CENTRALIZED vs DECENTRALIZED WASTEWATER MANAGEMENT FOR CAPE COD

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TYPICAL CHARACTERISTICS

- CENTRALIZED
  - Conventional gravity sewers (deeply placed with manholes & lift stations)
  - One treatment facility (normally activated sludge variation)
  - Effluent discharge directly to surface water

- DECENTRALIZED
  - Onsite or cluster systems
  - Multiple treatment and soil dispersal or reuse facilities
  - Low-cost, shallow sewer systems for clusters
GENERAL COMPARISONS

CENTRALIZED
- Old and taught in engineering schools
- High capital cost
- Transfers water away from source basin
- Long, disruptive construction
- Highly trained operator needed
- Potential for catastrophic failure

DECENTRALIZED
- New and not taught in engineering schools
- Lower capital costs
- Keeps water close
- Short, less-disruptive construction
- Basic operation skills required
- Failure consequences felt in smaller area
VISUAL COMPARISON

Centralized wastewater treatment

Decentralized approach
WHY IS DECENTRALIZED VALUABLE?

- **Existing Communities**
  - Minimal investment and maximum flexibility to solve wastewater and other water-related problems.
  - Water stays in original watershed
  - Minimal disruption to community

- **Developers**
  - Allows more lots and greater open space.
  - Open and common areas can serve as soil dispersal and/or reuse facility locations and social amenities.
  - Increased developer profits and resident aesthetics.
WHY IS IT BEING IGNORED ON THE CAPE?

“Too expensive to build”
“Too many systems to operate”
“Too much land needed for satellite systems”
“Cannot meet TMDL’s 100% nitrogen reduction like sewers”
“Cannot put soil dispersal under roads”
“Not enough data on small-diameter sewers”
“Users and developers dislike these systems”
WHAT IS A CONVENTIONAL SOLUTION?

Collection System – Deep (8 to 25 feet) pipes, with frequent manholes, and lift stations as needed to maintain gravity flow at minimum velocity.

Treatment System – A single large treatment facility, usually some form of activated sludge, with additional processes as necessary.

Discharge - Usually, surface water discharge, extracting waters from several upstream basins to one downstream location; however, on the Cape discharge must be to soil.
CONVENTIONAL GRAVITY SEWERS

1. Residence connection
   - Gravity building sewer from residence
   - Gravity sewer
   - Access ports

2. Transmission system
   - Sewer lateral or main
   - Road
CONVENTIONAL SEWER

- Above or below Water Table (WT)
- When sewer is below WT, nitrogen contaminates ground water
CONVENTIONAL SEWER COLLECTION

- COST ~83% of $52,000/edu + hookup fee (Chatham)
- Construction will cause major town disruption for long period
- Potentially could lower water table & increase salt water intrusion
- O/M $3,100/edu/yr (Chatham)
LOW-COST COLLECTION SYSTEMS

Effluent Sewers (STEG and STEP)

Composed of:
- interceptor tanks (with pumps for STEP)
- building sewers and service lines
- small diameter collection mains

Cost <$10,000/edu
O/M $230-260/edu/yr
LOW-COST COLLECTION SYSTEMS

Vacuum Sewers

Vacuum System is composed of:
✓ holding tanks with vacuum valves
✓ collection mains
✓ a central vacuum collection station

COST $10-15,000/edu
O/M $130-160/edu/yr
LOW-COST COLLECTION SYSTEMS

Grinder Pump System

Composed of:
✓ small-diameter pressurized collection system
✓ Grinder/pump with controls

COST $9,500
O/M $280/edu/yr
LOW-COST COLLECTION SYSTEMS

- Over a thousand alternative collection systems (ACS) exist, and always have significantly lower capital costs than conventional (~50%).

- ACS reduces infiltration and inflow (I/I) owing to shallow placement in the soil profile (2.5 ft vs up to 25 ft), fewer and tighter joints, and absence of manholes and few if any lift stations.

- Require less community disruption (not under roads), shorter construction duration (shallow), and much lower O/M personnel demand than a conventional system with multiple lift stations.
CONVENTIONAL TREATMENT = ACTIVATED SLUDGE PROCESS
CENTRALIZED TREATMENT MAY NOT BE THE BEST CHOICE

- Activated sludge was developed to reduce size of treatment facilities in large cities (NY, BOSTON) by intensifying biological action with skilled operators and added energy and air.

- Activated sludge is the highest energy user, most sensitive to upset, and the most operator-intensive treatment system used today.

- More modern activated sludge systems incorporate membranes in place of large clarifiers, but are best suited to larger flows.
WHAT KINDS OF TECHNOLOGY ARE TYPICALLY EMPLOYED IN CLUSTER TREATMENT SYSTEMS?

More passive treatment systems that can better withstand influent variability than activated sludge, require lower energy & are more simply operated.

More reliable systems that require a minimum of O/M because of fewer electro-mechanical components and process judgement requirements, e.g., once per week visits instead of daily ones.

Systems that can meet effluent requirements as well as conventional approaches, but require only a few O/M visits per week versus 24/7 operation.
Aerobic, fixed-film treatment system that treats septic tank effluent by filtering it through relatively fine sand or other media.

Typically removes 25 to 50% of total nitrogen.
RECIRCULATING MEDIA FILTER

FROM SEPTIC TANK EFFLUENT COLLECTION SYSTEM

RECIRCULATION TANK

RECIRCULATION PUMP DISCHARGE

SPLITTER BOX

TO BULRUSH/CATTAIL EMERGENT WETLAND

FILTER SAND

FILTER EFFLUENT

SAND FILTER

UNDERDRAIN

GRATED GRAVEL

RECIRCULATION SYSTEM
CONSTRUCTED WETLANDS

Subsurface constructed wetlands are most commonly used for small clusters with lots of land. Wastewater flows horizontally below the media surface. Nitrogen removal is minimal (<20%) and no DO is the norm.

Clay Township Regional Water District, Indiana
DENITRIFICATION IS USED FOR ALL TREATMENT SYSTEMS

Flow sheet for Separate Denitrification of Nitrified Wastewater Using Methanol

- Methanol
- Nitrified Waste
- DN
- A
- S
- Sludge Return
COMPARISON OF CENTRALIZED vs DECENTRALIZED DENITRIFICATION

- Essentially they are the same
- Smaller systems can supply their own labile carbon or use a different pathway so they will not need an external source of carbon
- This built-in carbon reduces O/M requirements, improves safety & causes less neighborhood disturbance
- Both the centralized and proposed decentralized treatment approaches should meet 3-5 mg/L of total nitrogen in their effluents
CHATHAM’S DENITRIFIED EFFLUENT TREATMENT & DISPERSAL

- The Chatham plan jams effluent into soil at >4 times the highest acceptable loading for attaining significant treatment in the soil.
- The Chatham facility effluent will likely remain high in nitrogen all the way to the sulphur springs sub-embayment and will increase the nitrogen loading to 66 kg/day or 9 times the present loading from that area.
- Based on the Cape USGS data, viruses that will remain in the undisinfected Chatham effluent will travel 1.7 miles downgradient from the treatment plant to the receiving bay.
DECENTRALIZED EFFLUENT TREATMENT & DISPERSAL

- With some variation depending on the location and number of decentralized facilities, effluent will be spread over most of the original basins, reducing water quantity impacts on the ponds and embayments.

- The soil dispersal application rates assure that soil treatment will occur, in the case of nitrogen, an additional 40%+ could be removed by drip dispersal application to the soil.
Decentralized systems are largely underground and allow public use of surface for recreation.

Parts of the decentralized treatment systems that must be accessed can, like centralized lift stations, be aesthetically improved with vegetation and architectural treatment.

The Chatham dismissal for inadequate land was belied by (1) the search for land to discharge the plant influent, which turned up dozens of sites in 13 sub-embayment basins, and (2) unrealistically high land requirements.
WHERE ARE THESE APPROACHES BEING USED?

- There are hundreds of such distributed management and decentralized technology solutions employing decentralized technologies across the US, many of which are being studied.
- The following list includes numerous sites where successful decentralized systems are in operation. The causes for their adoption vary and their final designs are quite different.
- The listed locations provided are only examples, and many more exist than these.
DECENTRALIZED SYSTEMS WITH SIMILAR PROBLEMS

- Block Island, Rhode Island
- La Pine, Oregon
- Willard, New Mexico
- 2 dozen New Jersey developments served by American Water
- Otter Tail Lake, Minnesota
- Georgetown Divide PUD, California
- Stinson Beach, California
- Mobile County, Alabama
- Loudoun County, VA
- Bethel Heights, Arkansas
- Pima County, Arizona
- Santa Fe, New Mexico
- Cave Springs, Arkansas
- Lubeck, Germany
- Wickford Village, RI
- Beecroft, NSW, Australia
All these locations have centralized management programs that have...

- Public education and involvement through planning, implementation and operation phases
- Dynamic inventory and billing databases that are updated whenever any service is provided
- Requirements to use only trained and certified/licensed service providers
- All necessary powers to set/enforce rules and collect necessary fees to remain sustainable
MOST SUCCESSFUL CASE STUDIES ARE CHARACTERIZED BY...

- Adoption of decentralized approaches after rejecting cost estimates of conventional systems.
- Adoption of only the strongest community involvement processes during the selection, design, construction, and operational phases of the project, as well as in rule development.
- The most effective programs...
  - Require signed easements for access by RME.
  - Include regular inspections of all key components.
  - Include the power to enforce needed repairs through liens, tax bill add-ons, or water/wastewater shutoff.
THANKS FOR YOUR ATTENTION

Any Questions?