THE Water Research FOUNDATION

Project #5087: Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems & Online Analytical Measurement Reliability & Accuracy

Decision Flowcharts

for evaluating & selecting BNR controls

2024

Woodard & Curran | Northeastern University | HATCH | UMass Amherst

About the decision flowcharts

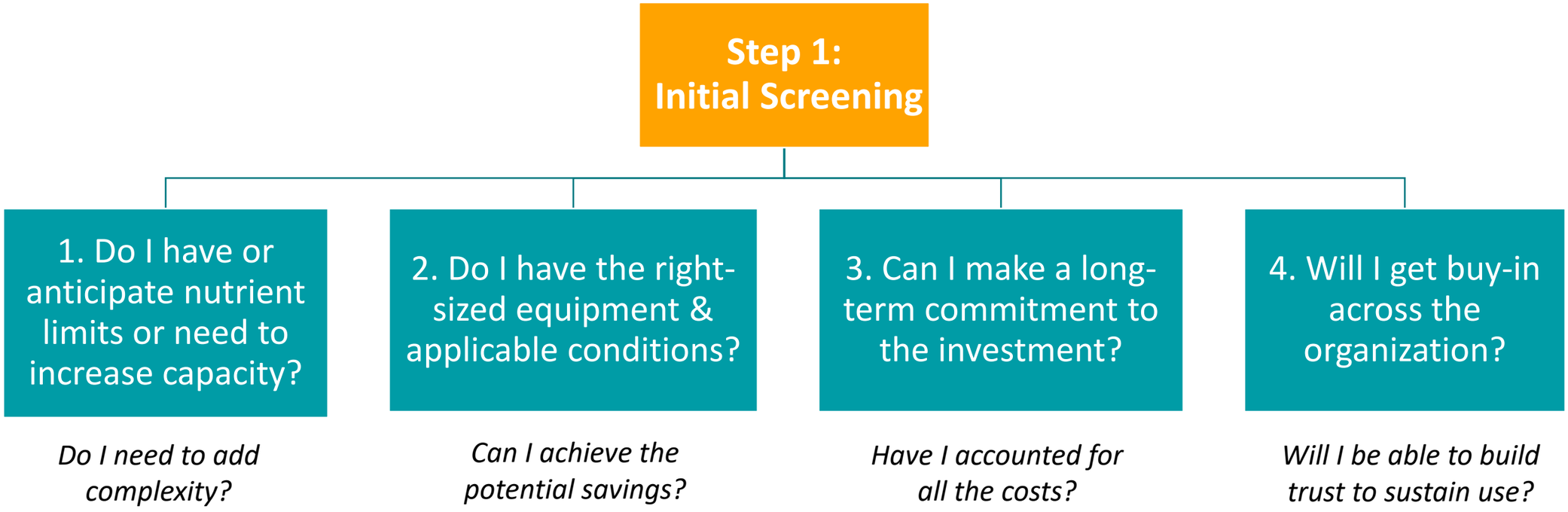
This tool is intended to help you answer the question:

Should I invest in BNR instrumentation & controls for my WRRF?

Successful implementation of a BNR control system requires much more than simply the selection of the controls & associated instruments. This tool contains a series of questions and criteria to help you understand the scope of what is required for successful implementation & evaluate potential options, including those identified during the selection adventure. The tool is structured around three rounds of evaluation:

Step 1: Initial screening approach

The initial screening questions are intended to help you quickly determine whether BNR controls & instrumentation will be applicable to your WRRF. If you answer no to one or more of these questions, it may make sense to not proceed. Alternatively, you may want to consider the option of installing on-line sensors and/or analyzers for monitoring only rather than control.



Step 1: Initial screening criteria

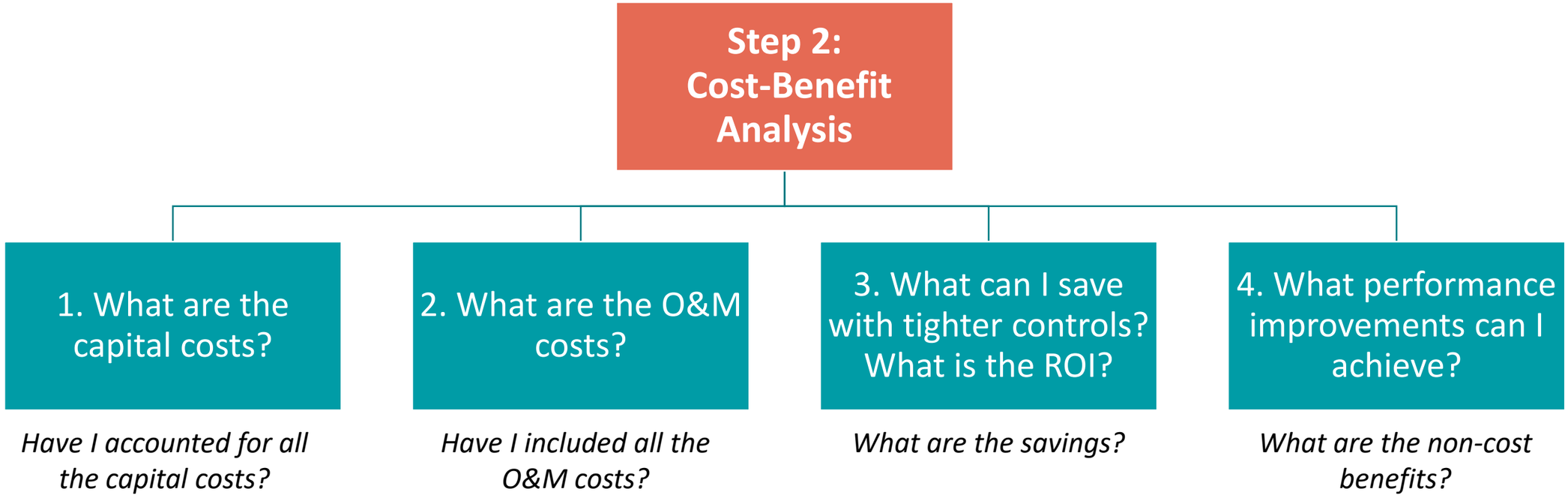
The following are several criteria to consider when conducting an **initial screening** of BNR controls & related instrumentation:

1. Do I have or anticipate nutrient limits or need to increase capacity?	• TN ≤10 mg/L, TP ≤1 mg/L, Combination of low TN & TP Limits • Tighter control may be able to improve performance and therefore defer/eliminate need for capital investment in new tanks/equipment
2. Do I have the right-sized equipment & applicable conditions?	• Variable speed/output control over full desired range on equipment (e.g., pumps & blower turndown) • Valves that are or can be automatically actuated to control air distribution to and within the BNR tanks • No mixing limitations in aeration basins • Nitrification is required for several of the aeration control options (ABAC, AvN™, SND)
3. Can I commit to the investment?	• Total capital costs not just including controls and instruments but also installation, data storage, needed equipment upgrades • O&M of instrumentation as well as periodic control loop tuning, on-going performance validation & data management
4. Will I get buy-in across the organization?	• Favorable business case to present to decision makers • Implementation approach considerations: full-scale and/or initial pilot test • Communication & cooperation across functions (including operations, lab, equipment & instrumentation maintenance, data hardware & software managers)

Step 2: Cost-benefit analysis

Determination of the costs & benefits of the BNR control system is an important step in building a business case for implementation. Some of the benefits may be qualitative (e.g., improving reliability), and identification and articulation of both qualitative and quantitative costs & benefits can support the justification for implementation.

A return on investment (ROI) calculator can be downloaded as an Excel spreadsheet from the Selection Adventure App Destination page and used to aid in the quantification of the costs and benefits for your WRRF. A process simulator developed for Training Opportunities can be utilized to help estimate savings.



Step 2: Cost-benefit analysis criteria

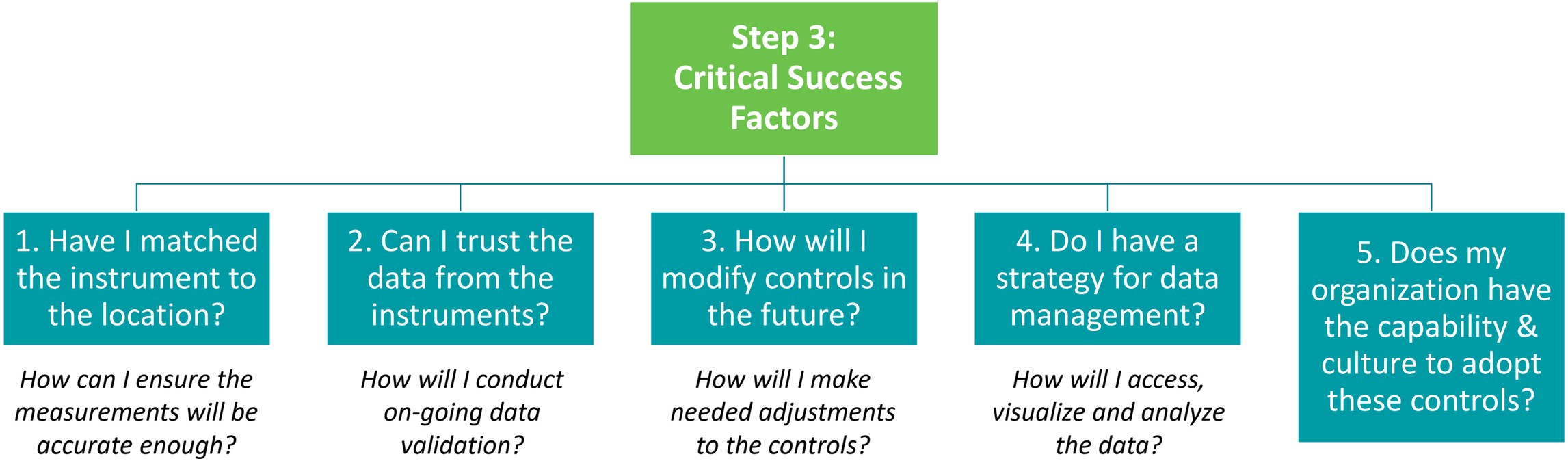
The following are several criteria to consider when conducting an **ROI evaluation**:

1. What are the capital costs?	• Instrument costs including instruments (number of trains to outfit with instrumentation), accessories (e.g., transmitters, filters, automatic cleaning), electrical, installation, and training • Controls costs including development & installation, data storage, and startup & commissioning • Equipment upgrades required (e.g., smaller blowers, automatic valves, VFDs, additional mixers)
2. What are the O&M costs?	• Instrument cleaning & calibration, preventive maintenance, and parts replacement • On-going performance validation & data management • Control loop tuning • Third-party instrumentation and/or controls support
3. What costs can I save with tighter controls? What is the ROI?	• What are my chemical costs & usage and what can I save with this control system? • What are my power costs & consumption? Are there demand charges to consider? What can I save with this control system? • How much labor will the new system save to free up operators for other tasks? • What are the net total annual savings and reduction in annual operating budget? • Can I defer capital improvements (e.g., use the control system to “add” capacity)?
4. What performance improvements can I achieve?	• Additional nutrient removal • Increased stability • Increased capacity

Step 3: Evaluation of critical success factors approach

If you determine that the cost-benefit analysis is favorable & plan to move ahead with implementation, this third step includes evaluation of critical success factors intended to help you sustain successful implementation.

A Standard Operating Procedure (SOP) for data validation can be downloaded as an electronic hardcopy (PDF format) from the Selection Adventure App Destination page and used as a starting point for development of the in-house tools needed for long-term success.



Step 3: Evaluation of critical success factors criteria

The following are **critical success factors** to consider for successful implementation:

1. Have I matched the instrument to the location?	• Location is accessible for O&M • Instrument measurement range matches what's expected (e.g., >1-2 mg/L NH4 for ISE probes) • Installation meets manufacturer requirements (e.g., pre-filtration, automatic cleaning accessories, absence of interfering ions, sensor orientation, sufficient water depth, power requirements) • Analyzers & associated sample lines protected from weather (e.g., sun & freezing temperatures) • Sufficient mixing/turbulence available to prevent solids and/or films from developing
2. Can I trust the data I receive from the instruments?	• Frequent instrument cleaning plus on-going preventive maintenance & calibration • Lab support for validation; develop data validation SOP • Assess & assign roles (e.g., dedicated instrument technician)
3. How will I modify controls in the future?	• Plan for in-house and/or third-party control loop tuning & modifications • Evaluate risks & benefits of using third-party proprietary controls: ease, accessibility, long-term viability
4. Do I have a strategy for data management?	• Develop data management plan with input from stakeholders at all levels of the organization • Determine data storage capacity requirements and access protocols • Identify other desired uses of the collected data, including SCADA export for analysis and visualization (dashboards)
5. Does my organization have the capability & culture to adopt these controls?	• Get buy-in across and at all levels of the organization; stakeholder input during project development & design • Match approach to capability & capacity of the organization (e.g., phasing, piloting, complexity) • Provide initial and on-going training • Update cost-benefit analysis with any additional costs and/or benefits associated with these critical success factors