Desalination North of the Arctic Circle: Reverse Osmosis System in Remote Alaska

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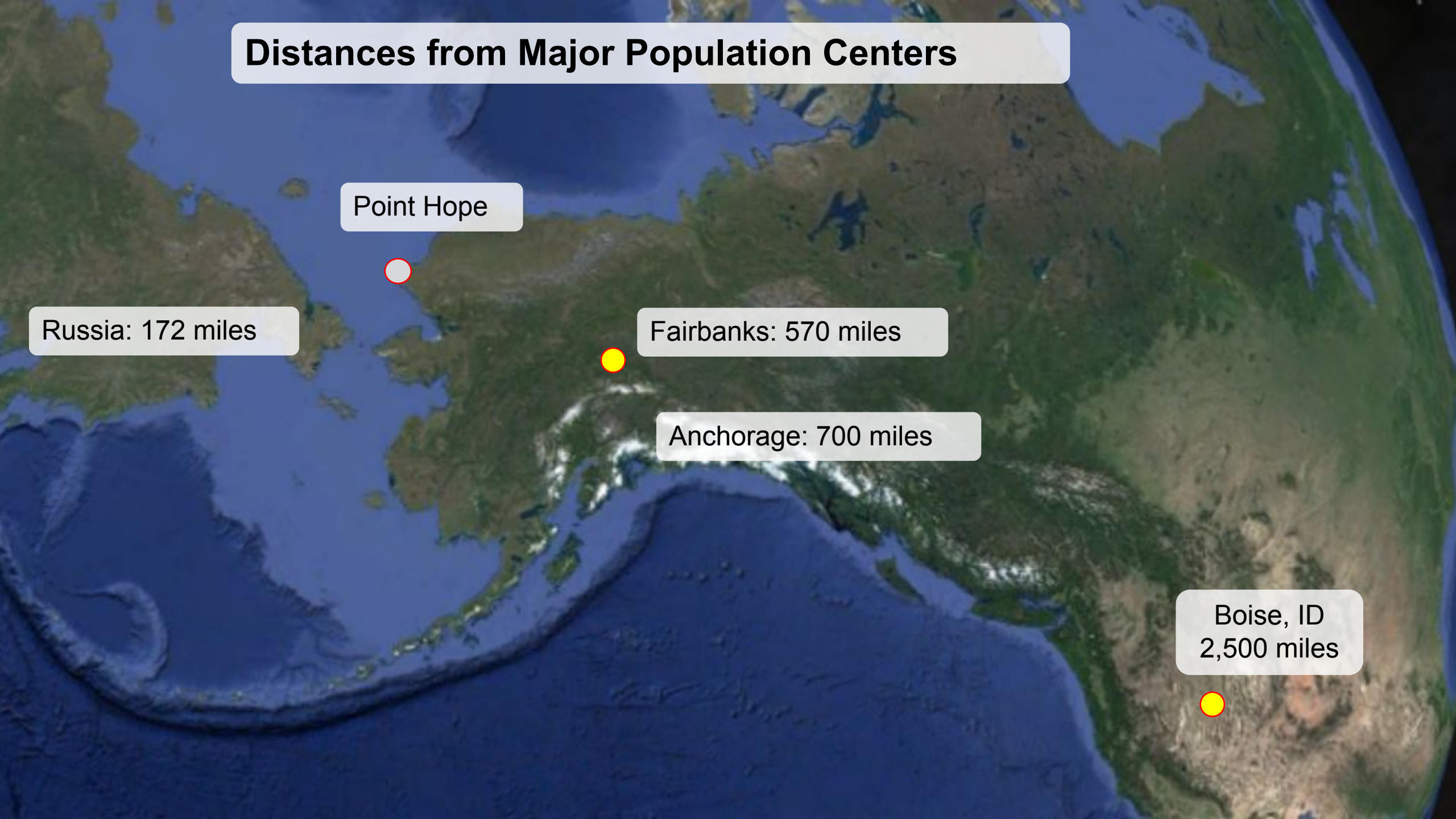
Point Hope, Alaska

- North Slope Borough, above Arctic Circle
- Today's high = balmy 33 °F (0.5°C)
- Sunset today – 12:34 AM
- Near continuous occupation since 500 BC
- ±0 cars per household, 3.3 min walk to work
- Roughly 800 villagers
- Whaling, Whaling, Whaling!


Distances from Major Population Centers
Point Hope
Russia: 172 miles
Fairbanks: 570 miles
Anchorage: 700 miles
Boise, ID
2,500 miles


Chukchi Sea
Marryat Inlet
Point Hope
Qagiaq Lake

Point Hope Water Supply

- Water thaws and ice damns form lakes from mid-summer to early fall
- 2 – 3 months/year of flowing water
- Water pumped from lakes and treated
- Multiple above ground, heated, recirculating storage tanks to supply 9 – 10 months
- Class II WTP


PINUPTAQ AVENUE
KIVANNAQ AVENUE
WATER TREATMENT PLANT
WATER STORAGE TANK (T-4-1)
WATER TANK (T-5-1)
T-5-3
T-5-2
TIKIGAQ AVENUE
QALGI AVENUE
MANIGRAQ AVENUE
ITTIVYAAQ AVENUE
SIKUTAGVIK DRIVE
IPUTAAQ STREET
UMIGRAGVIK STREET
PPIQ STREET
TUTTU STREET
TASIQ STREET
AQVIVIK STREET
AMIK STREET
NANUQ STREET
AGVIQ STREET
SISUAQ STREET
KANUQ STREET
KUPAAQ STREET
NOSINGIAQ STREET
NATCHIQ STREET

Point Hope Water Issues

- Operations vulnerable
  - Inability to resupply for most of the year
  - Any fire flow is risk of later water shortage
- Frequent risk of severe water rationing, prolonged water outages
  - Emergency bottled water flown in
  - Potential village evacuation
  - Extremely difficult in winter/continuous darkness
- Climate change
  - Qagiaq Lake in jeopardy
  - New well drilled for supply

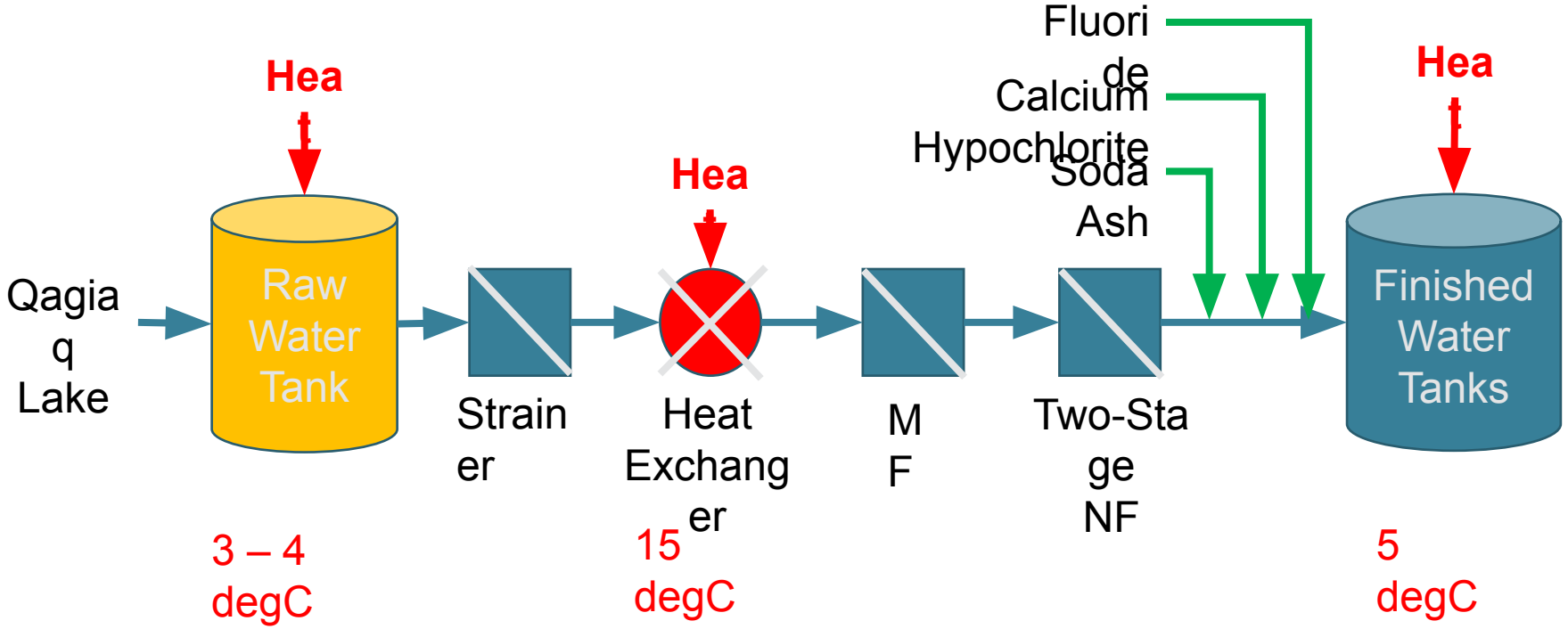
Plant challenges

- If there are any issues, operators need to try and fix with the spare parts available at the plant.
- Extra boxes, hoses, piping.
- Temporary measures put in place
- Labor
- Keeping water circulating in the winter
- Equipment Maintenance

Current Water Treatment

- Built in 1999
- Raw water storage: 3.8 MG
- Two stage treatment:
  - Microfiltration
  - Nanofiltration – TOC removal
- Finished water storage: 5.9 MG
- Plant staffed with 2-3 operators' year round
- Max. production ~ 30,000 GPD

Current Water Treatment



Design Requirements

- Sampling June 2021 and May 2022
- Groundwater connected to an underground brine pool/lens
- Such pools common to the Arctic
- 58% more saline than typ. seawater
- Very cold water
- Salinity inhibits freezing in the well
- Flowable water even during spring/fall
  - Not certain about coldest winter

Parameter	Unit	2022 Value
TDS	mg/L	55,500
TSS	mg/L	96
Hardness	mg/L as $CaCO_3$	11,000
Alkalinity	mg/L as $CaCO_3$	322
pH	s.u.	7.0
Ammonia	mg/L	3.8
Iron	mg/L	21.7
Manganese	mg/L	2.44
Color	PCU	10
TOC	mg/L	5.9
Temp.	deg C	-3

Existing WTP Building

- Equipment must fit inside existing bldg
- Any work very expensive
  - Labor flown in
  - Equipment supplied by barge or airplane
  - Freezing temperatures most of the year
- Existing backwash/brine disposal is small on-site infiltration basin (not suited for year-round use)

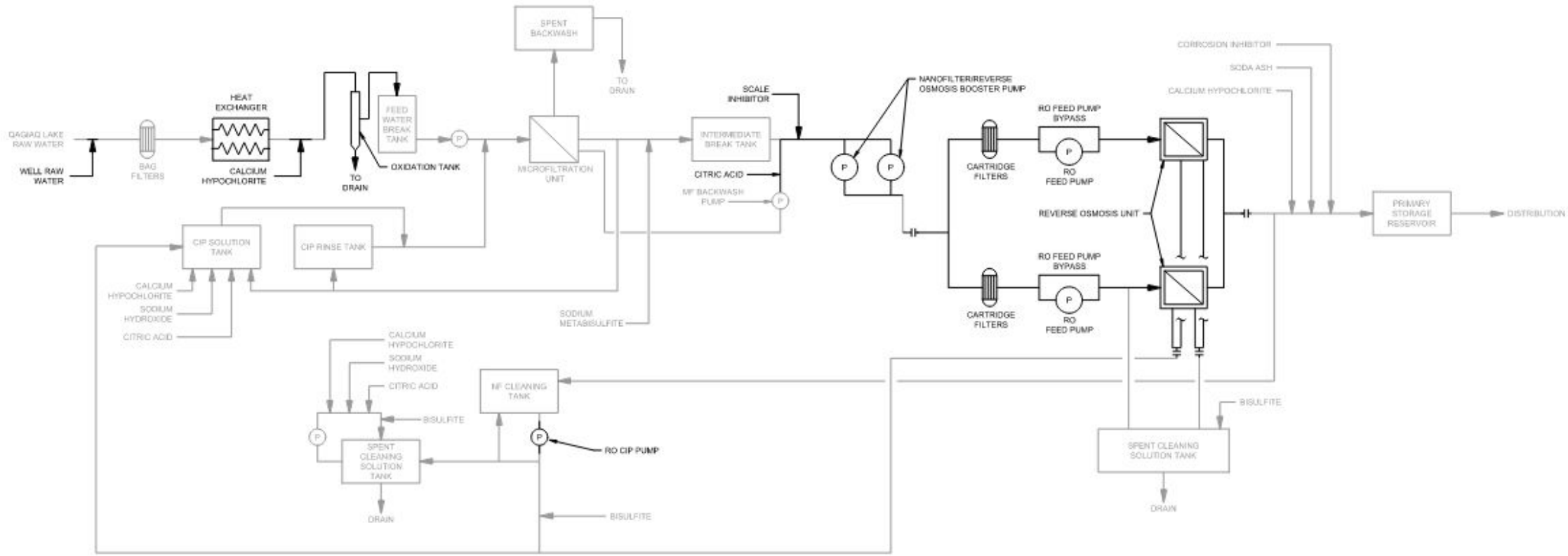
Approach

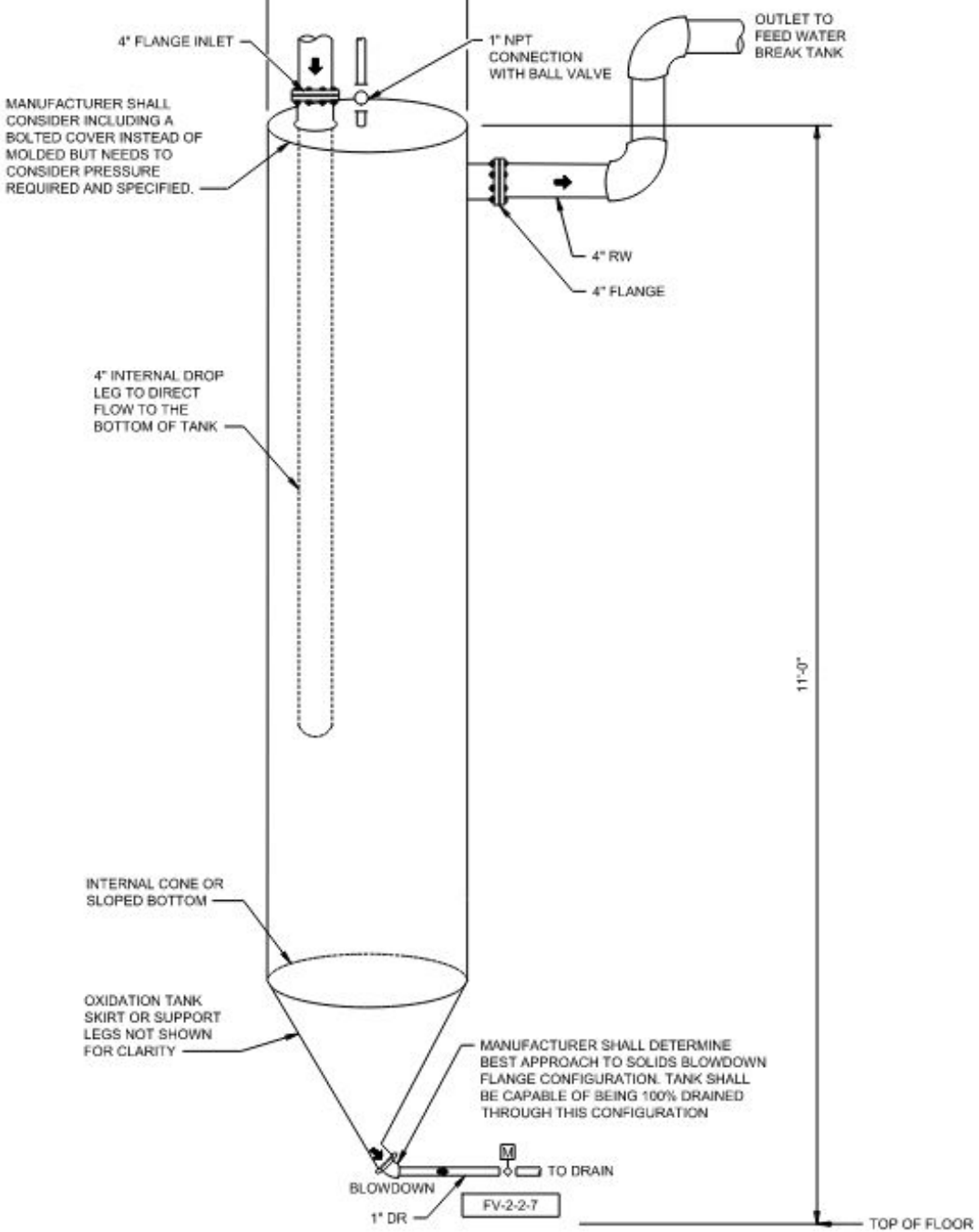
- Replace heat exchanger
- Precipitate iron
- Increase MF cleaning capabilities
- Reverse osmosis
- Replace CIP pump, reuse rest of existing
- New ocean outfall

Proposed Treatment

- TDS (Lake vs Well)
  - Very different RW quality
  - Ability to treat either(2x 175 GPM Units)
  - 2 units on 1 skid
  - 1 unit nanofiltration
  - 1 unit reverse osmosis
- Precipitate Iron

Proposed Treatment





OXIDATION TANK (2)

Iron

- New chlorine dosing pump
- New oxidation tank
- Existing feed water tank
- MF filtration

NF Unit

- Limited to 3 months until lake is gone completely
- Designed to be converted to 2nd RO unit
- Continuous water production during summer window
- Incident response more of a challenge

RO Unit

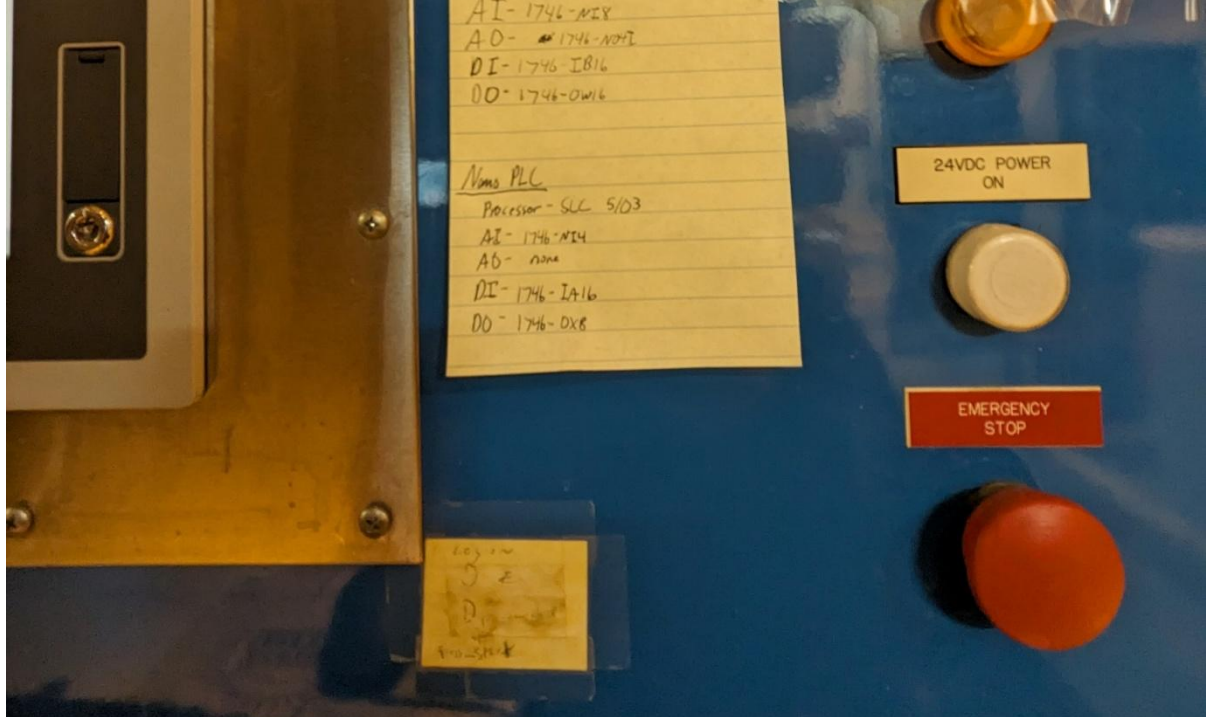
- Well frozen is not frozen as long, thus water production window is close to year round
- Plant can operate 8-10 hours a day
- Incident response is easier
- 100 HP maximum design requirement. Using energy recover on feed pumps

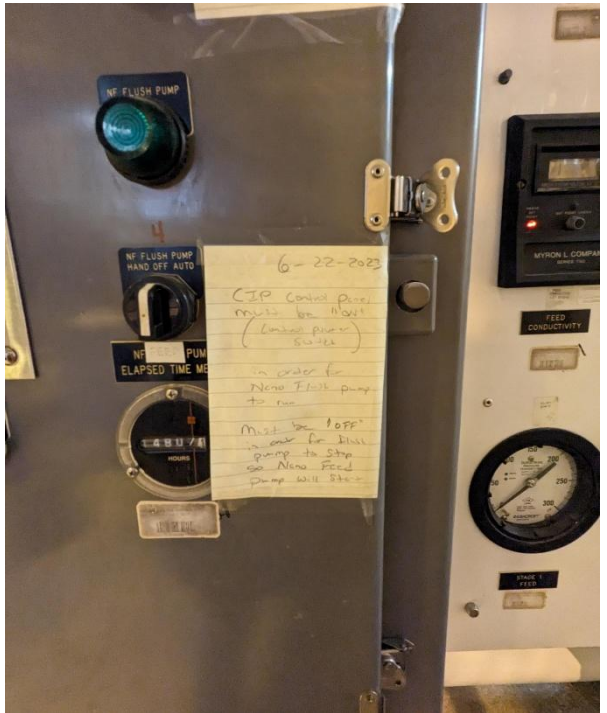
Projections

	Lake Source	Well Source
Pressure vessels	8	8
Elements per vessel	4	4
Feed flow (gpm)	290	175
Permeate flow (gpm)	130	53
Recovery (%)	45	30
Feed Pressure (psi)	75	1,000
Booster Pump HP	20	20
Energy Recovery	Bypass	Yes
Feed Pump HP	Bypass	100

Training

- Operators will receive training on new system.
- Older equipment is replaced and will be under warranty





Installation

- Limited footprint available
- Constrained by size of door
- Single skid is split for entry then reassembled
- Make sure everything is available
- Demolish in winter / clear a path
- Get done by spring

Cost Estimate

- Rates
  - 60 hours / week
  - 20% premium time
  - Subcontractors markup 35%
  - 3 Months to complete
- Equipment = $1.3M
- Contingency = $500K
- Total = $4M

Schedule

- ROM design of skid - summer 2025
- Equipment fabrication and shipping – 1 year
- Delivery to Point Hope – after ice, summer 2026
- Construction – winter 2026
- Startup – Spring 2027

Questions?