Stantec

USEPA Peak Stress Testing Framework Protocol

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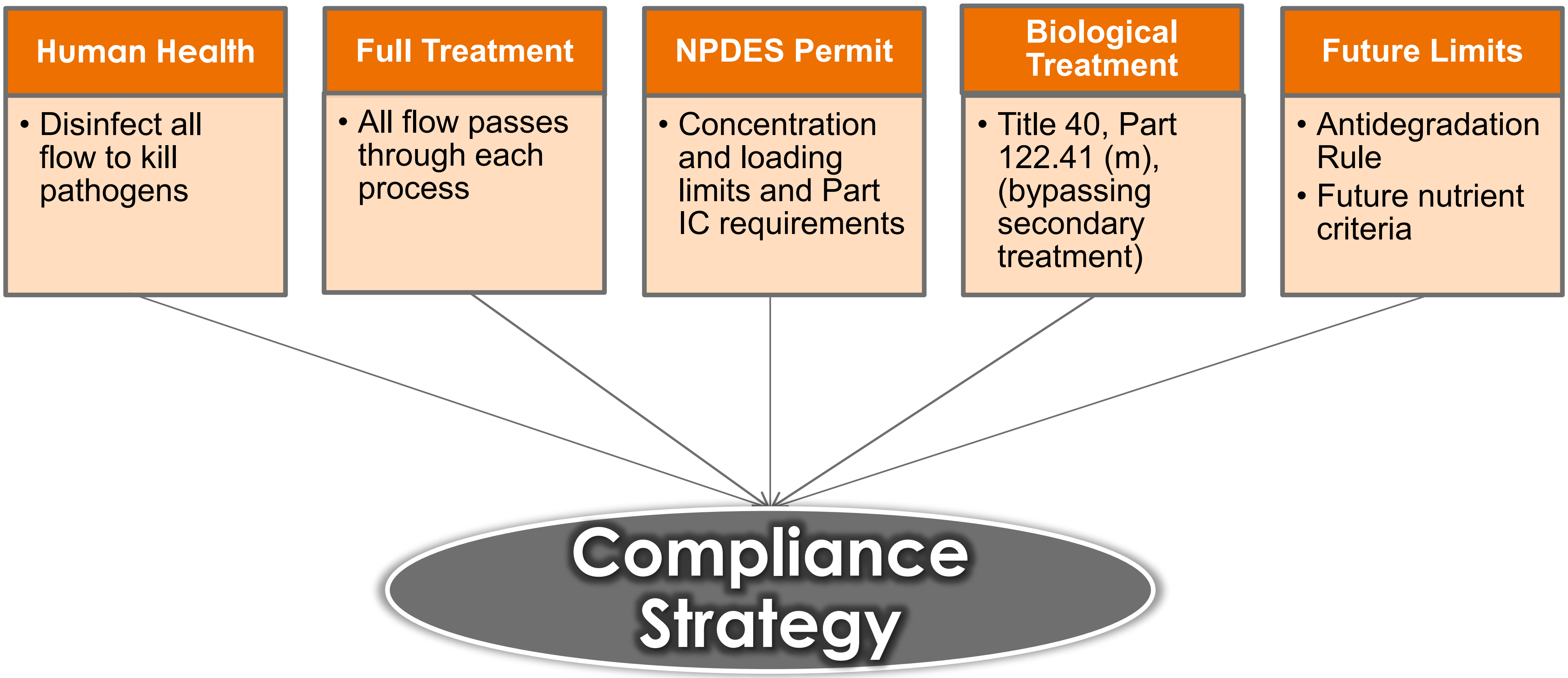
Regulatory Compliance



Ten States Standards

- Many wastewater treatment plants of the modern era are designed according to Ten States Standards:
  - Represents a conservative approach
  - Facilitates the PTI approval process
- Most plant systems are not run to full capacity
- Some process units have more capacity than others
- The key is to understand a plant’s strengths and weaknesses

Wet Weather Compliance

- Wet weather operations is an important focus of environmental compliance in Ohio
- Overflows and bypasses
  - No SSOs
  - < 4 CSOs/Typical year
- Internal WWTP Bypasses
  - NPDES concentration and mass loadings
  - Full treatment rule (must run through flow all units)
  - 85% treatment rule

Wet Weather Stress Testing

- Originated from USEPA's Nine Minimum Controls
- No treatment occurs from overflows in the collection system
- The only treatment occurs at the WWTP
- Get the flow to the WWTP where potential for treatment exists

Wet Weather Stress Testing - continued

- Stress Testing defines true capacity a wastewater treatment plant
- Tested to the brink of failure
- Hydraulic failure of loss of treatment failure
- Ohio EPA wants to define peaks for primary and secondary treatment
- Define weak links and identify corrective action strategies
- Many ways to fix at reasonable cost and achieve a high value per dollar spent

Wet Weather Stress Testing - continued

- Determine the true wet weather capacity
- Often design is based on documents such as Ten States Standards
- Compute true wet weather capacity as real situations differ
- Hydraulics, design features, percent capacity utilities, and microbiology play a role in determining plant capacity
- Duration of test

NPDES Permit Language

I. **Study Plan** - Within eighteen months of the effective date of this permit, permittee shall submit a study plan with an objective of identifying operational modes for optimizing hydraulic capacity during high flow events. The study plan should consider, at a minimum, using stress test(s) to evaluate aeration basins adjustments for step feed and contact stabilization, and solids handling during high flow events. The study shall be submitted to the District Office for review and acceptance.

II. **Optimization Report** - Within thirty months of the effective date of this permit, the permittee shall have completed the study according to the Plan accepted by OEPA in item C.1. The permittee shall submit a report detailing the results of the study and the recommended implementation actions.

III. **Implementation** - Before the expiration date of this permit, the permittee shall have implemented the recommended actions detailed in the report in item C.2 and accepted by the OEPA.

Peak Flow Management Options

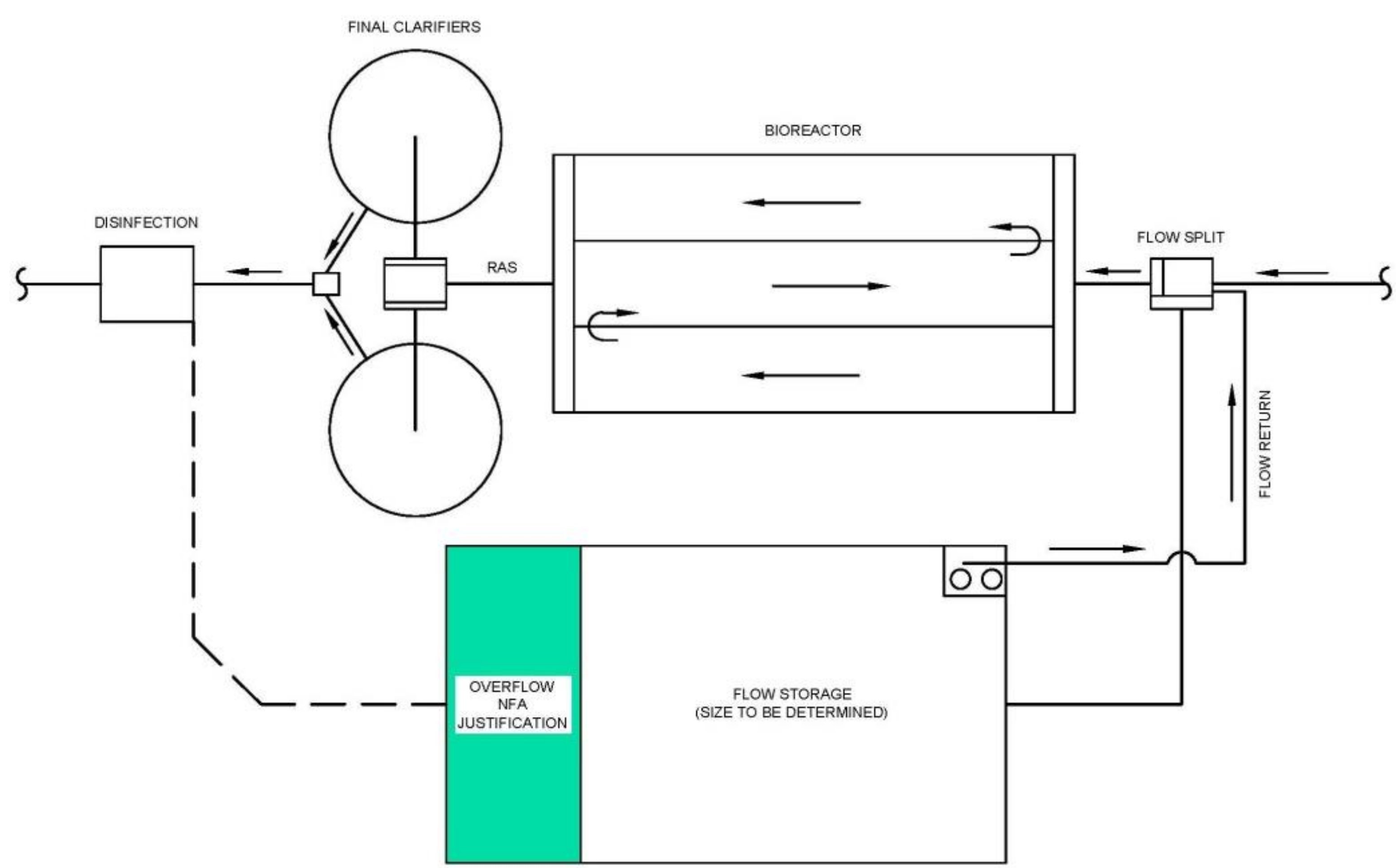
- Side line flow storage
- Step feed
- High rate treatment
- I/I Reduction including satellite communities

Approaches to Stress Testing

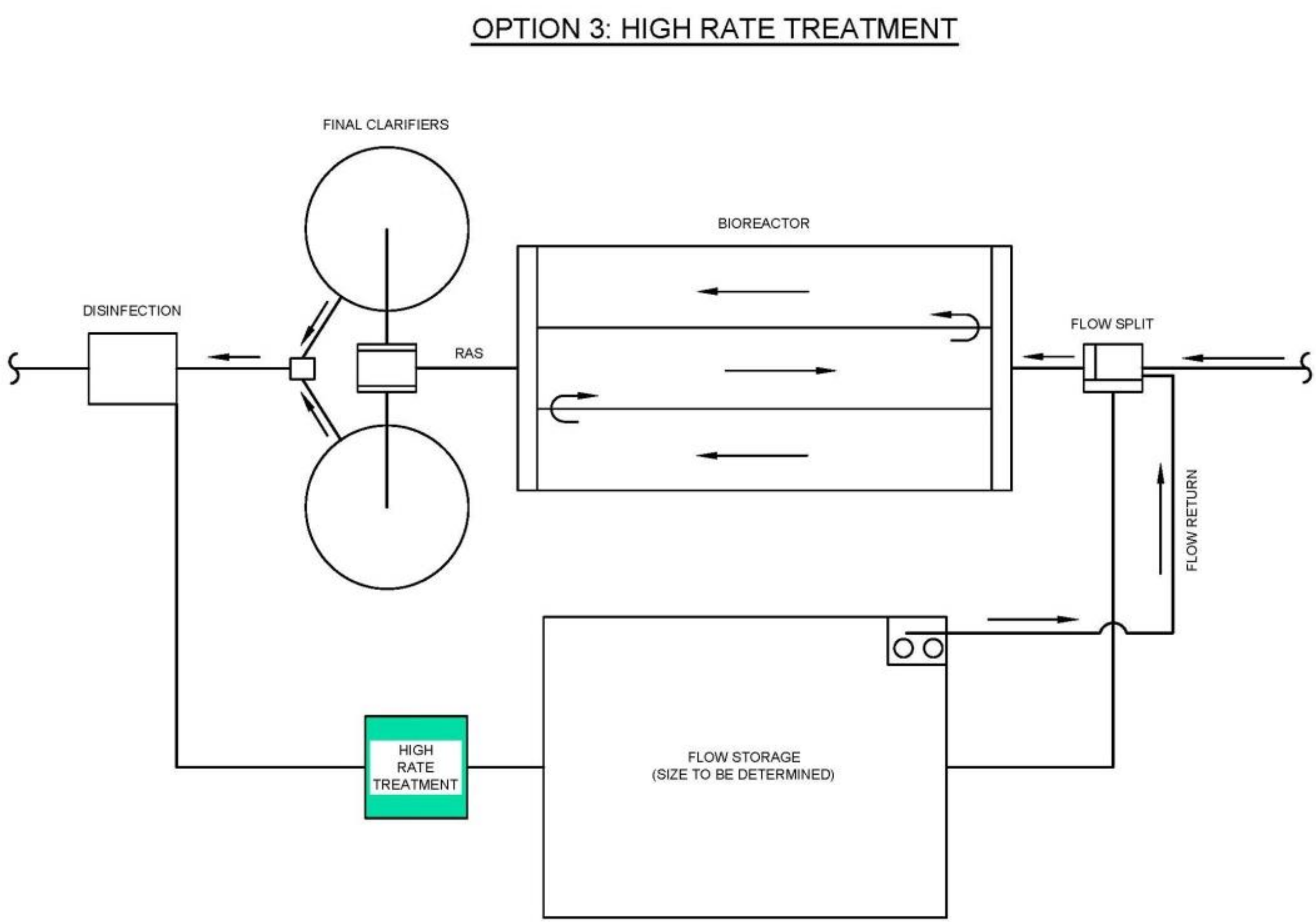
- Modeling
- Actual conditions
- Shut down part of process to simulate stressed conditions
- Combination approach

Peak Flow Management Options

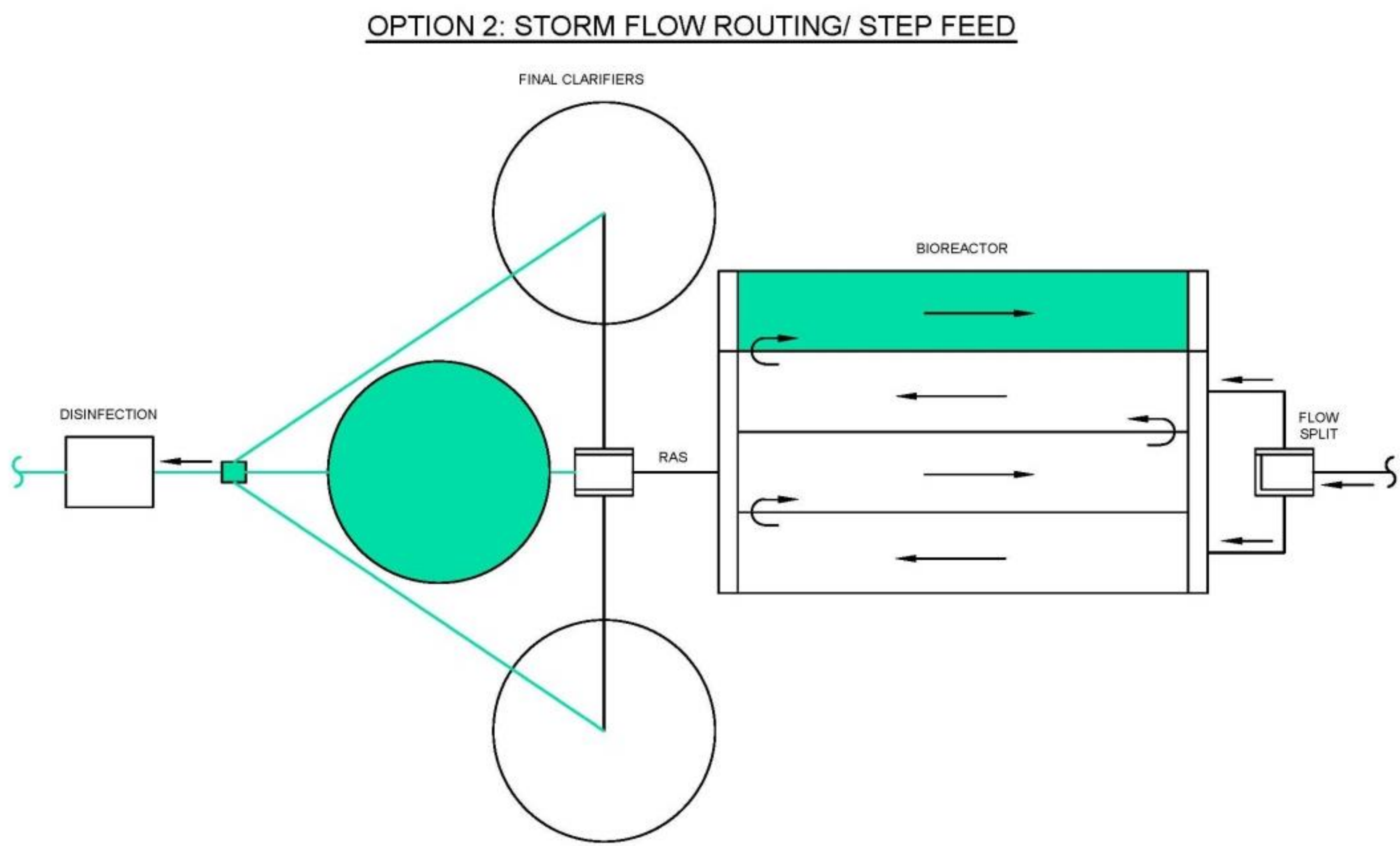
OPTION 1: "SIDE CAR" FLOW STORAGE



Peak Flow Management Options



Peak Flow Management Options

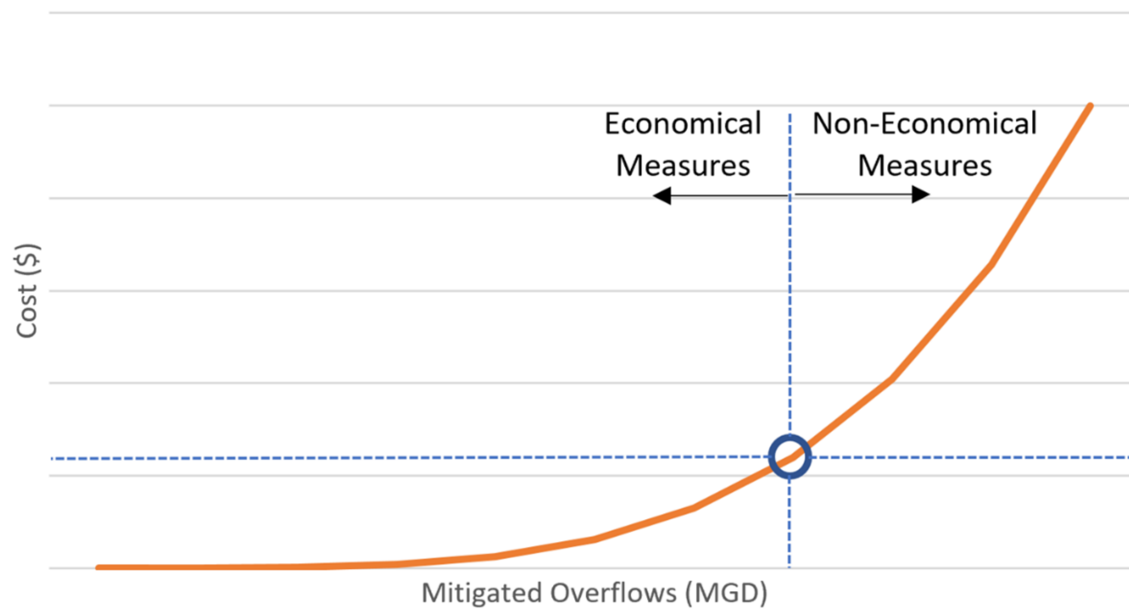


What is an NFA?

- NFA means "No Feasible Alternative"
- The NFA seeks to reconcile EPA's position that "no SSOs are allowed" against past practice and reality
- Flow blending and the requirement to provide biological treatment i.e., "Full Treatment" are in conflict
- It is an operational plan for wet weather that demonstrates a POTW is doing the best it can based on engineering and management considerations and affordability

NFA Analysis

- Must be a dialogue with OEPA
- Part of long term strategy
- Takes into consideration what is economical versus what is not.

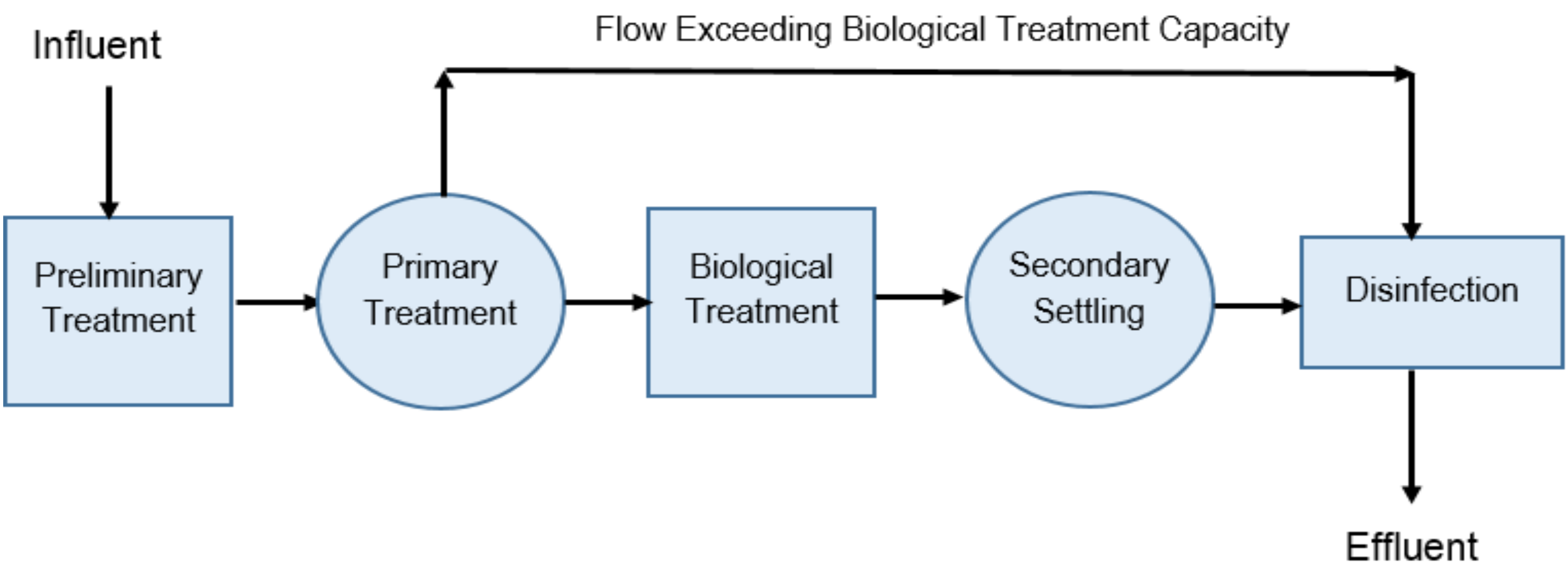


Ohio Environmental Protection Agency

Flow Blending

- Bypass a portion of flow during peak wet weather around biological process to disinfection
- Differs from step feed or contact stabilization
- Smart operators have used for decades to avoid wash out.
- Generally understood that wet weather process peaking factor around most biological systems is approximately 2.5-3 x Rated Capacity

Flow Blending



Mechanics of Stress Testing

- Each plant is unique and testing can be done in different ways to the brink of failure
- Computer programs such as Biowin and GPS-X can be used to supplement field efforts
- For smaller plants, analysis can be desk top
- All require data gathering, analysis, laboratory sampling, and great knowledge of the WWTP

Understand Your Service Area

- Industrial base and flows
- Combined versus separate flow
- Potential bottlenecks in the collection system
- Growth corridors
- NPDES permit concentration and loading limits for 7 and 30 day periods

Understand Flow Averaging

Flow	Example
Instantaneous peak flow	15 MGD
Peak hourly flow	12 MGD
Average daily flow	2.5 MGD
Design flow (rated capacity)	4.0 MGD
7-day average	
30-day average	

Use of Computer Models

- Computer models rely on measurement of many parameters: otherwise default values are used
- Computer models provide a dynamic view of the behavior of the plant
- GIGO!
- Lab analysis is a significant part of the evaluation

How Failure is Determined?

- Loss of the ability of the plant to meet conditions of its NPDES permit for 30-day and 7-day limits
- Problems are often first seen at final clarifiers with loss of TSS over weirs
  - Direct violation of TSS limit
  - Indicative of loss of solids inventory which can cause violations of other parameters

Prepare a Plan of Study

- Discussion with the Ohio EPA

Capacity Issues Encountered

These capacity limiting factors may need to be considered in any testing program:

- Hydraulic Capacity
- Organic
  - Direct Loading
  - Recycle Flows
- Changes in biology of mixed liquor
- Solids Flux Loading on Final Clarifiers
- Sludge wasting, handling and stabilization
- Reliability and redundancy considerations

Project Scope, Purpose, & Objectives

Past study in central Ohio community was done in 2004 for $28,500:

- Prepare Plan of Study (to review with OEPA)
- Review operational data
- Enhanced composite and grab sampling
- Ammonia profiling bioreactor through discrete sampling and testing
- Continuous pH and DO sampling at bioreactor
- Microscopic and SVI analysis at regular intervals
- Report preparation

Project Scope, Purpose, & Objectives - continued

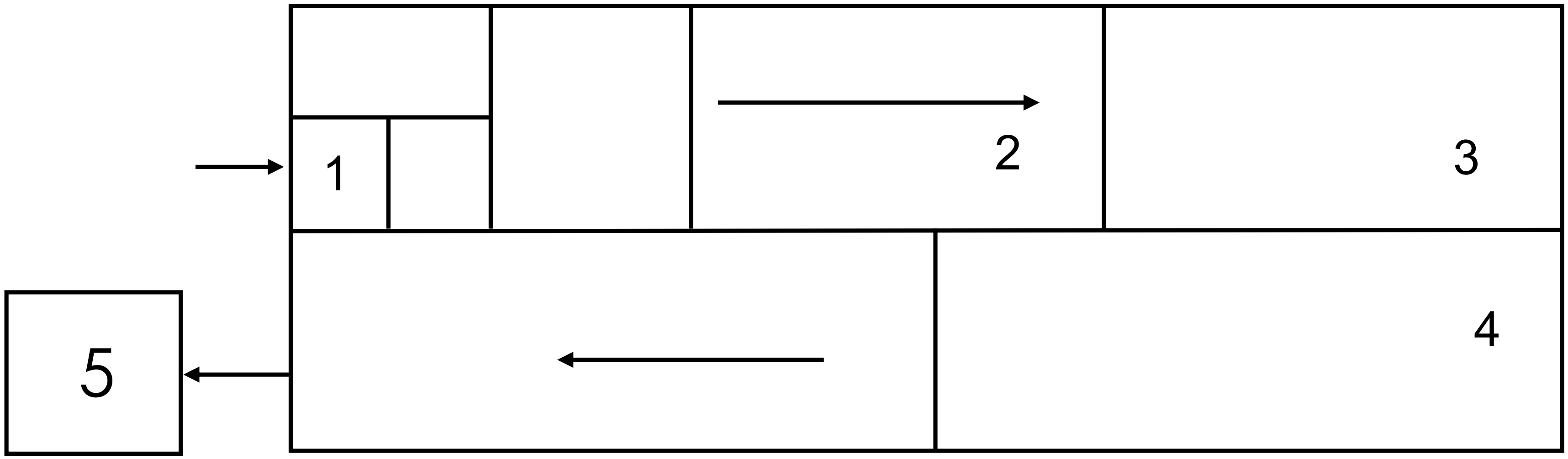
- Chief focus was the bioreactor system and solids flux on final clarifiers
- Ammonia-nitrogen profiling was used to define process failure in bioreactor
- Other systems examined for hydraulic capacity, wet weather peaking factor, and Ten States Standards requirements

Testing Procedures for Ammonia-Nitrogen: Introduction

- Full-scale operational demonstration using influent and effluent sampling over a period of about four weeks
- One half of the bioreactor system and final clarifiers were taken off to duplicate a condition of greater loading

Tank System and Sampling Method

- The bioreactor is baffled into six compartments
- Sample locations were chosen to coincide with the end of a baffled tank
- Samples were taken using a core sampler, centrifuged, and sampled for ammonia-nitrogen with a Hach colorimeter (low tech)
- The process of collection, centrifuging and analyzing took about one hour
- Formal ammonia profiles were run to characterize the rate of ammonia-nitrogen removal across the bioreactor



Final clarifier
Flow splitter

West Bioreactor Tank

Findings

- $CBOD_5$ conversion was assimilated into MLSS within approximately 60 minutes (rapid assimilation)
- Ammonia-nitrogen removal adhered to the exponential model
- No significant changes in MLSS biomass or SVI were noted
- Some increase in foam was observed (foam trap)
- RAS rates were 100% of forward flow and were reduced

Composite Sampling Data for Influent Wastewater

Parameter	10/30/2004 Data	10/31/2004 Data	Notes
Ammonia-nitrogen	18 mg/l	19 mg/l	These values are typical of those reported by operations personnel on a consistent basis
TKN	32 mg/l	35 mg/l	TKN defines the amount of ammonia-nitrogen to be removed at the plant
Alkalinity as $CaCO_3$	440 mg/l	400 mg/l	Maximum alkalinity consumed will be approximately 248 mg/l as $CaCO_3$.
BOD5	180 mg/l	130 mg/l	BOD5 is the parameter defined in most historic design manuals
$CBOD_5$	260 mg/l	140 mg/l	$CBOD_5$ is typically monitored at the plant
$CBOD_{20}$	150 mg/l	98 mg/l	$CBOD_{20}$ is a close approximation of ultimate CBOD
COD	329 mg/l	244 mg/l	COD is a measure a both bio-gradable and non-biodegradable constituents
TSS	220 mg/l	65 mg/l	Typical values approximate BOD_5.
TKN/NH_3-N	1.78	1.84	Approximately 56% of the reported nitrogen is delivered to the plant as soluble Ammonia-nitrogen
$BOD_5/CBOD_5$	1.20	1.33	Typical ratio reported by the Ohio EPA is 1.2
COD/BOD_5	1.83	1.87	Values < 2.0 indicate the presence of no toxicity in waste stream flows
Ultimate CBOD	272 mg/l	141	This parameter is a component of the calculation of decay rate "k."
Decay Rate "k"	-0.16	-0.24	Values are in terms of "inverse days." Values greater than -0.1 suggest higher than normal conversion rates."

Supplemental Ammonia-Nitrogen Data

Date	Concentration
3-Dec-04	13.7 mg/l
6-Dec-04	18.6 mg/l
7-Dec-04	15.0 mg/l
8-Dec-04	12.3 mg/l

Process Capacity Summary

Unit Process	Maximum Capacity	Basis of Determination
Pumping	4.4 MGD/ PF of 2.75 = 1.6 MGD	Actual performance and original basis of design
Preliminary Treatment	5.0 MGD/ PF of 2.75 = 1.8 MGD	Manufacturers' determination and engineering evaluation
Bioreactor	1.6 MGD	Stress test evaluation
Final Clarifiers	1.6 MGD	Stress test evaluation and Ten States Standards
Tertiary Filtration	5.0 MGD/ PF of 2.75 = 1.8 MGD	Ten States Standards and original basis of design
Effluent Treatment	5.0 MGD/PF of 2.75 = 1.8 MGD	Ten States Standards and original basis of design
Sludge Treatment	1.8 MGD	Original basis of design and engineering evaluation

Bioreactor and Final Clarifiers were rated at 1.6 MGD

Possible Results of Running Bioreactor Harder:

- A reduction in the size of “anoxic” selector zones removes an important means to control Sludge Volume Index (SVI)
- Dedicated aerated zones may not be able to provide need DO
- If Total Nitrogen removal is necessary, reactor volume requirements will increase by approximately 25%
- Process redundancy will be reduced
  - N-1 redundancy
  - Tanks out of service
  - Monthly maximum loads

Managing Sludge Volume Index (SVI)

- SVI is the amount of space that settled mixed liquor occupies per unit mass: the less space the better!
- SVI drifts may occur and be subtle
- Adverse changes in sludge settling as measured by SVI and microscopic analysis of mixed liquor will decrease capacity
- Most plants are subject to filaments; the key is controlling them
- While it may be possible to push additional loading through the bioreactor if you cannot achieve effective liquid-solids separation, you have achieved nothing!

Total System Understanding

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Total System Understanding

1. Hydraulic carrying capacity of all elements
2. The bioreactor’s ability to remove ammonia-nitrogen
3. Final clarifier solids flux loading (State Point Analysis)
4. Sludge treatment processes (in particular for wasting sludge)
5. Maintenance considerations

The “weak link” governs capacity

Questions & Answers

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