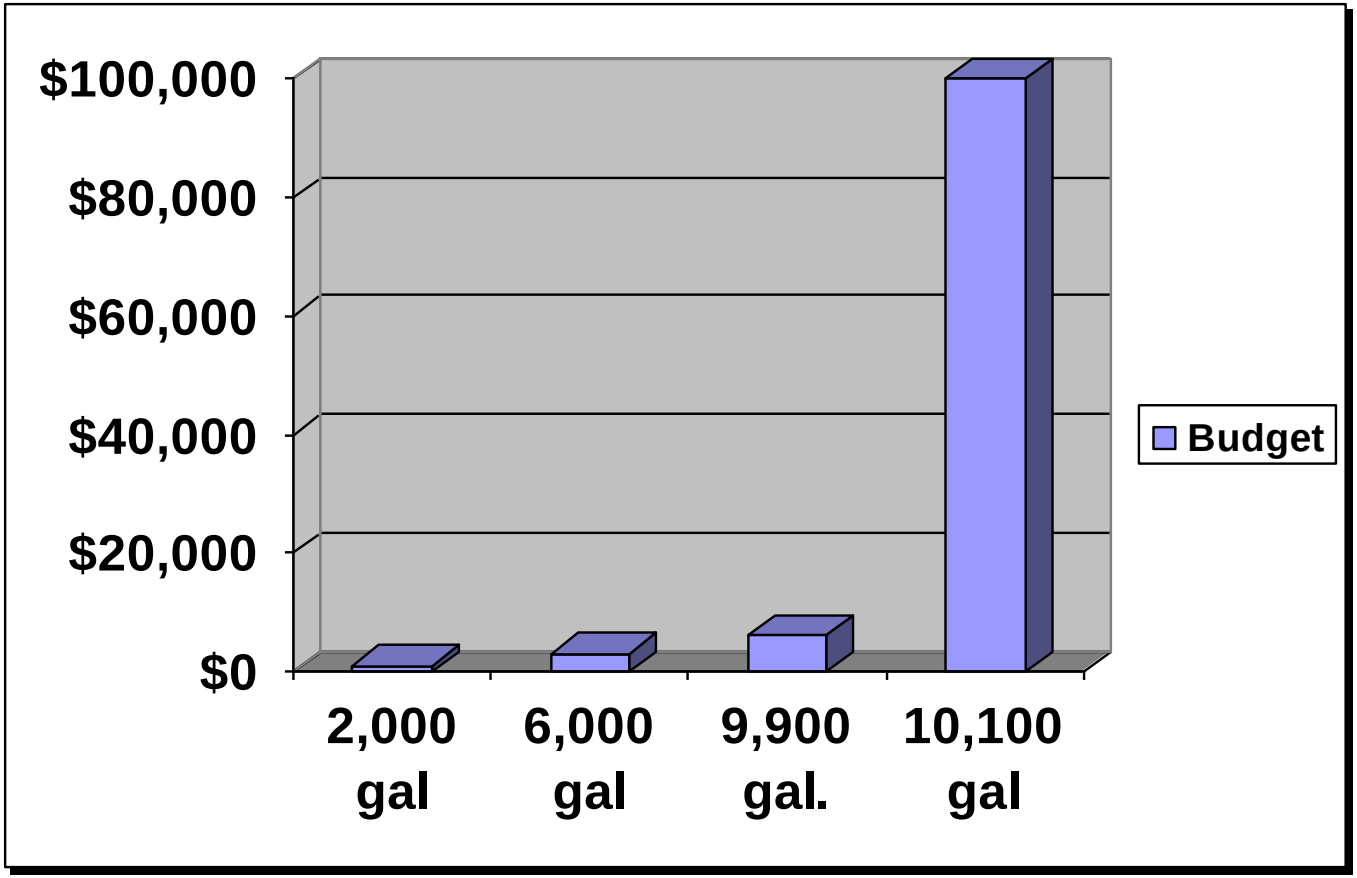
Wastewater Systems Construction Costs



HANCOCK ASSOCIATES

CRWA

Wastewater Operation and Maintenance Annual Budget



HANCOCK ASSOCIATES

CRWA

The Numbers

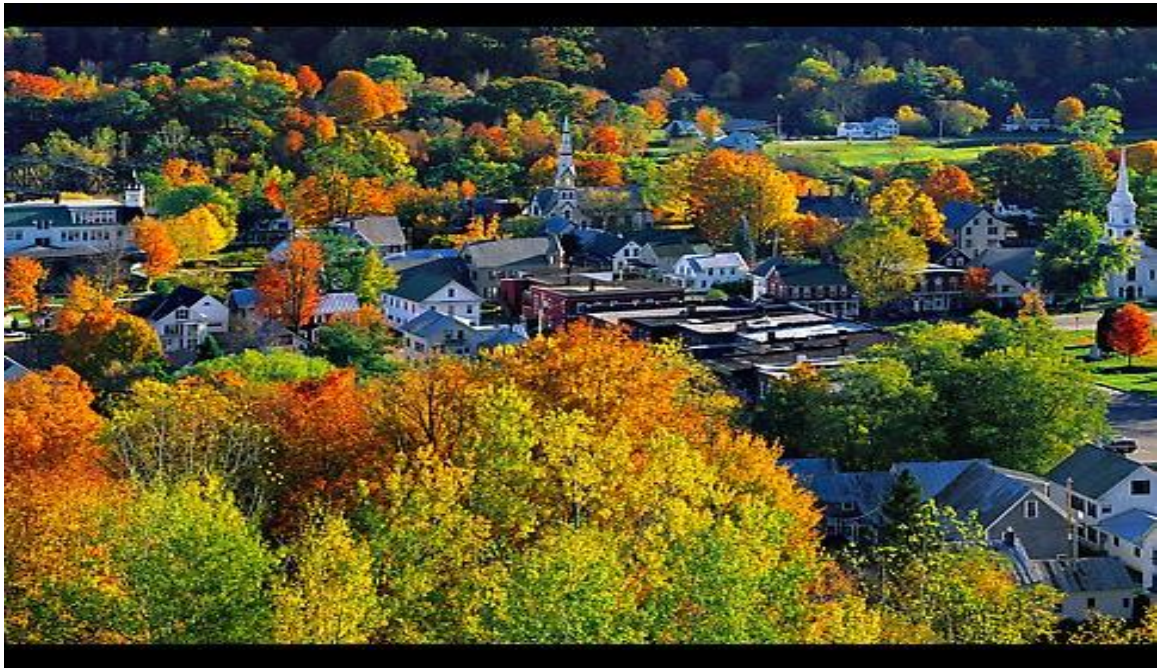
- There are approximately 63 active wastewater treatment facilities in Massachusetts serving multi-family developments.
- The average flow to the facilities is 43,000 gallons per day, representing 393 bedrooms.
- Only 8 of the 63 have fewer than 200 units or 13%.
- The largest system is 200,000 gallons per day.
- The smallest system is 7,000 gallons per day.

Possible Solutions

- Revise regulations to consider more realistic design flows for larger residential developments.
- Revise regulations to create a framework of analysis, design and oversight that provides adequate public health and environmental protections while being sensitive to the financial feasibility of projects between 10,000 and 30,000 gallons per day.
- Raise the 10,000-gallon-per-day (GPD) maximum design flow of a Title 5 system to 15,000 GPD in Section 15.004 (c). The original version of Title 5 in 1978 had the maximum at 15,000. It was changed in the 1986 revision to the regulations.

Possible Solutions

- Implement “Smart Sewering” in public-private partnerships for phasing limited town sewer systems with an integrated infrastructure where wastewater, septage and food waste are utilized to generate energy while treated effluent is recharged back into the ground locally. Smart Sewering is a paradigm shift from conventional sewering, and achieves affordable limited sewer districts with additional economic, environmental, and social benefits. Town could facilitate much needed higher density affordable housing within these districts.



It is clear there is a point of economic feasibility when looking at what the residential development community has built over the last twenty years in the Commonwealth under current regulations. Regulations should allow for a full range of project sizes while protecting the public health and the environment. A gap exists caused by a combination of regulatory and financial factors in the Commonwealth between 90 and 200 bedrooms.

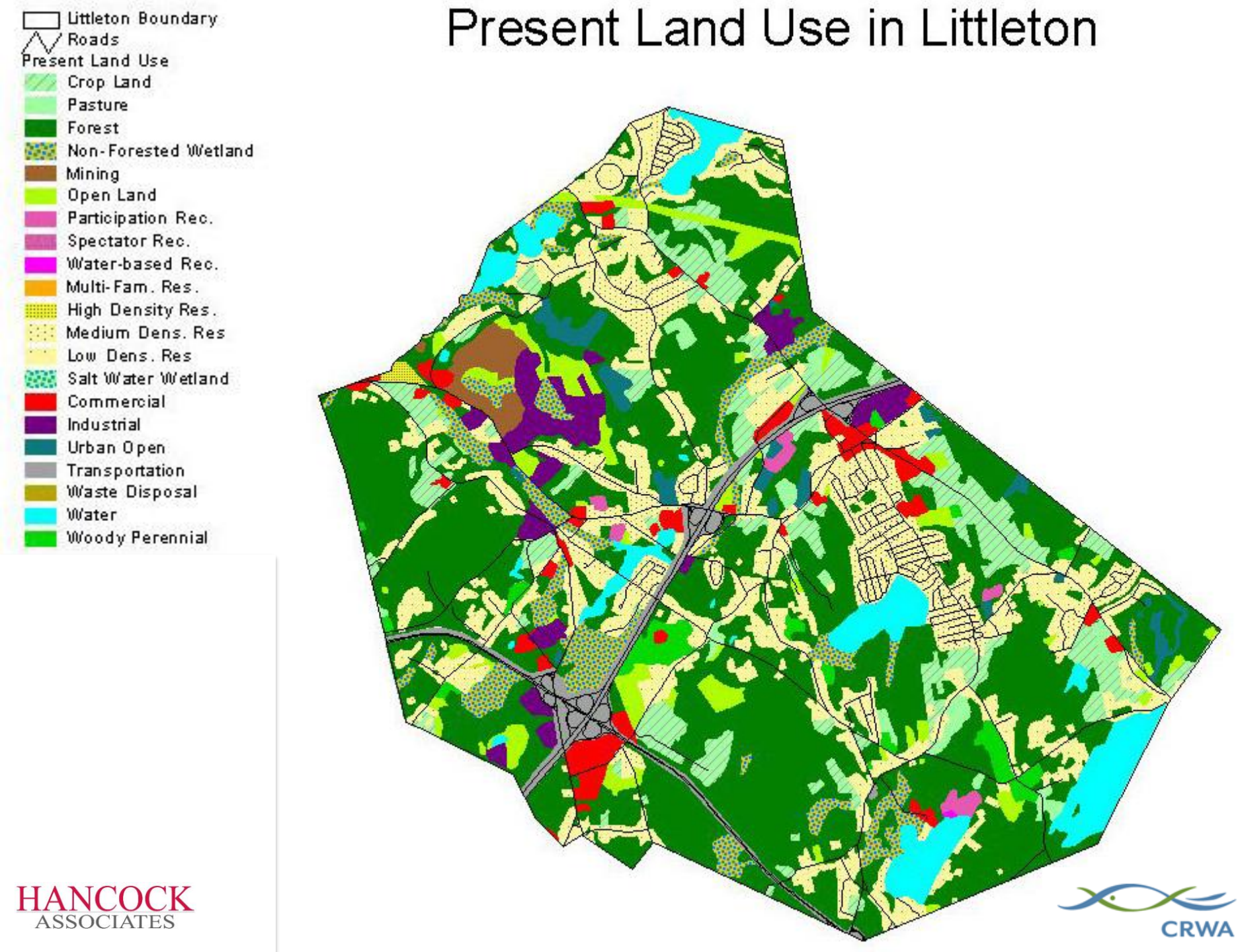
CRWA: Working to Restore Nature by Learning from Nature

- ***Resource-to-Waste-to-Resource*** - There are no wastewater treatment plants or landfills in nature; each waste product becomes another resource.
- ***Keep Water Local*** - Water is slowed down, infiltrated, and used several times.
- ***Flexibility, Adaptability, Interconnectedness*** - Nature handles catastrophic events by lending the capacity of each to all others.
- ***Promote and Support Rich Diversity*** - Nature celebrates diversity as a strength, a way for communities to be more adaptable, more resilient, and to gain strength through evolution.

HANCOCK ASSOCIATES

CRWA

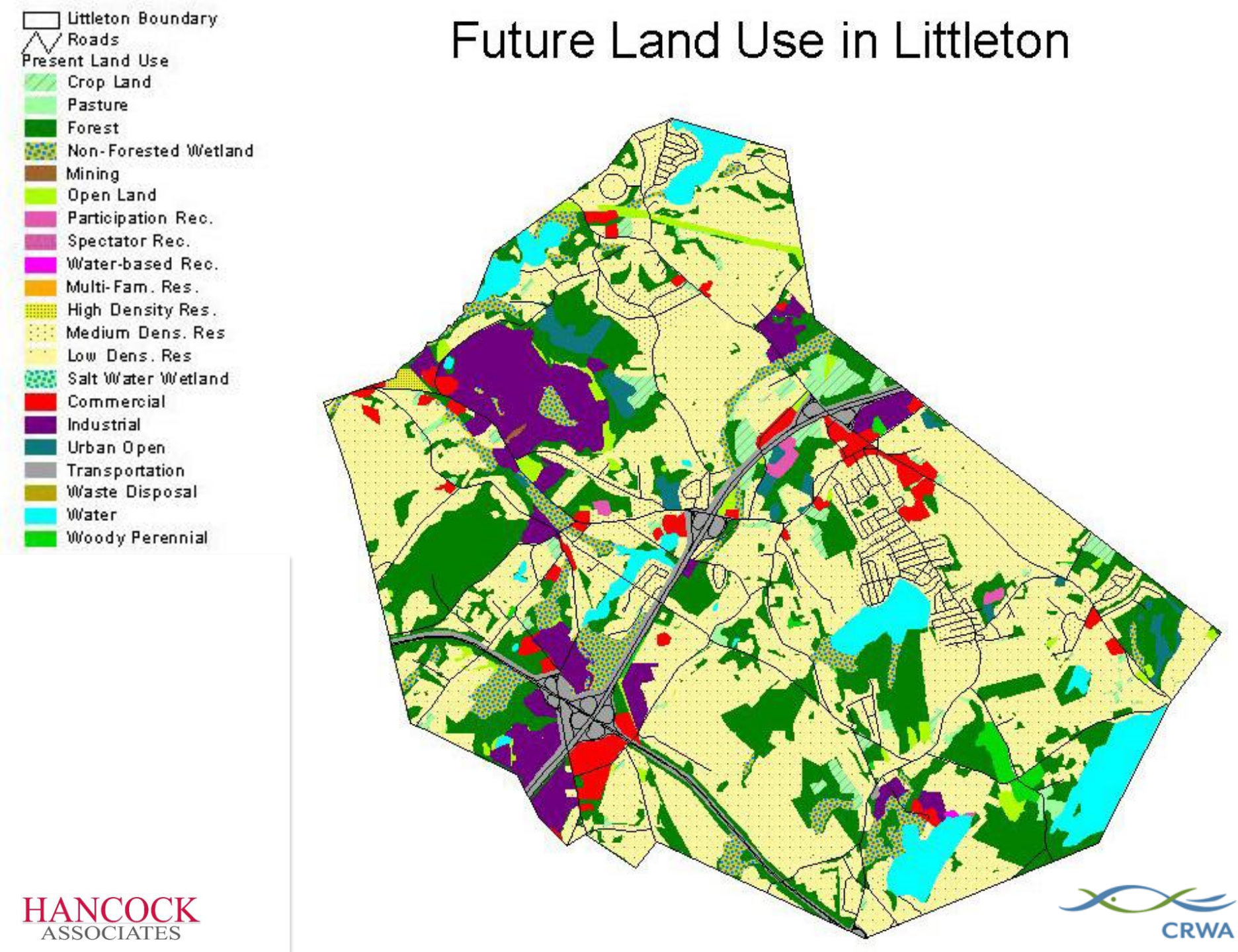
Present Land Use in Littleton



HANCOCK ASSOCIATES

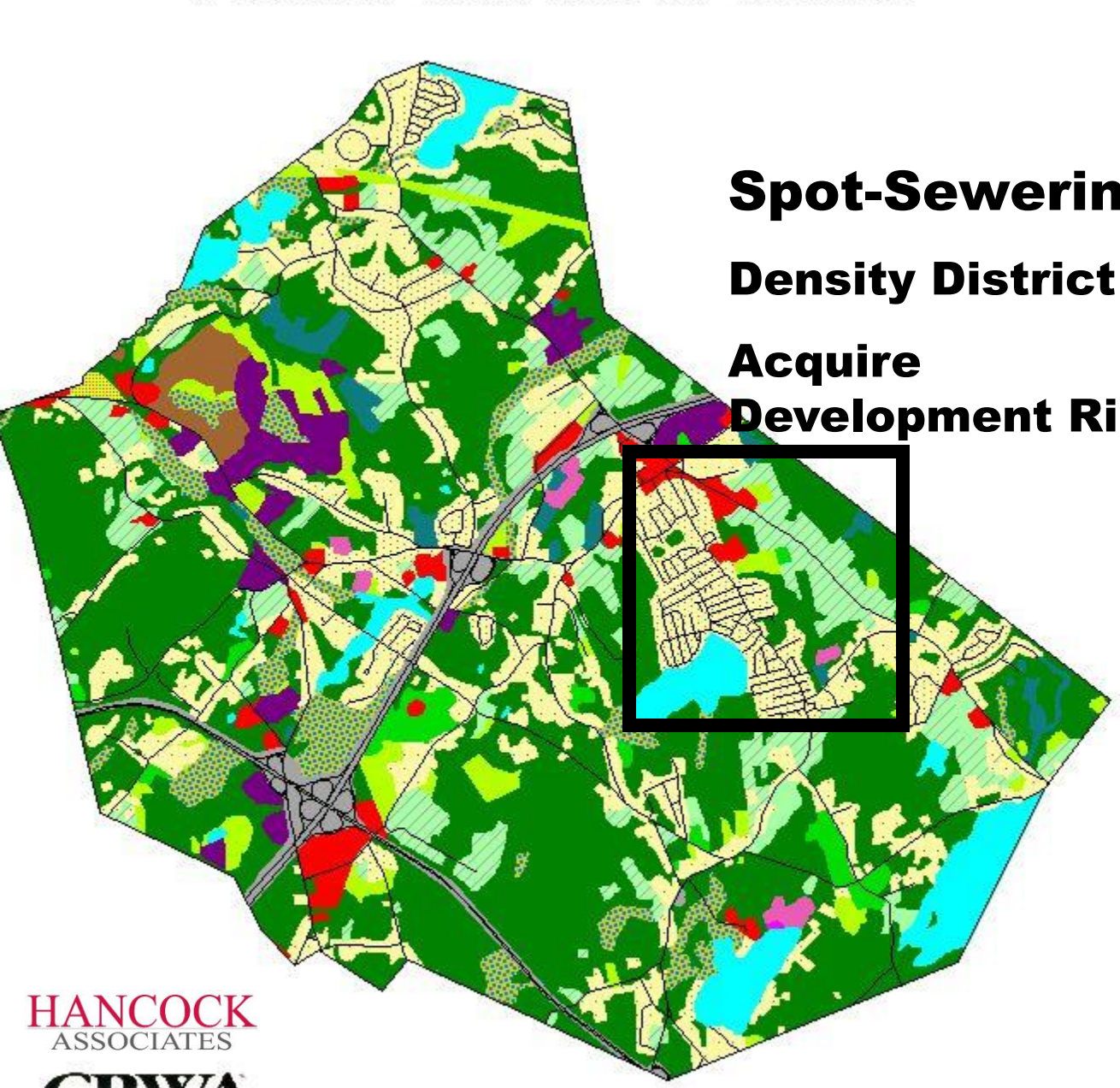
CRWA

Future Land Use in Littleton



HANCOCK ASSOCIATES

CRWA



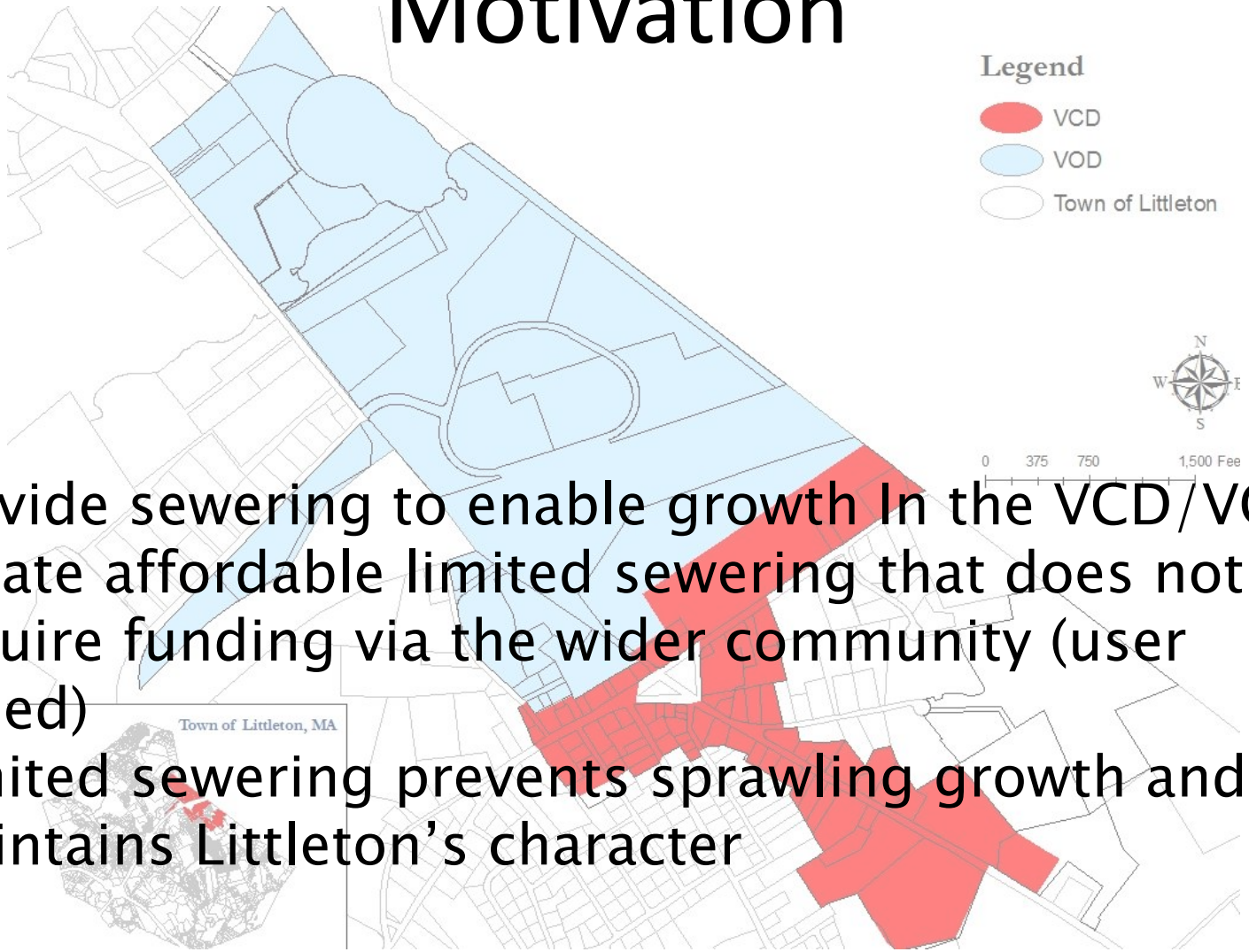
HANCOCK ASSOCIATES

CRWA

atershed Management Consortium

Note: Data was obtained from MassGIS. Additional land use data was obtained from MAPC.

Motivation

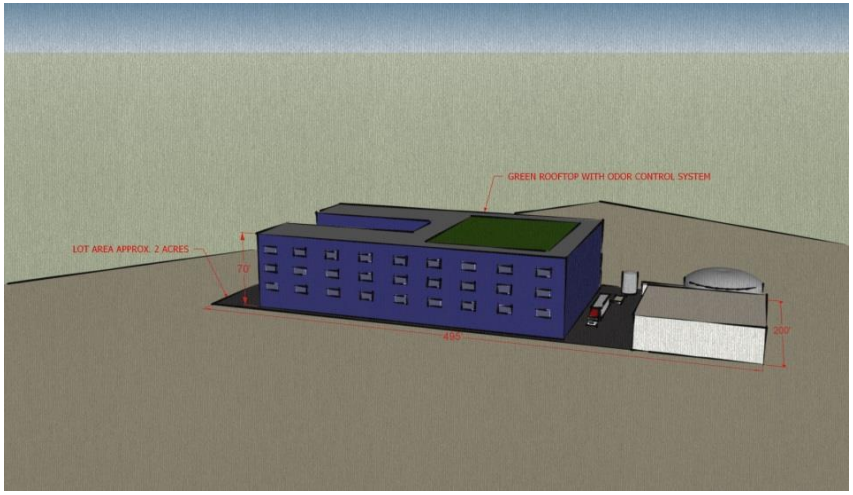


- Provide sewering to enable growth In the VCD/VOD
- Create affordable limited sewering that does not require funding via the wider community (user based)
- Limited sewering prevents sprawling growth and maintains Littleton's character

HANCOCK ASSOCIATES

CRWA

Community Water and Energy Resource Center = CWERC



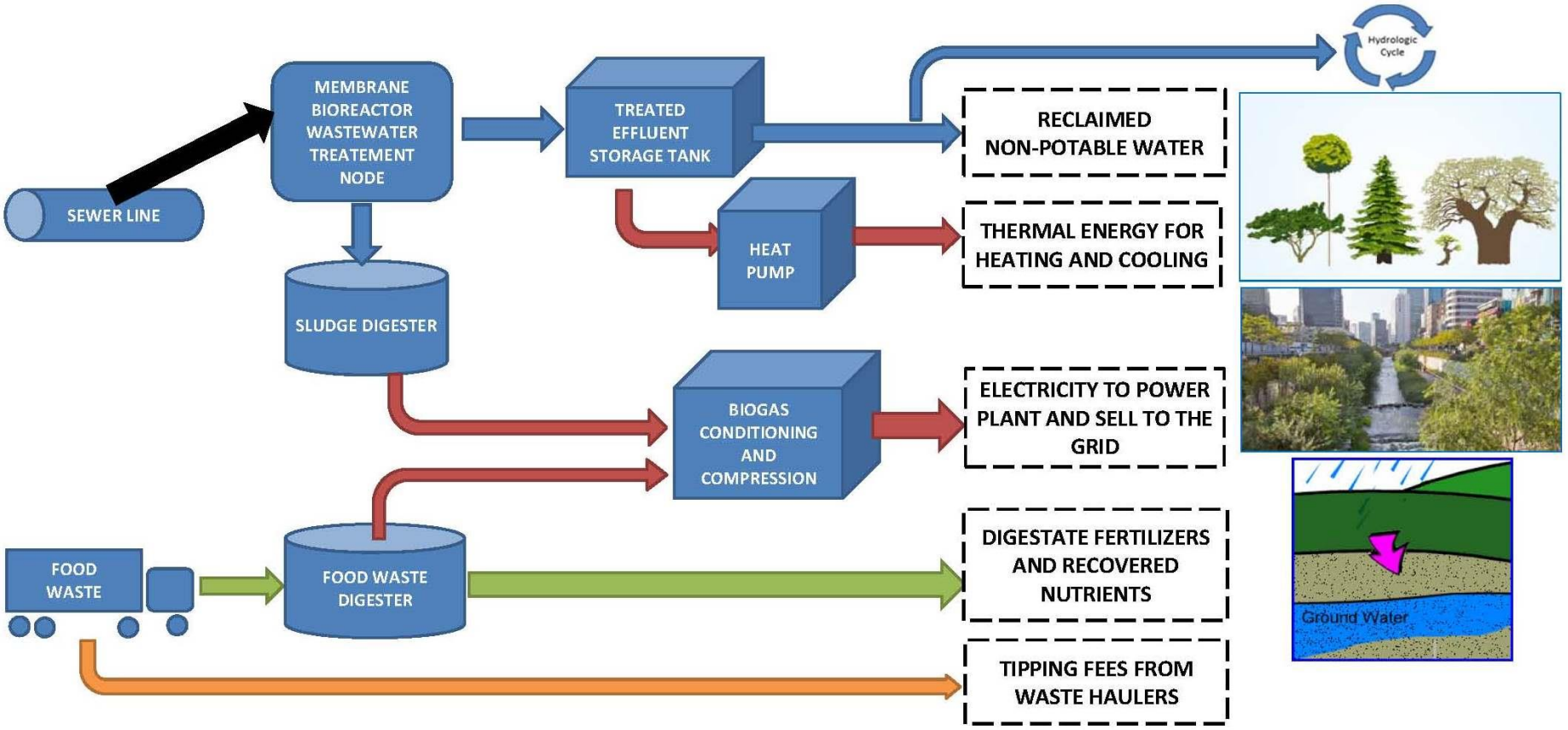
- Treat and resell a portion of the water (MBR)
- Capture and use/sell thermal energy (heat pump/exchange)
- Produce and use/sell biogas through co-digestion (CHP)
- Capture nutrients (N) for resale
- Produce compost for resale (2 tiers, separating sludge and SSO streams)

HANCOCK ASSOCIATES

CRWA

Resource-to-Waste-to-Resource

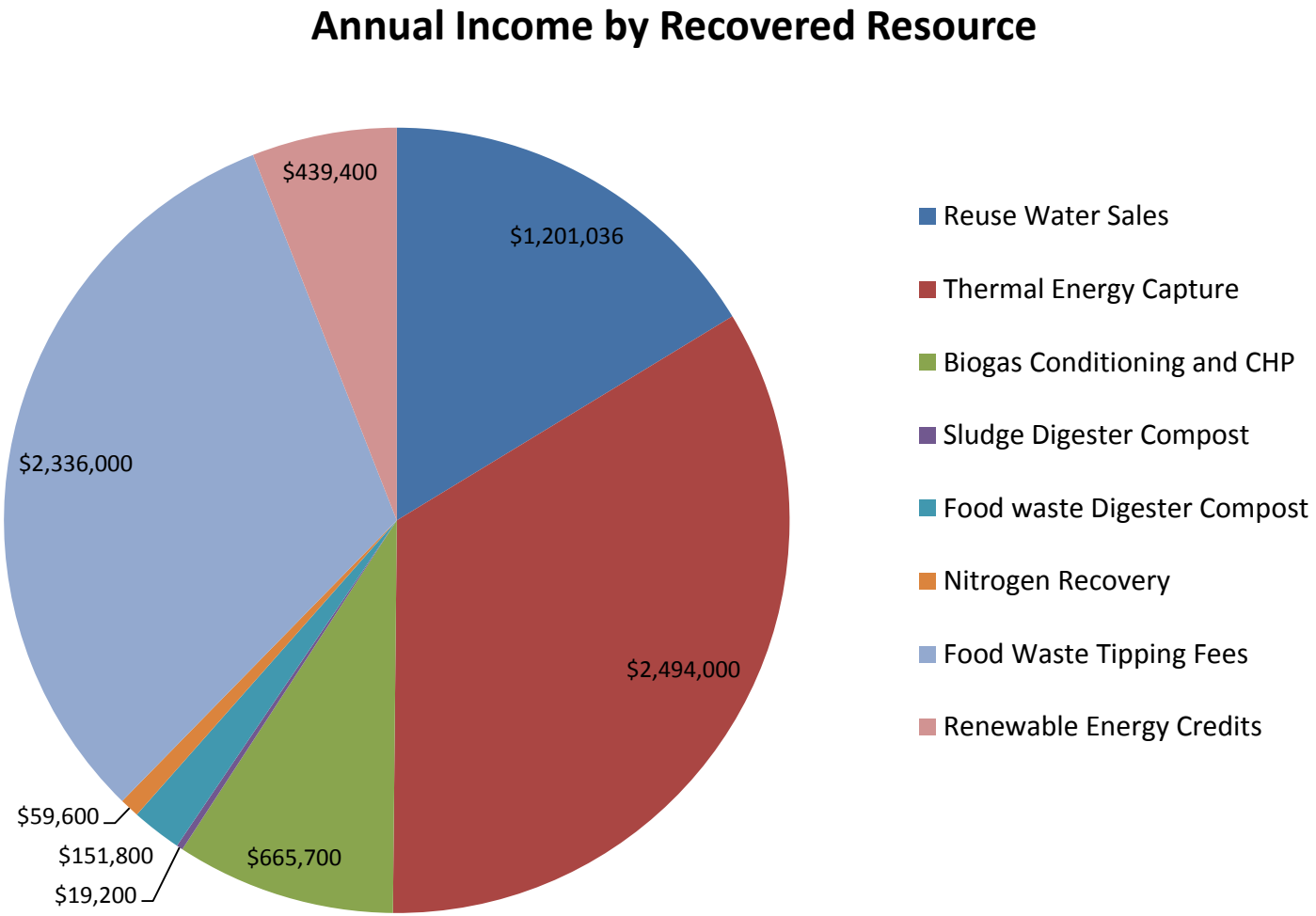
Maximizing Water and Energy Resources



HANCOCK ASSOCIATES

CRWA

Neighborhood 1 CWERC Output



HANCOCK ASSOCIATES

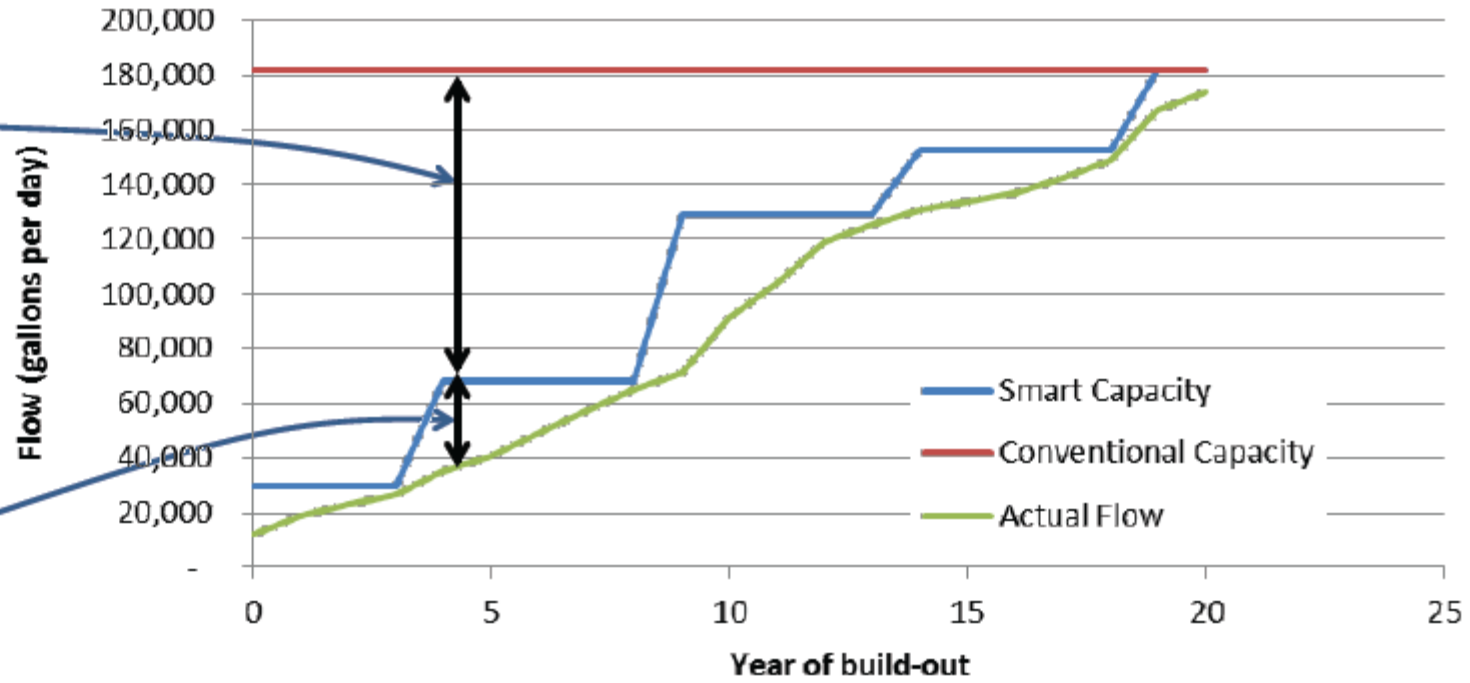
CRWA

Conventional vs. Smart Sewering 1

- Reducing carrying costs by using technologies that are affordable at small scale and then installing capacity in phases to match growth – "just-in-time, "fit-for-purpose"

Large carrying costs – higher risk or tax increase to subsidize user rate

Small carrying costs – reduced risk to tax base and user



HANCOCK ASSOCIATES

CRWA

Smart Sewers – confined development

Directs growth & density to the district

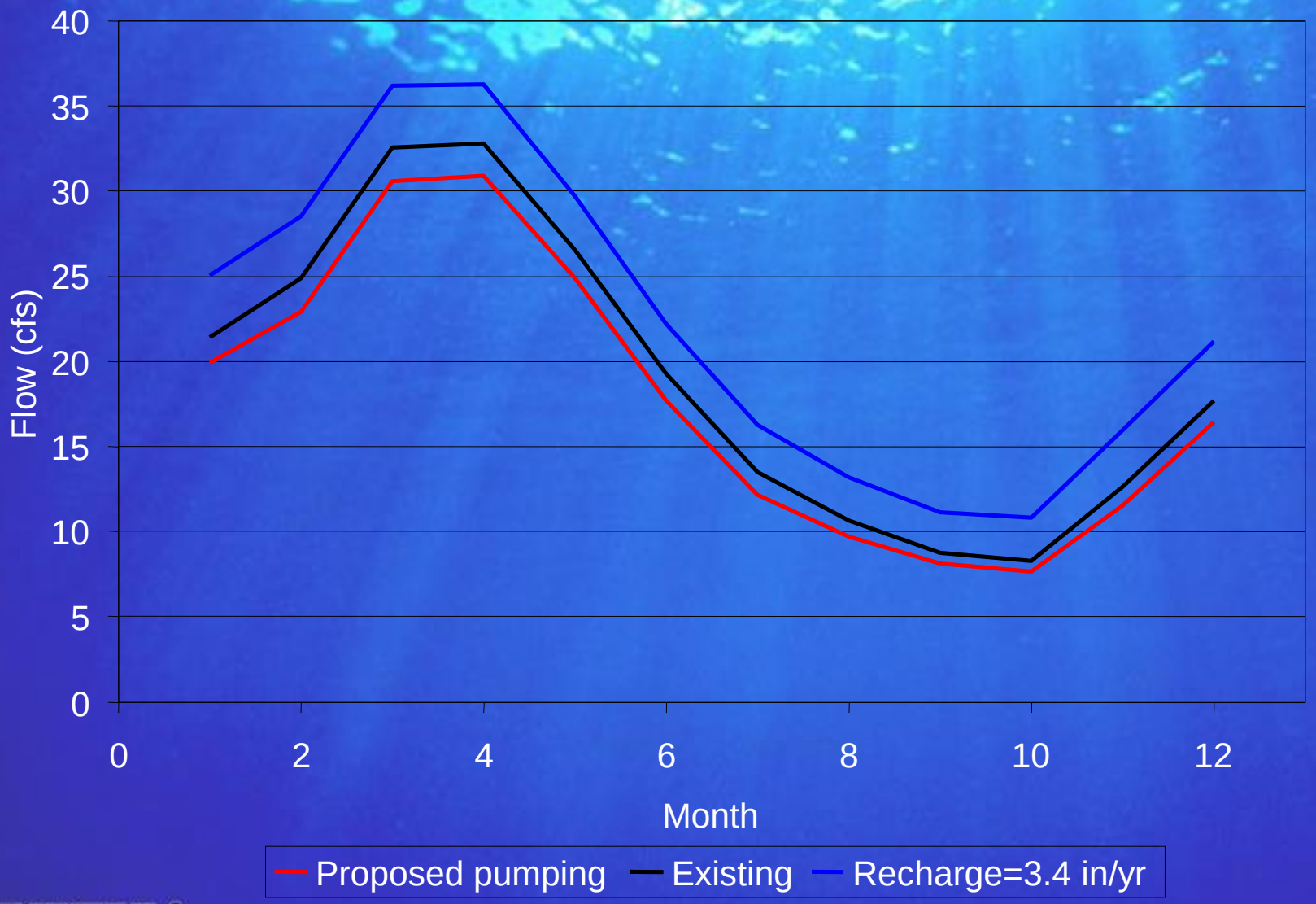
Reduce pressure for urban sprawl

Economic Advantages

HANCOCK ASSOCIATES

CRWA

PREDICTED FLOWS FROM MINE BROOK



CRWA

HANCOCK ASSOCIATES

Technical Inputs/Outputs and Business Model Scenarios for CWERC

MODELING

HANCOCK ASSOCIATES

CRWA

Modeling CWERC Inputs and Outputs

Neighborhood	1	2
WW Reclamation (MGD)	2	3
Water for Hydrologic Restoration (MGD) (% total)	0.5 (25%)	1 (33%)
Food Waste Processing (Tons/Day)	80	54
Food Waste Tipping Fee ($/Ton)	80	60
Electric Rate based on energy production vs. parasitic load	$0.12/kWh	$0.15/kWh
Wastewater Treatment Fee (% Boston Retail Treatment Fee)	0	0 – 31%
Water Reuse Fee (% Boston Potable Water Retail Fee)	30%	50 – 100 %
Approximate Facility Footprint	2 acres	2.5 acres

Other Assumptions:

- WW content based on influent at DI WWTP
- Reuse water buyer is onsite or nearby
- Thermal energy sold at $9.77/MMBTU
- Food waste producer location and availability based on MassDEP estimates (no overlap b/t neighborhood #1 and #2 suppliers)
- No discharge to sewer
- SSO 20% solids as received

HANCOCK ASSOCIATES

CRWA

Resource Recovery CWERC Modeling Neighborhood #1 Technical Results

	Unit Cost/Fee Assumed	Total Volume Produced	Total Value Produced	Volume Used Onsite
Reuse Water Sales	$2.20/1000 gallons	1.5 MGD	$1,201,000/yr	None
Thermal Energy Capture	$9.77/MMBTU	292,981 MMBTU/yr*	$2,494,000/yr** ($715,000 net)	188,466 MMBTU/yr**
Biogas Conditioning and CHP	$89/MWh ($0.089/KWh) (sale)	7,480 MWh/yr	$665,700/yr	3,870 MWh/yr *($121/MWh rate for usage)*
Sludge Digester Compost	$25/cu. yds.	770 cu. yds./yr	$19,200/yr	None
Food waste Digester Compost	$12/cu. yds.	12,650 cu. yds./yr	$151,800/yr	None
Nitrogen Recovery	$0.70/lb N	85,100 lbs-N/yr	$59,600/yr	None
Food Waste Tipping Fees	$80/wet ton ($0.04/lb)	80 ton/day accepted	$2,336,000/yr	All
Renewable Energy Credits	$65.27/MWh		$439,400	

* Includes heat capture from CHP unit

**Includes energy to run heat pump which is available as output but is a cost to the plant

HANCOCK ASSOCIATES CRWA

Resource Recovery CWERC Modeling Neighborhood #2 Technical Results

	Unit Cost/Fee Assumed	Total Volume Produced	Total Value Produced	Volume Used Onsite
Reuse Water Sales	$3.25/1000 gallons	1.99 MGD	$2,365,300/yr	None
Thermal Energy Capture	$9.77/MMBTU	421,926 MMBTU/yr	$3,591,900/yr	279,536 MMBTU/yr
Biogas Conditioning and CHP	$89/MWh ($0.089/KWh)(sale)	5,295 MWh/yr	471,300 $/yr	4,929 MWh/yr *($147/MWh rate for usage)*
Sludge Digester Compost	$25/cu. yds.	1,150 cu. yds./yr	$28,700/yr	None
Food waste Digester Compost	$12/cu. yds.	8,540 cu. yds./yr	$102,500/yr	None
Nitrogen Recovery	$0.70/lb N	57,500 lbs-N/yr	$40,200/yr	None
Food Waste Tipping Fees	$60/wet ton ($0.03/lb)	54 ton/day accepted	$1,182,600/yr	All
Renewable Energy Credits	$65.27/MWh		$311,100	
Wastewater Treatment Fee	$0-$2.87/1000 gallons	3 MGD	$0-3,144,700	

Non-market benefits

SOCIAL WELFARE EVALUATION

HANCOCK ASSOCIATES

CRWA

Major Benefit Categories Examined

- Energy benefits
- Emissions reduction and climate change benefits
- Functional open space and other GI benefits
- Distributional benefits

Summary of Annual Benefits

	BENEFIT CATEGORY	VALUE	
		LOWER	UPPER
Additive	Energy Recovery and Energy Savings	$3,727,535	$3,982,105
	Reduced Carbon Emissions	$334,635	$1,722,388
	Reduced Criteria Pollutant Emissions	$55,909	$139,392
	Carbon Sequestration from GI	$3,991	$20,679
	Air Quality Benefits from Greening	$6,755	$16,889
	Avoided Stormwater BMP Costs	$1,572,345	$3,144,689
	Avoided Underpinning Costs	$8,600,000	$22,900,000
	Stream Daylighting Benefits	$139,442	$1,426,351
	TOTAL	**$14,440,612**	**$33,352,494**
Areas of Significant Overlap	Property Value (Street Greening)	**$1,522,778**	**$3,045,556**

HANCOCK ASSOCIATES

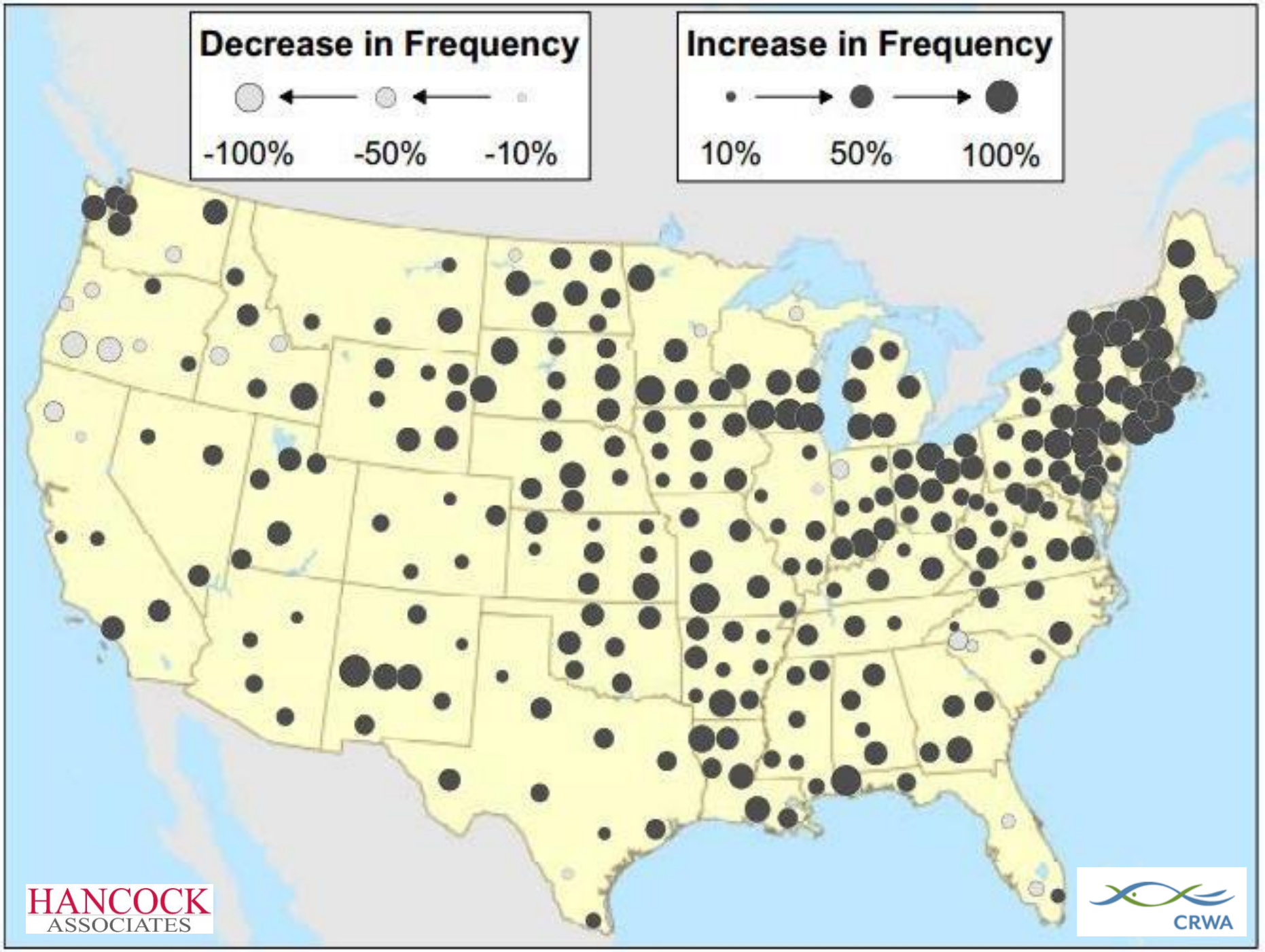
CRWA

Marrying potable, storm-, waste-, surface and groundwater management to restore the natural water cycle

INTEGRATING STORMWATER MANAGEMENT

HANCOCK ASSOCIATES

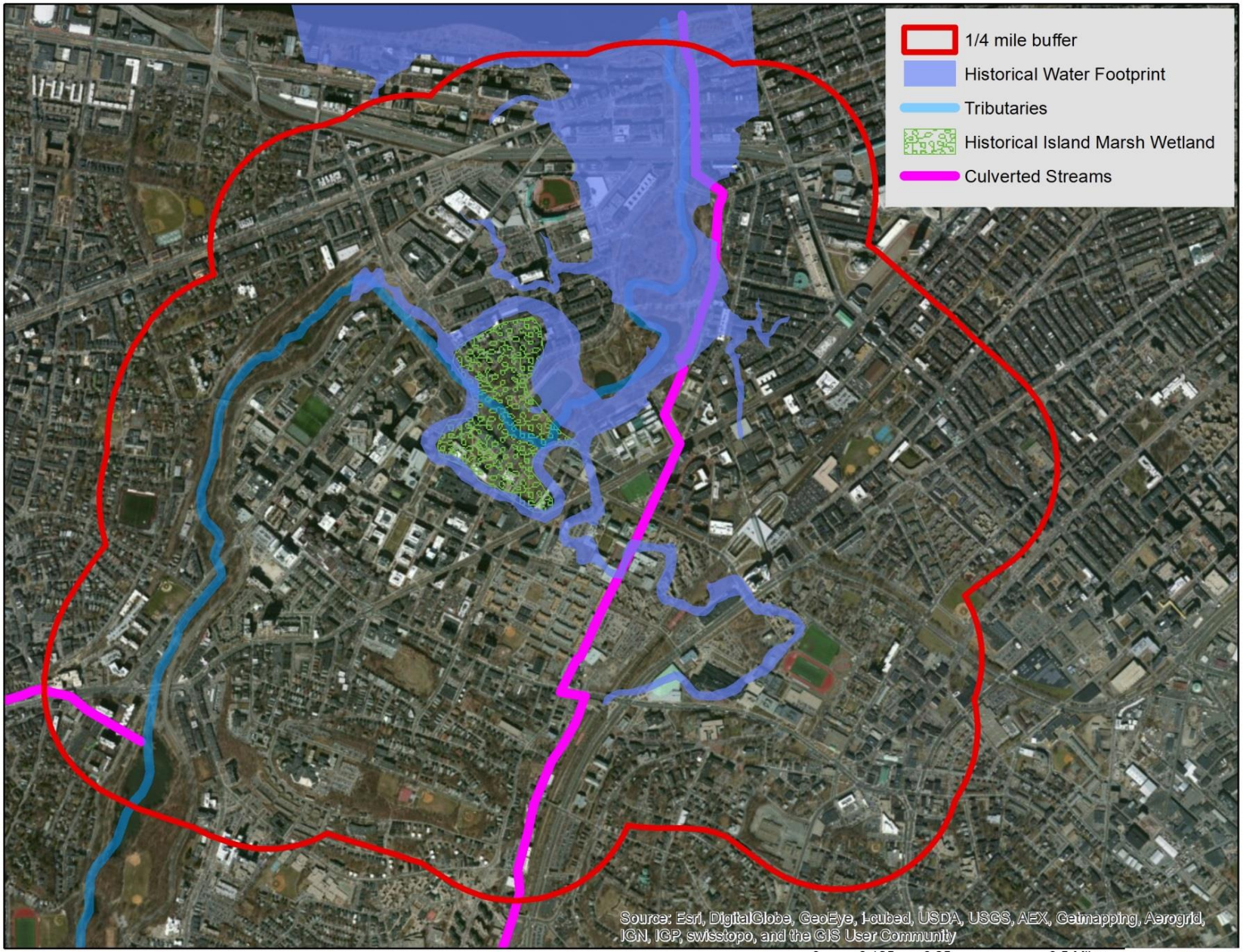
CRWA


Decrease in Frequency
-100%
-50%
-10%
Increase in Frequency
10%
50%
100%
HANCOCK
ASSOCIATES
CRWA

Neighborhood 2 Greening Plan

HANCOCK ASSOCIATES

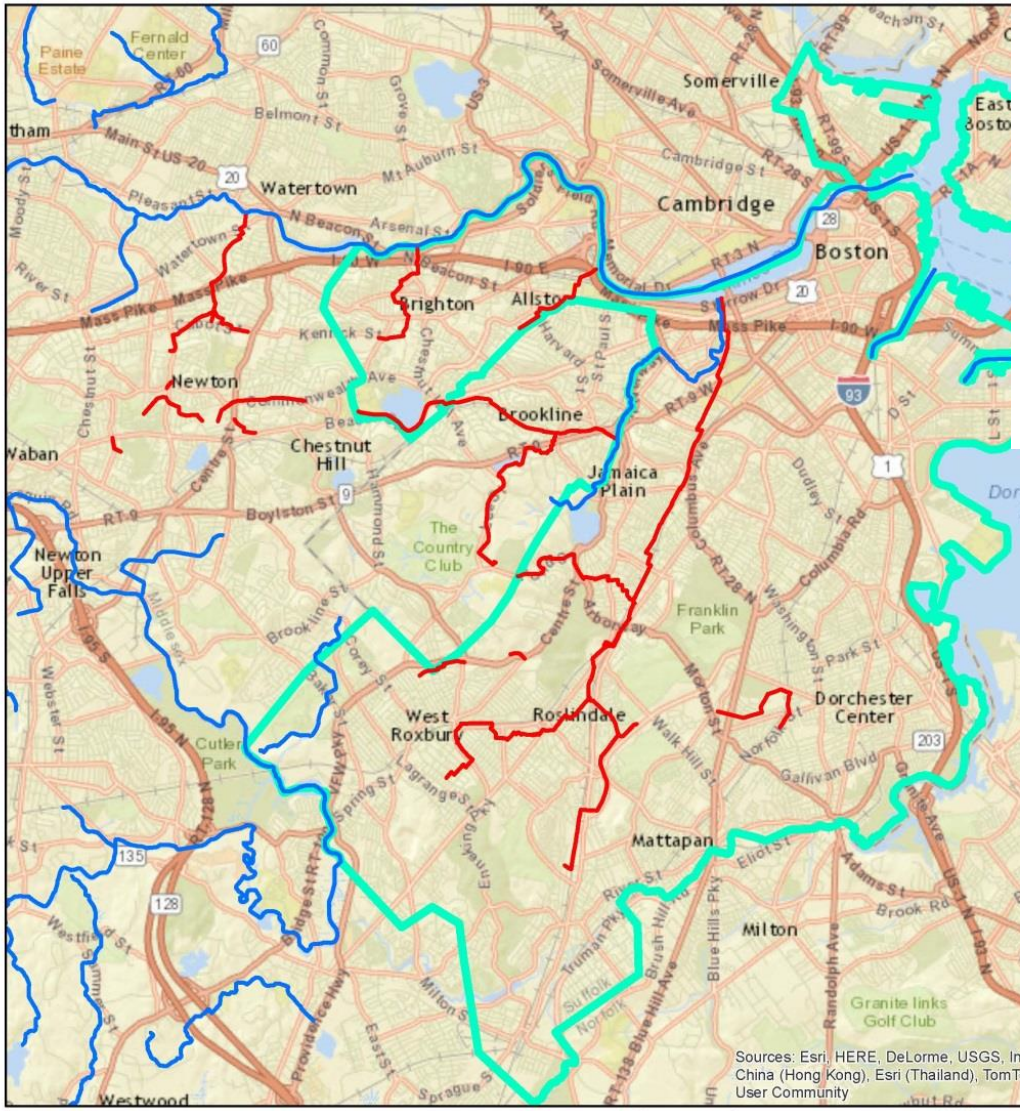
CRWA



HANCOCK ASSOCIATES

CRWA

Neighborhood A



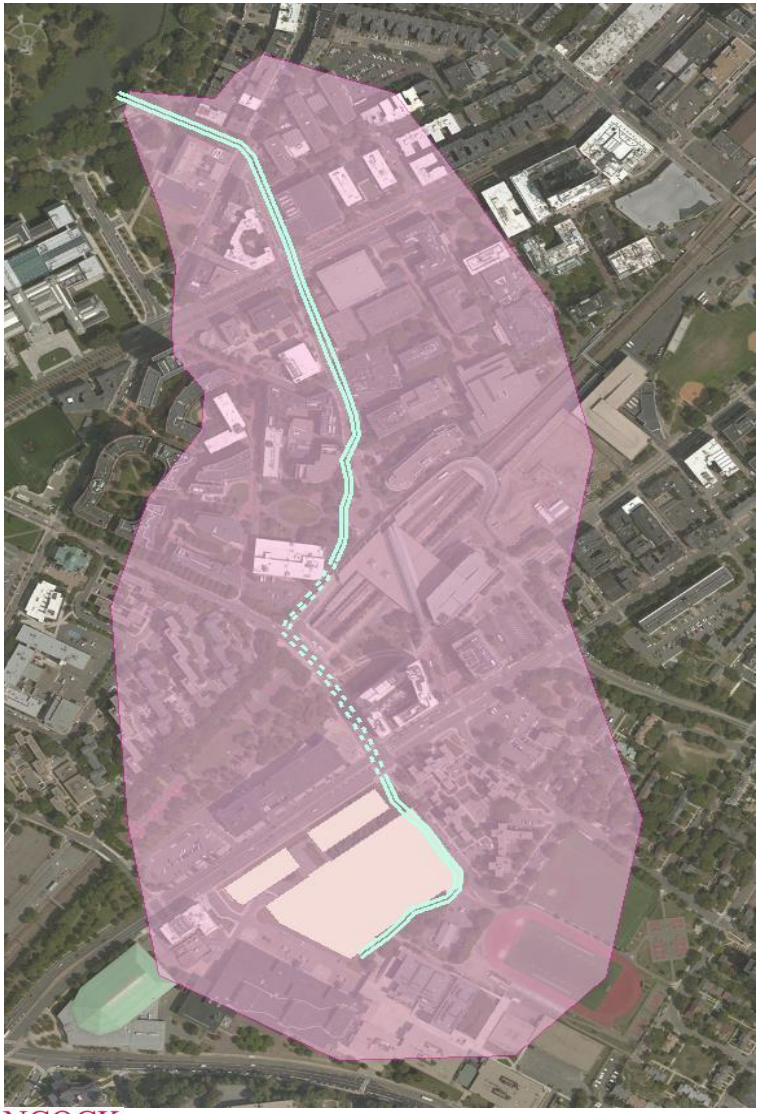
Courtesy of Boston Water and Sewer Commission

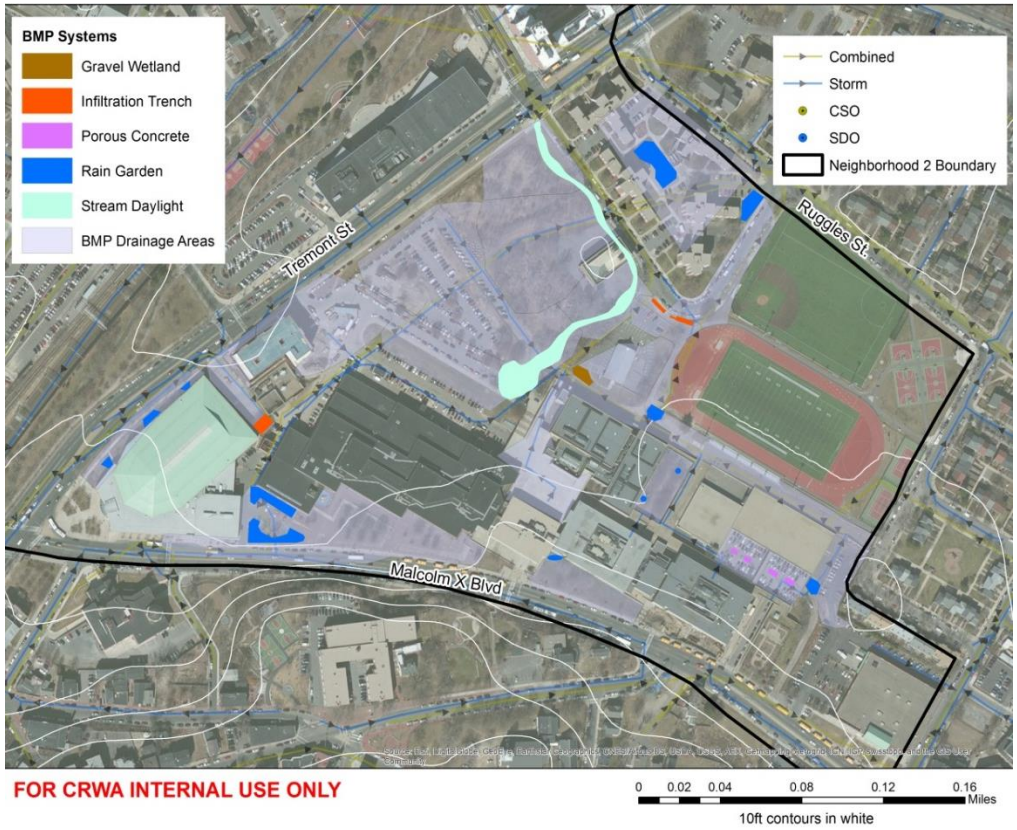
Figure 11. The culverting of Stony Brook at Forest Hills, about 1905.

HANCOCK ASSOCIATES

CRWA

Stream Restoration or Creation





HANCOCK ASSOCIATES

CRWA

NU Stream Daylighting-Visualization

HANCOCK ASSOCIATES

CRWA

NU Stream Daylighting-Visualization

HANCOCK ASSOCIATES

CRWA

More Information

- Joe Peznola: jpeznola@hancockassociates.com
- Bob Zimmerman: rzimmerman@crwa.org
- MassDEP Wastewater: Marybeth.Chubb@state.ma.us
- New England Interstate Water Pollution Control Commission

  www.neiwpcc.org

HANCOCK ASSOCIATES

CRWA

www.charlesriver.org

HANCOCK ASSOCIATES

CRWA