San Luis Project: Process Optimization

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Optimization and sustainability

- Optimized facilities are more efficient: reducing energy demand and GHG emissions, reducing chemical demands, and lowering opex
- Optimized facilities may obviate the requirement for expansion or new facilities, thus reducing future capex
- Optimized facilities assure stakeholders that water management activities are focused on reducing impacts to the environment, while minimizing the consumption of energy and chemical resources, all at the lowest cost

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Optimization: general

- An evaluation of the operating facility to determine the factors limiting the facility from achieving its desired performance.

Example performance metrics:

- Flow rate of discharge water
- Compliance with discharge standards
- Reliability of service
- Maintenance of groundwater level
- Compliance with future requirements (growth, regulation)

- Result of examination of these operational processes is to identify the factors, correct the deficiencies, and plan for future improvements
- Factors include equipment, design, personnel and process limitations

Optimization: Design-related factors

Evaluate the design criteria of unit processes to determine conformance with performance requirements.

Examples:

- insufficient hydraulic residence time to achieve disinfection
- insufficient equipment units to provide required redundancy
- insufficient storage to provide required volume
- cavitation from insufficient NPSHa
- incorrect worst-case assumptions during design (e.g., temperature)

Optimization: Process-related factors

- Evaluate how well existing processes achieve performance requirements
- Processes include physical, chemical and/or biological processes
- Processes can include **business processes** such as standard and emergency operating procedures, information management systems (EAM/CMMS, LIMS)

Example: Tracer Testing

- use inorganic salt to identify short circuits. Denver Potable Reuse Plant – tested each basin, each process, to optimize treatment and to determine sample time for plant challenge testing. Testing results were used to improve residence times, reaction conditions.

Example: Emergency Procedures

- Absence of emergency operating procedure for stand-by generator. Power failure at lift station resulted in raw sewage overflow.

Optimization: Equipment-related factors

Inventory and assess condition of equipment

- Redundant units?
- Condition assessment – plug into asset management program
- Hydraulic limitations –
  - worn pump impeller cannot deliver required pressure/volume,
  - insufficient NPSHa
  - scaling in pipelines limiting hydraulic capacity
- Short-circuiting due to out-of-level clarifier weirs

Optimization: Personnel-related factors

Evaluate staffing requirements in perspective of current/future performance requirements

- Succession planning
- Hire
- Train
- Automation
- Outsource

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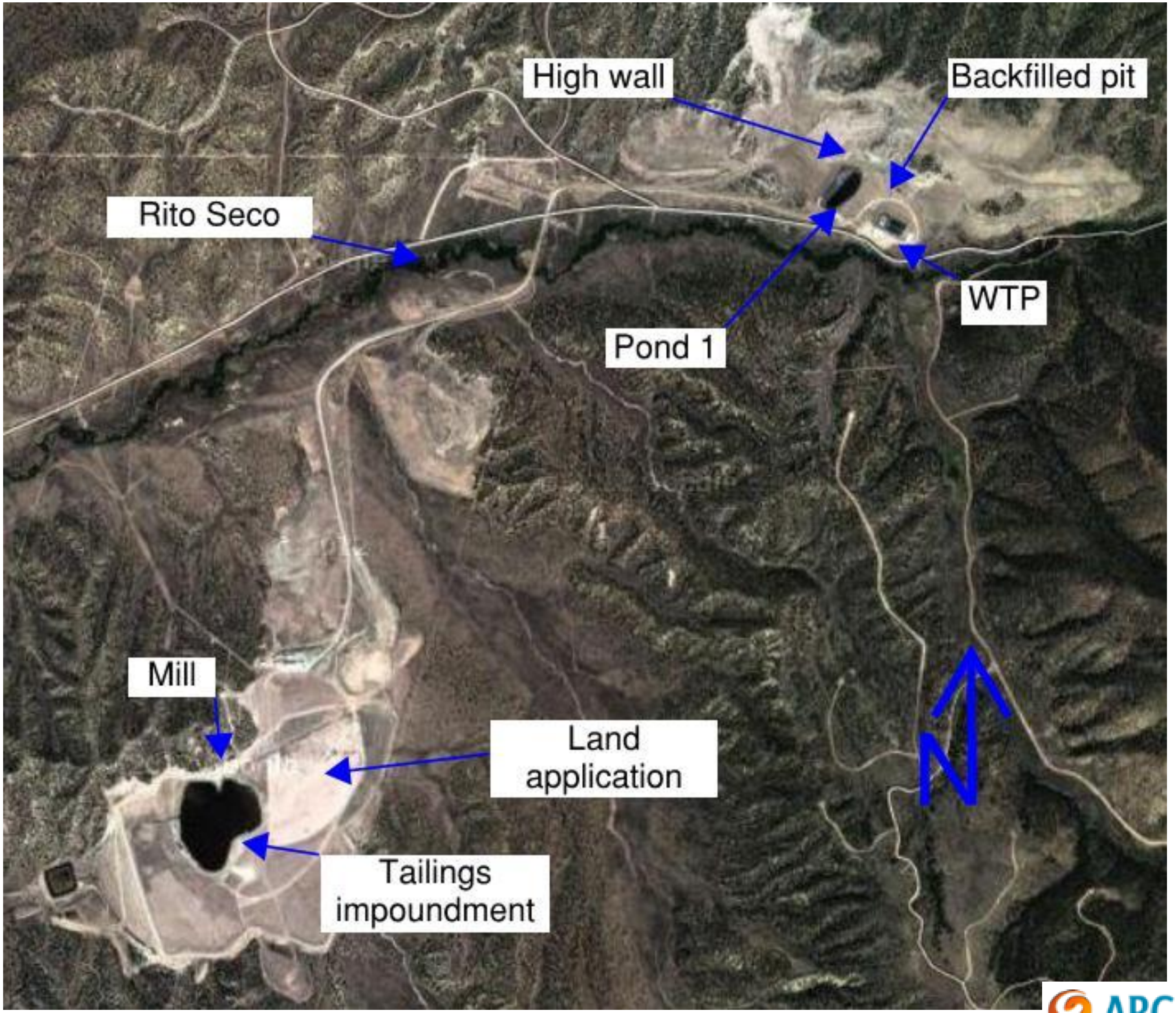
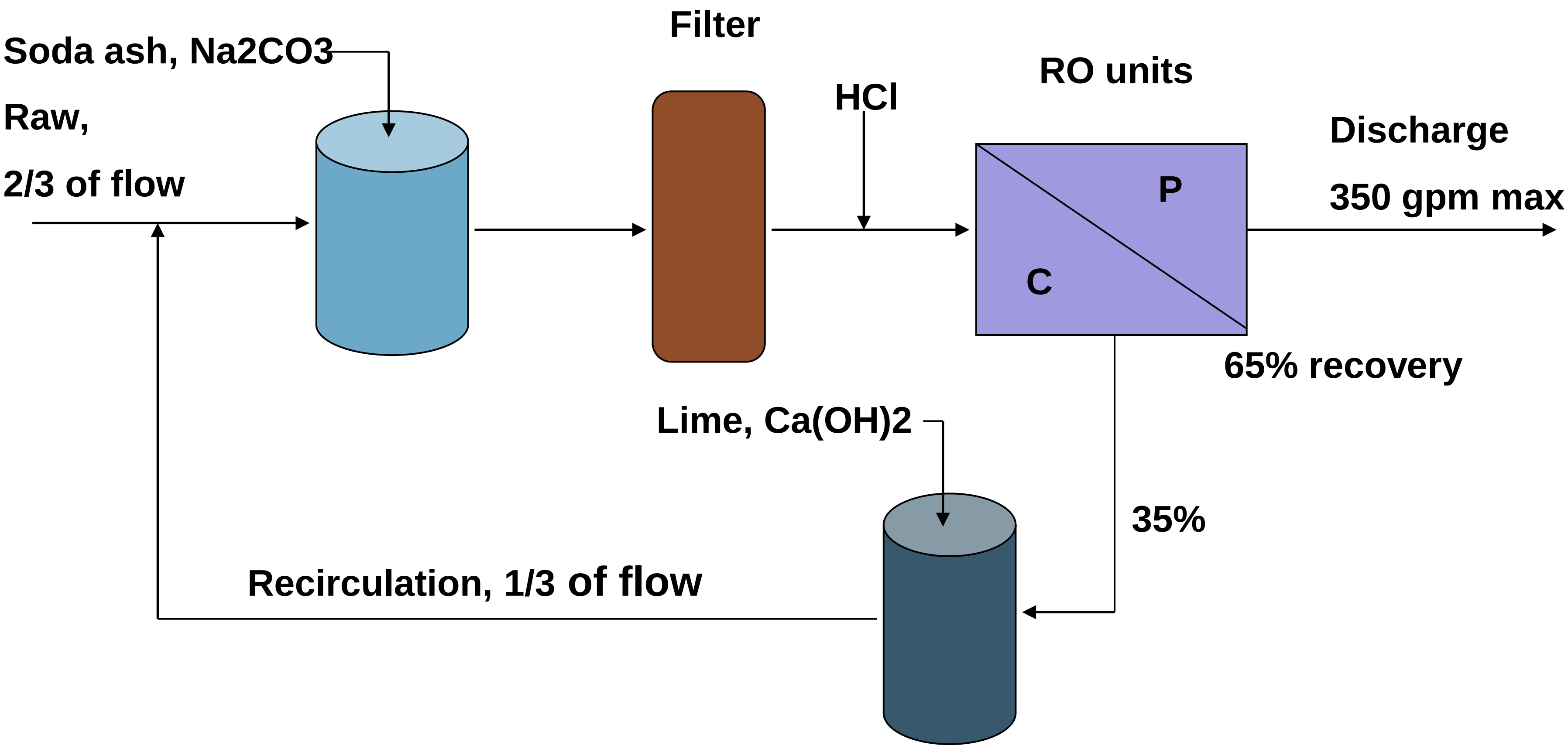
- Gold mine in closure, unpermitted surface and groundwater discharges, Notice Of Violation/Cease & Desist order, antidegradation standards applied to receiving stream
- Water Treatment Plant sourced as Design/Build/Operate, reverse osmosis selected technology – never performed as designed
- Owner wanted to take <u>adverse</u> possession of WTP: no staff trained to operate or maintain advanced treatment processes. Because of litigation, it was necessary to demonstrate that the client could operate the WTP according to its design intent.
- Performance requirements: Meet required discharge flow rate (350 gpm), and lower site groundwater levels, using untrained and inexperienced staff
  - Operator in Responsible Charge
  - Train new staff (ex-mining employees)
  - Identify and correct process limitations


High wall
Backfilled pit
Rito Seco
WTP
Pond 1
Mill
Land application
Tailings impoundment
N

Original design:

P = permeate

C = concentrate



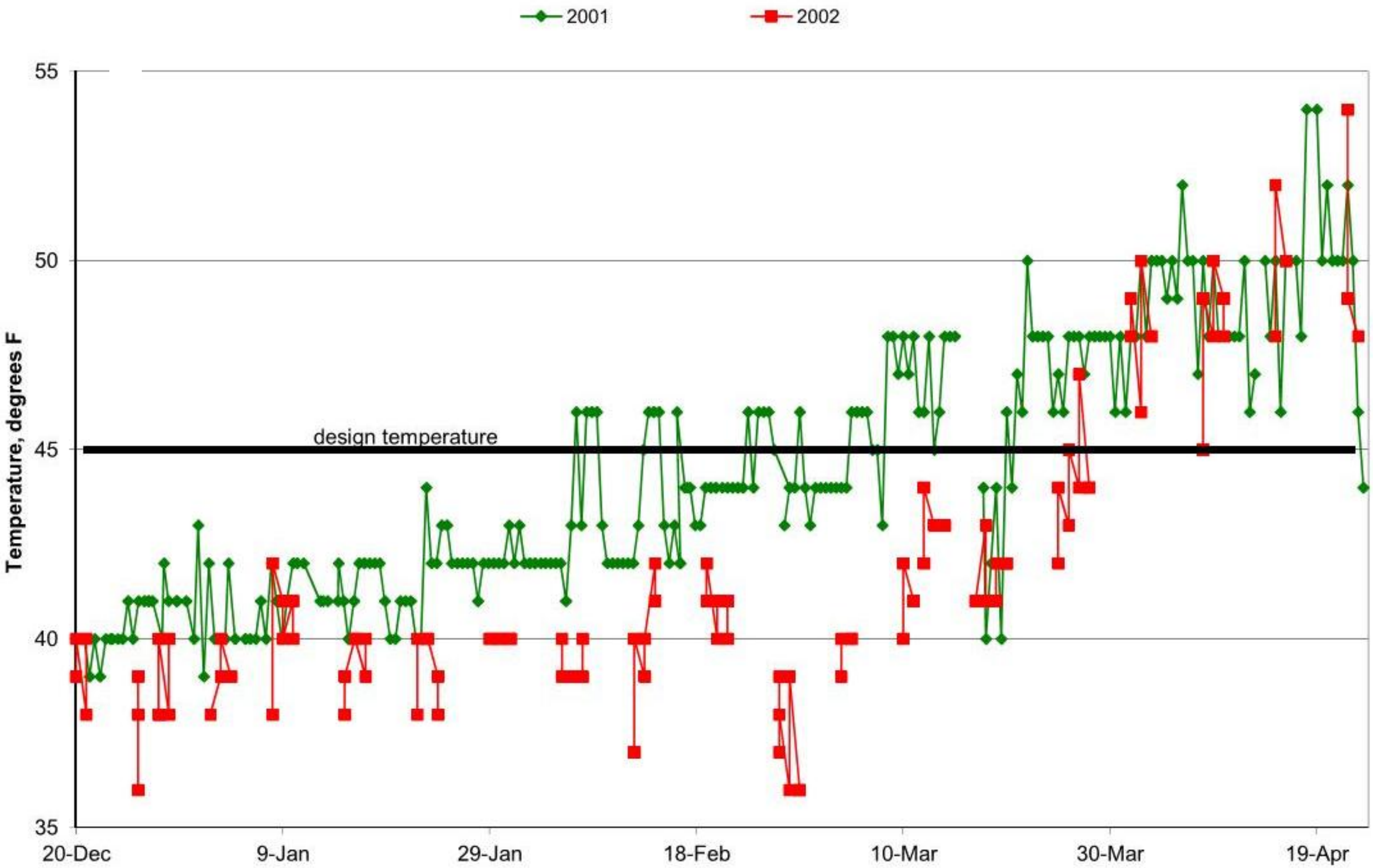
Design-related factors

- Hydraulic - insufficient NPSHa, suction lift
- Filters – incorrect media (uniform, spherical)
- RO – poor and declining system recovery, ***temperature effects***, materials of construction, incorrect membranes for process chemistry

Equipment-related factors

- Open Drip Proof motors in washdown area
- Flat-bottomed tanks instead of slope-bottomed
- "Clarifier" underdrain could not convey gypsum sludge, centrifuge could not receive consistent feed
- Grain augers for conveying dry chemicals (ineffective for powder, adequate for granular material)

RO Influent Temperature, Dec. through Apr.



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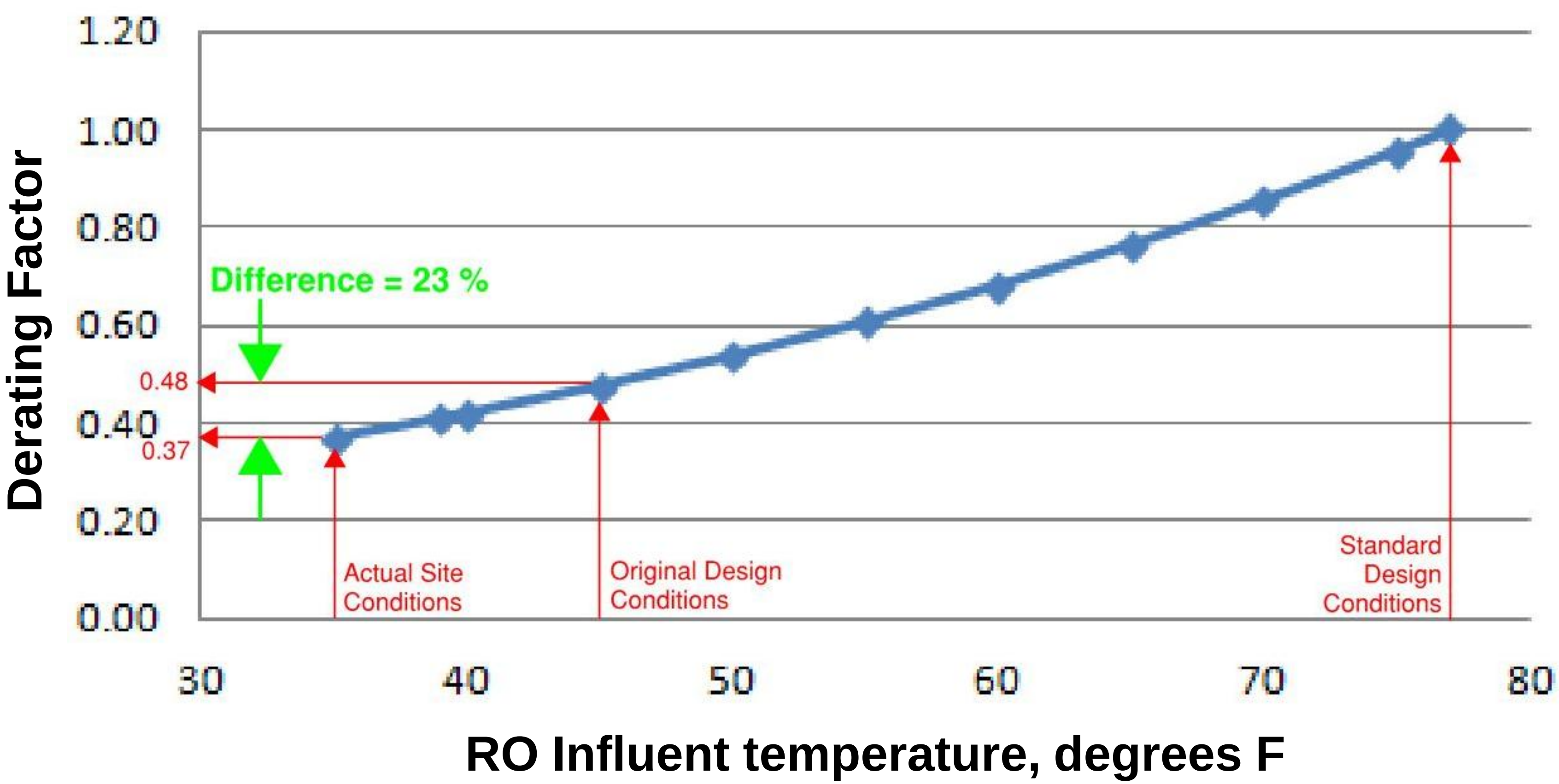
Temperature Correction Factor



Personnel-related factors

- “Mill Dinks” – one electrician, one equipment operator, one with some college (one introductory chemistry course)
- No training in mathematics, chemistry, hydraulics
- No treatment certification

Process-related factors

- No concentrate disposal

Improvements

PART 1:

- Crash training course – two days sequestered in a motel conference room: math, chemistry, hydraulics (personnel)
- Fabricated lime eductor feed system (equipment)
- Submersible pumps in sedimentation basins (design)
- Weekly updates of RO setpoints in response to constantly changing chemistry (operating processes)
- Concentrate disposal to tailings impoundment land application system (process)
- Replace filter media (design)

Improvements

PART 2:

- Revise precipitation process to single-stage lime/soda ash (process)
- Increase RO system recovery from 65 percent to 90 percent via concentrate recycle (design, process)
- Install RO bypass line (flow paced based on on-line fluoride analyzer) (design, process)

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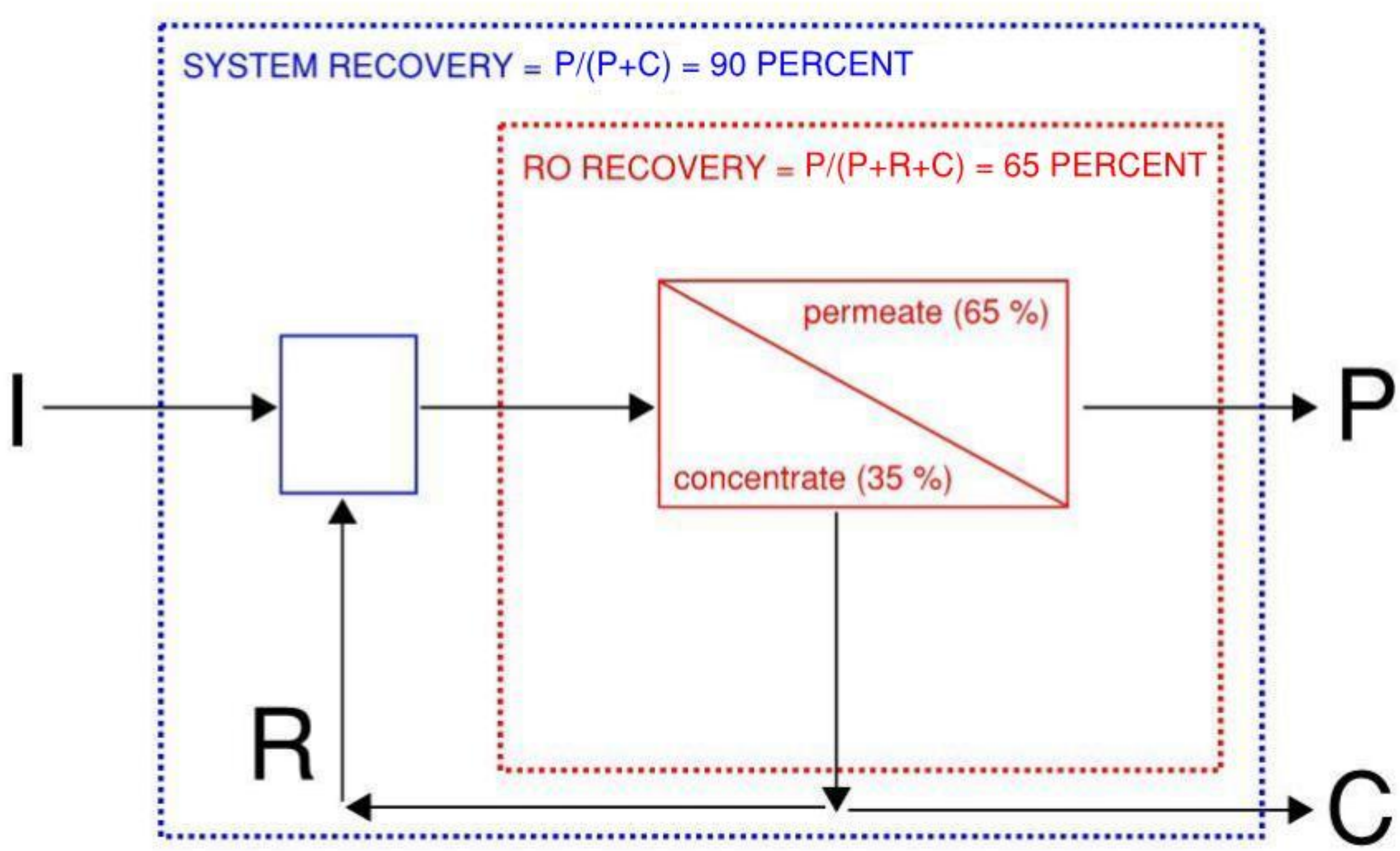
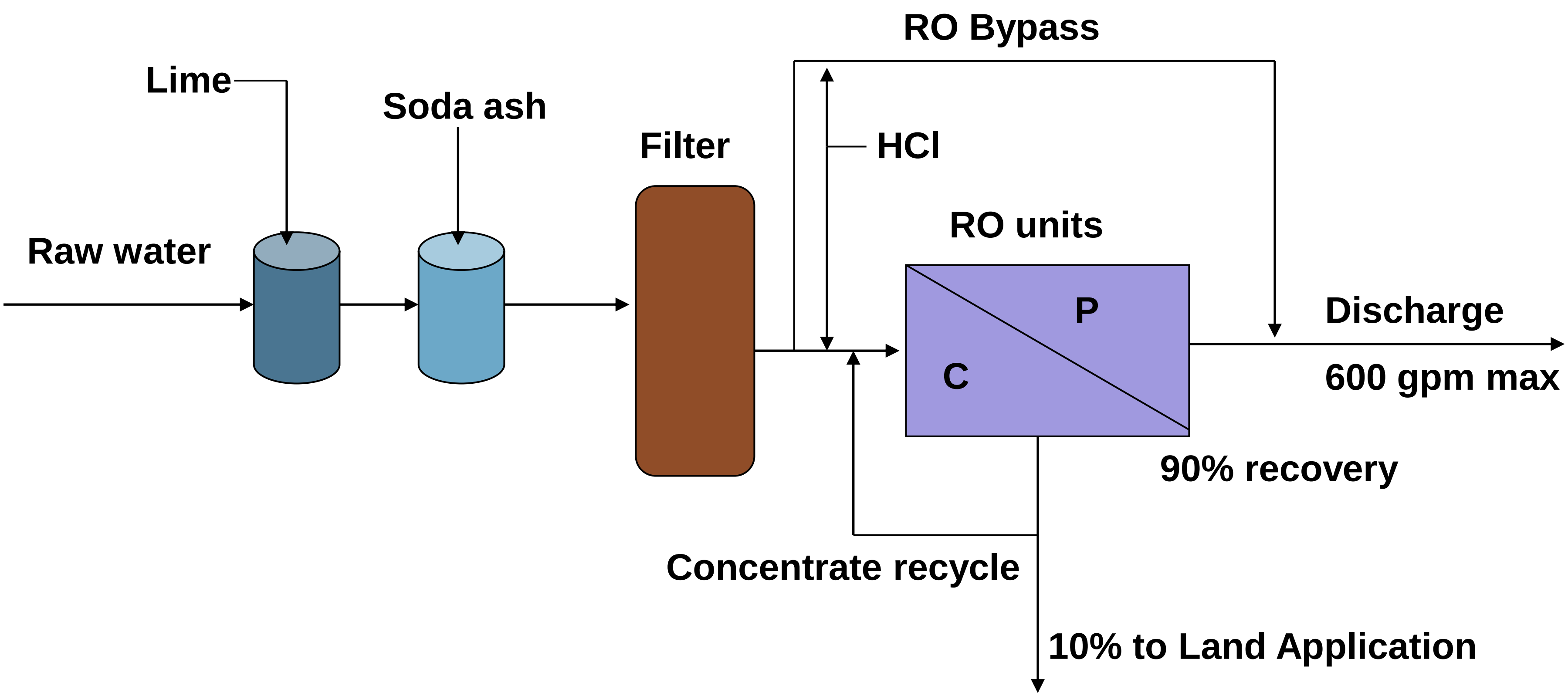
Recovery

I = influent
P = permeate
C = concentrate
R = recycle



Revised process:



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Benefits

- Stable chemistry, smooth operation
- Increased throughput allowed intermittent operation (from 7 days/week to 4 days/week)
- Staff reduction (by 40%)
- Reduced energy use (by > 40%)
- Reduced chemical use (by > 75%)
- Reduced disposal volume (by 50%)
- Improved chemical feed control
- Extended RO membrane life (**>13 years**, and still going)
- Improved overall WTP recovery from 58% to 94%