# A Flight Plan for Success: Practical Aspects of Pilot Testing in Planning, Design and Optimization

PA AWWA Annual Conference

April 27, 2017

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# Understanding the Benefits of Experiments

## Quotes

All you engineers want to do are studies, I want solutions and a facility to solve my problem.

There is nothing more expensive than cheap engineering.

***Questions:*** Are these two statements compatible?

- How do we know a solution will work?
- What are the operating costs?
- Can adverse water quality or residuals issues be predicted?
- Simultaneous Compliance?
- What is the cost if the solution does not work?

# Our Purpose

Have the facilities been done before?

**All the business of war, and indeed all the business of life, is to endeavor to find out what you don't know by what you do; that's what I called 'guessing what was at the other side of the hill.**

(Duke of Wellington)

## Presentation Outline

- Defining what we mean by the term Pilot Plant Testing
- Reasons for performing a pilot test
- Types of testing
- Protocol
- Case Studies

# Definition

Pilot Testing

# Definition

## Pilot Testing

Pilot testing is a catch all term that refers to an experiment that is conducted to obtain additional data to make a decision.

- Experiments were used to develop traditional equations
- New problems can benefit from conducting experiments
- Provide initial guidance on potential improvements
- Small scale version of a potential improvement
- Full scale version of a potential improvement
- Sometimes it can be valuable to use a more explicit term

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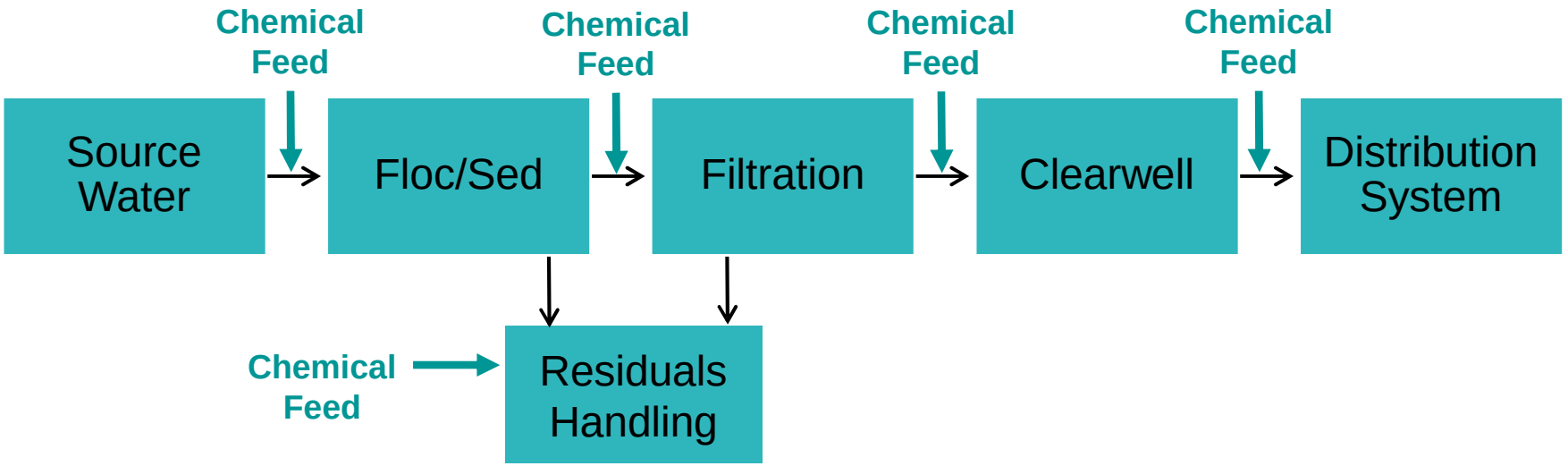
# Reasoning and Importance

Pilot Testing

# Problem Solving

What types of problems do you need to solve?

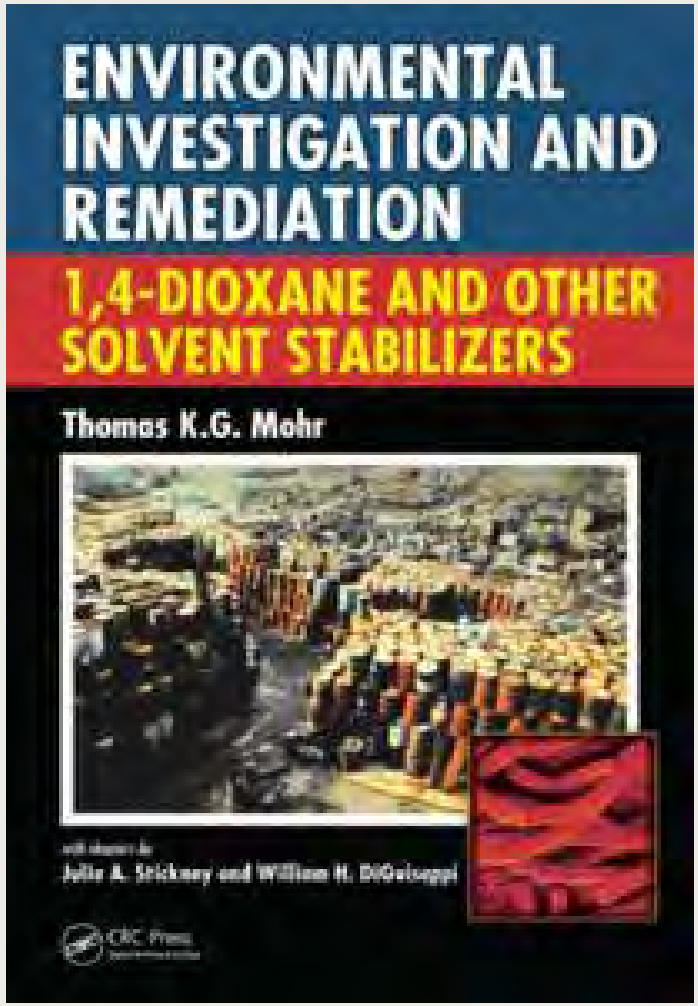
- Experiments are not limited to treatment plants
- Problems in the distribution system include:
  - > Pipe condition (liners, flushing, types of pigging)
  - > Tank stratification
  - > Water age
  - > Nitrification
- Source Water Quality (algae, HAB, grit)



# Problem Solving

What kind of problems do we need to solve?

- Treatment
  - High rate processes
  - Better removal of existing contaminants such as:
    - TOC
    - DBP
    - Fe/Mn
    - Pb/Cu
  - New contaminants
    - 1,4-Dioxane
    - PFCs



# Testing

Bench, Pilot, and Demonstration Protocol

# Bench Testing

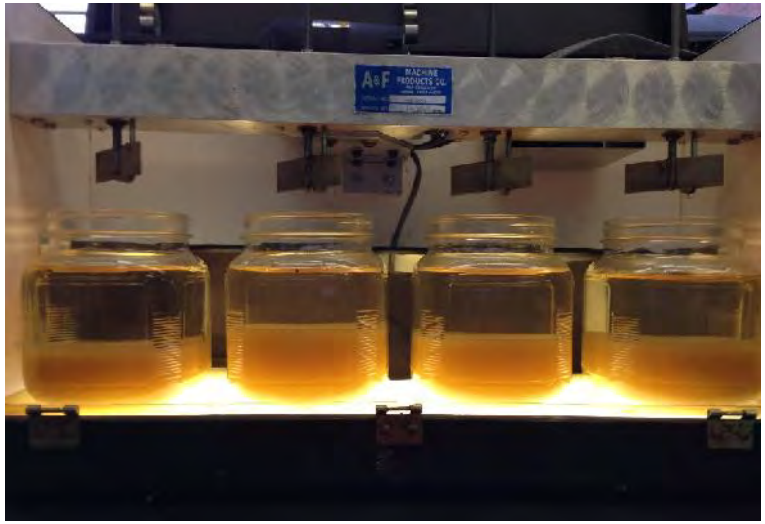
Static Experiment

Often used as a screening tool to assess feasibility of technology (Pass/Fail)

- Feasibility of DAF, feasibility of centrifuge

Jar Testing is a more reliable test used to:

- Evaluate whether to raise or lower a coagulant dose, change pH
- Evaluate alternate coagulants
- Alternative oxidants (ozone, permanganate, chlorine dioxide)



# Bench Testing

## What type of testing needs to be done?

Examples of Types of Testing

- Waste filter backwash settling column testing
- Thickening columns to obtain loading rates
- UV and peroxide for destruction of organics
- Rapid small scale column test for organics removal

Helpful Hints

- Take pictures of your bench test experiment
- Vendors can often perform the bench tests
- Be careful in shipping the fluid
- Establish objectives

# Pilot Testing

# Pilot Testing

## How Does it Work?

- **Continuous flow** using smaller scale equipment that is operated for several weeks to several months
- Duration of the test depends on the variability of the source water and the treatment technology
- Surface waters change seasonally and can experience elevated water quality parameters during rain and snow events
- Some treatment technologies can be pilot tested for 1-2 weeks as their performance can be assessed in this time period: greensand on a groundwater, belt filter press
- Need to address scale up issues during final design

# Pilot Testing

How long does it last?

- GAC will not be exhausted for several months, therefore the pilot will need to be operated for several months
- Micro and ultrafiltration membranes generally operated for a minimum of 2-3 months as a goal is to have 30 days between recovery cleans and one month is generally needed to establish initial flux and backwash operating parameters
- Regulators will have unique requirements
- Consider integrated equipment
  - Clarification and filtration
  - Chlorine dioxide and corrosion loops

# Pilot Testing

## Questions to Consider

- Are residuals representative of full scale?
- Are the results applicable to vendors that were not pilot tested?
- Can the long term equipment degradation be simulated?

# Demonstration Testing

## Benefits

- Entire flow is treated and data is gathered to determine the effectiveness of the technology and whether a permanent installation is to be provided
- Benefit is that there are no scale up issues
- For some technologies such as chemical feed and residuals demonstration testing can be cost effective
  - Liquid lime
  - Chlorine dioxide
  - Sodium permanganate
  - Centrifuge

# Demonstration Testing

## Benefits

- Potentially cost effective for plants with a capacity of up to 1 MGD
  - GAC (two 10 ft dia. vessels provide 15 min. EBCT at 1 MGD)
  - Plates and DAF (generally limited to 200 gpm in a trailer )
  - Dewatering pilots are high capacity
- Test will receive significantly more scrutiny by the regulators

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# Planning

Equipment, Timing, Budget, Staffing

# Planning for the Study

## Protocol

- Very, very, very important
- Similar to a Project Plan of Work (plan the work and work the plan)
- Clearly and carefully define the objectives: consensus from the owner, supplier and regulator
- Executive, engineering, operator objectives
- How much data do you need (balance the ability to fund the data collection and analyses)
- Equipment
- Schedule
- Cost
- Staffing and QA

# Equipment

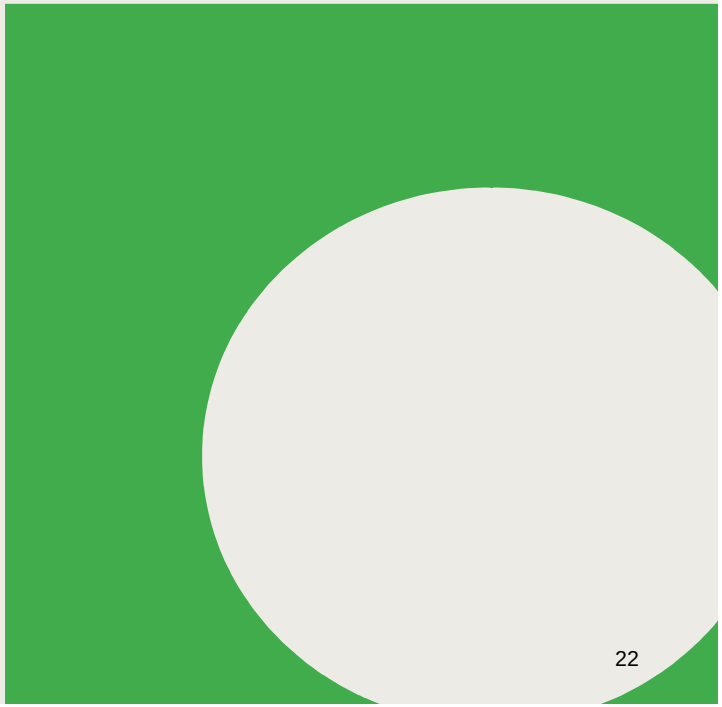
## Thoughts to consider

- Flowrate
- Size: L x W x H
- Location: inside or outside
- Access for delivery
- Is the site level?
- Piping Connections
- Residuals discharge
- Electrical
- SCADA

# Timing

What needs to be scheduled?

- Equipment procurement
  - There are not many pre-fabricated pilots and their availability is limited
  - Do you need to build it?
- Protocol development
- Regulatory approval
- Duration of commissioning
- Duration of operation
- Stress test and duration
- Lag in contract laboratory results



# Budget

How do you determine the cost?

- Are multiple quotes needed?
- Rental cost is related to capacity
- Duration
- Is full time staffing by the vendor required?
  - > For DAF often yes, for membranes and plates: no
- Analytical: off site contract lab fees – more data may provide better information but is the cost acceptable?
- Extent of electrical modifications:
- Mott MacDonald coordination

# Staffing and QA


- Equipment with continuous chemical feed generally requires full time staff (DAF, dewatering)
- Membranes are automated and need staff for commissioning, daily inspection and sample collection
- Instruments need to have calibration procedures defined
- Standard operating procedures should be prepared
- Analytical test method should be defined
- Weekly review and analysis of the data
- Safety

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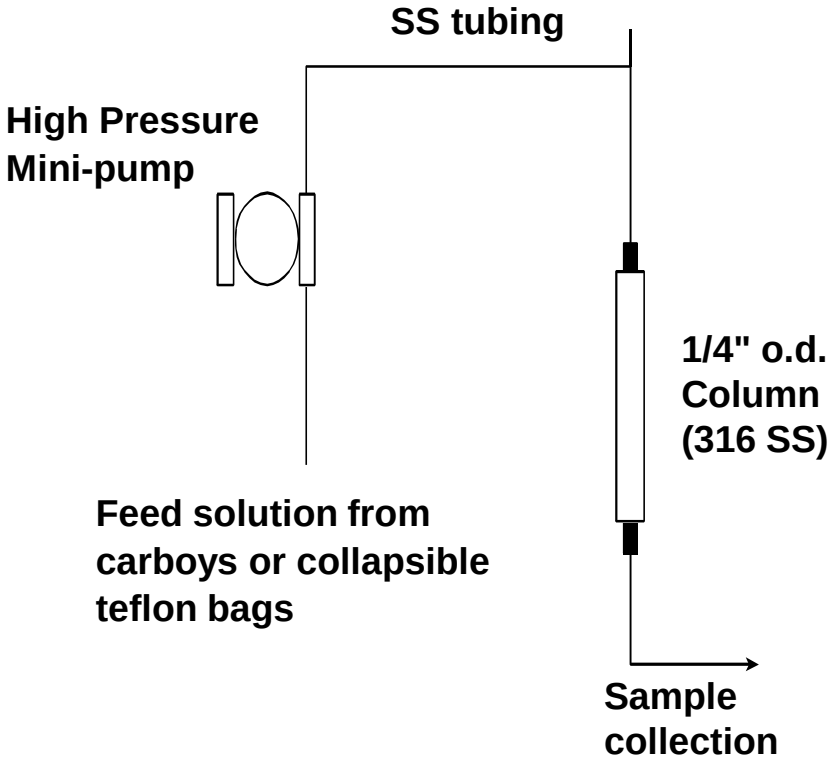
# Case Studies

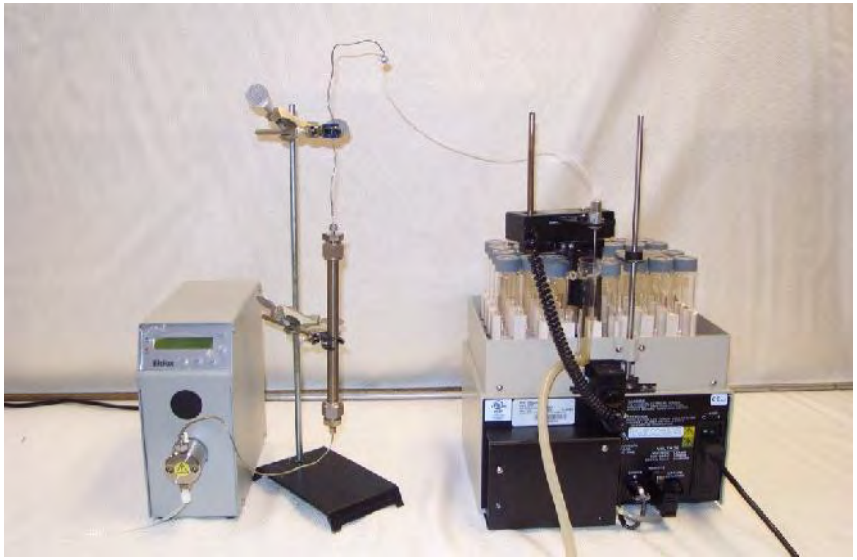
1. GAC
2. Residuals
3. Membrane

# GAC

## GAC RSSCT Setup

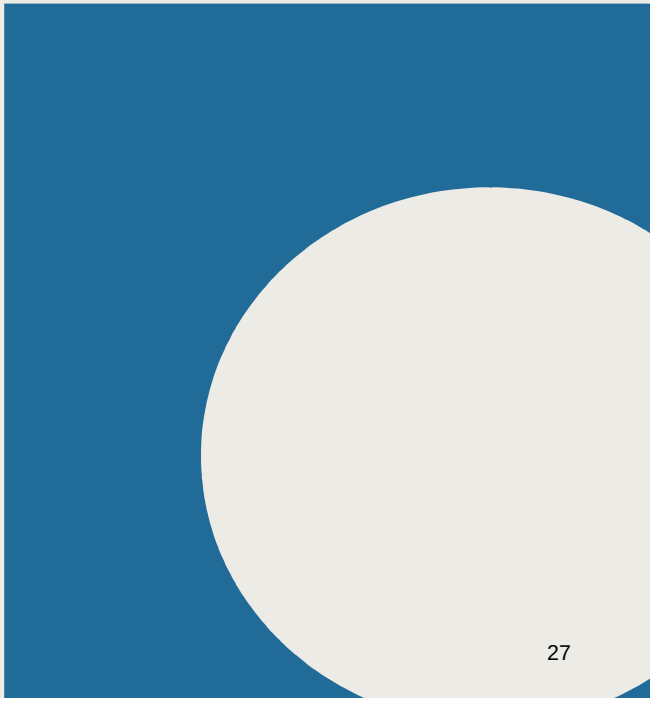
- PFC Issue
- Select optimum type of GAC (F-400 & F-600)
- Evaluate optimum EBCT
- Evaluate removal of range of PFCs
- Estimate the life of the GAC



# Protocol

- Testing is done in approximately 2-3 weeks as this will allow for simulation of approximately one year of full scale operation
- Generally collect samples 2-3 times per week day so that breakthrough can be identified
- Identify the lab that will do the analysis – an outside lab is usually needed
- Cost of running a 2-3 week test is approx $10K

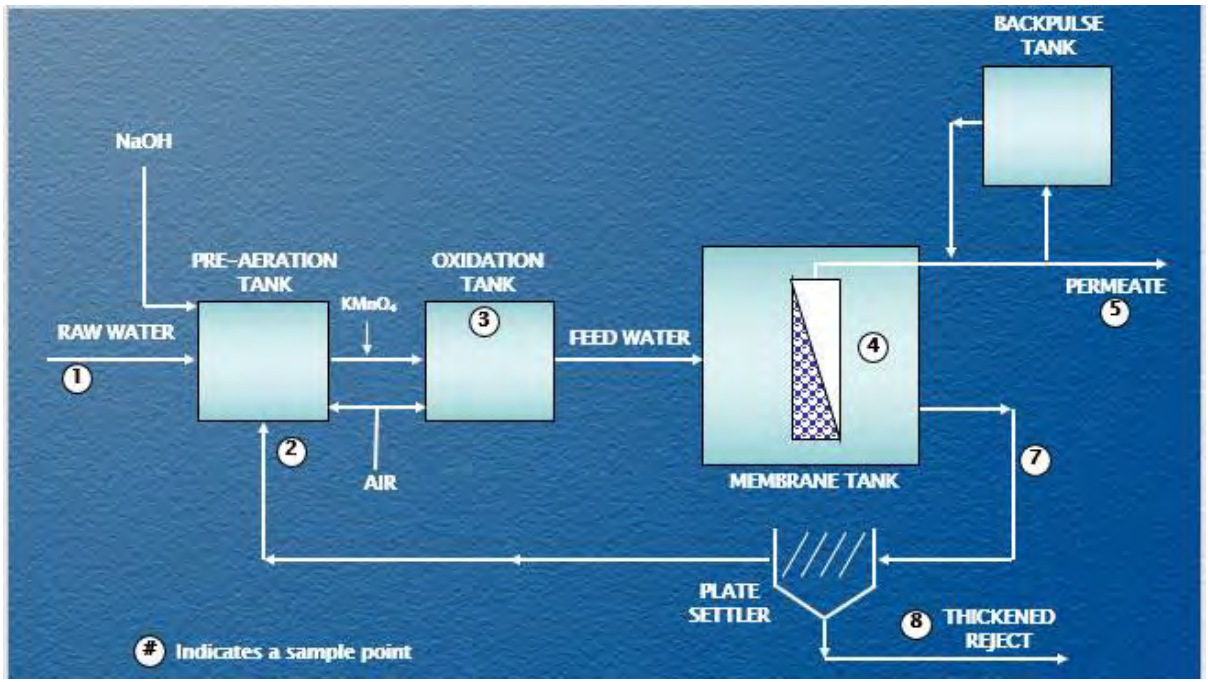


# Centrifuge Pilot Case Study

- Owner needs a mechanical dewatering facility for an 18 MGD facility
- We performed bench testing and desktop evaluation and recommended a centrifuge
- Pilot test was performed to obtain design parameters
- Considerations
  - Sufficient and representative sludge
  - How do we simulate thickeners
  - Power supply to centrifuge
  - Wastes

# Membrane Pilot Case Study

- 2 Wells – each at 1.5 MGD
- Fe range:  7.5 - 9.2 mg/L; avg.=8.4 mg/L
- Mn range:  0.10 - 0.14 mg/L; avg.=0.12 mg/L
- Existing Plant reaching the end its useful life
- Membranes selected as the optimum treatment



# Zenon ZeeWeed Pilot Study


# Acknowledgements, Thank You and Questions

- Margie Gray
- Jason Marie
- Mike Pickel