



Northeastern
University

UMass Amherst

HATCH

Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

Survey Introduction

Welcome! The Water Research Foundation (WRF) Project 5087 titled *Implementation of Innovative Biological Nutrient Removal (BNR) Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy* is underway, and we invite you to take part in this utility survey. Feedback about your experiences with BNR control systems and online sensors is critical. Your responses will be compiled with those from other WRRFs and will be used to synthesize the current state of the art and develop a framework for the practical and cost-effective implementation of BNR control systems with sensor technologies.

This survey is administered through Survey Monkey, and responses will be shared directly with the WRF project team. If you have multiple WRRFs in your system, please submit a separate completed survey for each applicable WRRF. Please don't forget to hit "Submit" at the end of the survey once you are finished. Once you hit "Submit," the survey will be closed, and if you have any information that you'd like to change, please contact us at jfortin@woodardcurran.com.

Don't hesitate to reach out to any of the Co-PIs on the project with questions. Please refer to the introductory email for additional guidance and contact information.

Thank you!



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

Contact Information

Please provide contact information for your Water Resource Recovery Facility (WRRF). If your utility has multiple facilities, please complete a separate survey for each facility.

1. Contact Information for Person Completing the Survey:

*Name:

*Position:

*Email address:

*Phone number:

2. Contact Information for Utility Director (*if different from Question 1 above*):

Name:

Position:

Email address:

Phone number:

3. Water Resource Recovery Facility (WRRF) Name and Address:

*Name:

Address:

City/Town:

State/Province:

ZIP/Postal Code:

Country (if other than United States):

**required response*



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

Facility Overview

Please answer the following questions based on your Water Resource Recovery Facility (WRRF). If you have seasonal/multiple limits, please indicate the most stringent limit.

4. WRRF design capacity:
 - a. <1 MGD
 - b. 1 to <5 MGD
 - c. 5 to <10 MGD
 - d. 10 to <20 MGD
 - e. \geq 20 MGD
 - f. Other (please specify):

5. Discharge permit limit for ammonia (NH₃):
 - a. No permit limit
 - b. \leq 1 mg/L
 - c. >1 to 5 mg/L
 - d. >5 to 10 mg/L
 - e. > 10 mg/L
 - f. Load based limit (please specify allowable load and equivalent concentration at permitted flow):

6. Discharge permit limit for total nitrogen (TN):
 - a. No permit limit
 - b. <3 mg/L
 - c. >3 to 5 mg/L
 - d. >5 to 10 mg/L
 - e. > 10 mg/L
 - f. Load based limit (please specify allowable load and equivalent concentration at permitted flow):

7. Discharge permit limit for total phosphorus (TP):
 - a. No permit limit
 - b. <0.1 mg/L
 - c. 0.1 to <0.2 mg/L
 - d. 0.2 to <0.5 mg/L
 - e. 0.5 to 1 mg/L
 - f. > 1 mg/L
 - g. Load based limit (please specify allowable load and equivalent concentration at permitted flow):

8. Please provide any additional comments on your WRRFs flows and permit limits:



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

BNR Process & Controls

Please answer the following questions based on the biological process(es) and related controls systems at your Water Resource Recovery Facility (WRRF).

9. Indicate the biological process(es) present at your WRRF (check all that are applicable):
 - a. Conventional activated sludge (e.g. complete mix, plug flow, MLE, A2O, Step Feed, 4- or 5-Stage Bardenpho)
 - b. Membrane bioreactor (e.g. complete mix, plug flow, MLE, A2O, Step Feed, 4- or 5-Stage Bardenpho)
 - c. Aerobic granular sludge
 - d. Sequencing batch reactor
 - e. High purity oxygen system
 - f. Fixed-film process
 - g. Other (please describe):

10. Describe the configuration(s) of the biological process(es) at your WRRF and provide any additional clarifying comments:

11. Indicate the Control System(s) associated with your biological process(es) (check all that are applicable):
 - a. Dissolved Oxygen
 - b. Ammonia-Based Aeration Control (ABAC)
 - c. Simultaneous Nitrification & Denitrification (SND)
 - d. Ammonia versus Nitrate (AVN)
 - e. Timer-based Aeration Control
 - f. Internal Mixed Liquor Recycle (IMLR) Pumping
 - g. RAS/WAS Pumping
 - h. SRT
 - i. Supplemental Carbon Addition
 - j. Supplemental Alkalinity Addition
 - k. Metal Salts (Alum, Ferric, PAC, and etc.) Addition
 - l. Polymer Addition
 - m. Other (please describe):

12. Please provide any additional descriptions or clarifying comments, including the year your control system(s) was installed and/or phasing of any major upgrades:



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

13. Indicate the online sensors (in situ) and analyzers (wet chemistry) that are associated with your biological process(es). For each type, note which are used for monitoring only and which are used for monitoring & control (select all that apply):

	Monitoring (e.g. trending, operator manual adjustments)	Control (e.g. blower speeds, IMLR pump speeds, chemical feed pumps)
Dissolved Oxygen sensor		
pH sensor		
Ammonium sensor		
Ammonium analyzer		
Nitrate sensor		
Nitrite analyzer		
Nitrite sensor		
Nitrite analyzer		
Phosphate analyzer		
COD/BOD sensor		
COD/BOD analyzer		
Suspended solids sensor		
Turbidity sensor		
ORP sensor		
Conductivity sensor		
Temperature sensor		
Other (please describe)		

14. Please provide any additional description and clarifying comments:



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

Sensors & Analyzers

The following questions ask details about the performance and maintenance for the online sensors & analyzers used in your biological process(es) for monitoring and control.

15. Note the quantity and describe location of the online sensors and analyzers:

Sensor	Monitoring Only (e.g. trending, operator manual adjustments to blower speed)		Monitoring & Control (e.g. blower speeds, IMLR pump speeds, chemical feed pumps, adjusting valve positions)	
	Number	Location	Number	Location
Dissolved Oxygen sensor				
pH sensor				
Ammonium sensor				
Ammonium analyzer				
Nitrate sensor				
Nitrite analyzer				
Nitrite sensor				
Nitrite analyzer				
Phosphate analyzer				
COD/BOD sensor				
COD/BOD analyzer				
Suspended solids sensor				
Turbidity sensor				
ORP sensor				
Conductivity sensor				
Temperature sensor				
Other (please describe)				

16. Please provide any additional description and clarifying comments (e.g. auxiliary cleaning system):



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

17. In general, how do the online sensor(s) and analyzer(s) perform? (Check all that apply):

	Meets qualitative accuracy needs (e.g. detecting trends)	Meets quantitative accuracy needs	Reliable for use in controller	Signal drift is minimal	Signal interference/bias due to process water is minimal	Other – please describe
Dissolved Oxygen sensor						
pH sensor						
Ammonium sensor						
Ammonium analyzer						
Nitrate sensor						
Nitrite analyzer						
Nitrite sensor						
Nitrite analyzer						
Phosphate analyzer						
COD/BOD sensor						
COD/BOD analyzer						
Suspended solids sensor						
Turbidity sensor						
ORP sensor						
Conductivity sensor						
Temperature sensor						
Other (please describe)						

18. Please provide any additional description and clarifying comments:



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

19. Describe the typical calibration associated with the sensor(s) and analyzer(s)? Select responses for the sensors present in your system.

	Calibration frequency <i>(1/year - Quarterly - 1/month - 2/month - 1/week - >1/week)</i>	Ease of Calibration <i>(Very Easy – Easy – Hard - Very Hard)</i>	Acceptability of Calibration Requirements <i>(Minimal – Acceptable – Significant – Burdensome)</i>
Dissolved Oxygen sensor			
pH sensor			
Ammonium sensor			
Ammonium analyzer			
Nitrate sensor			
Nitrite analyzer			
Nitrite sensor			
Nitrite analyzer			
Phosphate analyzer			
COD/BOD sensor			
COD/BOD analyzer			
Suspended solids sensor			
Turbidity sensor			
ORP sensor			
Conductivity sensor			
Temperature sensor			
Other (please describe)			

20. Please provide any additional comments related to calibration.



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

21. Describe the typical manual cleaning associated with the sensor(s) and analyzer(s)?

	Cleaning frequency <i>(1/year - Quarterly - 1/month - 2/month - 1/week - >1/week)</i>	Ease of Cleaning <i>(Very Easy – Easy – Hard - Very Hard)</i>	Acceptability of Cleaning Requirements <i>(Minimal – Acceptable – Significant – Burdensome)</i>
Dissolved Oxygen sensor			
pH sensor			
Ammonium sensor			
Ammonium analyzer			
Nitrate sensor			
Nitrite analyzer			
Nitrite sensor			
Nitrite analyzer			
Phosphate analyzer			
COD/BOD sensor			
COD/BOD analyzer			
Suspended solids sensor			
Turbidity sensor			
ORP sensor			
Conductivity sensor			
Temperature sensor			
Other (please describe)			

22. Please provide any additional comments related cleaning.



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

23. Describe the typical maintenance associated with the sensor(s) and analyzer(s)?

	Preventive Maintenance Frequency <i>(1/year - Quarterly - 1/month - 2/month - 1/week - >1/week)</i>	Ease of Maintenance (e.g., accessibility, complexity, special tools, specialized personnel) <i>(Very Easy – Easy – Hard - Very Hard)</i>	Acceptability of Maintenance <i>(Minimal – Acceptable – Significant – Burdensome)</i>
Dissolved Oxygen sensor			
pH sensor			
Ammonium sensor			
Ammonium analyzer			
Nitrate sensor			
Nitrite analyzer			
Nitrite sensor			
Nitrite analyzer			
Phosphate analyzer			
COD/BOD sensor			
COD/BOD analyzer			
Suspended solids sensor			
Turbidity sensor			
ORP sensor			
Conductivity sensor			
Temperature sensor			
Other (please describe)			

24. Please provide any additional comments related to the maintenance.



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

25. In general, how much cost and additional support is associated with the sensor(s) and analyzers?

	O&M Costs <i>(Minimal – Acceptable – Significant – Burdensome)</i>	Need for Training <i>(Minimal – Acceptable – Significant – Burdensome)</i>	Use of Third-Party Service Contract (e.g., annual contract with manufacturer) <i>(Yes or No)</i>
Dissolved Oxygen sensor			
pH sensor			
Ammonium sensor			
Ammonium analyzer			
Nitrate sensor			
Nitrite analyzer			
Nitrite sensor			
Nitrite analyzer			
Phosphate analyzer			
COD/BOD sensor			
COD/BOD analyzer			
Suspended solids sensor			
Turbidity sensor			
ORP sensor			
Conductivity sensor			
Temperature sensor			
Other (please describe)			

26. Please provide any additional comments related to cost and additional support.



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

Outcomes

The following questions speak to the **benefits**, and **challenges** of your BNR controls and sensors/analyzer systems. Please respond for each control system at your WRRF. Also, we'd like your perspective on how you would improve your system(s) and what you would recommend to others implementing new BNR Control systems with sensors/analyzers.

27. What **process improvements** are associated with the control system(s)? Check all that apply:
- Improved nutrient removal
 - Improved settleability and MLSS characteristics
 - Improved operations - More control
 - Improved operations - More monitoring
 - Improved reliability and less variability

Comments and additional description:

28. What other **benefits** are associated with the control system(s)? Check all that apply:
- Energy savings
 - GHG reduction
 - Chemical savings
 - Sludge generation reduction
 - O&M labor savings
 - Other:

Comments and additional description:

29. What are your biggest **challenges** associated with the control system(s)? Check all that apply and provide additional detail, as applicable:
- Capital cost
 - O&M costs
 - Control system stability
 - Sensor accuracy
 - System complexity

Comments and additional description:

30. Was the implementation of the sensor based control system worth the investment?

31. If you could do it again, **what would you do differently?**



Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

32. Based on your experience, what **factors are important** to consider for a new sensor/analyzer-based control system? Check all that apply:

- a. Input from WRRF team during design (including operators, lab personnel, maintenance, controls and instrumentation techs)
- b. Operator familiarity with the control system though prior use based on past experience
- c. Information from the sensor/analyzer manufacturers
- d. Information from controls vendors
- e. Information from other WRRFs who operator similar control systems and/or sensors
- f. Training
- g. Implementation of Standard Operating Procedures (SOPs)
- h. Understanding of O&M requirements for sensors/analyzers
- i. Understanding of controls tuning
- j. Availability of on-going manufacturer field support (e.g., via annual service contracts)
- k. Other

Comments and additional description:

33. Please share any other information you'd like to provide:



Northeastern
University

UMassAmherst

HATCH

Utility Survey

Water Research Foundation – Project 5087:

Implementation of Innovative Biological Nutrient Removal Processes through Improvement of Control Systems and Online Analytical Measurement Reliability and Accuracy

Follow Up

Thank you for completing the survey! The results will be aggregated with responses received from other WRRFs and used to develop tools to guide others in implementing BNR controls with online sensor and analyzers. A member of our project team may reach out for clarifications and additional details about your experience with BNR controls and sensors either through a supplemental survey or through a phone discussion with a member of our team in Winter-Spring 2022.

34. Does the information you provided in this survey need to remain anonymous and only presented in aggregate with the overall data collected?
 - a. No
 - b. Yes - all information should remain anonymous.
 - c. Yes - a portion should remain anonymous. Please describe:
35. Would you be willing to have your experience shared as a case study for the project:
 - d. No
 - e. Yes