



Metropolitan Water Reclamation District of Greater Chicago

Welcome to the October Edition
of the 2025 M&R Seminar Series

NOTES FOR SEMINAR ATTENDEES

- Remote attendees' microphones are muted at entry to minimize background noise.
For attendees in the auditorium, please silence your phones.
- A question and answer (Q/A) session will follow the presentation.
- For remote attendees, please use “**Chat**” only to type questions for the presenter. For other issues, please send emails to MnRseminars@mwrld.org.
For attendees in the auditorium, please raise your hand and wait for the microphone to ask a verbal question during the Q/A session.
- The presentation slides will be posted on the MWRD website after the seminar.
- This seminar has been approved by the Engineering Society of Illinois (ESI) for one PDH and is pending approval by the IEPA for one TCH. Certificates will be issued only to participants who attend the entire presentation. For PDH certificate seekers, **completing a brief course evaluation and submitting it are required.**

Travis Vodnik, P.E., Engineer

North Shore Water Reclamation District

Gurnee, Illinois



Travis Vodnik earned a Bachelor of Science degree in Environmental Engineering from the University of Wisconsin – Platteville. He worked for a local civil engineering company for two years, before joining the North Shore Water Reclamation District (NSWRD) in 2021 as an Engineer. He is a Registered Professional Engineer in the State of Illinois since 2023, and is the NSWRD's only non-management P.E. Since working for the NSWRD, he has designed and managed numerous plant and collection systems projects. He has been involved with the NSWRD Biosolids Masterplan (BMP) since the project began in 2022 and was one of the NSWRD Engineers to perform the in-house condition assessment. Travis is currently the NSWRD's main project manager for the BMP Basis of Design Report.

Joe Marino, P.E., ENV SP **Chicago Local Leader** **Brown and Caldwell**



Joe Marino brings over eighteen years of expertise in water and wastewater planning, design, and construction. Specializing in the management and design of biosolids and energy projects, Joe leads the Chicago office of Brown and Caldwell, driving innovative solutions and sustainable practices in the industry.

Developing North Shore's 2023 Biosolids Master Plan

Joe Marino, PE

Travis Vodnik, PE

MWRD M&R Seminar | October 24, 2025

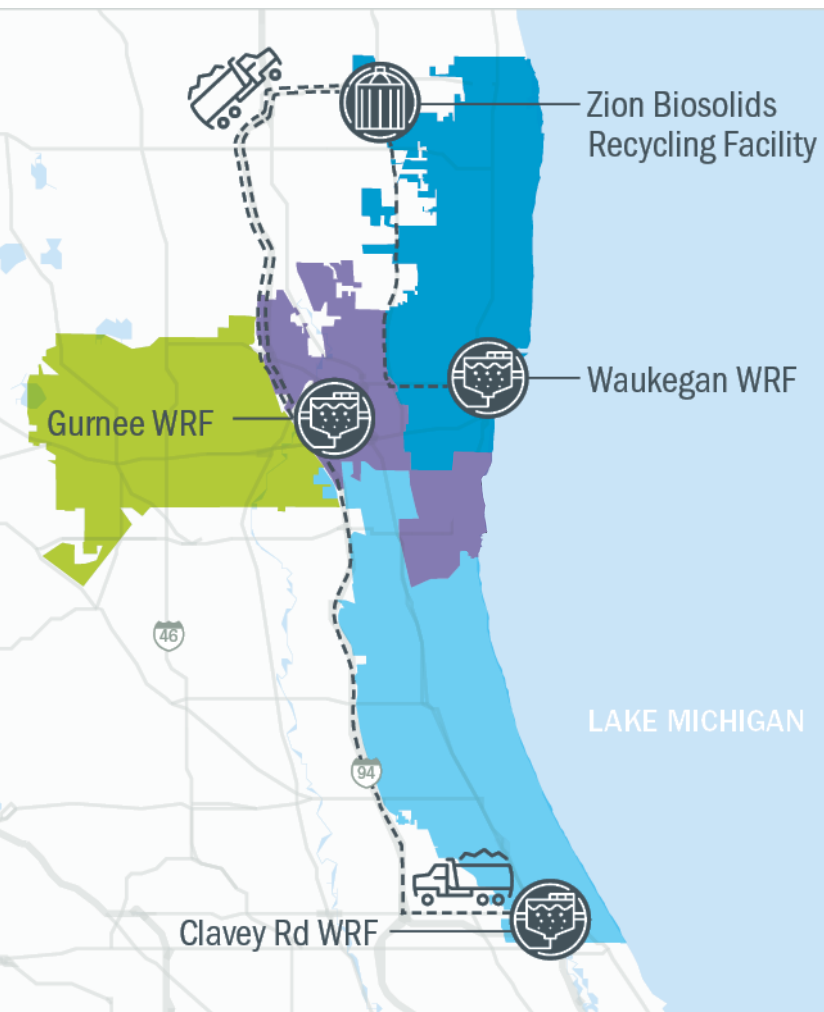


Protecting Lake Michigan & Our Waterways.

**North Shore Water
Reclamation District**



Program Drivers for Change



- **Functional Performance:**
Need to replace aging equipment at WRFs and Zion BRF
- **Regulatory Drivers:**
 - Potential PFAS land application regulations
 - Future phosphorus limits (may exceed existing dryer capacity)
- **Biosolids Product Quality:**
Limited digestion results in odorous and flammable dried biosolids product
- **Energy/Sustainability:**
No existing biogas or energy recovery

The District by the Numbers

1914
NSWRD
founded

100
miles of
interceptor sewers

125+
achievement
awards



300,000 residents served in
17 communities



Waukegan WRF
22.0 MGD

Clavey Road WRF
17.8 MGD

Gurnee WRF
23.6 MGD



3 state-of-the-art facilities 63.4 million gallons a day

Daily Numbers (March 2021)



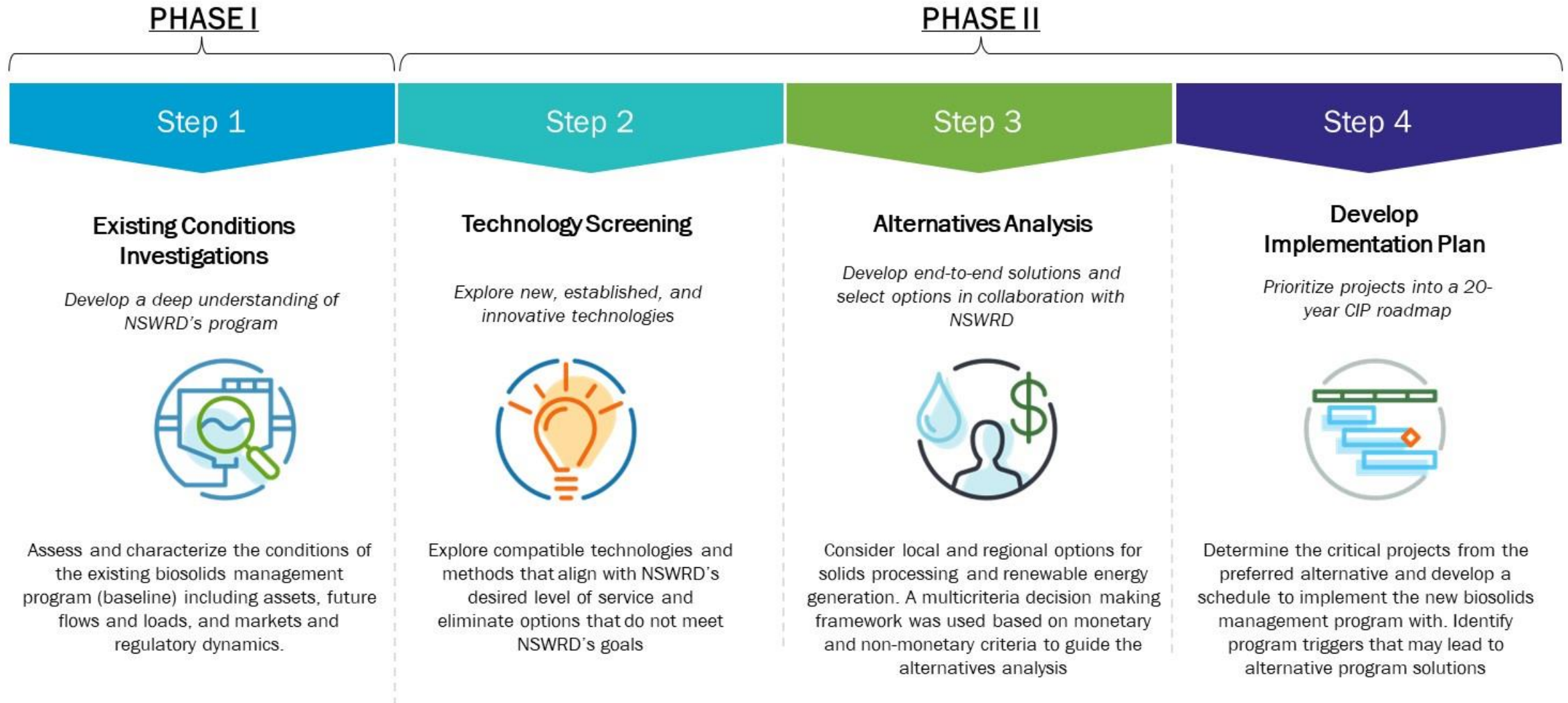
151 WT



7 Trucks

27 DT Heat Dried Product

Comprehensive BMP Approach for North Shore WRD



Existing Conditions



Capacity Constraints from upcoming phosphorus limits

Expected solids increase (+15 to +27%)

BRF processing capacity



Aging Assets require renewal/replacement

Risks from current treatment performance limitations

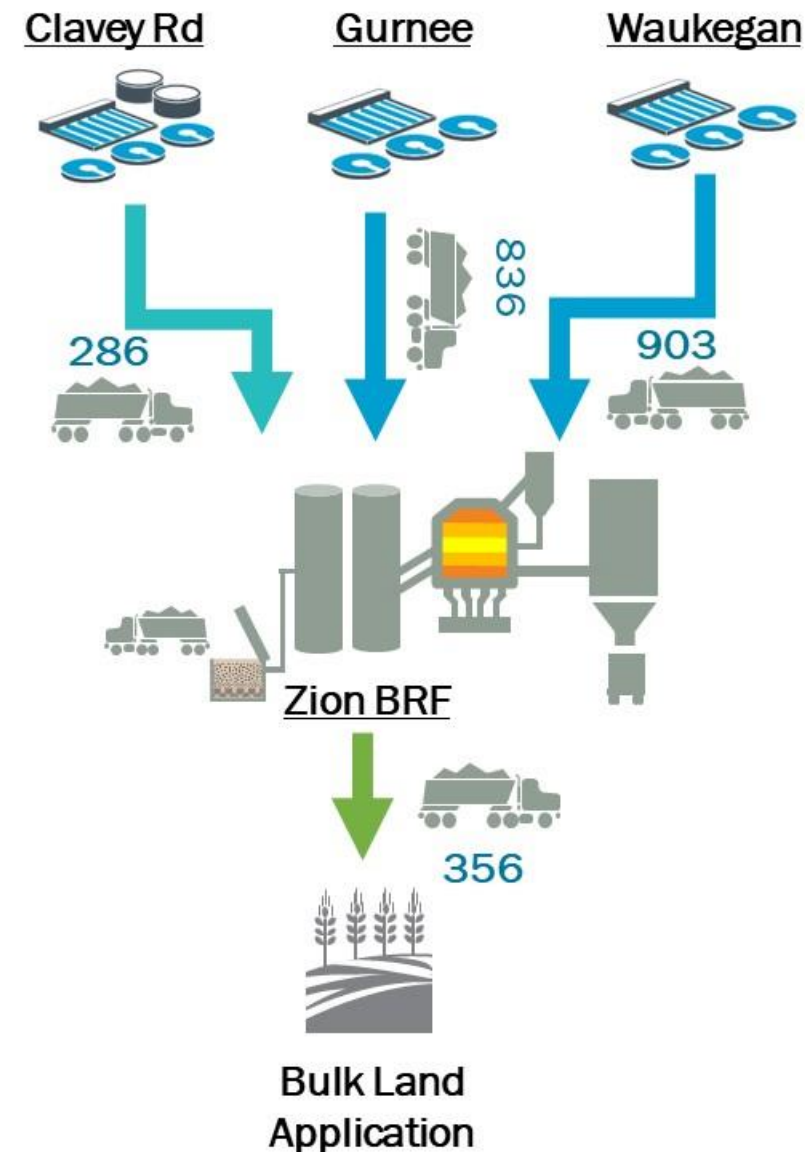
Anticipated PFAS regulations

No redundancy/Plan B option

Product quality results in landfilling



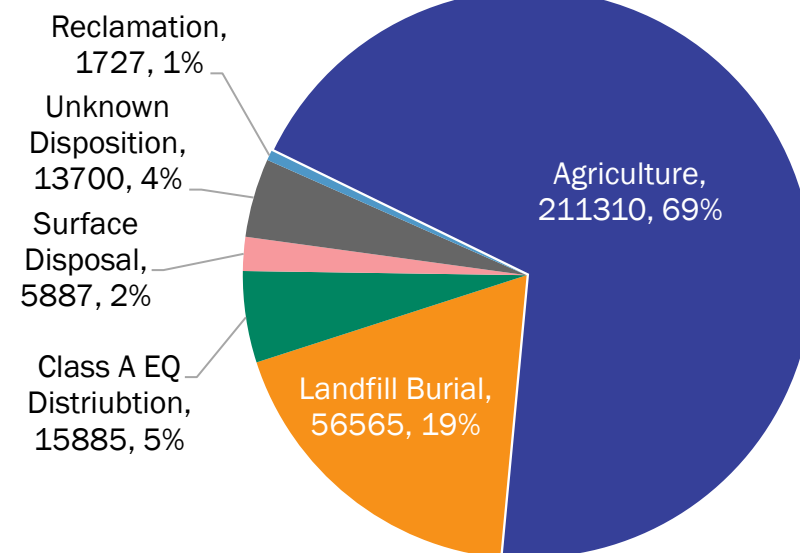
Estimated investments of >\$160M needed in the existing system (baseline) just to increase capacity and asset renewal



Market Assessment

- Consumer Interviews
 - 50 lb. bags, 1-ton bulk bags, truck loads, train carloads
 - Good impressions or open, but more education required
- Regional Competition
 - Strong regional competition in bagged consumer-grade biosolids
 - Opportunities for un-digested, Class A biosolids in the state

Illinois Biosolids Use & Disposal 2018



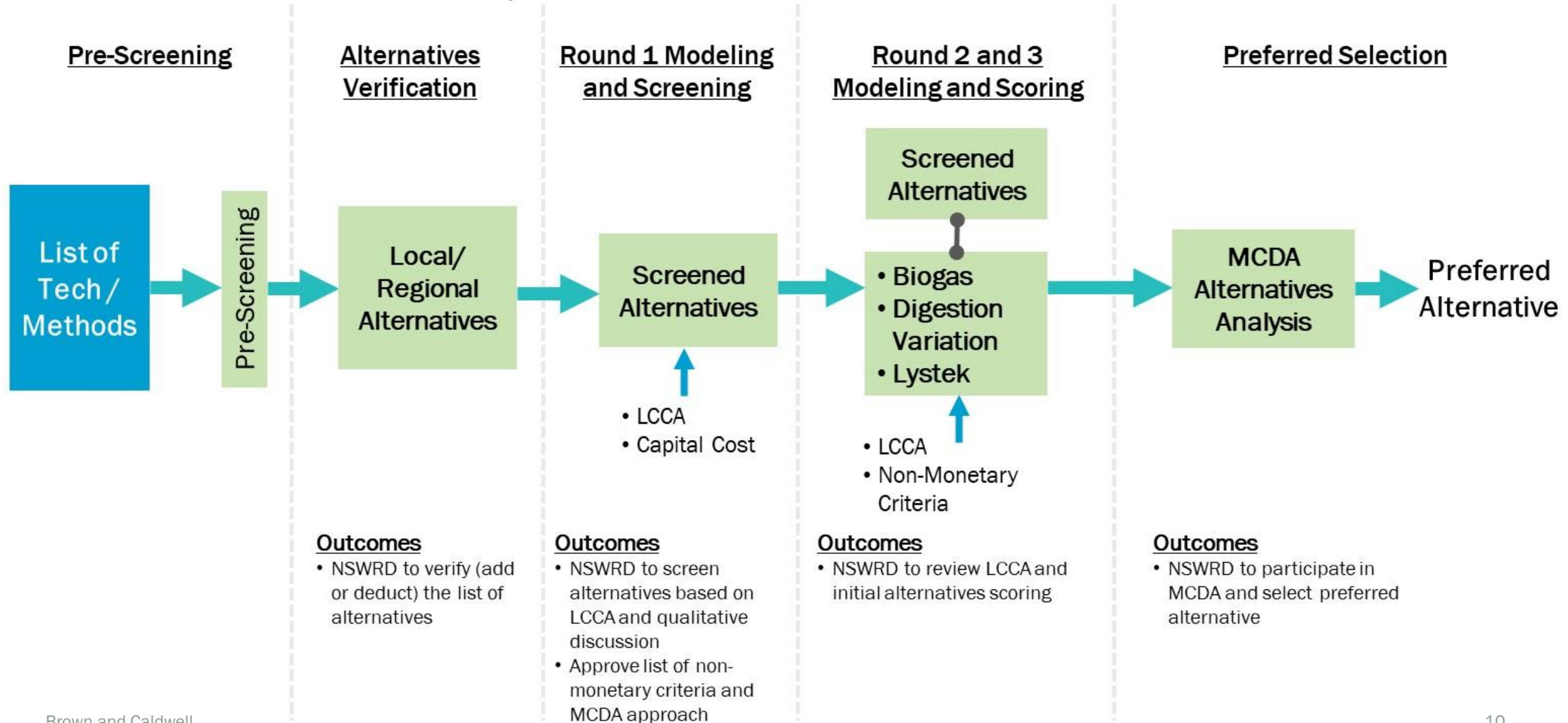
Class A, bulk/bagged thermally dried product, un-digested feedstock



Class A bulk/bagged dried product, digested feedstock



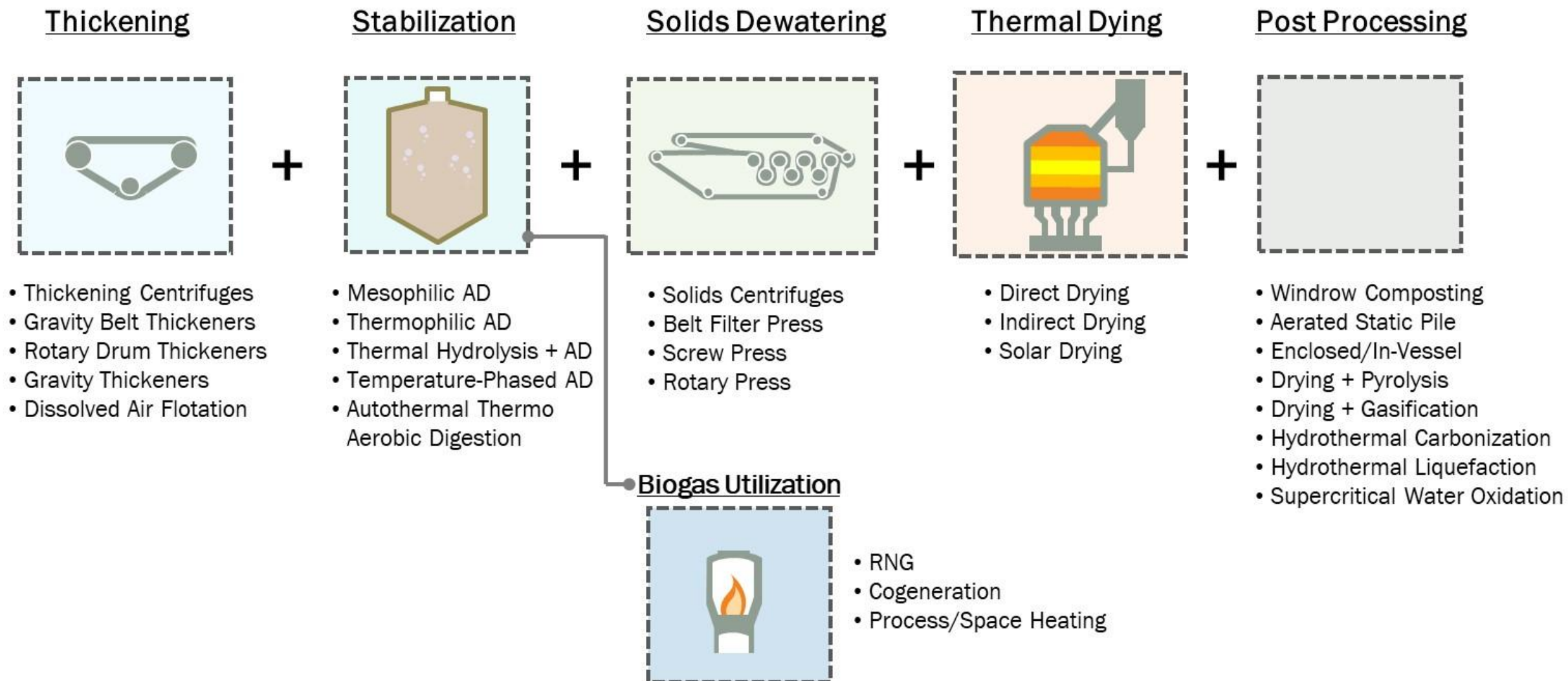
Alternatives Analysis Workflow



Pre-screening the Universe of Technologies



Universe of Technologies/Options



Pre-Screening

List of
Technologies/
Methods



Pre-Screen Criteria

1. Produces Class A Biosolids
2. Creates Program Resiliency
3. Compatibility with Existing Operating Scheme
4. Established/Mature



Screened Tech/Methods

Thickening

- Thickening Centrifuge
- Gravity Belt Thickener
- Rotary Drum Thickener

Digestion

- Mesophilic AD
- Thermophilic AD
- Thermal Hydrolysis + AD
- Temperature-Phased AD
- Thermo-Alkaline Hydrolysis + AD

Dewatering

- Centrifuge
- Belt Filter Press
- Screw Press
- Rotary Press

Drying

- Direct Drying
- Indirect Drying

Modeling Alternatives



A Look at Many Alternatives, with a Structured Approach

270 → 9

Round 1: Local versus Regional

25

Round 2: Stabilization and Energy Variations

5

Round 3: End to End Alternatives

1

Preferred Alternative

Round 1: Development of Alternatives

Starting with regionalization

- No existing system, economies of scale, consolidated staffing

Objectives:

- Is there a financial benefit to regionalization or is it better to process locally?
- How would regionalization look?
- Is there an advantage to advanced (Class A) digestion?
- What is the best way to move solids around the system in a regional scenario?

Methodology:

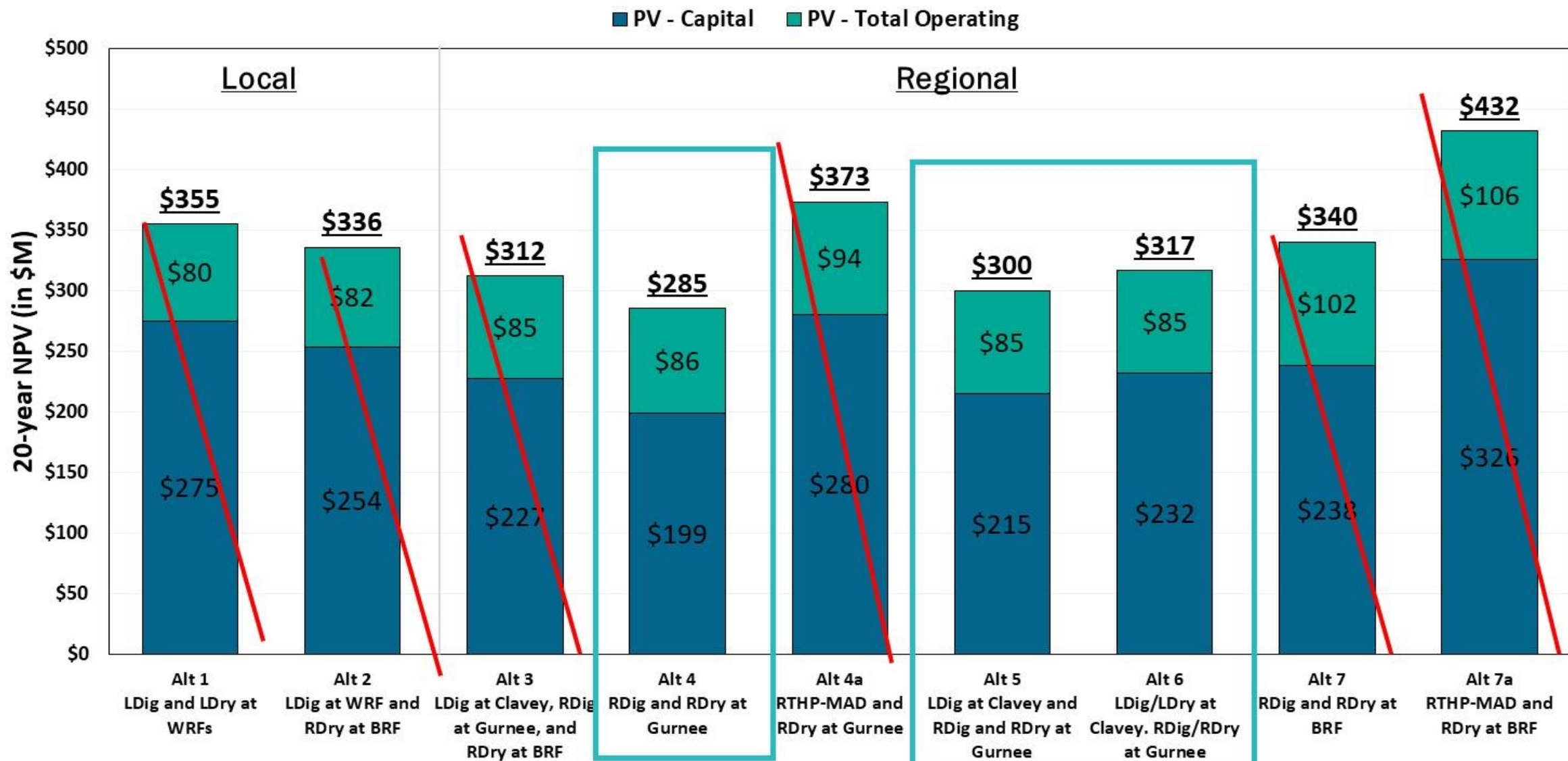
- All solids processing technologies held constant; size/location varied
- Parallel in-depth drying analysis
- Held Constant: GBT, MAD, centrifuges, biogas flaring, and belt dryers

Round 1 Alternatives

		Waukegan		Gurnee		Clavey Road		Zion	
		Digester	Dryer	Digester	Dryer	Digester	Dryer	Digester	Dryer
Local	Alternative 0 (Baseline)								
	Alternative 1								
	Alternative 2								
Regional	Alternative 3								
	Alternative 4								
	Alternative 4a								
	Alternative 5								
	Alternative 6								
	Alternative 7								
	Alternative 7a								



Round 1: LCCA



Round 1: Conclusions

- Clear benefits to regional digestion, not necessarily true for drying
- Force main between Waukegan WRF and Gurnee WRF advantageous
- THP-MAD expensive solution for regionalization (dewatered cake)
- Local alternatives improved redundancy and independence but at cost

Alternatives to Round 2

Alt 4: Regional digestion and drying at Gurnee WRF

Alt 5: Local digestion at Clavey Rd; Regional digestion and drying at Gurnee

Alt 6: Local digestion and drying at Clavey Rd; Sub-regional digestion and drying at Gurnee

Round 2: Development of Alternatives

Parallel evaluations of stabilization and gas utilization

Objectives:

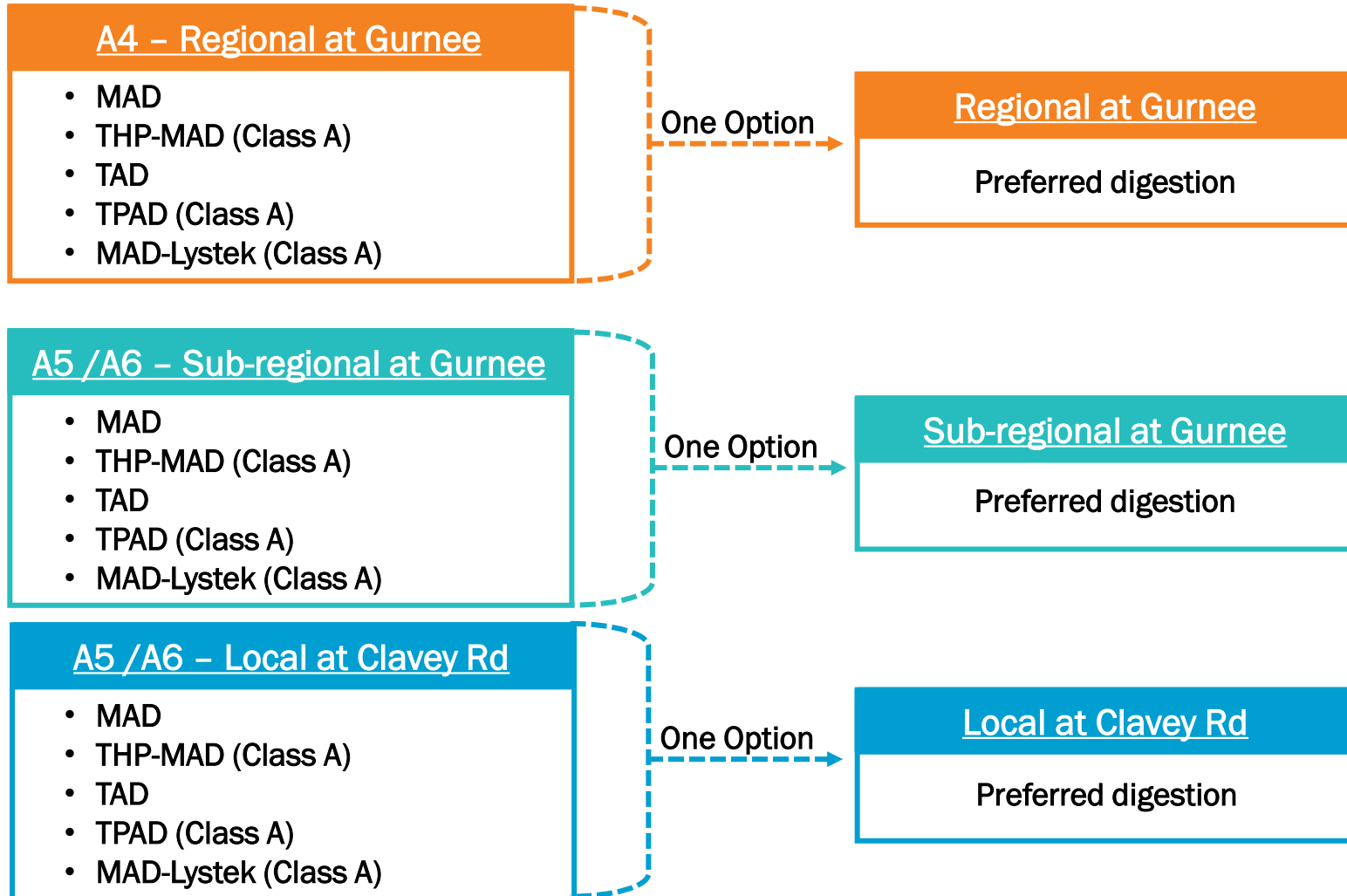
- What gas utilization strategies pair best financially with the selected solids stabilization?
- What types of stabilization and gas treatment processes can take advantage of economies of scale?

Methodology:

- Solids stabilization and biogas utilization evaluated separately
- Held Constant:
 - Biogas flaring with varying solids stabilization
 - MAD with varying biogas utilization

Round 2 Alternatives - Solids

Digestion Selection

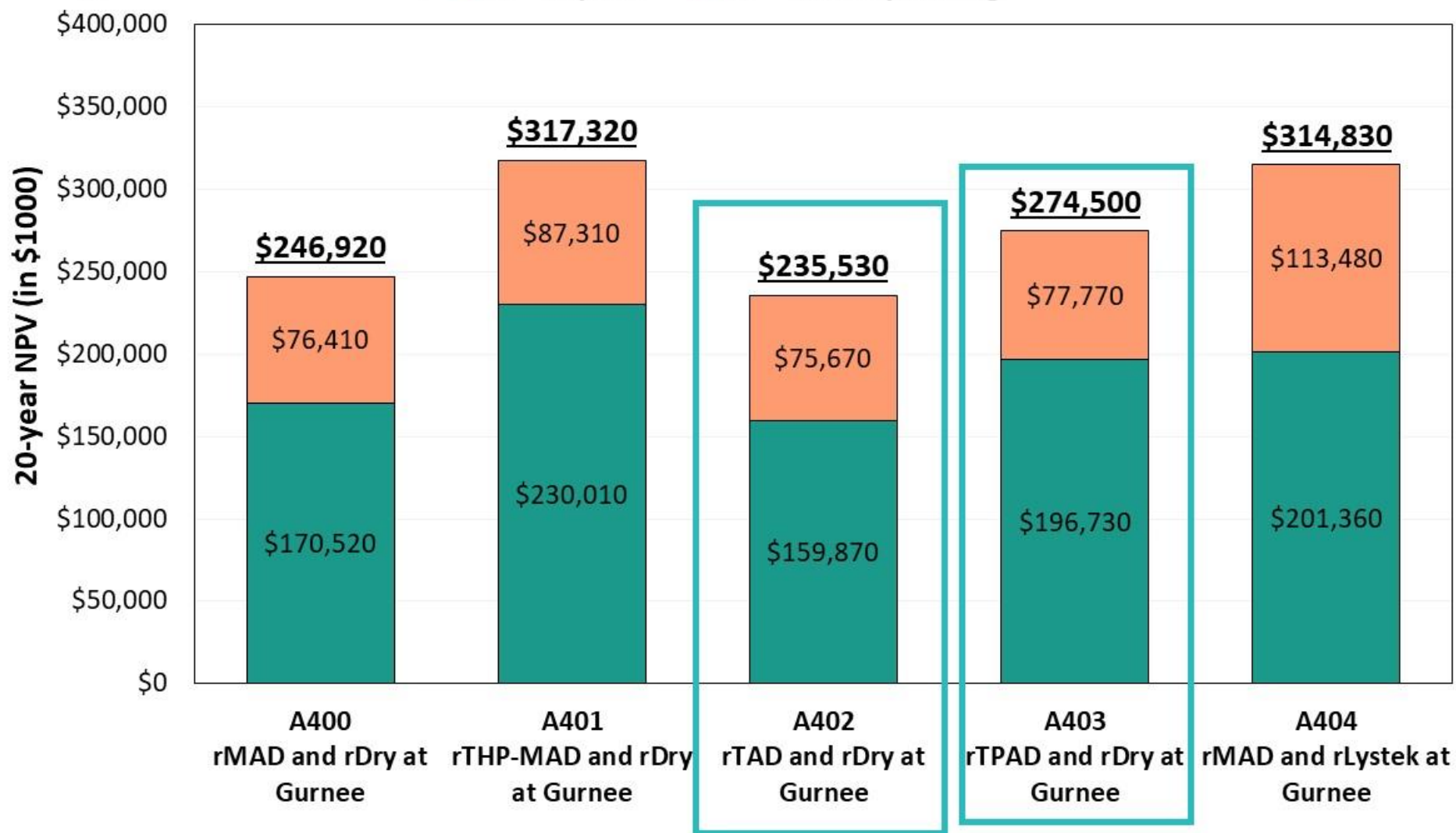


Round 2: Solids LCCA

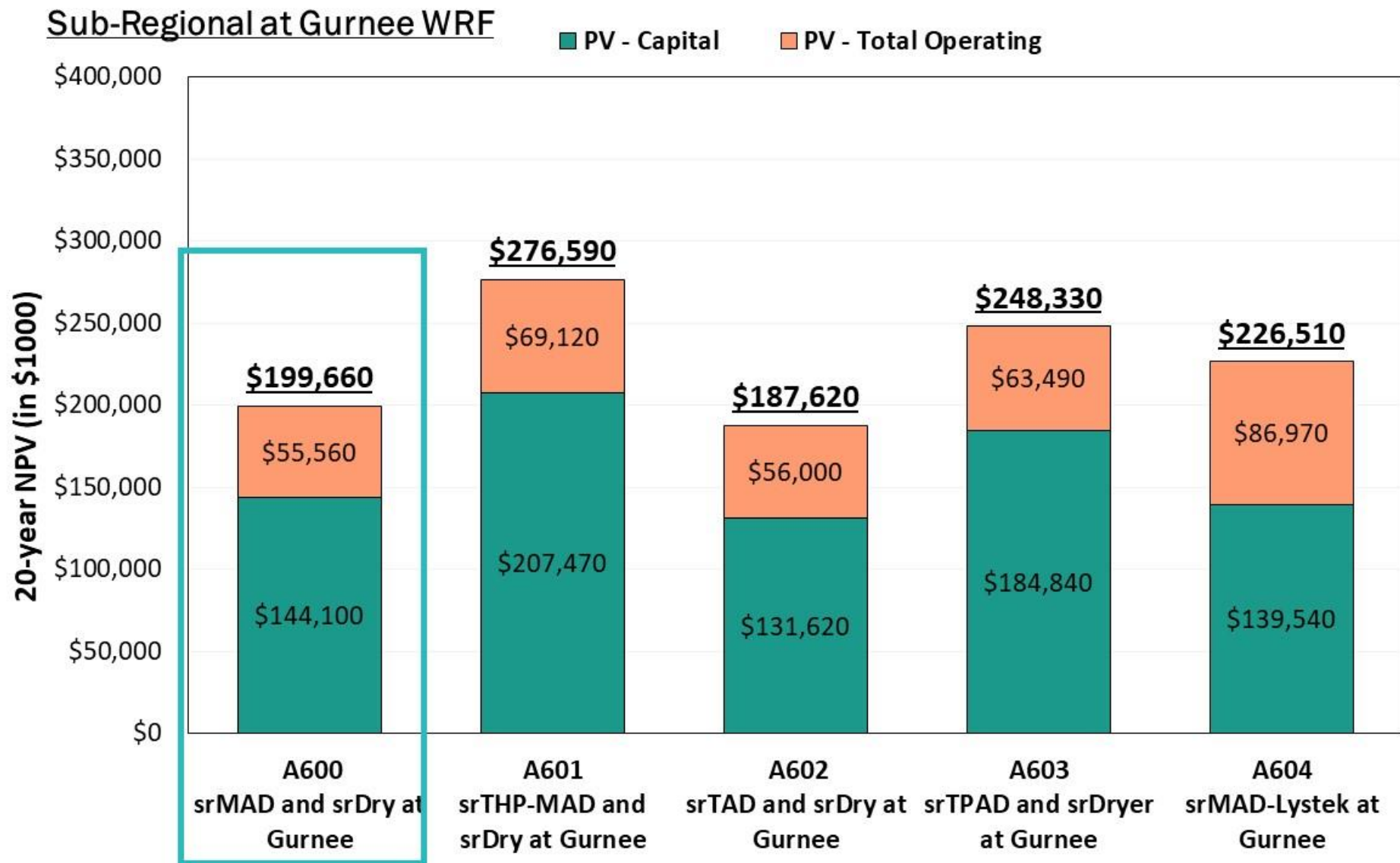
Full Regional at Gurnee WRF

PV - Capital

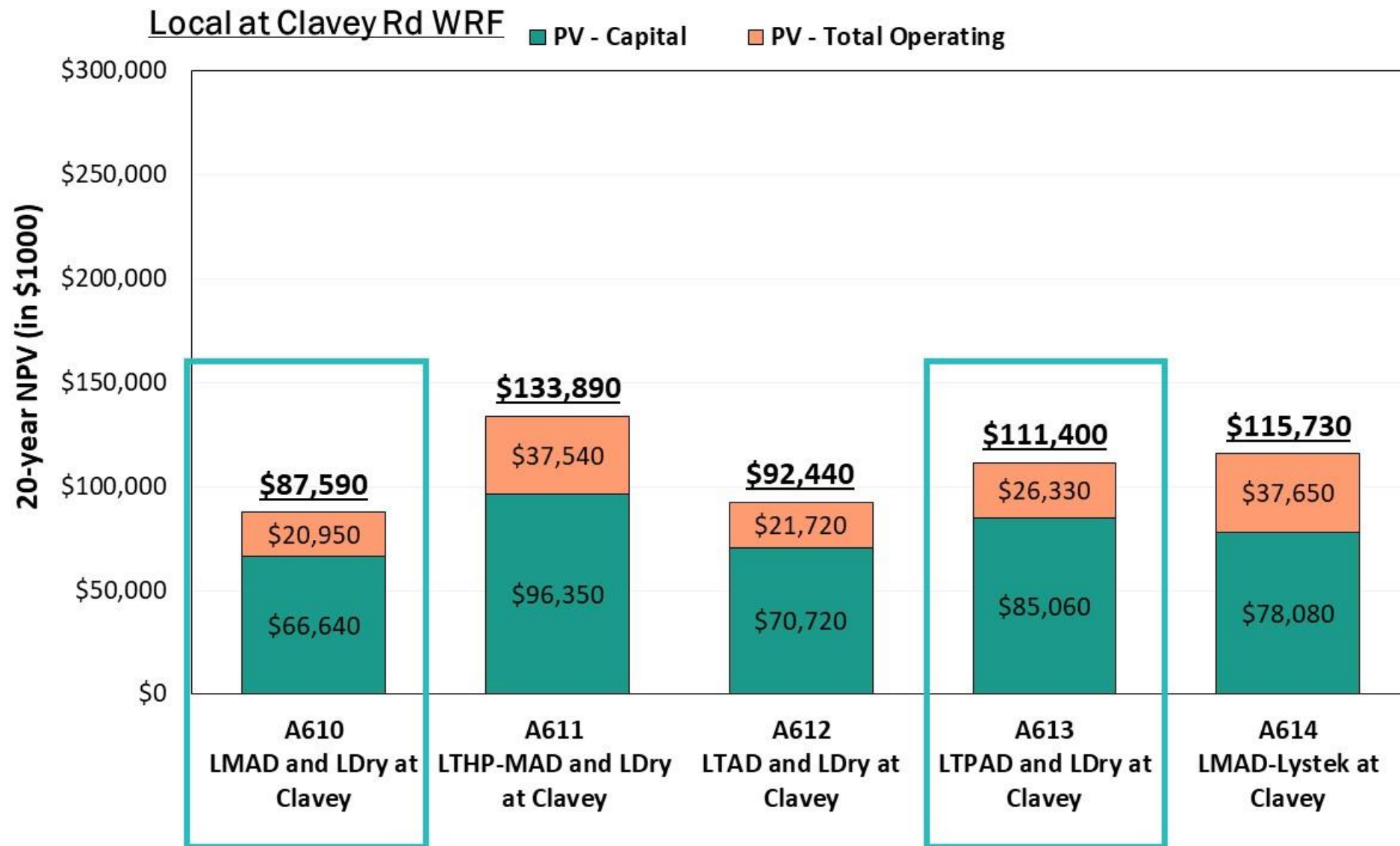
PV - Total Operating



Round 2: Solids LCCA

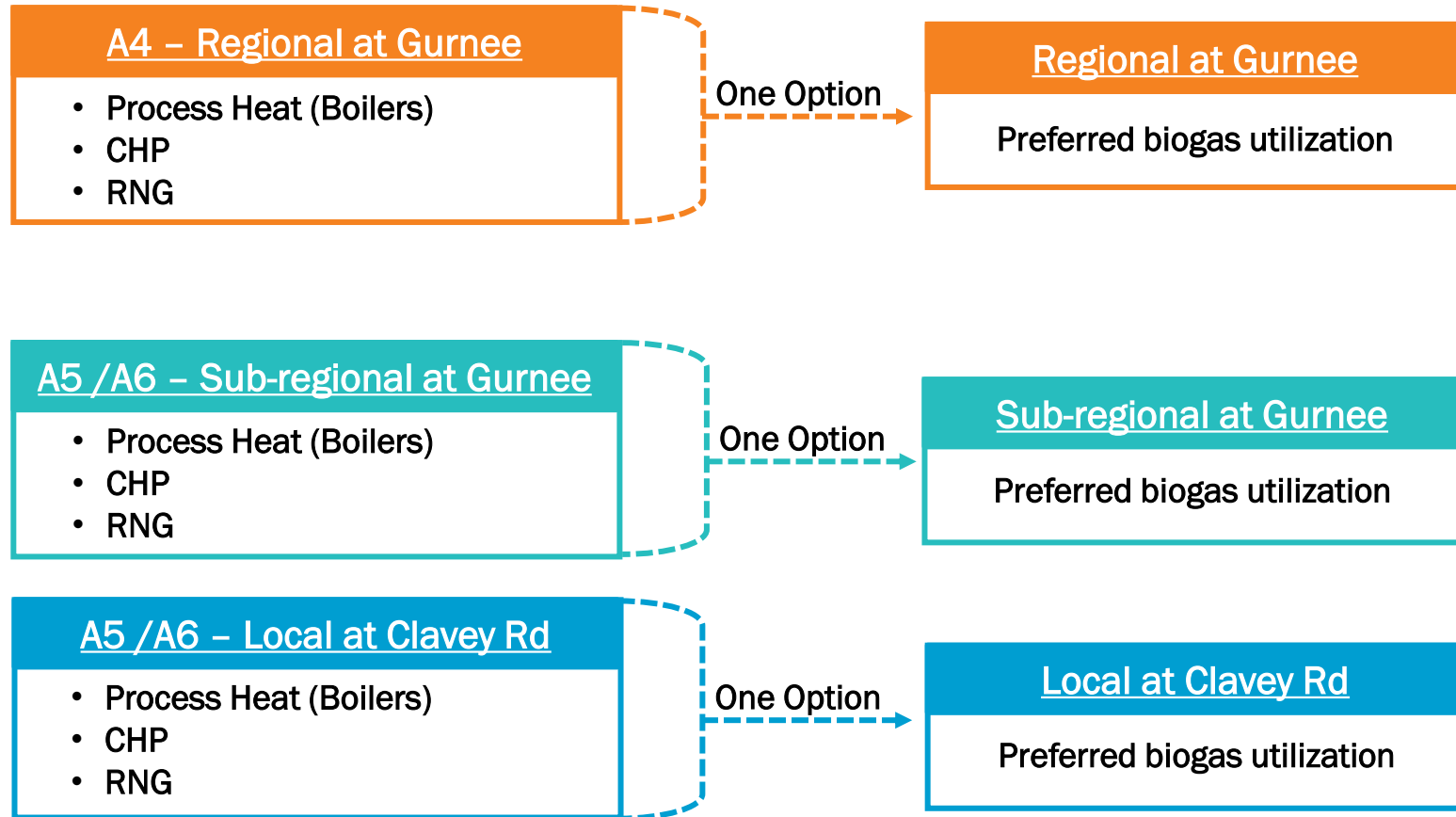


Round 2: Solids LCCA

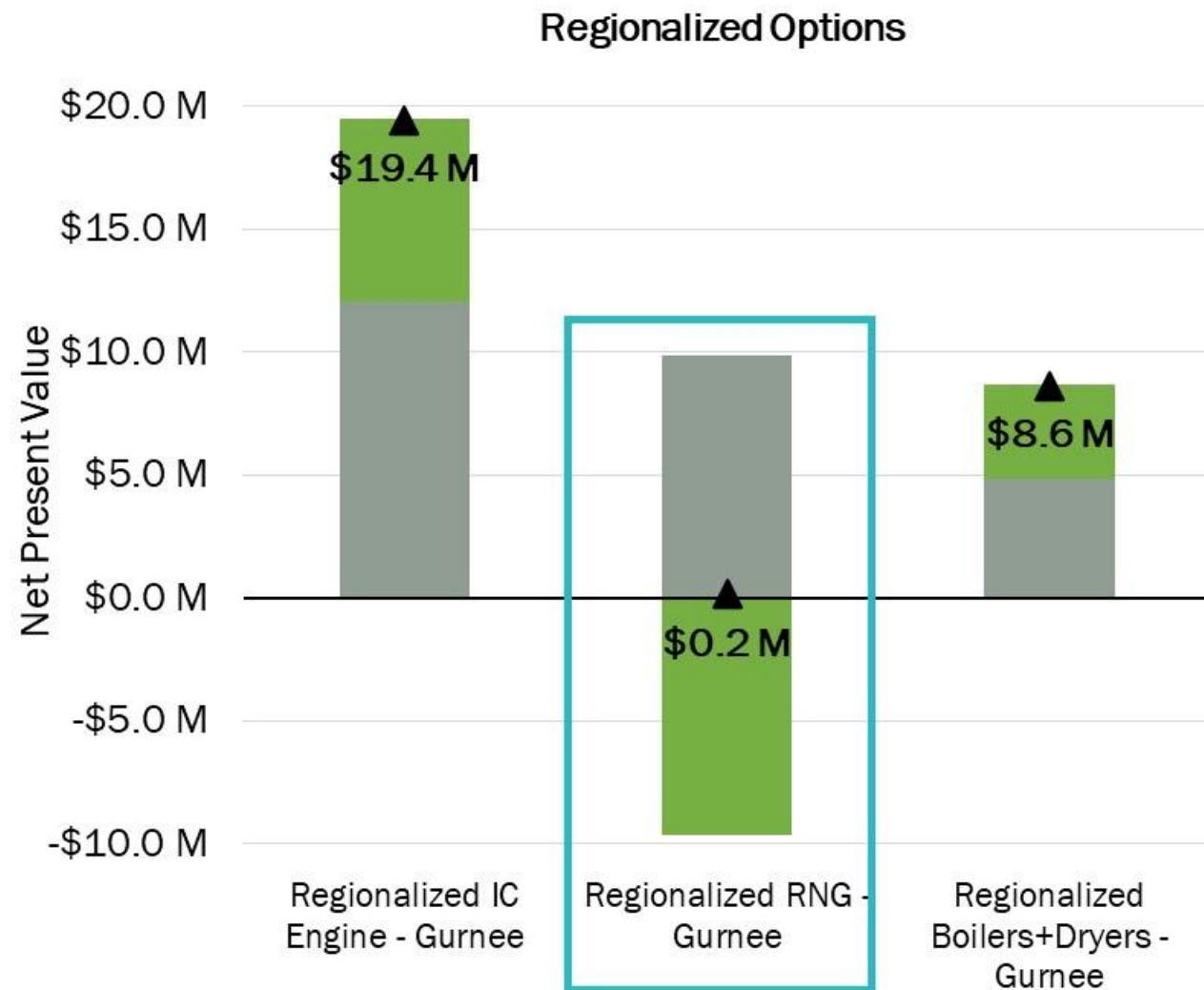
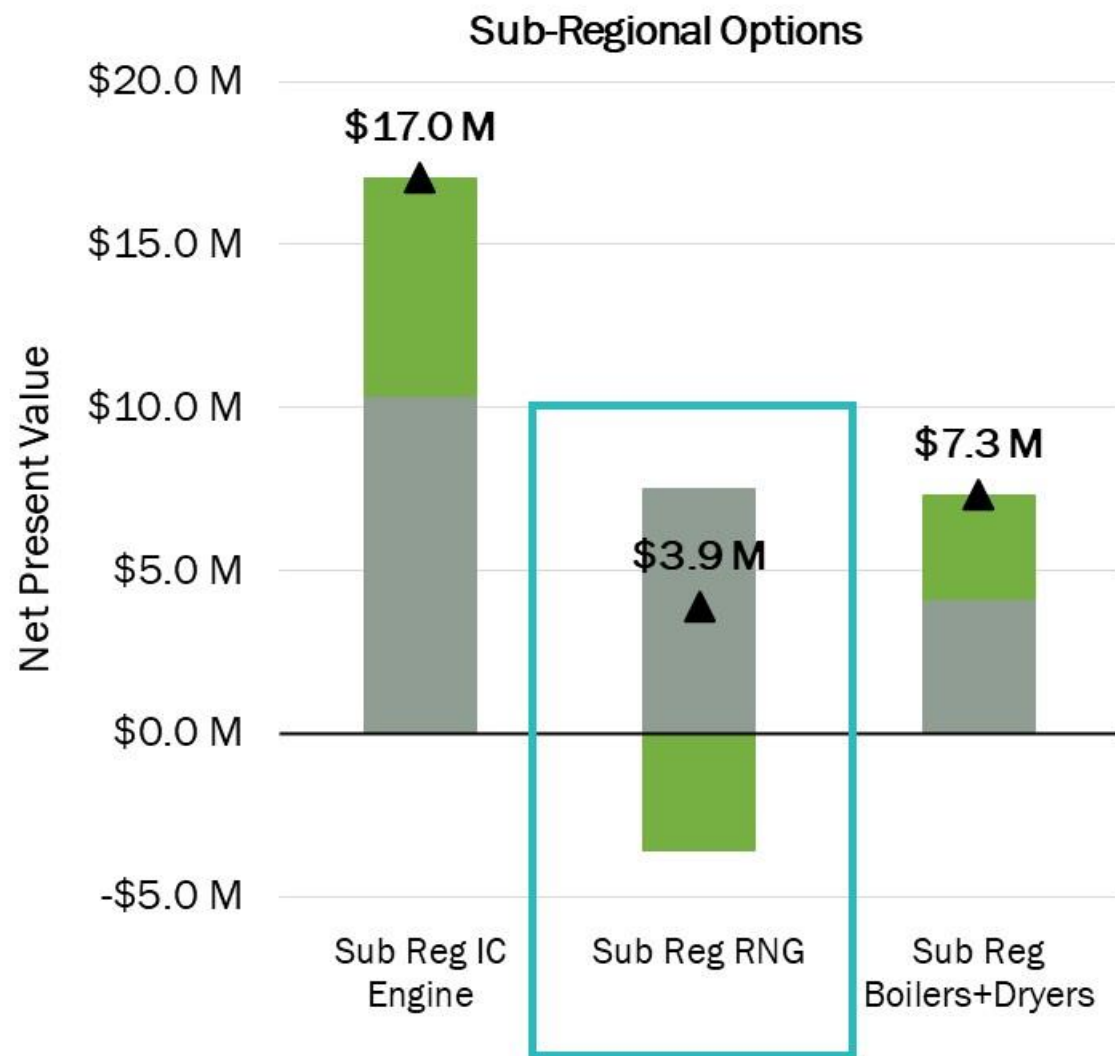


Round 2 Alternatives - Biogas

Gas Utilization Selection

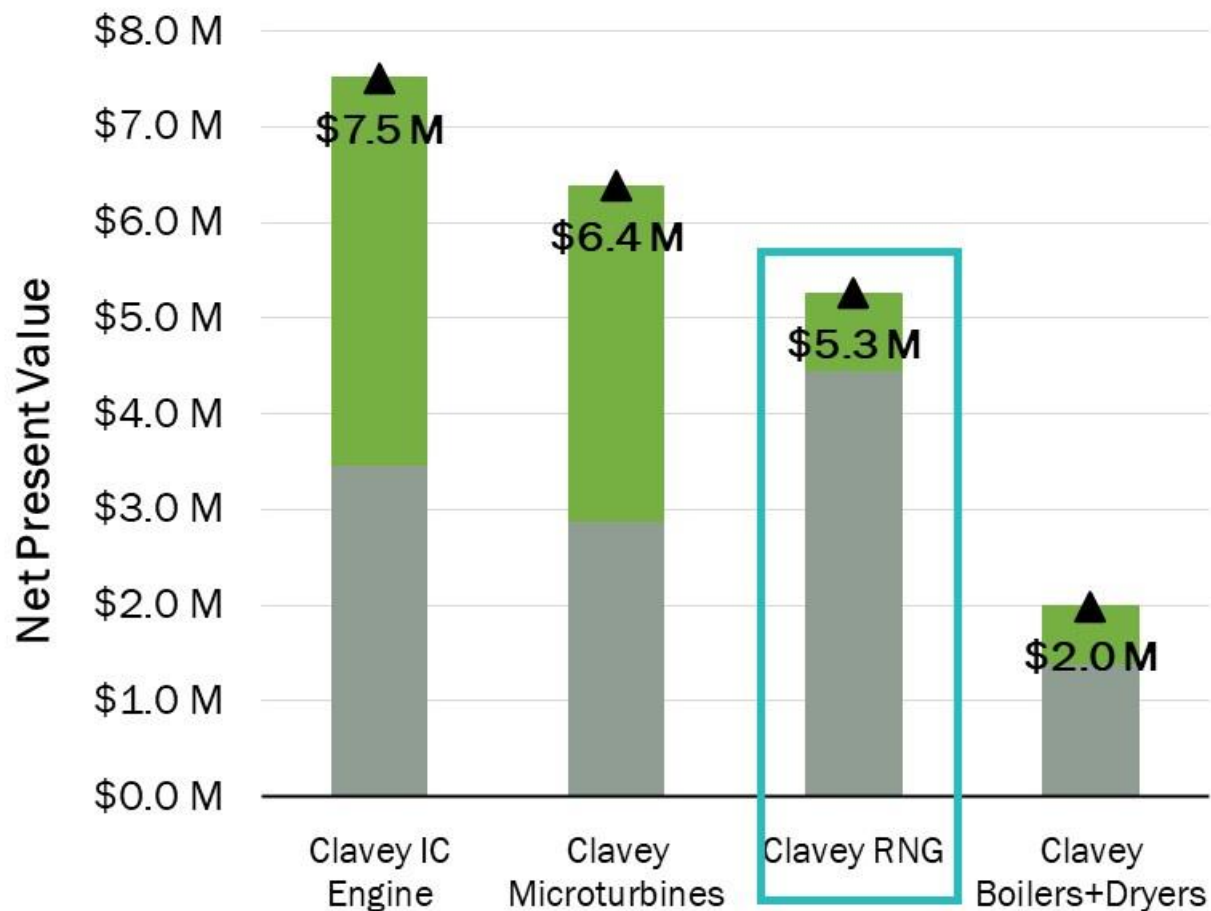


Round 2: Biogas LCCA

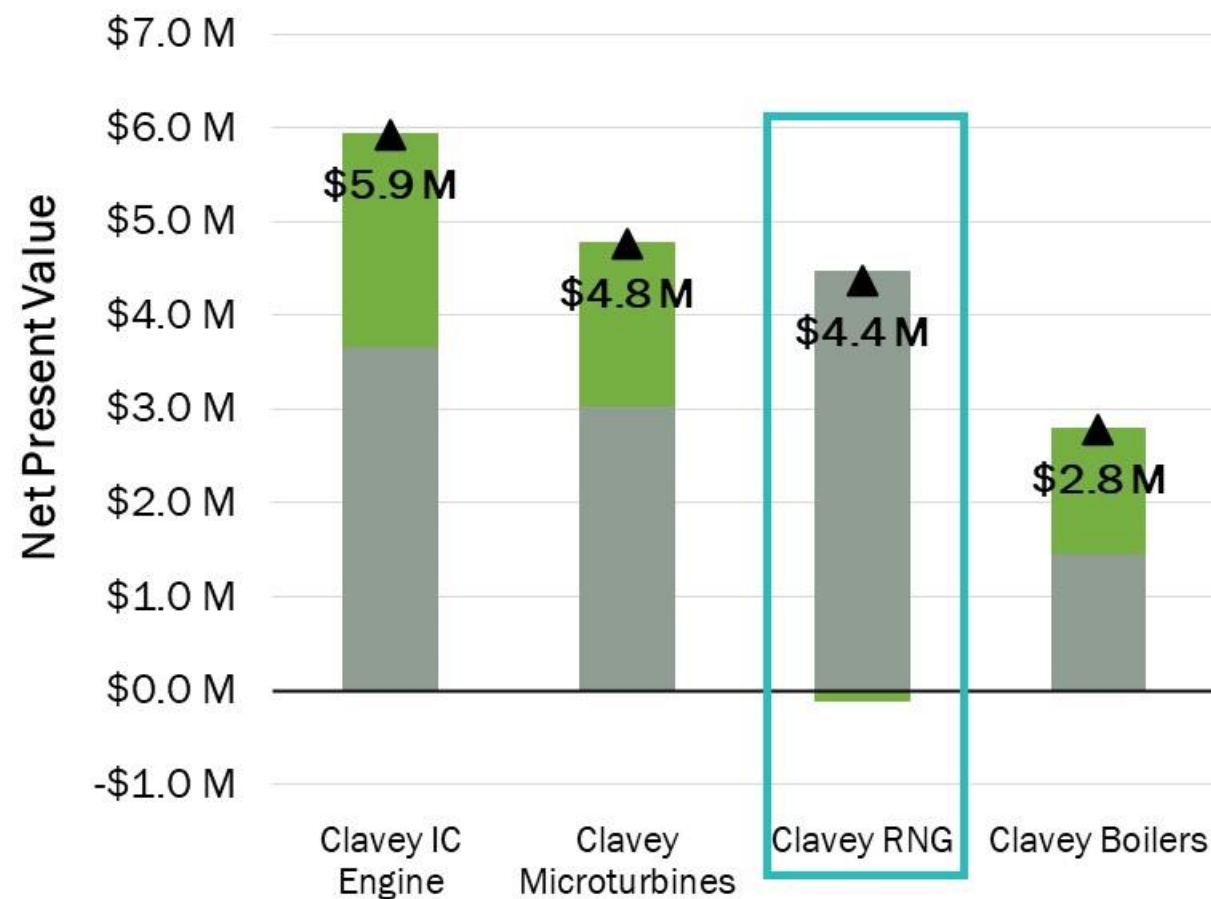


Round 2: Biogas LCCA

Clavey Rd WRF Options - Dryers



Clavey Rd WRF Options - No Dryers



Round 2: Conclusions

- Clavey Rd WRF's biogas production is too low to make current biogas options feasible
 - RNG was selected for potential to access IRA Funding
- TAD and MAD tend to be cheapest options
- TPAD cheapest Class A option
- Selection to Round 3 based on interest from NSW RD

A – Sub-regional at Gurnee

- MAD, Belt Dryer, RNG @ Gurnee
- MAD, Belt Dryer, Boiler @ Clavey

B – Sub-regional at Gurnee

- MAD, Belt Dryer, RNG @ Gurnee
- TPAD, RNG @ Clavey

C – Regional at Gurnee

- TAD, Belt Dryer, RNG @ Gurnee

D – Regional at Gurnee

- TPAD, Belt Dryer, RNG @ Gurnee

Round 3: Development of Alternatives

Compare end-to-end alternatives developed through Rounds 1 & 2 with the baseline

Objectives:

- Select preferred alternative that achieves all the program goals
- Reach consensus on selection

Methodology:

- Baseline assumes an upgraded BRF to increase capacity
- Waukegan-Gurnee force main included
- Structured decision support framework in terms MCDA

Round 3: Alternatives

Alt Oa – Baseline

- Capacity expansion at BRF
- Repair and replace at Gurnee, Clavey Rd, Waukegan WRF

Alt A – Sub-regional at Gurnee WRF

- MAD, Belt Dryer, RNG @ Gurnee WRF
- MAD, Belt Dryer, Boiler @ Clavey Rd, WRF

Alt B – Sub-regional at Gurnee WRF

- MAD, Belt Dryer, RNG @ Gurnee WRF
- TPAD, RNG @ Clavey Rd WRF

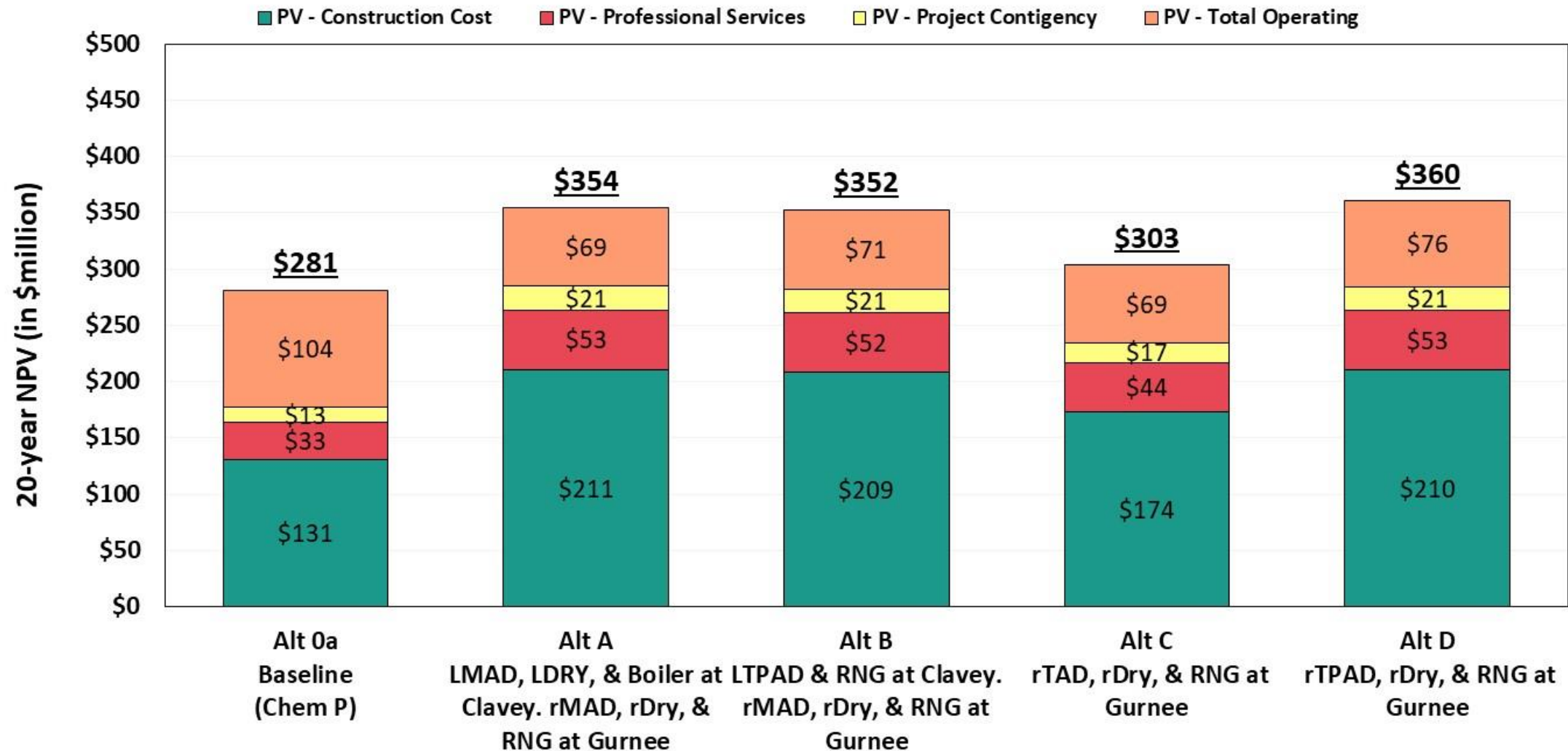
Alt C – Regional at Gurnee WRF

- TAD, Belt Dryer, RNG @ Gurnee WRF

Alt D – Regional at Gurnee WRF

- TPAD, Belt Dryer, RNG @ Gurnee WRF

Round 3: Life Cycle Cost Analysis (LCCA)



Multiple Criteria Decision Analysis (MCDA)

Clear and defensible decision-support framework

- Non-monetary criteria, defined and weighted by stakeholders
- Within each criteria, rank the alternatives best to worst
- Aggregate scores
- Scaled benefits to compare against NPV LCCA



Buying a Car



Safety

Comfort

Range

Speed

Reliability

Fuel Use

Cost

Round 3: Non-Monetary Criteria

Technical:

- O+M friendly/easy to own
- Compatible with existing operation
- Maximize regulatory and market resiliency
- Technology maturity
- Modernization

Environmental:

- Minimize carbon footprint
- Maximize beneficial use of recoverable resources

Social:

- Minimize community impact (truck traffic, noise, visual aesthetic)
- Minimize odors



Performance Metrics

Parameters	Alt Oa Baseline (Chem P)	Alt A LMAD, LDry, & Boiler at Clavey. rMAD, rDry, & RNG at Gurnee	Alt B LTPAD & RNG at Clavey. rMAD, rDry, & RNG at Gurnee	Alt C rTAD, rDry, & RNG at Gurnee	Alt D rTPAD, rDry, & RNG at Gurnee
Hauling, Trucks/yr ¹	3,269	4,243	4,546	6,020	6,022
Hauling (FM), Trucks/yr ¹	3,269	385	688	2,162	2,164
Biogas Use, scf/yr	0	133,521	142,599	160,134	158,626
GHG Emissions, MT CO ₂ e/yr	13,038	2,581	3,158	1,482	1,560
GHG Emissions (FM), MT CO ₂ e/yr	13,037	2,436	3,013	1,339	1,416

1. Includes inter-plant hauling and final product

Select a Stakeholder

☒ Select all

☐

☐

☐

☐

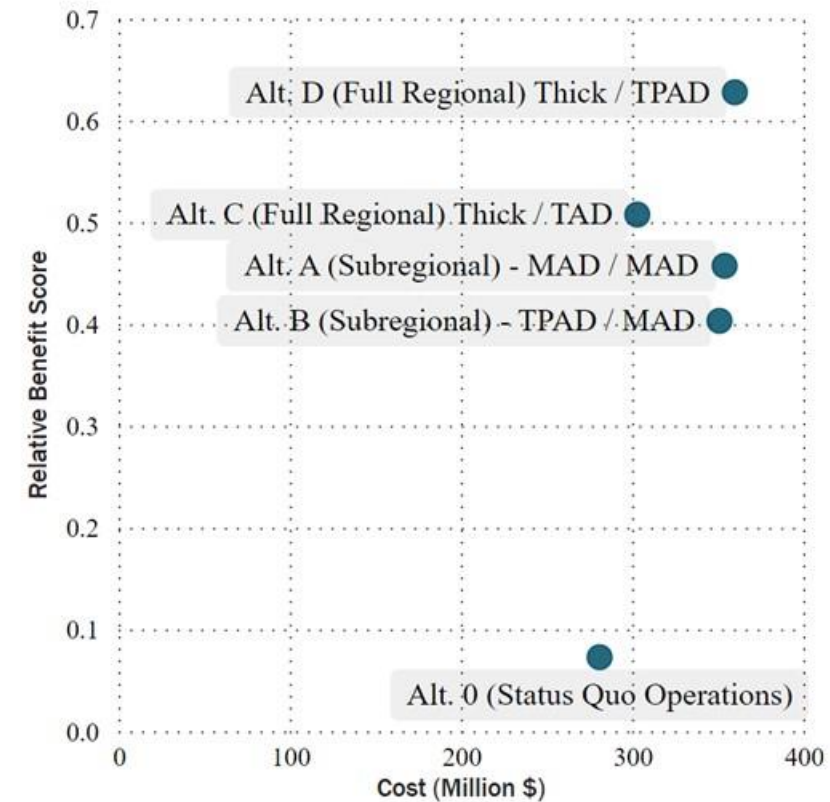
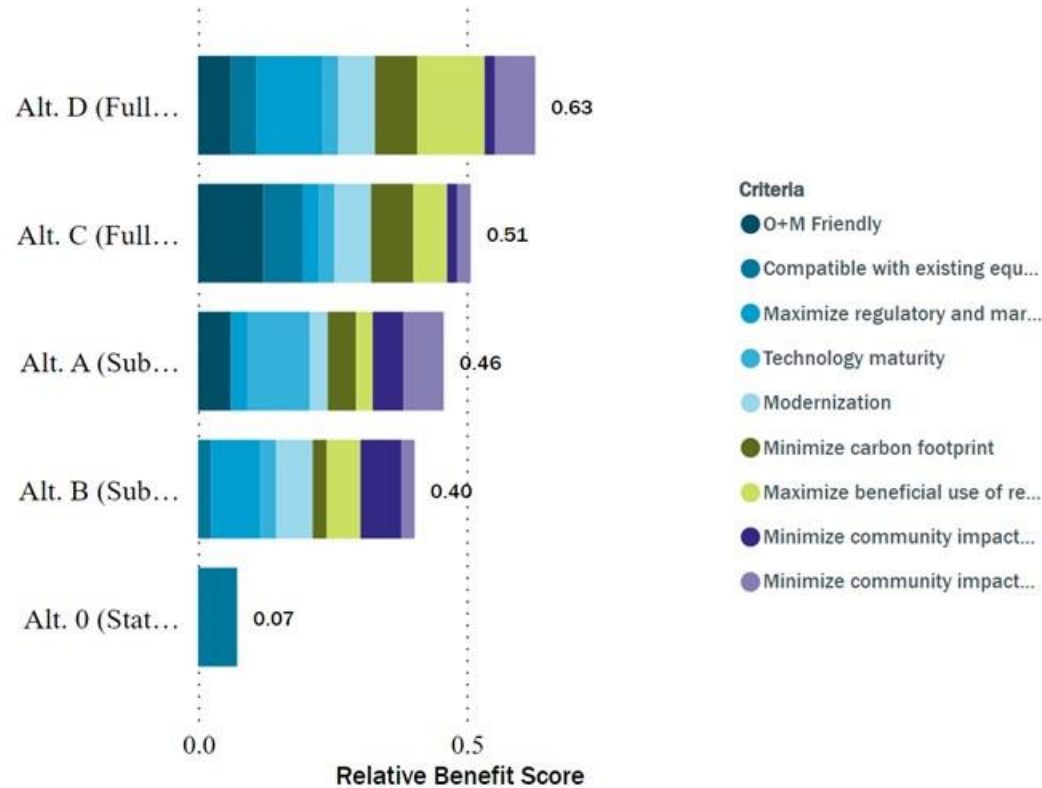
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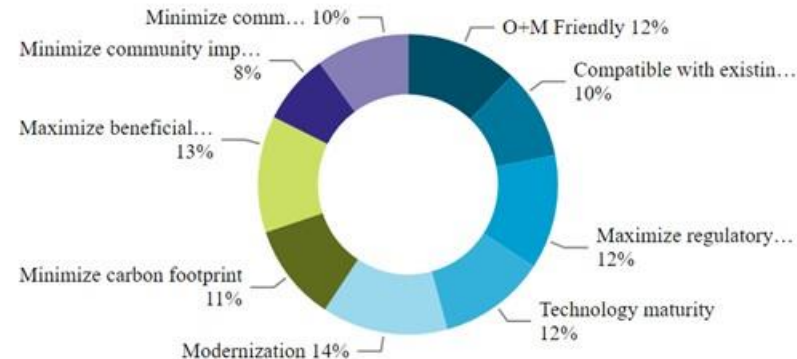
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Non-economic Criteria Were Used to Highlight Differential Benefits Among Alternatives.

Average Weight of Selection



Sum of Weights

100%

Stakeholders Selected

9

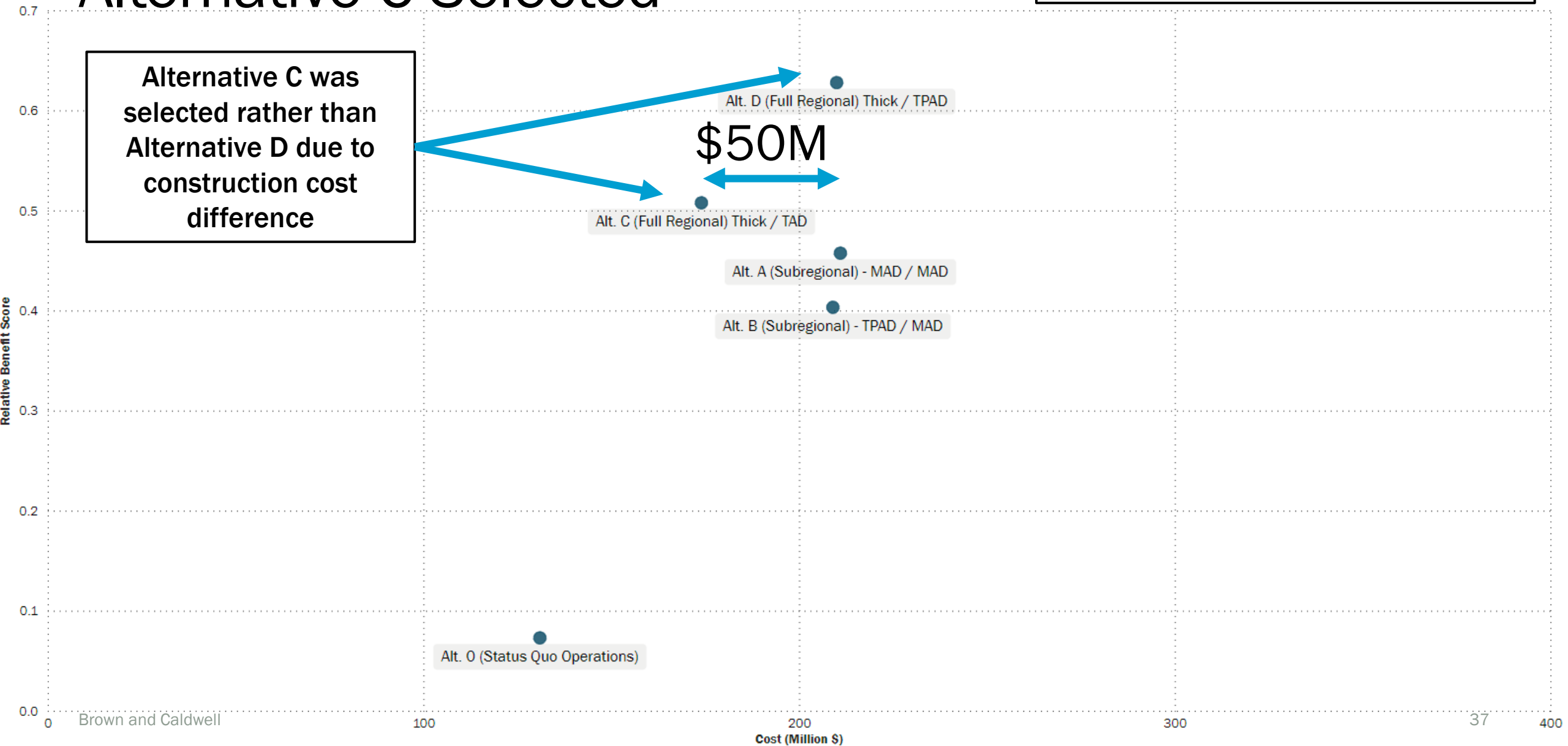
Select a Cost Type

- ☐ Construction Cost
- ☐ Construction Cost (30% IRA)
- ☒ Net Present Value
- ☐ Net Present Value (30% IRA)

Alternative C Selected

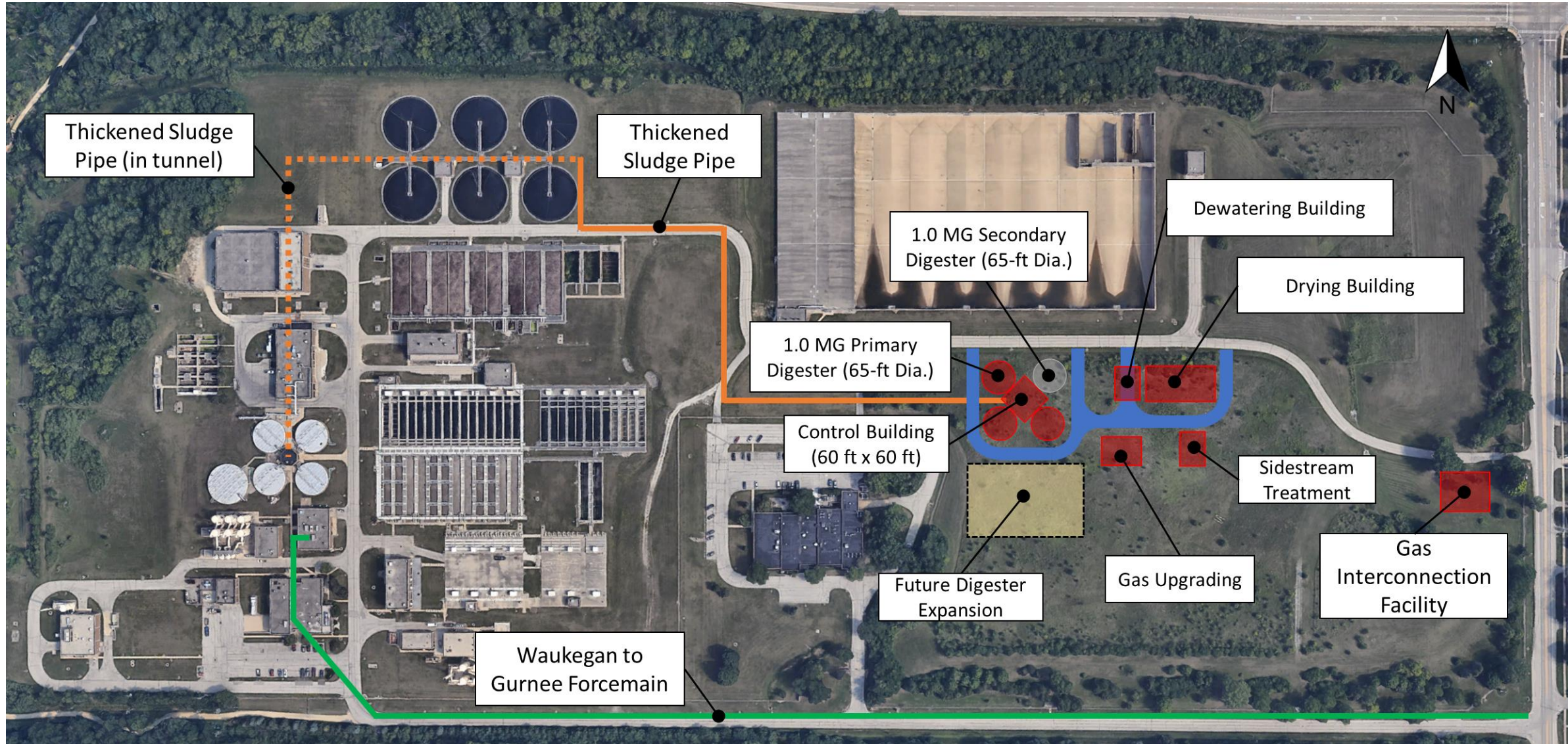
Direct Construction Cost without IRA

Alternative C was selected rather than Alternative D due to construction cost difference



SELECTED ALTERNATIVE:

Regional Digestion and Drying at Gurnee WRF



Development of Projects

ID	Projects	Benefits	Direct Construction Cost ¹
1a	Gurnee WRF - New Regional Digesters, Dewatering Facility, Sidestream Treatment, Solids Receiving Station Waukegan WRF – Solids Hauling Station	✓ Solids reduction ✓ Solids stabilization (improved product quality) ✓ Biogas/energy production	\$66M - \$94.2M - \$141M
1b	Gurnee WRF – Renewable Natural Gas (RNG) Energy Recovery	✓ Biogas/energy utilization ✓ RNG revenue / cost offset	\$7.5M - \$10.8M - \$16.1M
1c	Gurnee WRF - Digester Expansion	✓ Solids reduction ✓ Increase biogas/energy production ✓ Replace aging digesters at Clavey RD WRF	\$11.3M - \$16.1M - \$24.1M
2	Gurnee WRF - Thickening Improvements	✓ Increased capacity	\$9.1M - \$13.0M - \$19.5M
3	Clavey Rd WRF - Thickening Improvements	✓ Increased capacity	\$5.2M - \$7.40M - \$11.1M
4	Waukegan to Gurnee WRF – Solids Forcemain	✓ Reduced truck traffic	\$12.9M - \$18.4M - \$27.5M
5	Gurnee WRF – Biosolids Belt Drying Facility	✓ Energy reduction ✓ Improved facility operability / ability to operate with NSWRD staff	\$25M - \$35.8M - \$54M
TOTAL			\$137M - \$196M - \$293M

1. AACEI Class 4 estimate -30% to +50% in 2023 dollars

A Flexible and Adaptive Plan

Based on several industry trends, contingent projects were identified beyond the core program that can be implemented if certain triggers occur.

What if...

PFAS regulations impact biosolids land application?

PROJECT 6

Implement Pyrolysis Contract or NSWRD Operated

Cost - \$17M - \$24M - \$48M

Chemical costs increase significantly?

Struvite impacts operations?

Regulations change and land application is limited by a phosphorus application rates?

PROJECT 7

Phosphorus Recovery at Gurnee WRF

Cost - \$7M - \$10M - \$20M

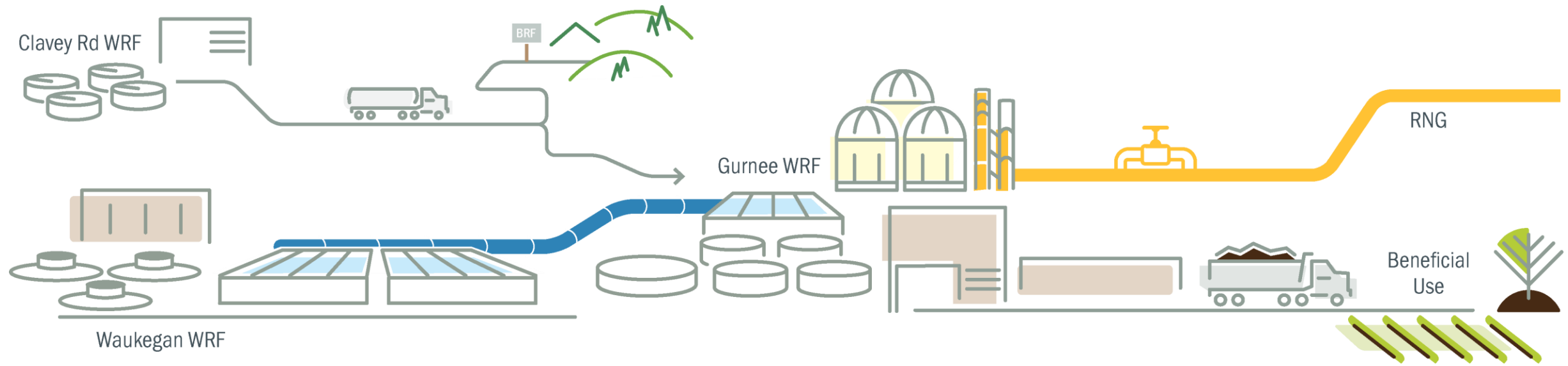
Hauling cost escalate significantly?

Community impacts?

PROJECT 8

Clavey to Gurnee Forcemain

Cost - \$33M - \$48M - \$71M



Through this process, the district now has a biosolids management plan that reduces their solids volumes, adds resiliency and operational redundancy, and creates renewable energy.

Working Towards our BODR

- ✓ Liquid Stream Special Sampling
- ✓ Surveying/Preliminary Field Work
- ✓ Clarifier Stress Testing
- ☐ Flows and Loads
- ☐ Solids Process Analysis
- ☐ Digester Pilot Study
- ☐ Permitting Outreach



Lessons Learned (so far...)

- Audit Sample Points
 - Is location representative?
 - Is the data received useful?
- Are lab tests being conducted properly?
- PLC Data Usefulness
 - Verify if calculated or measured
 - Fix logic and calculation problems as they occur
- Shipping Sludge can be challenging!



Thank you.
Questions?

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Brown AND **Caldwell** :



For PDH Certificate seekers,

The link to the new on-line course evaluation form has been posted in the Chat. The link is also available on the District website. The form will **only** be available online until the start of next month's seminar. Please be sure to fill it out and submit promptly.

