Upgrading/Retrofitting Your WWTP with MBR Technology

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Making the Old Young Again

After 10 years of Operation

After upgrade

Retrofit Opportunities

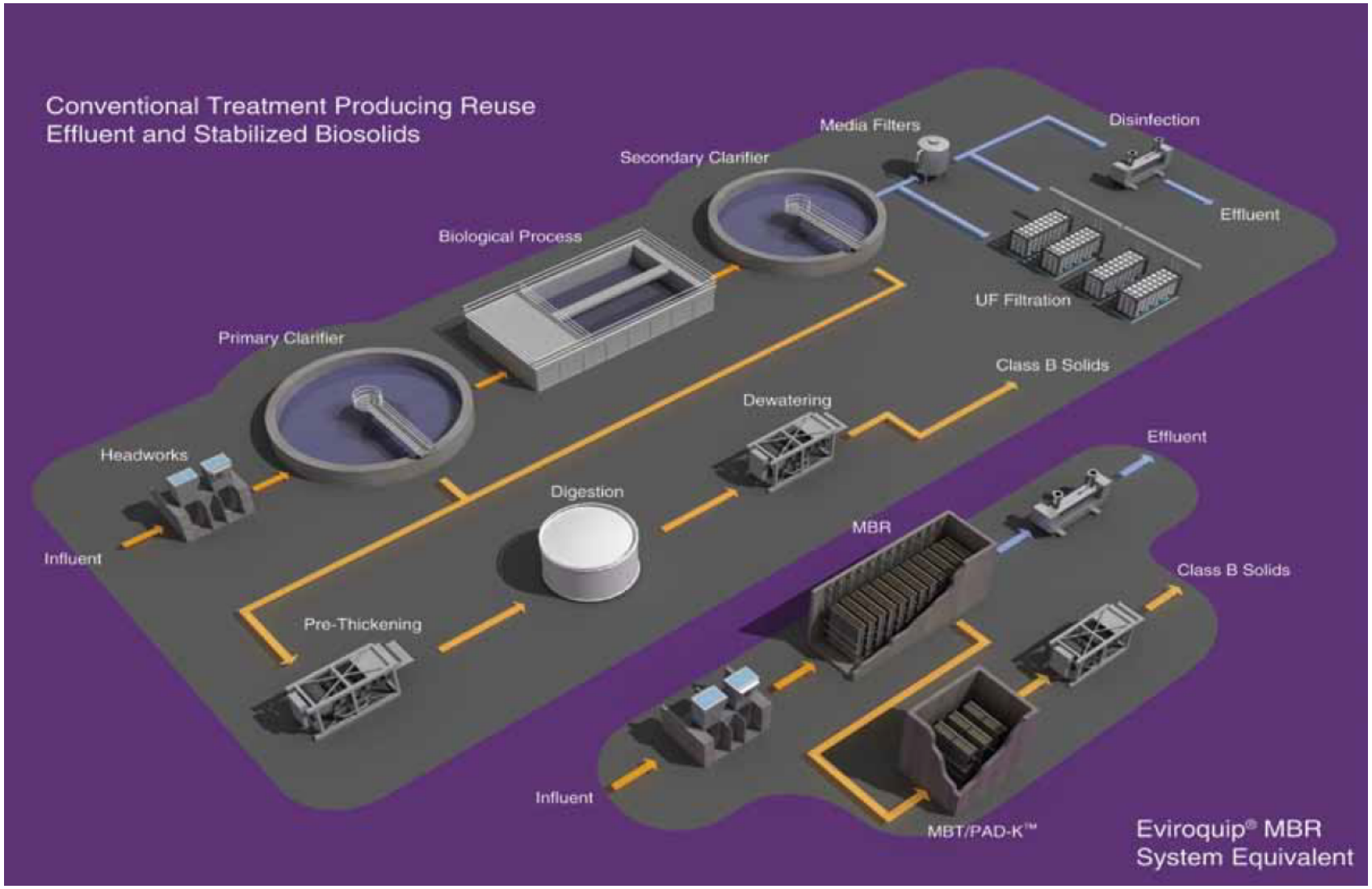
Drivers for Retrofits

- **The Traditional Reasons**
  - Increase flow, same footprint
  - Quality discharge effluent
- **Economic Downturn**
  - Cost
  - Quicker incremental upgrade

- **Regulations**
  - Total Maximum Daily Loads (TMDL)
  - Quality driven rather than technology based.
- **Recycle, Reuse**
  - Lower potable usage

Why MBR?

Look at the whole plant to see the advantages…



Fundamental Concept

MLSS ↑

Volume ↓

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Application in Retrofits

The Existing System

3000 mg/l MLSS Capacity Q (MGD)

The MBR

12,000 mg/l MLSS Capacity 2-3 Q (MGD)

Ovivo MBR Systems

Application in Retrofits

Conventional MBR Systems
Operations at 8,000 to 18,000 MLSS
Process aeration with fine bubble diffusers
Peaking capacity to 2.5Q
BNR (TN to < 3 mg/l, P to < 0.03 mg/l) • Bio P • SNdN
Single recycle design
Total system efficiency 0.5 - 0.7 kWh/m^3
SMUs: Small systems (< 2 MGD): RM or RW Large systems (> 5 MGD): SP400

Retrofit Approach
Maximize capacity within existing trains (Minimize new construction) ▪ Design MLSS between 11,000 and 12,000 mg/l ▪ Use SNdN to minimize anoxic volume ▪ Use MBR oxic volume to offset Pre-Aeration volume
Optimize MBR Selection ▪ Balance basin SWD + HRT + SOTE
Utilize basins to further optimize system NPW ▪ Inline EQ for operations flexibility and energy ▪ Offline EQ for peaks (minimize MBR system size) ▪ Install MBTs (membrane thickeners)

SMU Model Sampling

ES

50 to 200 plates

EK

300 to 400 plates

RM

150 to 200 plates

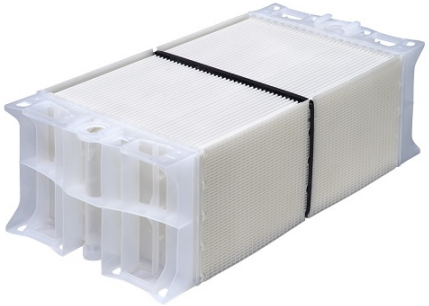
RW

300 to 400 plates

The SP-400 SMU

Membrane block

Aeration block



Membrane module

Diffuser

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Application in Retrofits

OVIVO
Bringing water to life

Conventional Activated Sludge Systems

Typical CAS Characteristics	Retrofit Opportunity
MLSS Between 2,000-4,000 mg/l SRTs Between 5 and 15 days	Capacity & BNR within existing basins • No new basins
Primary and Secondary Clarifiers	Ability to re-task clarifiers • Equalization for reducing MBRs • Sludge thickeners
Multiple Trains	Ability to stage construction
Diffused Aeration Systems	Minimizing new air system costs
Depths Between 8’ and 16’	Select from multiple SMUs to optimize system

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Application in Retrofits – Canton, OH

Existing Plant

- Nitrifying Activated Sludge
  - **39 mgd average flow**
  - **70 mgd peak day**
- Current BNR
  - No TN limit (>20)
  - No Phosphorus limit (>1.9)
  - TSS Limit < 12
  - BOD Limit < 10
  - NH_3 Limit < 3

Goal of Upgrade

- Extend hydraulic capacity to
  - **42 mgd MMF**
  - **88 mgd peak day**
  - **110 mgd peak instantaneous**
- Improve BNR to
  - TN < 8 mg/l
  - Phosphorus < 1 mg/l

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Application in Retrofits – Canton, OH

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Application in Retrofits – Canton, OH

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Request for Proposal

- No single SMU technology specified
- No MLSS cap
- No flux cap
- Process design with supporting model (optimized per technology)

Present Worth Evaluation

- Total Plant
  - Capital Equipment
  - New tankage
  - Operations
    - Screening
    - Chemicals
    - Solids handling

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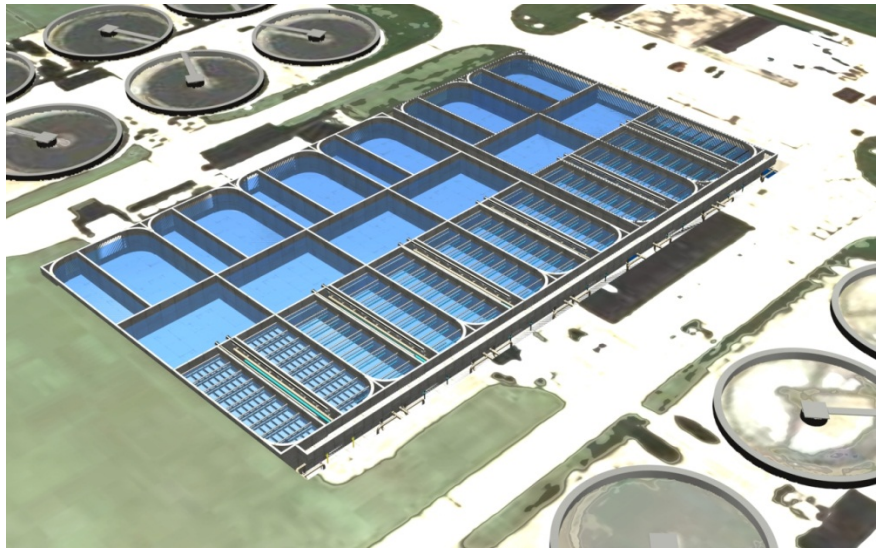
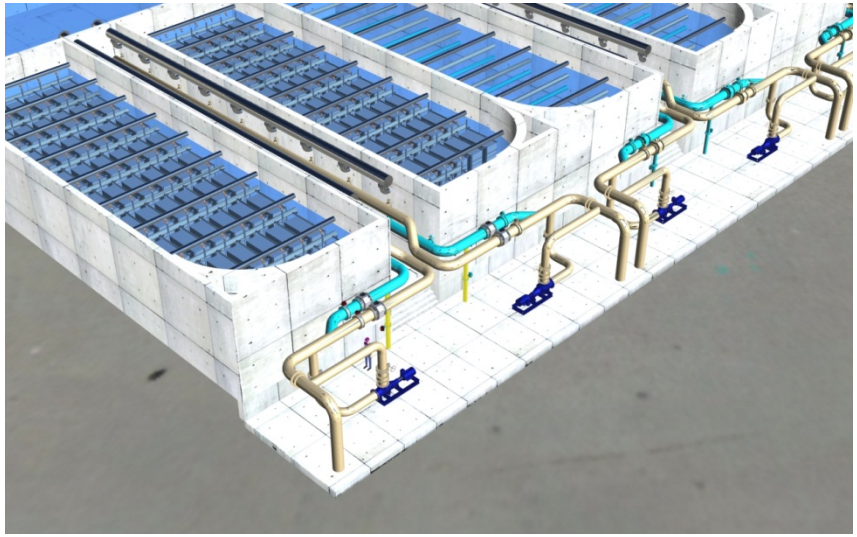
Application in Retrofits – Canton, OH

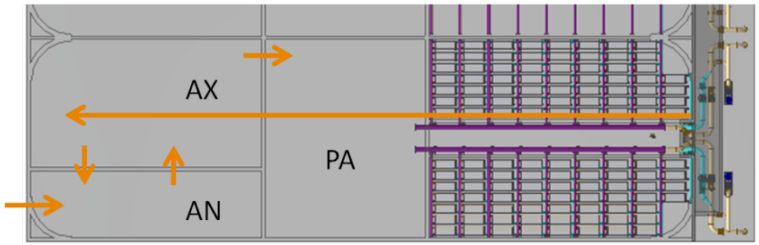
Proposed MBR

- SP400 SMUs (12’ SWD)
- Single recycle for MBR process
- Bio P phosphorus removal
- 12,000 MLSS design concentration
- Pump assisted gravity permeate configuration
- Biological nutrient removal (BNR)





- No new basins
- Ability for phased construction
- Clarifiers available for EQ
- Supplementing existing air system



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Application in Retrofits – Canton, OH

Present Worth Summary of Alternatives

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Present Worth Cost	Chem P	Bio P	Chem P & BNR	Bio P & BNR	IFAS	MBR
Total Project Cost both Phase I and Phase II	$107,575,000	$115,685,000	$103,700,000	$109,425,000	$100,635,000	$72,120,000
Operation and Maintenance Cost	$34,206,717	$38,765,693	$41,852,273	$45,355,979	$48,722,387	$43,332,085
Total Present Worth All Cost	$141,781,717	$154,450,693	$145,552,273	$154,780,979	$149,357,387	$115,452,085

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Application in Retrofits – Rio Del Oro, NM

Rio Del Oro, NM

100,000 gpd Conventional Activated Sludge System

Existing system basins allowed for phasing of construction while continuing to treat wastewater through current system

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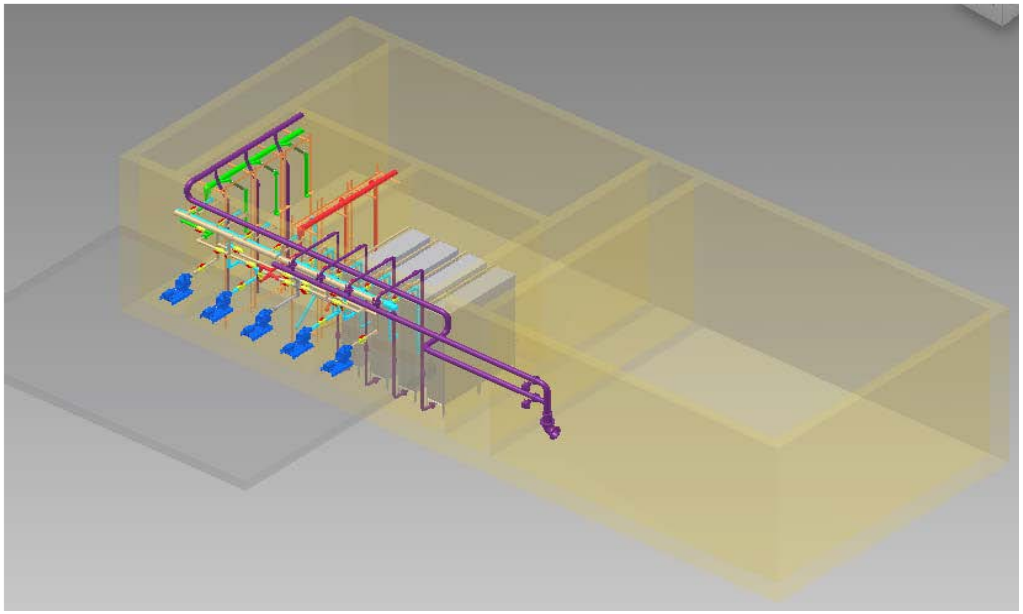
Application in Retrofits – Rio Del Oro, NM

- **Phase 1 (200,000 gpd, completed)** converted existing clarifier to MBR basins single stack SMUs
- **Phase 2 (400,000 gpd)**, to convert premix channel and chlorine contact basin to an AX basin. Add upper decks to MBRs
- **Phase 3 – (future) 800,000 gpd,** will convert existing Pre-Air basin to a second MBR facility



- Class A1 effluent for reuse
- **Phase 1 in at $13/gallon**
- **Phase 2 planned for $5/gallon**

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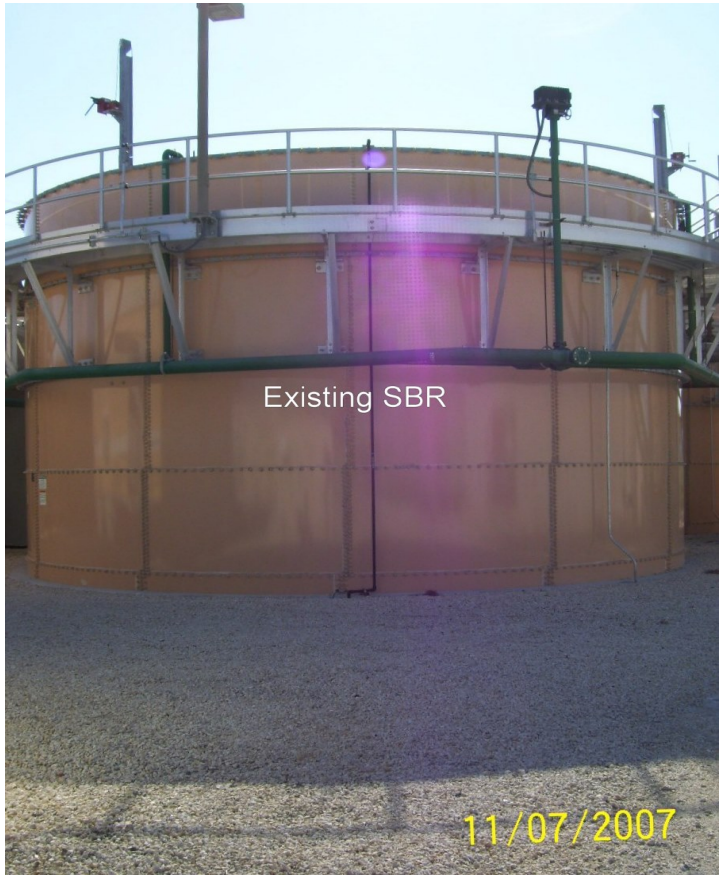
Marathon, Florida

Existing Circular SBR Basins



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Application in Retrofits

Sequencing Batch Reactors

Typical CAS Characteristics	Retrofit Opportunity
• MLSS Between 2,000-4,500 mg/l • SRTs Greater than 12 Days • Higher HRT to Accommodate Decant	Capacity & BNR within existing basins • No new basins
Discharge Equalization to Accommodate Decant Rate	Ability to re-task equalization • Additional BNR volume • Influent equalization for reducing MBRs • Sludge thickener
Multiple Trains	Ability to stage construction
Aeration Systems Sized to Accommodate Batch Sequencing	Minimizing new air system costs
Deep Tanks (15’-21’)	• Select from multiple SMUs • Gravity and PAG Designs
Square, Round, and Rectangular Tanks	Longer aspect ratios simplify retrofits

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Application in Retrofits – Spirit Mtn, OR

Spirit Mountain Casino, OR

- ABJ SBR
- 195,800 gpd AAF
- 432,300 gpd MMF

New System

- Extended hydraulic capacity to
  - 300,000 gpd AAF
  - 600,000 gpd MMF
- Improve BNR to
  - BOD5 < 5 mg/l
  - TSS < 5 mg/l
  - Nitrate < 5 mg/l
  - Ammonia < 1 mg/l

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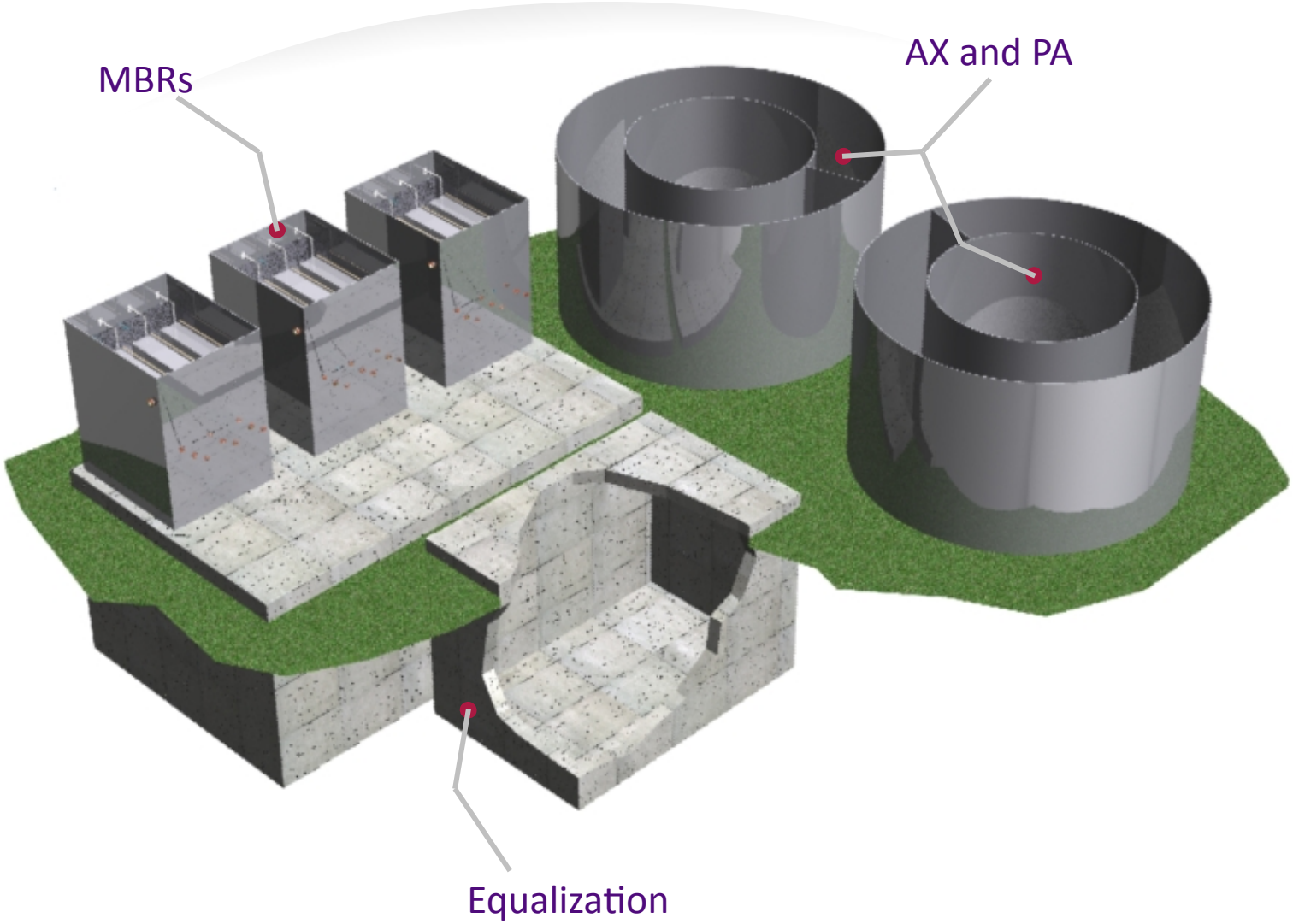
Application in Retrofits – Spirit Mtn, OR

- ES200 SMUs
- Single recycle
- Pre React zone converted to anoxic
- Gravity permeate configuration
- Only new wall added was to create the MBR basin

Ovivo MBR Systems
Marathon, Florida



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Application in Retrofits

Oxidation Ditches

Typical CAS Characteristics	Retrofit Opportunity
• MLSS Between 2,000-4,500 mg/l • SRTs 15-30 Days	Biological capacity and improve BNR without adding process tankage
Clarifiers	Ability to re-task clarifier • Additional BNR volume • Influent equalization for reducing MBRs • Sludge thickener or sludge holding
Shallow Tanks (10’ – 15’)	Select from multiple SMUs
• Surface Aerators or Brushes • Racetrack Configuration	Challenge with regard to retrofitting SMUs

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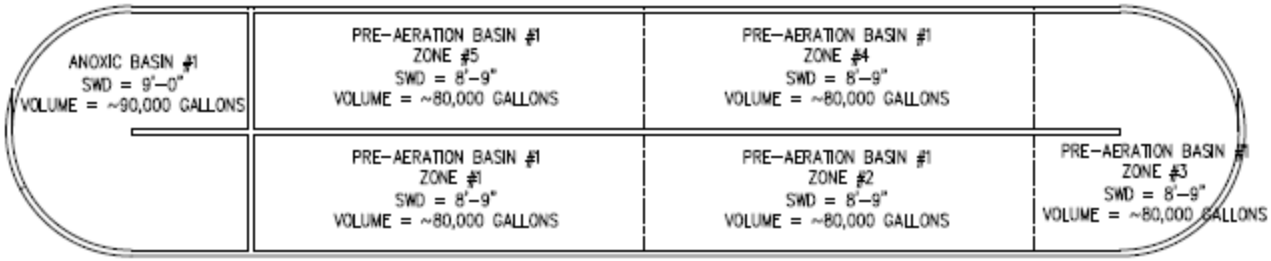
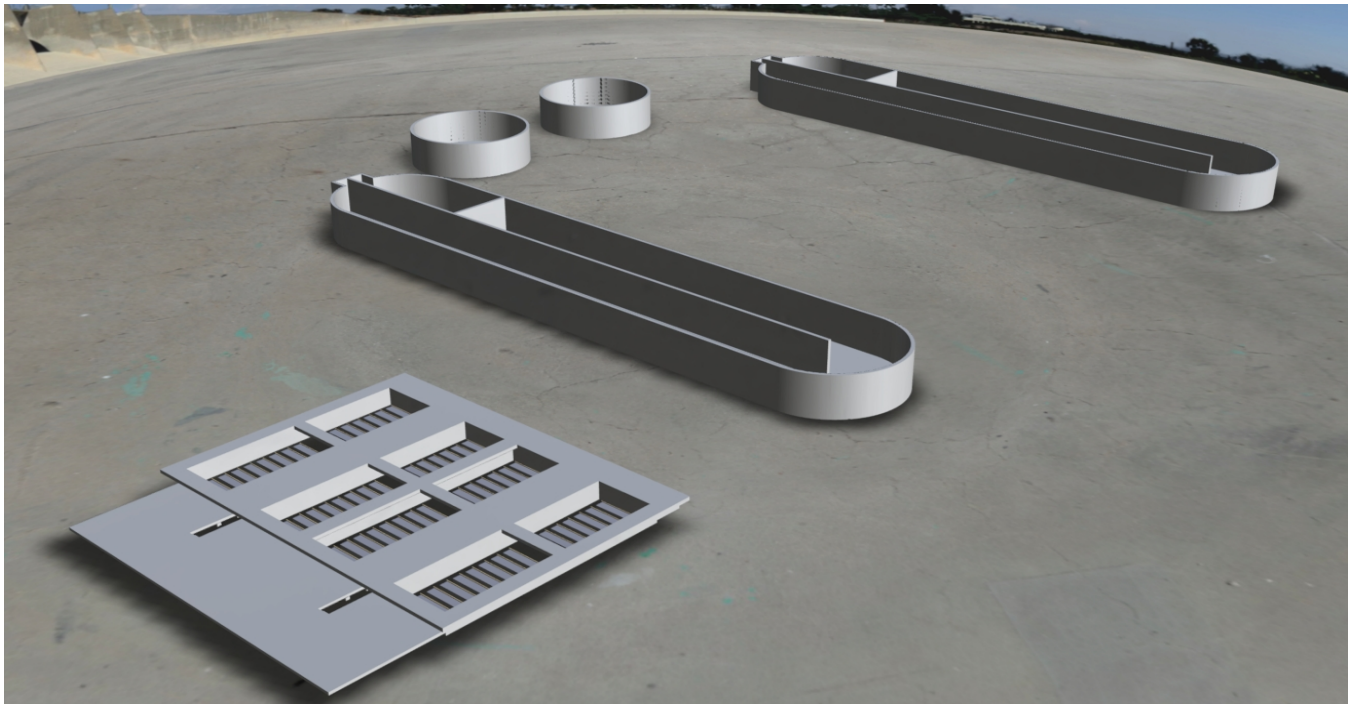
Application in Retrofits - Oxidation Ditches





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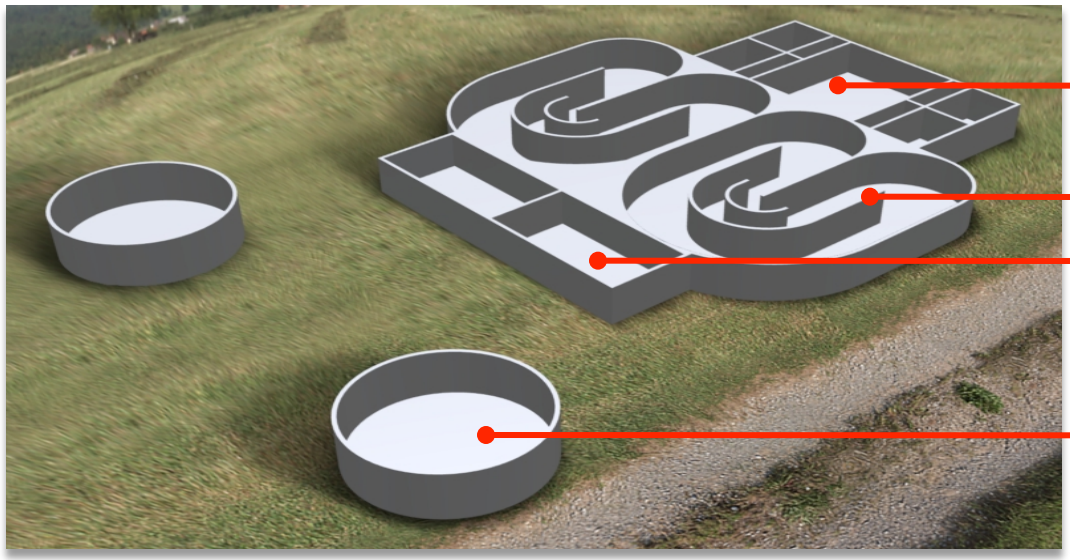
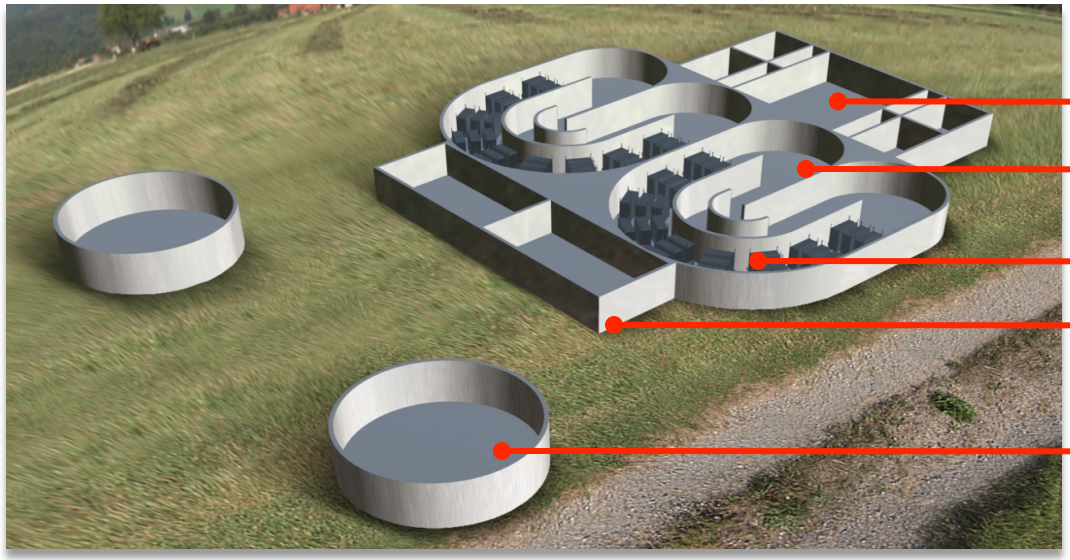
Application in Retrofits - Oxidation Ditches

Existing Ditch



MBR Solution



Ovivo MBR Systems
Application in Retrofits

Retrofit Approach
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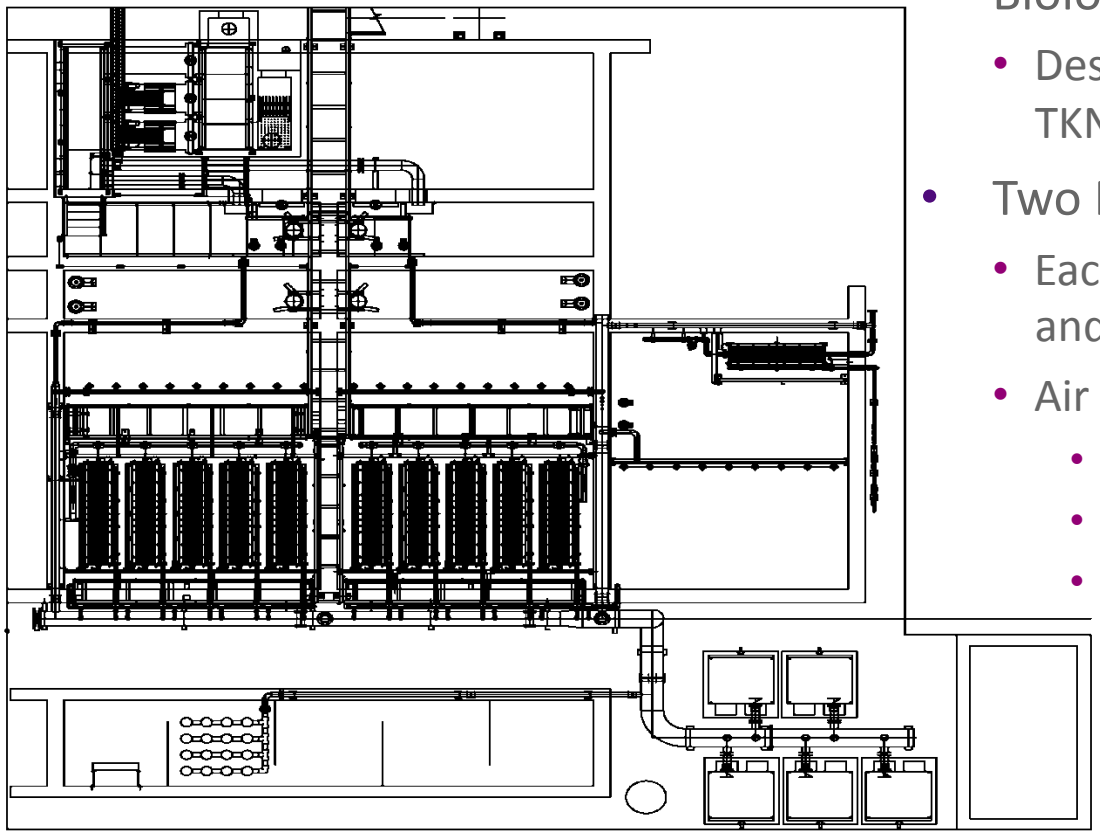
Optimize MBR Selection ▪ Balance basin SWD + HRT + SOTE
Utilize basins to further optimize system NPW ▪ Inline EQ for operations flexibility and energy ▪ Offline EQ for peaks (minimize MBR system size) ▪ Install MBTs (membrane thickeners)

Opportunity for maximizing retrofit capability with system approach

Case Study-Wilbarger Creek MUD No. 2 MBR



- Hydraulic Loading
  - designed for 0.5 MGD
- Biological Loading
  - Designed for 200 mg/L BOD and 40 mg/L TKN
- Two Process Trains
  - Each with one anaerobic, anoxic, pre-air, and membrane zones
  - Air supply system on common header
    - Membrane air scour
    - Pre-air zone course bubble diffusers
    - Multiple air lift pumps

Findings

- Influent flow 0.15-0.20 MGD (0.5 design)
- Influent BOD 300 and TKN 60 mg/L (200 and 30 design)
- Course bubble diffuses in pre-air basin limiting oxygen uptake
- Frequent membrane cleaning
  - Hard water
  - Dewatered sludge
  - CDS system designed to only fill 200 plates at a time
- Diffuser Cleaning Operation Inefficient
  - No ability to adjust air flow, high air flow (pressure) prevents efficient solids flow through diffuser
  - Fouled diffusers lead to dewatered sludge which leads to ineffective cleans
- Control System Malfunctions
  - Allowed permeate flow without air scour
- Hair and fiber agglomeration
- Energy Inefficient
  - 4.0kwHr/m^3 (should be targeting 1.4)

Proposed Modifications

- Energy Pro Conversion
  - Allows using one or both process trains as required
  - Only requires addition of four electrical actuators and some programming
- Install fine bubble diffusers
  - Increased oxygen uptake efficiency
  - Less blower load
- Provide separate air flow setpoint for diffuser cleaning cycle
  - Allows for optimization of solids back flow through diffusers
- Increase CDS system to allow cleaning 5 units simultaneously
  - Implement 2/yr acid cleans to address hard water
- Verify and/or modify control system to ensure protective membrane interlocks
- Install dedicated drain pump to allow for proactive tank inspections

Questions?

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