Hybrid Treatment Technologies for Upgrading a Lagoon-Based WWTP

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City of Camrose

- The “Rose City”
- ~1 hour SE of Edmonton, Alberta
- ~20,000 population
- 1 to 1.5% annual growth rate

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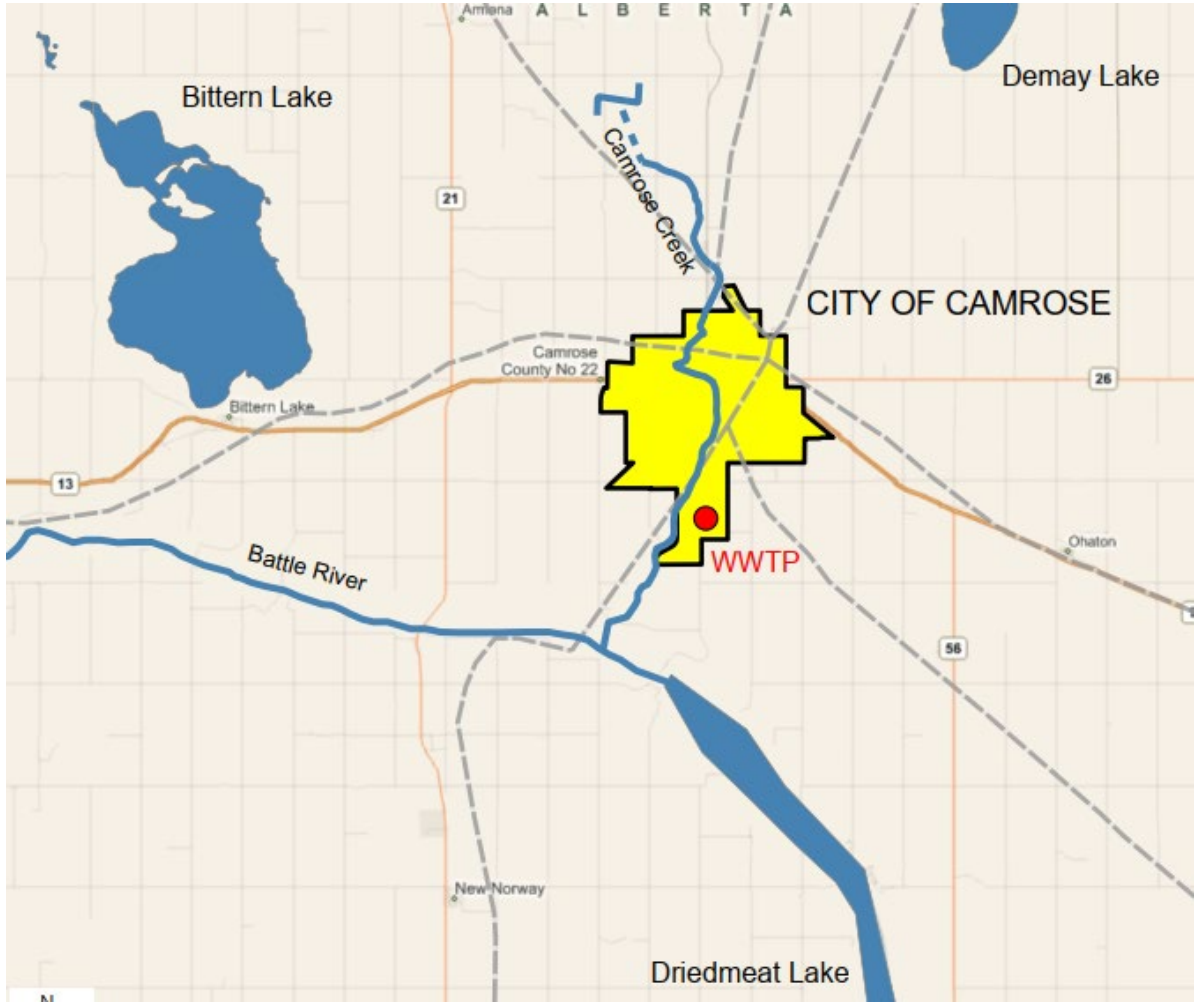
Camrose WWTP

- Located at the south end of Camrose
- Currently consists of aerated lagoons (3), and treated wastewater storage lagoons (6)
- Discharge treated wastewater to the Battle River via Stoney Creek (spring and fall)



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Camrose WWTP

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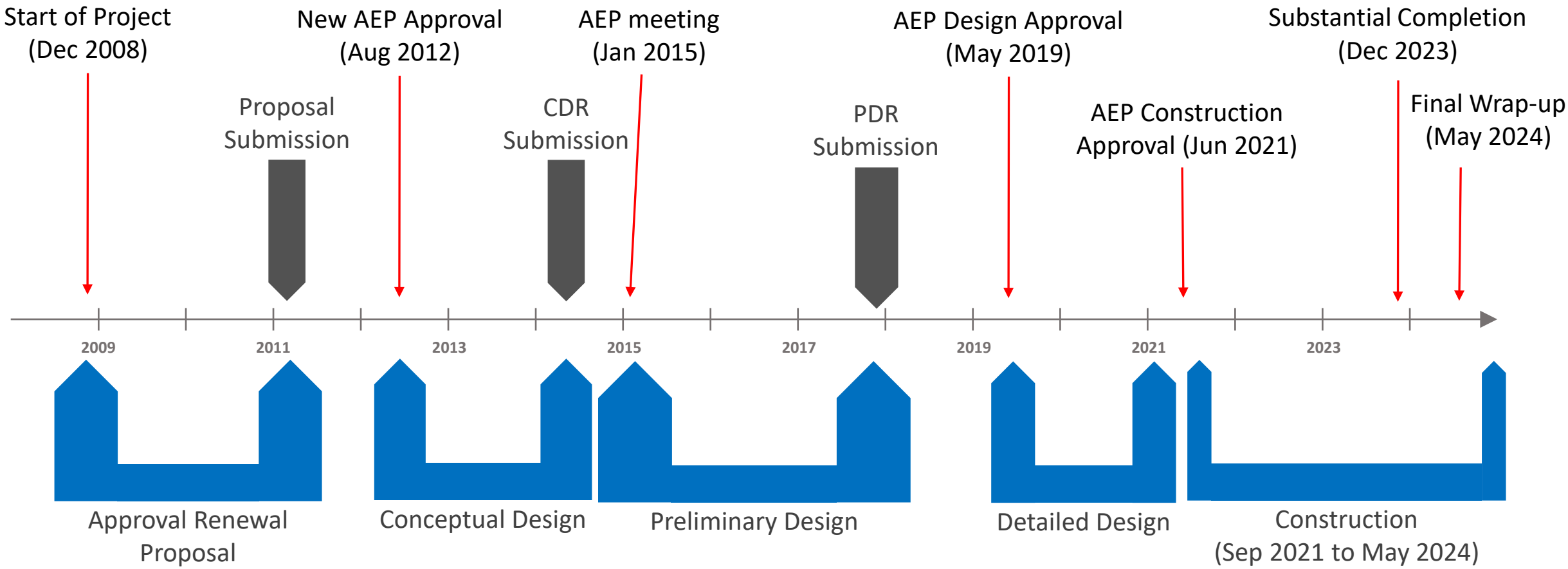
Key Milestones



Stages in WWTP Design / Construction Process

Summary of Approval Requirements

Parameter	Existing Limit	New Treatment Requirement	Regulatory Authority / regulation
cBOD	< 25 mg/L	< 20 mg/L	AB Environment & Protected Areas (AB EPA)
TSS	---	< 20 mg/L	AB EPA
NH_3-N, summer	---	< 5 mg/L	AB EPA
NH_3-N, winter	---	< 10 mg/L	AB EPA
NH_3, Un-ionized	---	< 1.25 mg/L	Wastewater Systems Effluent Regulations (WSER)
P	---	< 1mg/L	AB EPA
Total residual Cl	---	< 0.02 mg/L	WSER
Acute toxicity	---	Not acutely lethal (pass the LC-50 test)	WSER
E. coli	---	< 200 CFU / 100 mL	AB EPA

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Approval Renewal Proposal (2008-2011)

- Dec 2008
  - City retained Associated Engineering (AE)
  - Approval renewal proposal, conceptual and preliminary design

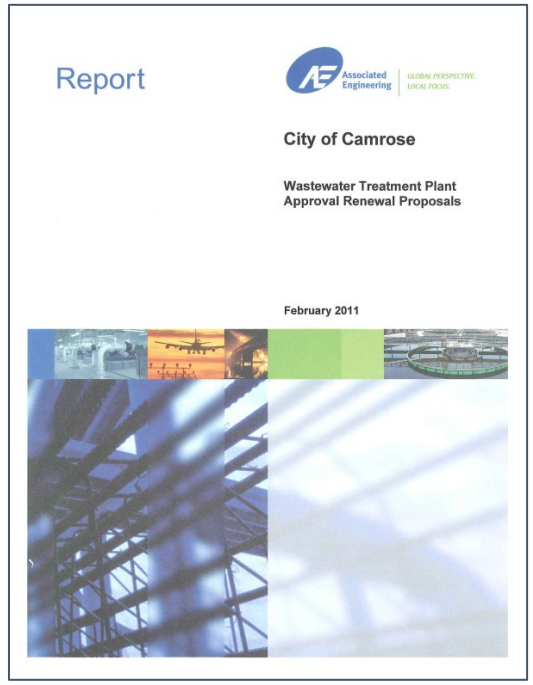
- Feb 2009
  - Initial meeting with Alberta Environment (now AB EPA)
  - Consider risks to both environment, and to human health

Approval Renewal Proposal (2008-2011)

- Feb 2009 – AB EPA meeting

- Testing (spring, summer, fall 2009)
  - Wastewater and of receiving environment
  - ~100 parameters tested during three seasons
  - Review of results by AE (2009-2010)

- Submission of "Approval Renewal Proposal" – Feb 2011



Conceptual Design (2012-2014)

- August 2012
  - AB EPA granted the City with a new 10-year approval
  - Outlined requirement to design / construct upgraded WWTP
    - Based on treatment limits outlined in 2011 Approval Renewal Proposal
    - Prelim design to be complete by 2017
    - Upgrades to be complete by end of Approval (August 2022)

- Fall 2012 – Start of Conceptual Design phase of project

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Conceptual Design (2012-2014)

- Design considerations
  - Future design population of ~30,000 people (vs. 20,000 currently), plus flows from regional industrial user (canola crushing facility)
  - Meet or exceed treatment requirements (AB EPA / WSER)

- Major technologies considered for tertiary treatment (nutrients)
  - Fully mechanical WWTP (based on Biological Nutrient Removal)
  - Hybrid WWTP (lagoons with new mechanical processes)
    - CAPEX about 33-50% cheaper than BNR process; easier and cheaper to operate

Conceptual Design (2012-2014)

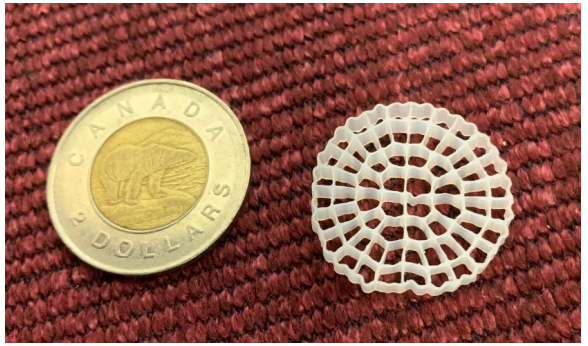
- Benefits of hybrid option
  - Continue to use existing / expanded aerated lagoons for cBOD, TSS removal
    - Represents significant prior investment by the City
    - 30+ years of useful life remaining

- Technologies considered
  - Phosphorus removal by chemical addition / filtration
  - New mechanical processes added for ammonia removal
    - SAGR (by Nexom) – Submerged Attached Growth Reactor
    - MBBR (by Veolia & others) – Moving Bed Biofilm Reactor

SAGR vs. MBBR

- Submerged Attached Growth Reactor
  - Bed of buried aggregate
  - Nitrifying bacteria attached to surfaces of aggregate
  - Bacteria remains fixed as WW flows past; air (O_2) provided

- Moving Bed Biofilm Reactor
  - Plastic media floating within holding tank
  - Bacteria attached to media
  - Constantly moving within WW, due to mixing from blowers (O2)



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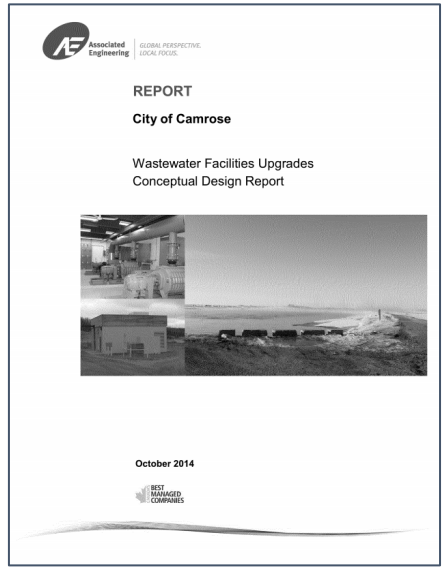
Conceptual Design (2012-2014)

- Conclusions
  - Fully-mechanical BNR plant not recommended (high cost, too expensive and complex to operate)
  - Both hybrid technologies (SAGR, MBBR) for ammonia removal seem promising, and should be considered further in Prelim Design

- February 2014 – Conceptual Design Report finalized & submitted to AB EPA



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Preliminary Design (2015-2017)

- Meeting with AB EPA – January 2015
  - AB EPA concerns over hybrid approach for ammonia removal
  - Neither technology (SAGR, MBBR) approved for use in Alberta
    - SAGR developed in MB; not used at that time in Alberta
    - MBBR used in Europe and in Quebec / Ontario
  - Concerns over ability to meet more stringent requirements in the future

- City and AE – address Province's concerns during Prelim Design stage

Preliminary Design (2015-2017)

Potential Future Operating Approval Limits

Parameter, (Units)	2022 Limits (Stage 1)	Potential Near Future Limits (Stage 2)	Potential Far Future Limits (Stage 3)
TSS, $cBOD_5$, (mg/L)	20, 20	15, 15	5, 5
NH_3 – N (mg/L, summer, winter)	5, 10	3, 5	1, 3
Total N (mg/L)	NA	15	5
Total Phosphorus (mg/L)	1.0	0.5	0.10
Fecal Coliform (CFU/100 mL)	200	20	2

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Steps to “Prove” Hybrid Technologies

1. Comparison of SAGR vs. MBBR technologies
   - Confirm “future proofing” capabilities of either technology
   - Updated proposals requested from NEXOM (SAGR) and Veolia (MBBR), showing ability to meet future treatment requirements
   - Multi-variable comparison of 8 identified criteria:
     - Track record under cold conditions
     - Low operator classification
     - Total life-cycle cost
     - Ease of routine maintenance
     - Ease of major maintenance
     - Ability to adapt to tighter future effluent requirements
     - Ease of conversion to future mechanical WWTP
     - Ultimate land footprint needs

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Steps to "Prove" Hybrid Technologies

Process Selection – Assessment Scorecard

Evaluation Criteria	Weight for Criteria	SAGR Score	MBBR Score	SAGR Weighted Score	MBBR Weighted Score
Track record under similar temperature conditions	10	5	4	50	40
Operator Classification	7	3	3	21	21
Ease of operation routine maintenance	9	5	4	45	36
Ease of maintenance (major)	9	3	5	27	45
Ease of adapting to tighter future effluent needs	6	4	5	24	30
Ease of conversion to future mechanical plant	4	3	5	12	20
Ultimate foot print required (set back issue)	6	3	5	18	30
Total life cycle cost to 20-year design horizon	8	5	4	40	32
Total	**59**	**31**	**35**	**237**	**254**

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Steps to “Prove” Hybrid Technologies

1. Comparison of SAGR vs. MBBR technologies
   - Suggested MBBR was preferred technology for Camrose

2. Bench testing of MBBR technology
   - Camrose “post-lagoon” wastewater sampled
   - Research by Dr. Robert Delatolla (University of Ottawa)
   - 1,200 L of wastewater shipped to Ottawa; tested over 2 months
   - Key finding – MBBR reactor able to achieve 10 mg/L limit for ammonia at 1ºC

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Steps to “Prove” Hybrid Technologies

1. Comparison of SAGR vs. MBBR technologies
2. Bench testing of MBBR technology

3. Telephone reference checks for MBBR
   - Existing plants chosen based on size / set-up of facility, climatic conditions
   - 1 plant in Wyoming, 2 plants in Quebec
   - MBBR technology was simple and easy to operate
   - No significant operational / maintenance concerns
   - Plants consistently meeting regulatory requirements

Steps to “Prove” Hybrid Technologies

1. Comparison of SAGR vs. MBBR technologies
2. Bench testing of MBBR technology
3. Reference checks for MBBR

4. MBBR pilot plant (Veolia)
   - Town of Neepawa, MB
   - Winter 2016/2017 pilot
   - Consistently achieved ammonia limit of < 10 mg/L at 1ºC

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Preliminary Design (2015-2017)

- Key conclusions from review
  - MBBR technology well suited for removal of ammonia in cold climates (as low as 1ºC)
  - Works for Camrose "post-lagoon" wastewater (bench testing)
  - Can adapt to meet future treatment requirements ("modular" construction)

- Dec 2017 – Prelim Design Report submitted to AB EPA
- May 2019 – Approval from AB EPA to proceed with detailed design

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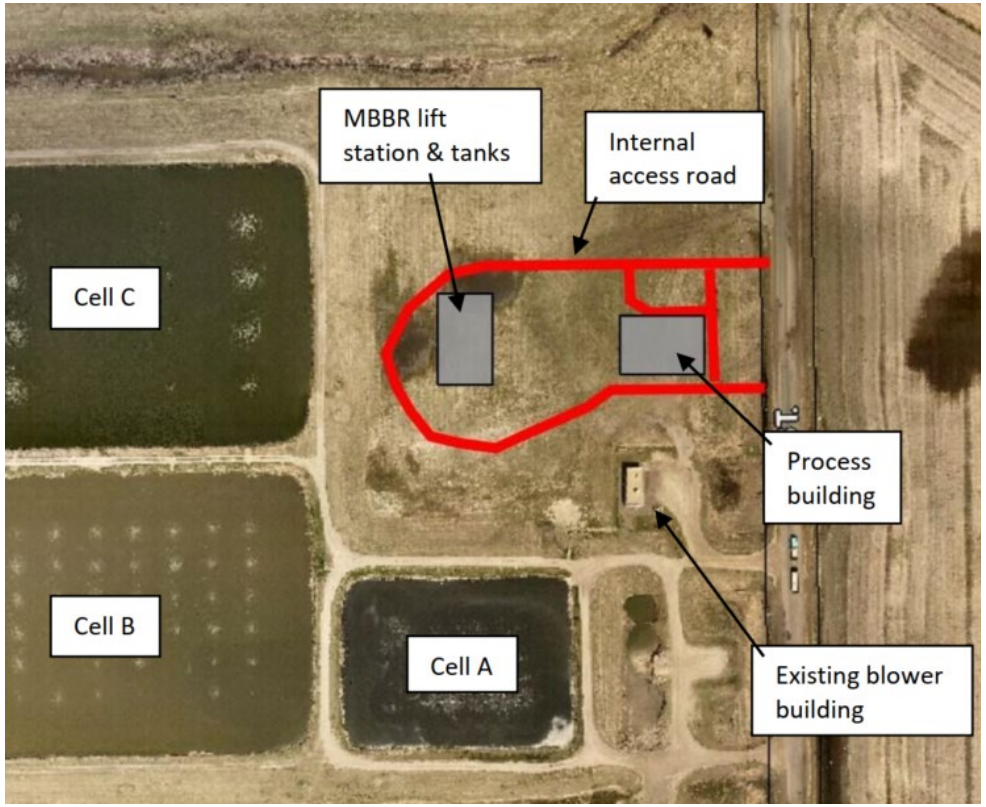
Recent Updates

- Detailed design – 2019 to 2021
- Tender – spring / summer 2021
- Construction – currently underway
  - Started in Sept 2021
  - Substantial completion by Dec 2023
  - Final project cleanup by May 2024



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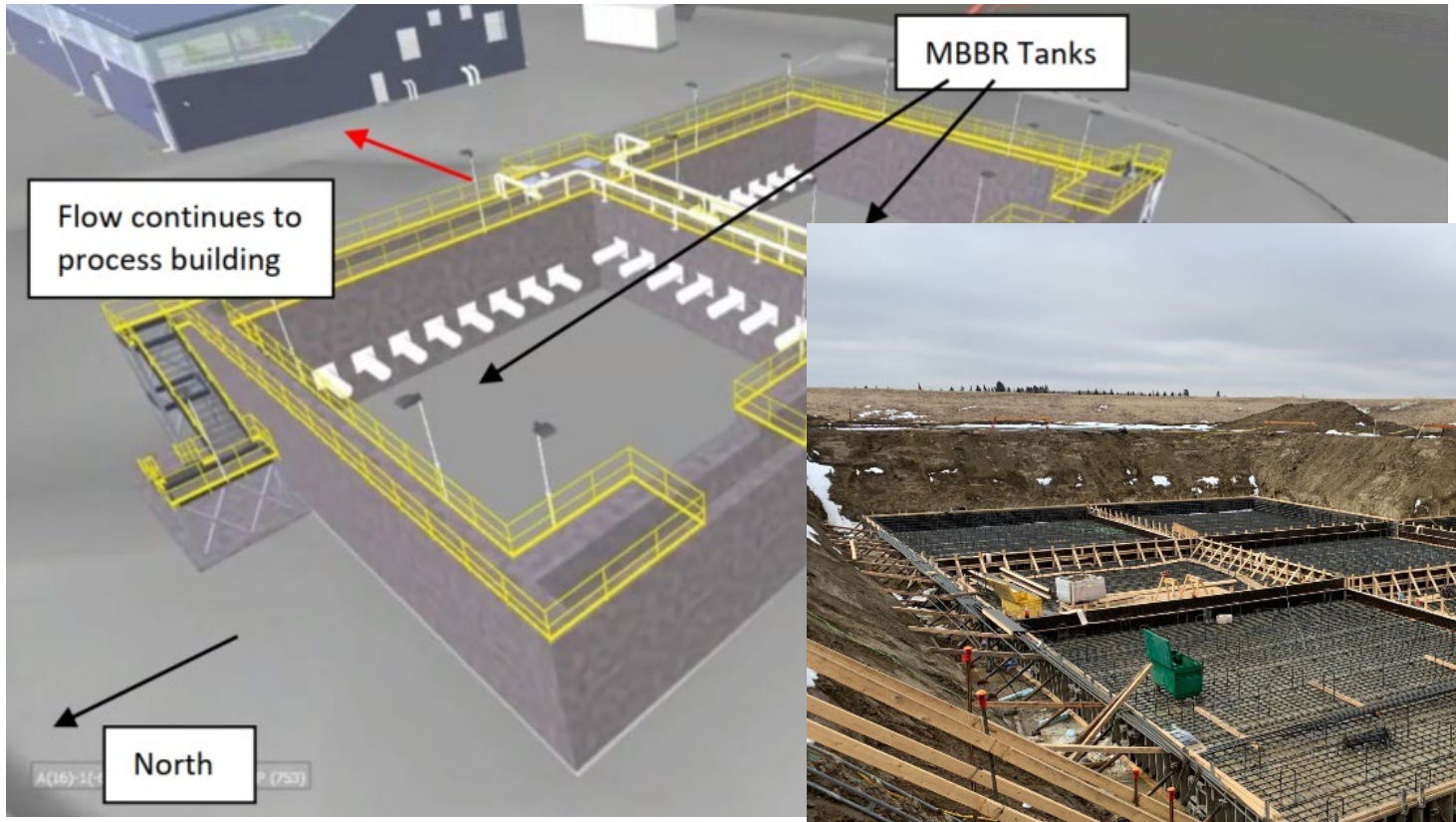
Recent Updates



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Recent Updates

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Recent Updates

Lessons Learned

- Long, slow approval process
  - 10+ years from start of project to approval to proceed with detailed design
- “Negotiate” with your regulator
  - Eventual buy-in from AB EPA to allow “hybrid” technology options
- Hybrid technologies should be considered
  - Leverage investment in existing assets
  - Savings of ~$20M (CAPEX) on $51M project
  - Savings of $0.5M / year (OPEX), as compared to fully-mechanical WWTP

Acknowledgements

- Alberta Environment and Protected Areas
  - Pervez Sunderani, Todd Aasen
- Associated Engineering
  - Graham Lang, Michael Whalley, Jing Jin
- Dr. Robert Delatolla – University of Ottawa

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