REQUEST FOR QUALIFICATIONS

Orange Water and Sewer Authority
Wastewater Treatment Plant Hydraulic and Treatment Process Evaluation
CIP Project No. 278-15
Issue Date: October 8, 2024
Submittal Deadline: November 12, 2024 at 2PM

1. INTRODUCTION

Your firm is hereby invited to submit a written statement of qualifications to provide professional engineering services to conduct a series of hydraulic and treatment process evaluations for the Mason Farm Wastewater Treatment Plant (WWTP). OWASA will conduct a Qualification-Based Selection process to identify the best qualified firm with which to negotiate a contract. All firms submitting qualifications must have demonstrated experience and expertise in conducting wastewater treatment evaluations.

To be considered by OWASA, responses to this RFQ must be received by 2:00 p.m. Eastern Time on November 12, 2024. Refer to Section 5 – Submittal Requirements for details.

2. OBJECTIVES

The primary objectives of the project are to complete the following with the next 12-months:

a) In conjunction with fermentation capacity evaluation, evaluate current and alternative carbon sources to meet nutrient removal demands in compliance with current and potential future NPDES (National Pollutant Discharge Elimination System) permitting and influent flow rates.
b) In conjunction with carbon study, evaluate fermentation capacity and redundancy necessary for adequate retention time and Volatile Fatty Acid (VFA) production.
c) Conduct Ammonia Based Aeration Control (ABAC) pilot study.
d) Evaluate flow equalization (EQ) options while operating within existing property boundary and develop a hydrograph to inform these measures.

3. BACKGROUND AND DESCRIPTION

OWASA operates the Mason Farm Wastewater Treatment Plant (WWTP) servicing the towns of Chapel Hill and Carrboro, as well as the University of North Carolina (UNC). The plant is rated at a maximum month flow of 14.5 million gallons per day (MGD) with peak flows of 43.5 MGD. The current average daily flow is 7.5 MGD. The identified buildout capacity for the WWTP is maximum month flow of 18.5 MGD with 55 MGD wet weather peak flows. Hazen and Sawyer completed a Master Plan for the facility in 2023, aligning with OWASA's WWTP core objectives to identify near and long terms goals. Multiple Technical Memorandums (TM) were developed to

accompany the WWTP Master Plan and contained the following recommendations for areas needing further study:

- Carbon Sourcing - Mason Farm WWTP currently feeds acetic acid as a carbon source to the nutrified sludge (NSL) basins to supplement fermentation to promote biological phosphorus removal. Additionally, OWASA currently utilizes deep-bed filtration for tertiary filtration prior to UV disinfection that can be converted to support biological denitrification with supplemental carbon addition. In conjunction with the fermentation capacity evaluation, an evaluation to assess alternative carbon sources, technologies, and strategies was recommended to provide options to economically and efficiently meet current and future nutrient removal requirements.
- Fermentation Capacity – The WWTP utilizes primary sludge fermentation to produce volatile fatty acids (VFA) to aid in nutrient removal to meet total nitrogen (TN) and total phosphorus (TP) nutrient removal requirements. As flow rates increase beyond 14.5 MGD, the hydraulic retention time within the primary sludge fermenter will fall below the required 2 days to meet VFA production requirements. Additionally, a physical expansion of the primary fermentation is undesirable due to limited footprint. In conjunction with the carbon study, a fermenter capacity evaluation is recommended to provide options to balance VFA production and supplemental carbon demand to meet current and future nutrient removal requirements.
- Ammonia-Based Aeration Control (ABAC) – Another recommendation to meet future nutrient removal limits is Ammonia-Based Aeration Control. This aeration control strategy adjusts dissolved oxygen (DO) in response to the ammonia concentration at the end of the aeration zone. Optimizing aeration and dissolved oxygen (DO) to meet target ammonia concentrations can minimize airflow and energy use, optimize nitrogen removal efficiency, maximize simultaneous nitrification and denitrification, and potentially reduce carbon usage. A pilot study is needed to evaluate the efficacy and inform the potential implementation of this strategy.
- Equalization Infrastructure and Hydrograph Study – The 2023 Master Plan was written with the assumption that on-site equalization (EQ) would eventually be implemented. A flow equalization study and hydrograph development are recommended to help determine how much on-site equalization can fit with-in the existing plant footprint to inform OWASA's support current and future plant operations.

4. SCOPE OF SERVICES

The engineering services required for this project are expected to be completed to meet the objective outlined above and in general accordance with a scope of services as needed to accomplish the tasks listed below. **However, the final scope of services will be negotiated with the selected engineering firm and may include modified and/or additional tasks.**

Scope of Services may include (but not limited to):

1. Carbon study and fermentation capacity evaluation:
    a. Assessment Services
        i. Review of 2023 master plan with updates/modification to reflect new information
    b. Planning Services
        i. Treatment technology/chemical assessment
    c. Preliminary Engineering Services
        i. Alternatives evaluation including (but not limited to):
            1. Alignment with core plant objectives from Master Plan
            2. Present worth analysis
            3. Impact to plant operations

2. Ammonia Based Aeration Control Pilot Study:
    a. Planning Services
        i. Pilot Testing
        ii. Procurement Planning for pilot equipment/installation
    b. Preliminary Engineering
        i. Evaluation including (but not limited to):
            1. Alignment with core plant objectives from Master Plan
            2. Present worth analysis
            3. Budgetary cost of full-scale implementation
            4. Impact of pilot and full-scale implementation to plant operations

3. EQ and hydrograph study services may include:
    a. Preliminary Engineering
        i. Hydrograph Study
        ii. EQ study
        iii. Alternatives evaluation including (but not limited to):
            1. Alignment with the core plant objectives from the Master Plan.
            2. Present Worth Analysis
            3. Impact to plant operation

The draft and final plans, reports, etc. will be provided in electronic and hard copy formats in a manner acceptable to and usable by OWASA. The actual list and format of deliverables will be negotiated with the selected firm.

5. SUBMITTAL REQUIREMENTS

Responses to this RFQ must be received by OWASA no later than 2:00 p.m. Eastern Time on Wednesday, November 12, 2024. To be considered, please submit four (4) hard copies and one (1) electronic copy in PDF format of the required qualifications to:

Mohisin Rasheed, P.E.
mrasheed@owasa.org
Utilities Engineer – Capital Projects
Orange Water and Sewer Authority

400 Jones Ferry Road
Carrboro, North Carolina 27510

The Statement of Qualifications (**including** resumes) shall be limited to a maximum of 10 double-sided pages (i.e., 20 pages printed double-sided onto 10 sheets of 8-1/2"x11" paper). Please note that all Submittals shall become public documents upon delivery to OWASA. If there is sensitive or confidential information that cannot be shared publicly, please include additional documentation along with your submittal.

Along with completed copies of forms in Attachment 1, each submittal must include the following in order to be considered:

a) ***Statement of Interest***: explaining your firm's interest in performing the work on this project, including how the project aligns with your firm's capabilities.
b) ***Project Team/Org Chart*** **[25 points]** showing the proposed project team members, including sub-consultants (if any), identifying their respective roles on the project, and indicating their availability to support this project. Each proposal shall include resumes of key team members. The primary contact shall be clearly identified.
c) ***Project Approach*** **[25 points]** describing your proposed approach to accomplish the work to meet the project objectives, identifying how you will manage schedule, risks, etc. Provide detailed information that will allow OWASA staff to distinguish your team from other firms that may be competing for this project.
d) ***Project Schedule*** **[15 points]** provide sufficient delineation of phasing and tasks to demonstrate your understanding of the necessary project activities and reasonable durations, interdependencies, etc. to complete the studies within 12 months.
e) ***Past Experience and References*** **[35 points]** most similar projects (i.e., nutrient optimization studies or hydrograph studies) completed by your project team in the last (5) years for other clients. Identify who served as project manager and key lead technical roles in those projects.
f) ***Contract Objections:*** It is OWASA's intention to use a contract similar to the one included as Attachment 2. If your firm objects to any element of the contract, please state the objections in the submittal.
g) ***Completed Attachment 1 forms***

6. TIMELINE AND SELECTION PROCESS

The timeline for this solicitation is as follows:

Advertisement	October 8, 2024
Questions Close	October 29, 2024
Statement of Qualifications Due	November 12, 2024
Anticipated Notice of Selection	November 26, 2024
Anticipated Completion of Final Scoping and Contracting	December 2024

All dates in the above table are subject to change.

OWASA reserves the right to reject any and all proposals, to waive any minor formalities, and to disregard all nonconforming or conditional submittals.

OWASA may elect to conduct face-to-face interviews with two or more firms being evaluated prior to making a final selection.

If OWASA cannot reach an agreement with the initially selected firm, OWASA will then proceed to negotiate with the next best qualified firm, or will reissue the RFQ.

In accordance with North Carolina State law (NC GS 143-128.2(g)) regarding Minority/Women Business Enterprises (M/WBE), it is the policy of OWASA to encourage and promote the use of minority-owned businesses in the procurement of goods and services. Proposers are strongly encouraged to include minority and women-owned businesses to the fullest extent possible when assembling their teams.

7. OWASA POINT OF CONTACT

Mohisin Rasheed will be OWASA's primary point of contact for all consultant selection matters relating to this project. **All questions regarding this Request for Qualifications must be emailed on or before October 29, 2024** to Mr. Rasheed at mrasheed@owasa.org.

8. SUPPLEMENTAL INFORMATION

Attachment 1: Procurement Forms
Attachment 2: OWASA Standard Design Services Agreement
Attachment 3: WWTP Core Objectives
1. Wastewater Treatment Plant Master Plan Deliverables with Attachments
2. TM 2 - Hydraulic Capacity Assessment
3. TM 3 - Nutrient Removal & Recovery
4. TM 4 - Biosolids and Bioenergy

Attachment 4: Mason Farm WWTP NPDES Permit
Attachment 5: Jordan Lake Rules

ACKNOWLEDGEMENT OF ADDENDA

The undersigned hereby acknowledges that their submission is reflective of any addenda posted for this solicitation by checking the appropriate box(es) below:

☐ N/A – no Addenda issued

☐ Addendum 1
☐ Addendum 2
☐ Addendum 3
☐ Addendum 4
☐ Addendum 5

Signature Date

Printed Name Title

E-VERIFY AFFIDAVIT

I,_____(the individual attesting below), being duly authorized by and on behalf of

_____ (the entity identified as the "Employer") after first being duly sworn hereby swears or affirms as follows:

1. Employer understands that E-Verify is the federal E-Verify program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program used to verify the work authorization of newly hired employees pursuant to federal law in accordance with Article 2 of Chapter 64 of the North Carolina General Statutes.

2. Employer understands that Employers Must Use E-Verify. Each employer, after hiring an employee to work in the United States, shall verify the work authorization of the employee through E-Verify in accordance with Article 2 of Chapter 64 of the North Carolina General Statutes.

3. Employer will ensure compliance with E-Verify by any subcontractors subsequently hired by Employer for specified contracts subject to E-Verify entered into with the Orange Water and Sewer Authority.

This_____day of_____,_____.

_____

Signature of Affiant

Print or Type Name: _____

State of_____County of _____

Signed and sworn to (or affirmed) before me, this the __

day of_____,_____.

My Commission Expires:

_____ _____

Notary Public

(Affix Official/Notarial Seal)

Name of Counterparty:

_____

IRAN DIVESTMENT ACT CERTIFICATION REQUIRED BY N.C.G.S. 143C-6A-5(a)

N.C.G.S. 143C-6A-5(a) requires this certification for bids or contracts with the State of North Carolina, a North Carolina local government, or any other political subdivision of the State of North Carolina.

N.C.G.S. 143C-6A-5(b) requires that contractors with the State, a North Carolina local government, or any other political subdivision of the State of North Carolina must not utilize any subcontractor found on the State Treasurer's Final Divestment List.

As of the date listed below, the vendor or bidder listed above is not listed on the Final Divestment List created by the State Treasurer pursuant to N.C.G.S. 143-6A-4.

The undersigned hereby certifies that he or she is authorized by the vendor or bidder listed above to make the foregoing statement.

Signature	Date
Printed Name	Title

Notes to persons signing this form:

The State Treasurer's Final Divestment List can be found on the State Treasurer's website at: https://www.nctreasurer.com/about/transparency/commitment-transparency/divestment-and-do-not-contract-rules
and will be updated every 180 days.

COMPANIES BOYCOTTING ISRAEL DIVESTMENT ACT CERTIFICATION REQUIRED BY N.C.G.S. §147-86.81*et seq*. *

Pursuant to N.C.G.S. §**147-86.81**, any company identified as engaging in a boycott of Israel, as defined by this Act, is ineligible to contract with the State of North Carolina or any political subdivision of the State. In addition, State agencies must divest from investments in such restricted companies, determined by appearing on the Final Divestment List created by the State Treasurer pursuant to G.S. 147-86.81.

As of the date listed below, the supplier or bidder listed above is not listed on the Final Divestment List created by the State Treasurer pursuant to N.C.G.S. §147-86.81.

The undersigned hereby certifies that he or she is authorized by the contracting party or bidder listed above to make the foregoing statement.

Signature Date

Printed Name Title

Notes to persons signing this form:

The State Treasurer's Final Divestment List can be found on the State Treasurer's website at: https://www.nctreasurer.com/about/transparency/commitment-transparency/divestment-and-do-not-contract-rules

and will be updated every 180 days.

NON-COLLUSION AFFIDAVIT

The submitter, being duly sworn, solemnly swears (or affirms) that neither he, nor any official, agent or employee has entered into any agreement, participated in any collusion, or otherwise taken any action which is in restraint of free competition in connection with any bid or contract, that the bidder has not been convicted of violating *N.C.G.S. § 133-24* within the last three years, and that the submitter intends to do the work with its own bonafide employees or subcontractors and will not submit for the benefit of another contractor.

By submitting this non-collusion affidavit, the Submitter certifies, under penalty of perjury according to North Carolina law, their compliance with non-collusion standards. This affidavit affirms the Submitter's adherence to the required non-collusion guidelines without any exceptions.

SIGNATURE OF BIDDER

Name of Submitter_____
Print or type name

Address _____

Signature of Submitter_____
Print or type Signer's Name

Signature of Witness_____
Print or type Signer's name

AFFIDAVIT MUST BE NOTARIZED
Subscribed and sworn to before me this the

_____ day of _____ 20__ .

Signature of Notary Public

of _____County

State of _____

My Commission Expires: _____ **NOTARY SEAL**

CERTIFICATION REGARDING CONFLICT OF INTEREST

All Vendors should be aware of OWASA'S Code of Ethics, which prohibits OWASA Employees and Board Members from having certain relationships with persons or entities conducting (or proposing to conduct) business with OWASA and which prohibits the acceptance of gifts from Vendors. If the Vendor has an actual or potential conflict, the Vendor shall disclose any Conflict of Interest that may exist.

Conflicts of Interest (potential or actual) will be evaluated by OWASA'S General Counsel to determine the proper course of action. Failure to comply with the provisions established above may render the vendor ineligible to participate in OWASA'S procurement process.

The Submitter is required to certify that performance of the work will not create any conflicts of interest or disclose any actual or potential conflicts of interest by completing and signing <u>one</u> of the following statements:

The Submitter hereby discloses no conflicts of interest.

DATE: _____

AUTHORIZED SIGNATURE: _____

TITLE: _____

SUBMITTER/COMPANY NAME: _____

OR

The Submitter hereby discloses the following circumstances that could give rise to a conflict of interest for the Submitter, any affiliates, any proposed subconsultants, and key personnel of any of these organizations. (Attach additional sheets as needed.)

Name of the Individual/Company to which potential conflict of interest might apply:

_____

Nature of potential conflict of interest:

_____

_____

Proposed Remedy:

_____

_____

_____

DATE: _____

AUTHORIZED SIGNATURE: _____

TITLE: _____

SUBMITTER/COMPANY NAME: _____

AGREEMENT
BETWEEN

ORANGE WATER AND SEWER AUTHORITY,

a political subdivision of the State of North Carolina, its successors and assigns, hereinafter referred to as "Owner" through its Board of Directors,

and

CONSULTANT NAME

its successors and assigns, hereinafter referred to as "Consultant"

IN ORANGE COUNTY NORTH CAROLINA

FOR
CONSULTING SERVICES

W I T N E S S E T H :

WHEREAS, Owner intends to conduct a study of the sanitary sewer system within its service area; and,

WHEREAS, Owner requires certain consulting services in connection with the project (the Services); and,

WHEREAS, Consultant is prepared to provide the Services;

NOW THEREFORE, in consideration of the mutual terms and conditions, promises and payments contained in this Agreement, Owner and Consultant agree as follows:

ARTICLE 1 - TIME FOR PERFORMANCE

1.1 The effective date of this Agreement is _____ and shall remain in effect until terminated. Consultant shall perform the services described in Attachment B (herein, the Project Scope of Services) to this Agreement. Owner will issue a separate Notice to Proceed for the work, and the work shall proceed according to the schedule as described in the Project Scope of Services. Any work initiated by Consultant prior to the Owner's written authorization of the Project will be at the Consultant's sole risk.

ARTICLE 2 - GOVERNING LAW

2.1 This Agreement shall be governed by the laws of the state of North Carolina. Any disputes which may arise out of this agreement shall be filed in the North Carolina Court of Justice, The Superior Court of Orange County NC.

ARTICLE 3 - SERVICES TO BE PERFORMED

3.1 Consultant shall perform the Services described in the Project Scope of Services as authorized

under this Agreement. Consultant shall provide all services as set forth in the Project Scope of Services, including the necessary, incidental and related activities and services required and contemplated in the Consultant's level of effort.

3.2 Consultant and Owner acknowledge that the Scope of Services described for the Project does not delineate every detail and minor work task required to be performed by Consultant to complete the work authorized by the Scope of Services. If during the course of the performance of the services authorized by this Agreement, Consultant determines that work should be performed to complete the Project which is in the Consultant's opinion outside the level of effort originally anticipated, whether or not the Project Scope of Services identifies the work items, Consultant shall notify Contract Administrator in writing within 30 days and wait for Owner approval before proceeding with the work. If Consultant proceeds with said work without notifying the Contract Administrator, said work shall be deemed to be within the original level of effort described in the Project Scope of Services. Notice to the Contract Administrator does not constitute authorization or approval by Owner to perform the work. Performance of work by Consultant outside the originally anticipated level of effort without prior written Owner approval is at the Consultant's sole risk.

3.3 Upon mutual written agreement, the Project Scope of Services may be modified. The Owner and the Consultant may negotiate additional scopes of services, compensation, time of performance and other matters related to the project. If the Owner and Consultant cannot contractually agree, Owner shall have the right to immediately terminate negotiations at no cost to the Owner and to procure services from another source.

ARTICLE 4 - OWNER'S RESPONSIBILITIES

4.1 Owner shall be responsible for all matters described in the Project Scope of Services (Attachment B).

ARTICLE 5 - COMPENSATION AND METHOD OF PAYMENT

5.1 Owner agrees to pay Consultant as compensation for performance of services as described in the Project Scope of Services. Compensation may be as a lump sum or as maximum amount not-to-exceed. The maximum amount not-to-exceed method of compensation will utilize hourly billing rates established as part of this Agreement.

5.2 Consultant shall separately invoice for services rendered each month. Each project invoice shall reflect percentage of work completed to date and for the invoiced month. Invoices shall provide a detailed breakdown of hours worked, hourly billing rates by each individual, and the expenses attributable to the project during the period.

5.3 The Owner shall assign a Project CIP Number, as well as a Purchase Order Number for the Project to facilitate internal contract administration. Each Project Invoice must reference the assigned CIP Number and the Purchase Order Number for the Project and be sent directly to the Owner’s Project Manager as assigned. Payment terms shall be the net invoice amount within 30 days.

5.4 The hourly billing rates for this agreement are set forth in Attachment A to this agreement and shall be used for maximum not-to-exceed compensation**.**

5.5 The reimbursable expenses for this agreement are set forth in Attachment A to this agreement and shall be used for maximum amount not-to-exceed compensation. Consultant shall be allowed to adjust expense items in accordance with changes in IRS criteria for deductible expenses.

5.6 Consultant shall keep such records and accounts and require any and all consultants and sub-consultants to keep records and accounts as may be necessary in order to record complete and correct entries as to personnel hours charged to the project and any expenses for which Consultant expects to be reimbursed. All books and records relative to the project shall be available at all reasonable times for examination and audit by Owner and shall be kept for a period of three (3) years after completion of all work pursuant to this Agreement. Incomplete or incorrect entries in such books and records shall be grounds for Owner's disallowance of any fees or expenses based upon such entries.

ARTICLE 6 - STANDARD OF CARE

6.1 General: Consultant shall exercise the same degree of care and diligence in the performance of the Services as is ordinarily exercised by a professional serving under similar circumstances.

ARTICLE 7 - LIABILITY AND INDEMNIFICATION

7.1 General: Having considered the potential liabilities that may exist during the performance of the Scope of Services, the benefits of the project, and the Consultant's fee for the Services, and in consideration of the promises contained in this Agreement, Owner and Consultant agree to allocate and limit such liabilities in accordance with this Article.

7.2 Indemnification by Consultant: Consultant agrees to defend, indemnify, and hold harmless Owner, its agents, and its employees from and against legal liability for all claims, losses, damages, and expenses to the extent such claims, losses, damages, or expenses are caused by Consultant's negligent acts, errors, or omissions.

7.3 Employee Claims: Consultant shall indemnify Owner against legal liability for damages arising out of claims by Consultant's employees to the extent such claims arise out of Consultant's negligent acts, errors or omissions.

7.4 Survival: Upon completion of all Services, obligations, and duties provided for in this Agreement, or if this Agreement is terminated for any reason, the terms and conditions of this Article shall survive.

ARTICLE 8 - INSURANCE

8.1 During the performance of the Services under this Agreement, Consultant shall maintain the minimum levels of insurance shown below and provide certificates of such coverage to Owner prior to performance. All policies must provide ten (10) days advance written notice to Owner in the event of cancellation, expiration, or alteration.

8.1.1 General Liability Insurance, with a combined single limit of $1,000,000 for each occurrence and $1,000,000 in the aggregate.

8.1.2 Automobile Liability Insurance, with a combined single limit of $1,000,000 for each person and $1,000,000 for each accident.

8.1.3 Workers' Compensation Insurance in accordance with statutory requirements and Employers' Liability Insurance, with a limit of $500,000 for each occurrence.

8.1.4 Professional Liability Insurance, with a limit of $1,000,000 annual aggregate.

ARTICLE 9 - OWNERSHIP OF DOCUMENTS AND INTELLECTUAL PROPERTY

9.1 Except as otherwise provided herein, documents and reports prepared by Consultant as part of the Services shall become the property of Owner upon payment for same. All finished or unfinished documents, data studies, surveys, drawings, maps, models, photographs and reports prepared or provided by Consultant in connection with this Agreement become the property of the Owner, whether the projects are completed or not, and shall be delivered by Consultant to the Owner within ten (10) days after receipt of written notice and upon payment for same. Consultant shall retain its rights to its specifications, databases, computer software, and other proprietary property. Rights to intellectual property developed, utilized, or modified in the performance of the Services shall remain the property of Consultant. Any use by Consultant of intellectual property owned by Owner is authorized solely for the project.

ARTICLE 10 - TERMINATION

10.1 This Agreement may be terminated by either party upon written notice in the event of substantial failure by the other party to perform in accordance with the terms of this Agreement. The nonperforming party shall have fifteen calendar days from the date of the termination notice to cure or to submit a plan for cure acceptable to the other party.

10.2 Owner may terminate or suspend performance of this Agreement for Owner's convenience upon written notice to Consultant. Consultant shall terminate or suspend performance of the Services on a schedule acceptable to Owner. If termination or suspension is for Owner's convenience, Owner shall pay Consultant for all the Services performed and termination or suspension expenses. Upon restart, an equitable adjustment shall be made to Consultant's compensation.

ARTICLE 11 - DELAY IN PERFORMANCE

11.1 Neither Owner nor Consultant shall be considered in default of this Agreement for delays in performance caused by circumstances beyond the reasonable control of the nonperforming party. For purposes of this Agreement, such circumstances include: floods; earthquakes; fire; epidemics; war, riots, and other civil disturbances; strikes, lockouts, and other labor disturbances; sabotage; judicial restraint; and the inability to procure permits, licenses, or authorizations from any local, state, or federal agency for which such permits have been properly applied for in accordance with the specified Project Schedule for any of the supplies, materials, accesses, or services required to be provided by either Owner or Consultant under this Agreement.

11.2 Should such circumstances occur, the nonperforming party shall, within a reasonable time of being prevented from performing, give written notice to the other party describing the circumstances preventing continued performance and the efforts being made to resume performance of this Agreement. Consultant shall be entitled to an equitable adjustment in schedule and compensation in the event such circumstances occur.

ARTICLE 12 - COMMUNICATIONS

12.1 Any communication required by this Agreement shall be made in writing to the address specified in the Project Scope of Services. The Contract Administrator for the Owner shall be specified in the Project Scope of Services. Nothing contained in this Article or the Project Scope of Services shall be construed to restrict the transmission of routine communications between representatives of Owner and Consultant.

ARTICLE 13 - WAIVER

13.1 No waiver by either Owner or Consultant of any breach of this Agreement shall be of any effect unless it shall be written and signed by the waiving party. Such a waiver shall not affect the waiving party's rights with respect to any other or further breach.

ARTICLE 14 - SEVERABILITY

14.1 The invalidity, illegality, or unenforceability of any provision of this Agreement, or the occurrence of any event rendering any portion or provision of this Agreement void, shall in no way affect the validity or enforceability of any other portion or provision of this Agreement. Any void provision shall be deemed severed from this Agreement, and the balance of this Agreement shall be construed and enforced as if this Agreement did not contain the particular portion or provision held to be void. The parties further agree to amend this Agreement to replace any stricken provision with a valid provision that comes as close as possible to the intent of the stricken provision. The provisions of this Article shall not prevent this entire Agreement from being void should a provision which is of the essence of this Agreement be determined void.

ARTICLE 15 - SUCCESSORS AND ASSIGNS

15.1 Owner and Consultant each binds itself and its directors, officers, partners, successors, executors, administrators, assigns, and legal representatives to the other party to this Agreement and to the directors, officers, partners, successors, executors, administrators, assigns, and legal representatives of such other party in respect to all provisions of this Agreement.

ARTICLE 16 - ASSIGNMENT

16.1 Neither Owner nor Consultant shall assign any rights or duties under this Agreement without the prior written consent of the other party. Unless otherwise stated in the written consent to an assignment, no assignment will release or discharge the assignor from any obligation under this Agreement. Nothing contained in this Article shall prevent Consultant from employing independent consultants, associates, and subcontractors to assist in the performance of the Services. Consultant will not employ subcontractors for the performance of the Services without the prior written approval of Owner, which approval shall not be unreasonably withheld. Consultant shall have the right to assign duties to any of Consultant’s related or affiliated companies.

ARTICLE 17 - THIRD PARTY RIGHTS

17.1 Nothing in this Agreement shall be construed to give any rights or benefits to anyone other than Owner and Consultant.

ARTICLE 18 - MISCELLANEOUS

18.1 INTERPRETATION: The language of this Agreement has been agreed to by both parties to express their mutual intent and no rule of strict construction shall be applied against either party hereto. The headings contained in this Agreement are for reference purposes only and shall not affect in any way the meaning or interpretation of this Agreement. All personal pronouns used in this Agreement shall include the other gender, and the singular shall include the plural, and vice versa, unless the context otherwise requires. Terms such as "herein," "hereof," "hereunder," and "hereinafter" refer to this Agreement as a whole and not to any particular sentence, paragraph, or section where they appear, unless the context otherwise requires. Whenever reference is made to a Section or Article of this Agreement, such reference is to the Section or Article as a whole, including all of the subsections of such Section unless the reference is made to a particular subsection or subparagraph of such Section or Article.

18.2 CONSULTANT'S STAFF: Consultant shall provide the key staff identified in their proposal for the Project as long as said key staff are in Consultant's employment.

18.2.1 Consultant will obtain prior written approval of Contract Administrator to change key staff members. Consultant shall provide Contract Administrator with such information as necessary to determine the suitability of proposed new key staff. Contract Administrator shall be reasonable in evaluating key staff qualifications.

18.2.2 If Contract Administrator desires to request removal of any of Consultant's staff, Contract Administrator shall first meet with Consultant and provide reasonable justification for said removal.

18.3 ENTIRE AGREEMENT: This Agreement, including all documents identified below, represents the entire understanding between the Owner and the Consultant as to this particular scope of work and shall supersede all prior and contemporaneous communications, representations, understandings, and Agreements relating to the subject matter hereof and may be amended only by written mutual Agreement of the parties.

18.4 ATTACHMENTS: Current listing of Attachments includes:

- Attachment A – Hourly Billing Rates and Reimbursable Expenses.
- Attachment B – Project Scope of Services.

ARTICLE 19 – PRE-EXISTING CONTAMINATION

19.1 Anything herein to the contrary not withstanding, title to, ownership of, and legal responsibility and liability for any and all pre-existing contamination shall at all times remain with Owner. "Pre-existing contamination" is any hazardous or toxic substance, material, or condition present at the project site or sites concerned which was not brought onto such site or sites by Consultant.

ARTICLE 20 – LIMITATIONS OF RESPONSIBILITY

20.1 Consultant shall not be responsible for: (1) construction means, methods, techniques, sequences, procedures, or safety precautions and programs in connection with the Project; (2) the failure of any contractor, subcontractor, vendor, or other participant, not under contract to Consultant, to fulfill contractual responsibilities to Owner or to comply with federal, state, or local laws, regulations, and codes; or (3) procuring permits, certificates, and licenses required for any

construction unless such responsibilities are specifically assigned to Consultant in Scope of Services.

ARTICLE 21 – NON DISCRIMINATION CLAUSE

21.1 The Consultant shall not discriminate against any person on the grounds of race, color, national origin, sex, age, or handicap in administration of this Agreement. Nor shall any person be excluded from participation in, or be denied the benefits of any project designed under this Agreement on the grounds of race, color, national origin, sex, age, or handicap.

ARTICLE 22 – MINORITY BUSINESS PARTICIPATION

22.1 It is the policy of OWASA to provide minority businesses an equal opportunity to participate in all aspects of OWASA's contract activities. Consultant shall comply with OWASA's Minority Business Participation Outreach Plan and Guidelines.

ARTICLE 23 – E-VERIFY

23.1 Consultant shall comply with the requirements of Article 2 of Chapter 64 of the General Statutes. Further, if Consultant utilizes a subcontractor, Consultant shall require the subcontractor to comply with the requirements of Article 2 of Chapter 64 of the General Statutes.

IN WITNESS WHEREOF, Owner and Consultant have executed this Agreement.

OWNER:

ORANGE WATER AND SEWER AUTHORITY

BY: _____

TITLE:

DATE: _____

CONSULTANT:

CONSULTANT NAME

BY: _____

TITLE:

DATE: _____

APPROVED AS TO FORM AND LEGALITY:

_____ _____

Date Robert Epting, Esquire
Authority General Counsel

This instrument has been pre-audited in the manner required by the Local Government Budget and Fiscal Control Act:

_____ _____

Date Kelly Satterfield
Director of Finance

ATTACHMENT A

HOURLY BILLING RATES AND REIMBURSABLE EXPENSES

INTRODUCTION

The hourly billing rates are set forth below.

Billing Category	Individual Name and Title	Hourly Billing Rate for the Agreement
Principal		
Senior Project Manager		
Senior Discipline Engineer		
Project Manager		
Project Engineer		
Engineer		
Engineering Associate		
Senior Technician		
Technician		
Administrative Assistant		

BILLING CATEGORY DEFINITIONS

The following table provides broad definitions for various Billing Categories. As a guideline, expected experience and duties for each of the categories have been included in the Billing Category Definitions. It is expected that in some instances the actual experience of an individual may be different than what is required for the corresponding Billing Category. In all such cases, Consultant will provide appropriate justification and seek approval from the Owner.

Principal	This is the firm's corporate officer. In some cases "Principal" may be the owner or one of the partners of the firm, and is generally in a position to make all the corporate level decision for the firm as it pertains to this Agreement.
Senior Project Manager	Person in this position provides senior level project management, provides high level of professional input for the project and is generally responsible for conducting high level project review. This person has a Professional Engineering license in North Carolina and professional-level experience of over 15 years.

Senior Discipline Engineer	Person in this position is considered the firm's expert for a particular discipline. This person will oversee Engineering work of particular discipline at the highest level for the firm. This person has a Professional Engineering license in North Carolina and professional-level experience of over 18 years. Engineering Disciplines may include, but are not limited to: Structural Engineering, Water Resources, Environmental Engineering, Transportation, Electrical Engineering, Mechanical Engineering, Pump Station Design, Instrumentation and Control, Construction Management, Power Generation, etc.
Project Manager	Person in this position provides day-to-day Project Management for the Project and acts as the key client contact. This person has a professional license in North Carolina and professional-level experience of over 8 years.
Project Engineer	Person in this position provides day-to-day engineering work for various disciplines as required by individual projects. This person has a professional license in North Carolina and professional-level experience of over 8 years.
Engineer	Person in this position provides day-to-day engineering support to the Project Manager, Project Engineer and other team members as required for their respective projects. This person has a professional license in North Carolina and professional-level experience of over 3 years.
Engineering Associate	Person in this position provides day-to-day engineering support to the Project Manager, Project Engineer, Engineer and other team members as required for their respective projects. This person is an Engineering Intern or has an Engineering Associates degree with appropriate technical experience.
Senior Technician	Person in this position provides senior technical-level support to the Project Team. Support may include CAD services, GIS, or other technical-level work. This person has 10 years of experience providing technical-level work.
Technician	Person in this position provides technical-level support to the Project Team. Support may include CAD services, GIS, or other technical-level work. This person has 4 years of experience providing technical-level work.
Registered Land Surveyor	This person is a North Carolina Board of Engineers and Land Surveyors certified Land Surveyor and has 4 years of professional-level experience.
2 Person Survey Crew	These individuals form a surveying team, acting as an Instrument Person and Rod-Person.
Administrative Assistant	This person performs administrative and clerical-level work for the Project Team, including data entry, word processing, and other non-technical support work as needed for the Project.

REIMBURSABLE EXPENSES

Reimbursable expenses for each individual project shall be clearly itemized by the Consultant. The following guidelines shall be used to develop these expenses:

1. Overtime at straight time rates shall apply for exempt employees to the extent the employee works more than 40 hours per week on Owner's project.
2. Subcontracted services shall be based on Cost Plus 5%. Consultant shall obtain Owner's approval before authorizing such services.
3. Cost of printing and reproducing drawings and bid documents, except for those included in the lump sum cost.
4. Cost for use of field equipment, safety equipment and field sampling equipment.
5. Cost of courier and express mail services.
6. Living and traveling expenses when Consultant's employees are away from home on Owner's project assignments. The following limitations shall apply:
    - Base room charges (excluding taxes and other fees) shall not exceed $119 per night.
    - Base rental car charges (excluding taxes and other fees) shall not exceed $60 per day.
    - Meal charges per individual shall not exceed $51 per day.
7. Automobile mileage to be reimbursed at rate established and updated by Internal Revenue Service.

ATTACHMENT B

PROJECT SCOPE OF SERVICES

Project Title: …

OWASA's CIP #: …

Project Contract Administrators:

OWASA	**Consultant**
...	**...**
Utilities Engineer	…
Orange Water and Sewer Authority	…
400 Jones Ferry Road	…
Carrboro, NC 27510	
Office: (919) 537-4248	

Project Background:

…
…

Project Scope:

Task 1 – Kickoff Meeting, Flow Monitoring and Data Collection
…
Task 2 - … …
…

Deliverables:

Specify deliverables, number of copies, and format.

Project Team:

…

Key Team Members:
…
The OWNER will be notified in writing of changes to the project team members. Other staff may participate in the project in a minor role at Consultant's discretion.

Project Schedule:

….

List durations for interim milestones and final completion in total number of days from Notice to Proceed.

Compensation:

…

Provide compensation basis (lump sum, cost ceiling) and subtotals by task.
Provide separate subtask breakdowns for projects above exemption limit, or as warranted.

Owner Responsibilities

…

Scope Exceptions, Additional Services, etc

January 29, 2024

To: Allison Spinelli, PE
Vishnu Gangadharan
Wil Lawson
Marcus Hill

From: Lamya King, PE
Eric Polli, PE
Amy Hanna, PE
Adam Behr, EIT
Patricia Drummey Stiegel, PE

Mason Farm WWTP Master Plan
Master Plan Development

FINAL

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd). Hazen is contracted to complete a Master Plan to identify near and long-term improvement projects that will help OWASA provide reliable and efficient wastewater treatment.

This Master Plan deliverable is a summary of the recommended paths forward to address hydraulic capacity, nutrient removal and recovery, biosolids management, and energy recovery and resiliency needs to accommodate future growth and meet regulations. This memorandum provides the trigger-based roadmaps, proposed site plans, and the cost estimates associated with the recommended improvements.

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Acronyms and Abbreviations

2010 Study	2010 Hydraulic and Treatment Capacity Study
ABAC	Ammonia Based Aeration Control
CHP	Combined Heat and Power
DAS	Densified Activated Sludge
DG	Digester Gas
EBAT	Energy Balance and Analysis Tool
eRIN	Renewable Fuel Pathway
EQ	Equalization
GAS	Gasification/Pyrolysis
MAD	Mesophilic Anaerobic Digestion
MCDA	Multi-criteria Decision Analysis
mgd	Million gallons per day
MLE	Modified Ludzack-Ettinger
NPDES	National Pollutant Discharge and Elimination System
NRCY	Nitrified Recycle
OWASA	Orange Water and Sewer Authority
PdNA/PANDA	Partial Nitrification-Denitrification-Anammox
PFAS	Per- and Polyfluoroalkyl Substances
RNG	Renewable Natural Gas
SC	Secondary Clarifier
SCWO	Supercritical Water Oxidation
TD	Thermal Drying
TM	Technical Memorandum
TN	Total Nitrogen
TP	Total Phosphorus
TPAD	Temperature-Phase Anaerobic Digestion
WWTP	Wastewater Treatment Plant

1. Summary of Recommendations

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd) as a maximum month flow. The Mason Farm WWTP is required to meet more stringent annual mass load allocations of 134,375 pounds per year of total nitrogen (TN) and 10,188 pounds per year of total phosphorus (TP) with the enactment of the Jordan Lake Nutrient Strategy. To address these mass allocations, Hazen completed a Hydraulic and Treatment Capacity Study in 2010 (2010 Study), which evaluated existing facilities and provided recommendations to address hydraulic and treatment constraints at the Mason Farm WWTP. The results of the study evaluated numerous nutrient removal and biosolids treatment alternatives and recommended improvements to optimize treatment while minimizing operational costs. Some of the recommended improvements identified in the 2010 Study were implemented, which has resulted in significant savings in operational costs.

Several changes have occurred in the wastewater treatment industry since the 2010 Study, such as the increasing concern for treating emerging contaminants and the development of advanced treatment technologies. Furthermore, the Mason Farm WWTP has undergone upgrades and operational changes that have improved treatment performance and the condition of existing infrastructure. Also, in the spring of 2023, OWASA developed a set of core objectives to align with the 15- and 50-year planning horizons of this Master Plan. OWASA's updated objectives were used to structure the nutrient, biosolids, and bioenergy evaluations in this Master Plan, and are included in **Appendix A**.

Due to these ongoing changes, OWASA contracted Hazen to develop a new master plan (Master Plan). The primary objective of this Master Plan is to identify near and long-term improvement projects that will help OWASA provide reliable and efficient wastewater treatment. Throughout this Master Plan, near term is defined as the period until 2037 and long term is defined as the period from 2037 to 2070. The intent is for this Master Plan to be used to assist OWASA in making capital improvement decisions based on optimizing performance, reducing resource consumption, and accommodating flow and load conditions within the service area, all while considering regulatory implications.

The recommendations of plant improvements are presented below in separate sections as follows:

- Section 1.1 Hydraulic Capacity Analysis
- Section 1.2 Nutrient Removal and Recovery
- Section 1.3 Biosolids Management
- Section 1.4 Energy Recovery and Resiliency
- Section 1.5 Immediate Recommendations

It is important to note that in the development of this master plan, the expansion to 18.5 mgd was identified as the buildout capacity of the Mason Farm WWTP due to site constraints. The buildout capacity may change as technologies with smaller footprints continue to develop and evolve in the industry.

1.1 Hydraulic Capacity Analysis

The purpose of the hydraulic capacity assessment task was to:

- Update the hydraulic profile developed in 2010 to incorporate all hydraulic-related changes made at the WWTP since 2010.
- Calibrate the hydraulic profile using water elevation measurements taken at the WWTP.
- Identify bottlenecks at the peak flow of 43.5 mgd and provide a summary of improvements that will be required to expand to 18.5 mgd and associated peak flow of 55.5 mgd.
- Identify other areas that can be further optimized and improved for general hydraulics and distribution at the permitted treatment capacity of 14.5 mgd and the future capacity of 18.5 mgd.
- Develop cost estimates for the hydraulic improvements recommended for a peak flow of 43.5 mgd.
- Develop cost estimates for the hydraulic improvements needed at a future capacity of 18.5 mgd and the associated peak flow of 55.5 mgd.

The detailed work and discussion on the alternatives evaluation is provided in *TM 2 – Hydraulic Capacity Analysis*, provided in **Appendix B**. The list of hydraulic bottlenecks and recommended upgrades are provided in Section 2 of the hydraulic capacity technical memorandum (TM). It is recommended that OWASA conduct a new survey of the entire plant to confirm elevations of weirs and flumes, as well as having a surveyor out to set and record the elevation of all weir gates in the BNR Basins.

A summary of trigger-based hydraulic recommendations, which are incorporated into the trigger-based roadmap presented in Section 3, are listed below. These recommendations are based on the hydraulic calculations performed with all units in service at peak flow:

1. Modifications to Secondary Clarifier No.1 and Secondary Clarifier No.3 influent lines for peak flows greater than 37.5 mgd.
2. Use of 14 mgd of primary bypass and removal of Splitter Box weir wall for peak flows greater than 43.5 mgd.
3. A new Intermediate Pump Station will be needed for peak flows greater than 43.5 mgd.
4. Design and construction of Secondary Clarifier No. 6 when flows begin to approach 47 mgd; the cost opinion for Secondary Clarifier No. 6 is included in *TM 3 – Nutrient Removal and Recovery*.
5. Increase the portion of the Secondary Clarifier No.2 20” influent line in the yard to a 24” pipe for peak flows greater than 52 mgd. It is recommended that this improvement be completed at the same time as the influent pipe improvements for Secondary Clarifiers No. 1 and No. 3.

6. Add a parallel 30" Secondary Clarifier No.4 effluent pipe for peak flows greater than 52 mgd.

7. Use larger nested influent Parshall flume for peak flows greater than 55 mgd.

1.2 Nutrient Removal and Recovery Improvements

The purpose of the nutrient removal and recovery task was to:

- Evaluate, at a conceptual level, numerous conventional and emerging technologies (tier 1 alternatives) to determine long-term feasibility of each technology at the Mason Farm WWTP.
- Out of the list of tier 1 alternatives, select two based on feasibility at the Mason Farm WWTP and alignment with OWASA's goals to be further evaluated as tier 2 alternatives.
- Complete BioWin™ modeling, develop site plans, calculate life-cycle cost estimates, and perform a multi-criteria decision analysis (MCDA) to compare the tier 2 alternatives and provide guidance on how they play a role in OWASA's long-term wastewater treatment goals.

The detailed work and discussion on the alternatives evaluation is provided in *TM 3 – Nutrient Removal & Recovery*, included as **Appendix C**. The two selected alternatives to evaluate were operating the plant in the Modified Ludzack-Ettinger (MLE) conventional treatment configuration with nitrified recycle (NRCY) and densified activated sludge (DAS) with existing step feed operation. Based on the evaluation, it was recommended that both MLE/NRCY and DAS/Step Feed be integrated into a long-term, multi-solution approach for the liquid train treatment process. Each alternative provides different benefits that, in combination, will provide the best results for the WWTP. NRCY is only an optimization strategy and does not provide a capacity increase. It can be incorporated with densification to provide a reduction in chemical to the denitrification filters, while DAS/Step Feed provides the capacity increase, resiliency in settling, and reduced risk at higher flows while using a smaller footprint than equalization. Furthermore, moving forward with both alternatives provides additional flexibility in treatment configurations. The likely recommended pathway would be for OWASA to begin with NRCY/MLE prior to implementing densification. Ammonia-based aeration control (ABAC), use of denitrification mode in the deep bed filters, and multipoint alum addition are also recommended solutions to aid in meeting future nutrient limits. Partial Nitrification-Denitrification-Anammox (PdNA/PANDA) and sidestream deammonification are technologies which OWASA should continue to evaluate as treatment requirements change in the future.

The trigger-based roadmap presented in Section 3 includes the phasing for each considered alternative and technology, including the addition of Clarifier No. 6. A summary of these trigger-based recommendations include (in no particular order):

1. Multi-point alum addition.

2. Point at which densification is required in existing footprint.

3. Point at which MLE/NRCY should be considered.

4. Supplemental carbon addition to the existing denitrification filters and completion of a carbon study to determine an effective and economical carbon source.

5. Consideration of implementation of ABAC.

6. Consideration of implementation of PdNA and/or sidestream treatment.

7. Point at which the design of Secondary Clarifier No. 6 shall be initiated.

1.3 Biosolids Management Improvements

The purpose of the biosolids management task was to:

- Evaluate the existing biosolids infrastructure for capacity and redundancy.
- Evaluate a total of three biosolids alternatives that produce a Class A biosolids product or demonstrate per- and polyfluoroalkyl substances (PFAS) destruction within the biosolids, in addition to the current temperature-phase anaerobic digestion (TPAD) process. The three biosolids alternatives are as follows:
    - Mesophilic Anaerobic Digestion (MAD) and Thermal Drying (TD)
    - MAD, Thermal Drying and Gasification/Pyrolysis (TD+GAS)
    - MAD and Super Critical Water Oxidation (SCWO)
- Develop site plans, calculate life-cycle cost estimates, and perform a multi-criteria decision analysis (MCDA) to compare the four alternatives and provide guidance on how they play a role in OWASA's long-term biosolids management goals.

The detailed work and discussion on the biosolids process alternatives evaluation is provided in *TM 4 – Biosolids and Bioenergy*, included as **Appendix D**. OWASA is fortunate to have very low biosolids disposal costs, which make the current TPAD operation most favorable. As such, there is currently no driver to transition to thermal drying or other advanced thermal treatment technologies. It is recommended that OWASA continue to treat biosolids to a Class A material with TPAD and land apply liquid or dewater for offsite composting. Driven by a significantly lower life-cycle cost, the current method of biosolids disposal meets both internal and external treatment goals and represents the most efficient use of current resources.

OWASA is forward thinking in investigating possible future regulatory changes, related to PFAS, that could significantly change the way biosolids are treated and disposed from the Mason Farm WWTP. Gasification/pyrolysis and super critical water oxidation (SCWO) are both demonstrated to destroy PFAS in biosolids and were included in this Master Plan to help OWASA explore how they could respond to regulatory limits for PFAS in biosolids. It is prudent to conduct testing of PFAS compounds in the biosolids generated at Mason Farm WWTP, with the understanding that any results would be available to the public through information request. While both MAD+TD+GAS and MAD+SCWO have similar

outcomes, the capital cost to implement SCWO is significantly less than the gasification alternative. However, it should be noted that SCWO is behind gasification in technology maturity, so it will be important to continue to follow both technologies as they develop in the coming years and as installations potentially increase within the industry.

The trigger-based roadmap presented in Section 3 includes recommendations with their associated triggers that will determine the implementation timeframe. A summary of these trigger-based recommendations include (in no particular order):

1. Continue to implement digester rehabilitation projects
2. Continue monitoring viability of land-applying biosolids
3. Continue monitoring gasification/pyrolysis and SCWO technologies as they mature and increase in their number of installations
4. Continue conducting testing of PFAS compounds in biosolids
5. Initiate PFAS destruction technology study
6. Initiate primary sludge fermenter evaluation in conjunction with nutrient removal carbon study
7. Increase thickening capacity

1.4 Energy Recovery and Resiliency Improvements

The purpose of the energy recovery and resiliency task was to:

- Evaluate the existing bioenergy recovery infrastructure capacity, condition, and remaining useful life.
- Evaluate a total of three bioenergy recovery technologies and strategies based on a review of energy analyses completed to-date and the objectives outlined in OWASA's Energy Management Plan. The three technologies are as follows:
    - Thermal Heating – digester gas (DG) heating and excess gas flaring
    - Biogas fueled combined heat and power (CHP)
    - Renewable Natural Gas (RNG) systems
- Complete an Energy Balance and Analysis Tool (EBAT) model that evaluates the bioenergy mass, energy, and financial balances and develop site plans to compare the three alternatives and provide guidance on how they play a role in OWASA's long-term energy recovery and resiliency goals.

Detailed work and discussion on the bioenergy recovery technology and strategy evaluation is provided in *TM 4 – Biosolids and Bioenergy*. Under current/baseline conditions, it is recommended to continue using DG to heat digesters since neither CHP nor RNG provides a positive 20-year net present value. DG to Thermal Systems has the lowest capital cost, and its financial benefits (natural gas cost savings) are relatively stable and predictable. Additionally, the DG to Thermal Systems alternative poses the lowest impact to existing operations of the WWTP and the site's emissions profile. CHP and RNG require higher capital investments, and the financial benefits (natural gas and electricity cost savings for CHP, revenues for RNG) do not underwrite the investments in either alternative. There are funding and incentives for CHP and RNG that could improve their financial pro forma. The list below includes conditions or "triggers" that could warrant OWASA to further explore or implement CHP or RNG. The most notable trigger is the renewable electricity which qualifies as a renewable fuel pathway (eRIN pathway), and could create a compelling financial case for CHP. These biogas utilization triggers are shown on the trigger-based roadmap, presented in Section 3:

- Thermal systems
  - Baseline recommendation: Use biogas to heat digesters. Use biogas in sludge drying systems if these systems are needed to meet regulatory or other drivers.
- CHP
  - If eRIN pathway develops and substantially boosts value of electricity production.
  - If additional funding opportunities develop that would create a financial justification for CHP.
  - If OWASA's objective is to minimize flaring.
- RNG
  - If funding specific to RNG is available or RIN market strengthens further.
  - If OWASA's objective is to minimize flaring.

1.5 Immediate Recommendations

A list of immediate recommendations which OWASA should implement within the next five years is as follows (in no particular order):

1. Flow equalization (EQ) study and develop hydrograph
2. Begin carbon study to determine effective and economical carbon source for denitrification filters
3. Begin fermenter evaluation (in conjunction with carbon study)
4. Begin ammonia-based aeration control pilot
5. Investigate PFAS source control and continue to monitor PFAS in biosolids

2. Cost Opinions

Detailed descriptions of how each cost opinion was developed are provided in each of the technical memoranda developed as part of this Master Plan. **Table 2-1** summarizes the breakdown of assumptions

and contingencies applied to each cost opinion, and **Table 2-2** provides the cost opinions for the different alternatives evaluated for each specific task. **Table 2-2** also includes an overview of the improvements associated with each cost opinion. Task 2 cost opinions include the construction costs for specific bottlenecks at 43.5 mgd and 55.5 mgd. Task 3 estimates include all the upgrades or additional processes required for each alternative as well as the installation of Clarifier 6. Task 4 cost opinions considered equipment and construction costs for new infrastructure and did not include rehabilitation costs of existing equipment. Task 5 estimates include equipment and construction costs for new the processes required for each alternative.

Table 2-1: Capital Cost Opinion Breakdown

Item	%
Materials and Labor Subtotal	-
General Conditions / Mobilization	5%
Contractor OH&P	15%
Bonds and Insurance	2%
Subtotal 1	**-**
Contingencies	40%
Subtotal 2	**-**
Engineering	10-20% [1]
Construction Management	10%
Total Capital Cost (2023) = Subtotal 2 + Engineering + Construction Management	

[1] Engineering is 20% for all alternatives except for thermal drying biosolids alternative. Refer to TM #4 for a more detailed breakdown of biosolids capital cost opinions.

Table 2-2: Capital Cost Opinions for the Mason Farm Master Plan

Alternative	Cost Opinion	Overview of Improvements
Task 2: Hydraulic Capacity Assessment		
43.5 MGD Hydraulic Improvements	$1,620,000	Increase portion of secondary clarifier (SC) #1 30" influent line, increase portion of SC#2 influent line, add parallel 20" influent pipe to SC#3
55.5 MGD Hydraulic Improvements	$23,140,000	New intermediate pump station, add parallel 30" SC #4 effluent pipe
Task 3: Nutrient Removal & Recovery Alternatives		
MLE/NRCY	$11,070,000	NRCY pumps, piping, gates, and wall penetrations needed for NRCY pump installation, new SC#6
DAS/Step Feed	$19,610,000	Demo and sitework, new building with hydrocyclones and pumps, new wet well and pumps for hydrocyclone overflow, piping to/from hydrocyclones, instrumentation, new SC#6
Task 4: Biosolids Management Alternatives		
Dewatering + TD	$78,960,000	New dewatering facility, new thermal drying facility, new odor control facility
Dewatering + TD + Gasification	$117,390,000	New dewatering facility, new thermal drying and gasification facility, new odor control facility
Screening + Dewatering + SCWO	$83,720,000	New dewatering facility, new sludge screens, new SCWO facility, new odor control facility
Task 5: Energy Recovery & Resiliency Alternatives		
DG to Thermal Systems	$1,700,000	Biogas pretreatment
CHP	$4,100,000	Biogas pretreatment, new CHP system
RNG	$9,000,000	Biogas pretreatment, new system to convert biogas to RNG

3. Trigger-Based Roadmaps

Three trigger-based roadmaps were completed as part of this Master Plan. The roadmaps present time-based and decision-based triggers based on factors such as flows and loads, capacities, regulations, and funding. Proposed solutions and/or capital improvements follow each trigger. The time-based triggers correspond to when an action, such as a study, report, or design for expansion, should begin. These triggers are represented by clock icons on the roadmaps. The decision-based triggers correspond to when a change in operation is required or expected and has multiple pathway options. These triggers are represented by three diverging arrows icons on the roadmaps. A key on the roadmaps provides the color-coding for each category of upgrade to indicate the interconnection between the different streams within the plant. The roadmaps intend to provide guidance on capital improvement implementation and timing while keeping options available as regulations and technologies change over time.

Figure 3-1 displays the trigger-based roadmap for nutrient removal and recovery, as well as hydraulics. Improvements that are flow and/or load-based are time-based triggers; they indicate when a study or pilot should begin. The decision-based triggers, such as when to implement denitrification mode in the filters

or install MLE/NRCY, are preceded and informed by these time-based studies and pilots outlined within the roadmap.

Figure 3-2 presents the biosolids management trigger-based roadmap which is presented based on the ultimate final product on the right-hand side of the figure. The main pathway on this roadmap is to continue with TPAD and land application of Class A biosolids. Like the nutrient roadmap, the time-based triggers depict actions such as studies, preliminary designs, and treatment capacity increases. The decision-based triggers focus on changes in disposal requirements and regulations, leading to new technology implementation. The main decision-based trigger in this roadmap is whether OWASA will implement SCWO or TD+GAS to comply with PFAS regulations. This decision will be informed by an Advanced Biosolids Treatment Study which should begin when the timeline of biosolids PFAS regulations is more defined.

Figure 3-3 illustrates the trigger-based roadmap for bioenergy. The main pathway on this roadmap is to continue utilizing digester gas in the boilers. There are four additional potential pathways presented on this roadmap based on which triggers take place, whether it be if the renewable energy market strengthens, the biosolids treatment process changes, or if partnership opportunities arise.

Table 3-1 is a companion table which summarizes each action item included in the roadmaps, their associated triggers, and expected timeline of implementation. The implementation timing for each recommendation in **Table 3-1**Error! Reference source not found. are determined using the baseline flow projections outlined in *TM 1 – Flow and Load Development*, and are subject to change as flows and loads vary over time.

Table 3-1: Trigger-Based Roadmap Companion Table

Action Item	Trigger of Action	Timing of Implementation [1]
Hydraulics		
EQ Study & Hydrograph Development	Current excessive peak flows	2024 - 2029
Hydraulic Improvements for 43.5 mgd	When peak flows approach 40 mgd	2024 - 2029
Hydraulics Improvements for 55.5 mgd (Expansion to 18.5 mgd)	When flow approaches 11.6 mgd	>2034, anticipated in 2055
Nutrient Removal		
Carbon Study	Increasing flows and loads	2024 - 2029
ABAC Pilot	Increasing flows and loads	2024 - 2029
Clarifier 6 PER	When peak day flow ~ 26 mgd and/or if SVI_{30} consistently >100 mL/g *Not hydraulically needed until >47 mgd	2029 - 2034
Denite Mode or MLE/NRCY	Informed by Carbon and ABAC studies – Effluent TN quality and meeting NPDES permit	2029 - 2034
Densification Pilot	When flow approaches 10 mgd	>2034, anticipated in 2043
PER for Expansion to 18.5 mgd	When flow approaches 11.6 mgd	>2034, anticipated in 2055
Design Expansion to 18.5 mgd	When flow approaches 13.0 mgd	>2034, anticipated in 2066
Sidestream treatment	If biosolids pathway has 24/7 dewatering or WWTP is passing 80% of yearly nitrogen mass allocation	>2034, anticipated after 2060, See Note 3
Advanced tertiary treatment	If passing 80% of nutrient limits or carbon costs increase	>2034, anticipated after 2060, See Note 3
Biosolids		
PFAS study	Informed by continuation of PFAS testing in biosolids	2024 - 2029
Fermenter evaluation	In conjunction with nutrient removal carbon study	2024 - 2029
PER for thickening capacity expansion	When densification is implemented or when standby RDT <1	>2034, anticipated after 2043
PER for HEX1 capacity expansion	When digester feed approaches 55,000 gpd	>2034, anticipated 2037
PER for fermenter capacity expansion	Informed by fermenter evaluation and/or when fermenter HRT < 2 days	>2034, anticipated 2037-2040
Assess alternate biosolids disposal	When land application is no longer viable	See Note 2
Advanced biosolids treatment study	When PFAS regulatory implementation timeline is well-defined	See Note 2

[1] Timelines are based on WWTP data collected during the development of this Master Plan and the baseline flow projections presented in TM 1. Timelines are subject to change based on several factors such as service area growth, future flows and loads, and regulatory changes.
[2] Timelines for land application feasibility and regulatory implementation are unclear at this time and should be assessed on an ongoing basis.
[3] Timelines for nutrient-based triggers depend on when filters are converted to denitrification filters. Anticipated timeline is based on denitrification filters being in use and an effluent TN of 2.5 mg/L.

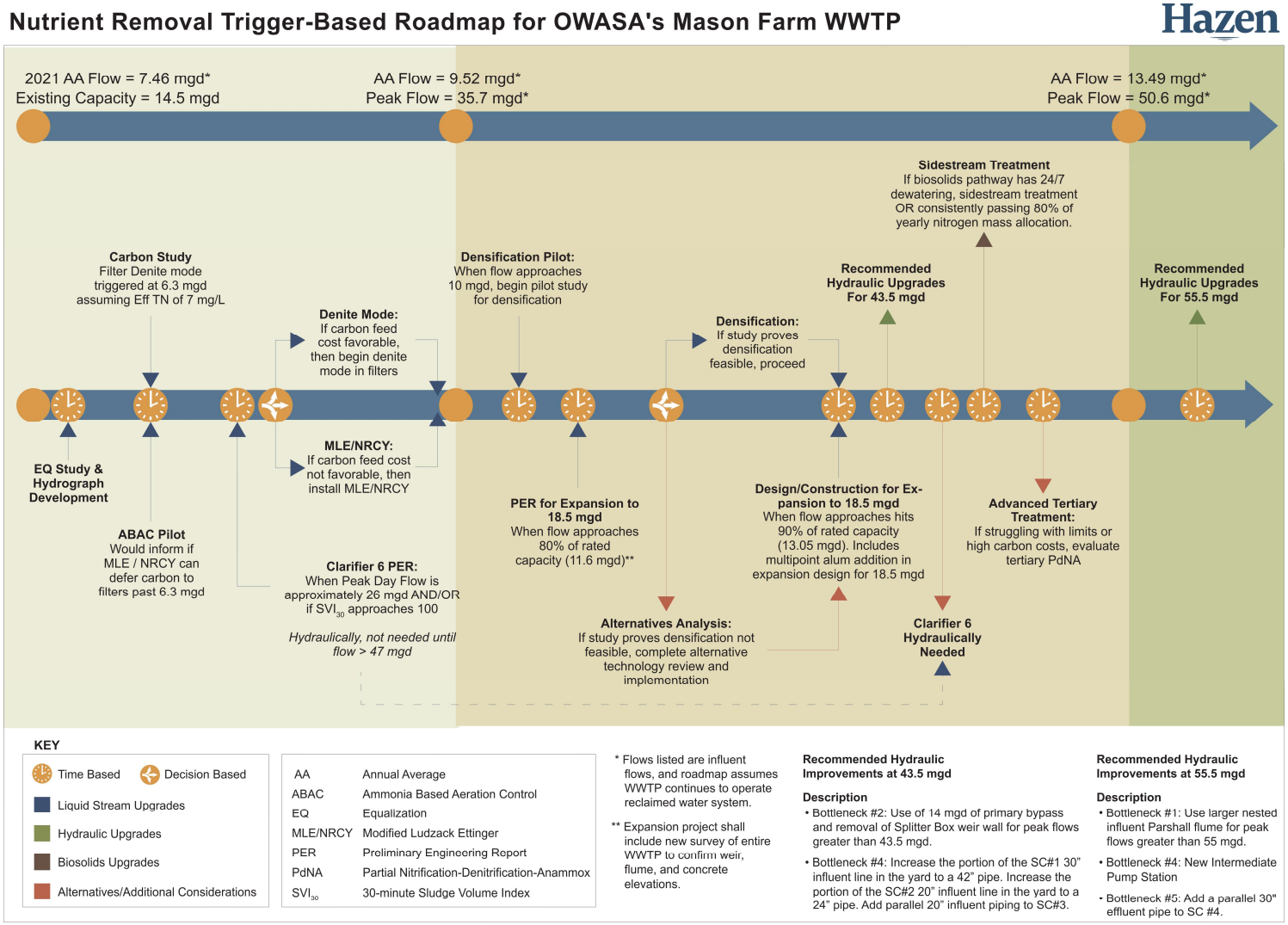


Figure 3-1: Nutrient Removal and Recovery Trigger-Based Roadmap

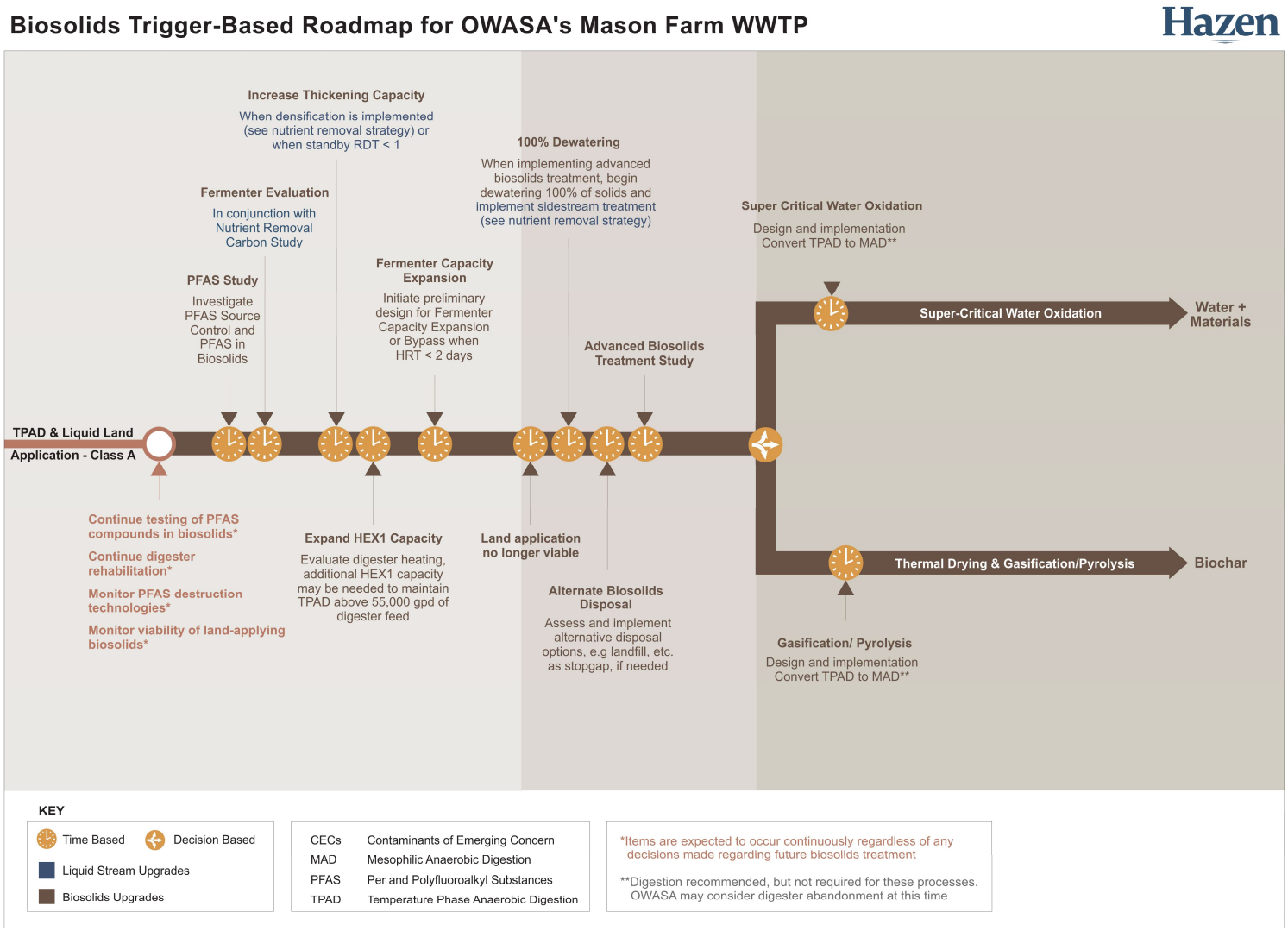


Figure 3-2: Biosolids Management Trigger-Based Roadmap

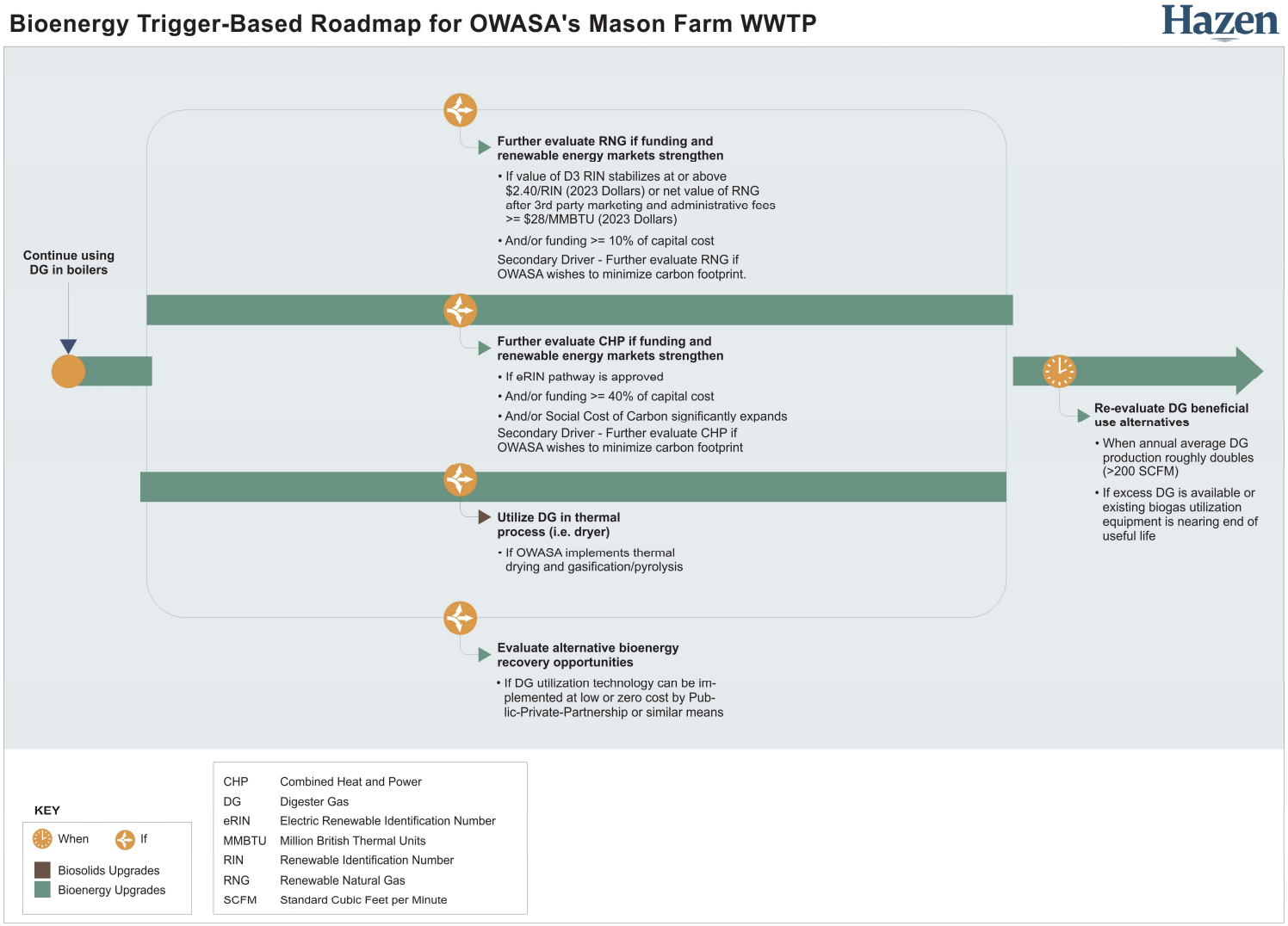


Figure 3-3: Energy Recovery and Resiliency Trigger-Based Roadmap

4. Site Plans

A demolition site plan, as well as proposed treatment alternative site plans were created for this Master Plan. The demolition site plan represents the facilities that could be demolished at any time without significantly impacting current WWTP operations. The site plans with proposed improvements include nutrient removal upgrades, biosolids upgrades, bioenergy upgrades, and additional considerations. The generated site plan portrays the biosolids and bioenergy treatment pathways with the largest footprints. A pdf that includes layers of all the different pathways will be provided to OWASA to accompany this Master Plan. The colors used on the site plan correspond with the color coding on the roadmaps to provide consistency within the deliverables.

Figure 4-1 is the demolition site plan and **Figure 4-2** provides the overall site plan with the future upgrades, assuming that thermal drying and gasification is implemented. The overall site plan in **Figure 4-2** shows some additional liquid stream infrastructure upgrades and other improvements not previously discussed in the other technical memorandums. **Table 4-1** provides a summary of these other improvements, which include a primary sludge pump station, a warehouse facility, a new intermediate pump station, additional deep bed filters, and UV channels.

Table 4-1: Additional Liquid Stream Infrastructure Upgrades and Other Improvements

Infrastructure	Description and Reason
Primary Sludge Pump Station	A consolidated primary sludge pump station is proposed as plant loads continue to increase and to improve primary sludge pumping reliability.
Warehouse Facility	Approximately 8,500 ft^2 of site space is allocated for a warehouse facility where the existing UNC Research Facility is located.
Intermediate Pump Station	A new intermediate pump station is proposed to replace the two existing pump stations. Five (5) 11 mgd pumps would be included with space for a sixth pump in the future. This would allow the location of the existing pump stations to be converted into additional chemical storage.
Deep Bed Filters	Two additional filter cells of 793 ft^2 are required to maintain a hydraulic loading rate of 2 gpm/sf at maximum month flow with all units in service.
UV Channels	One additional UV channel of 16 mgd capacity is required to pass a peak flow of 55 mgd.

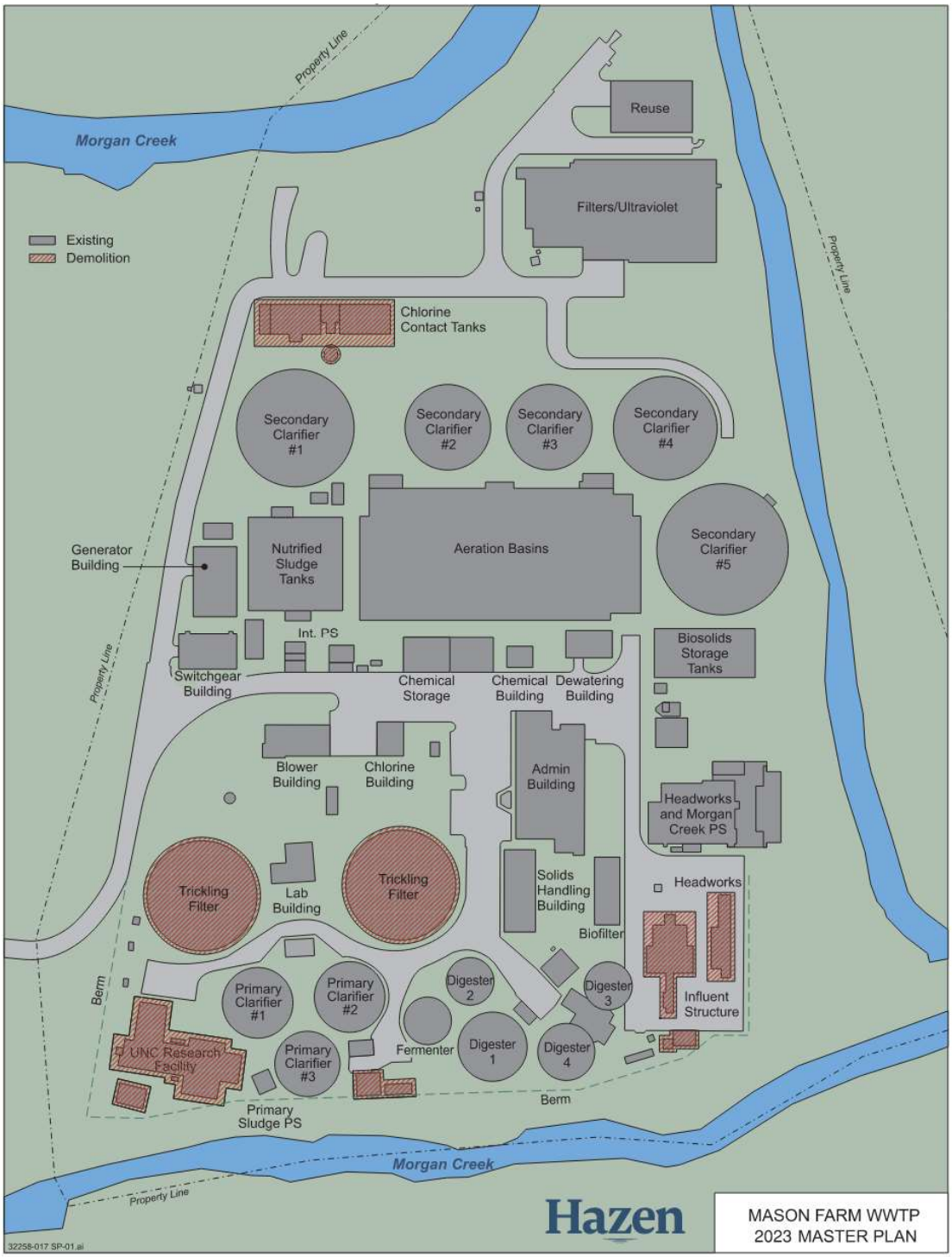


Figure 4-1: Demolition Site Plan

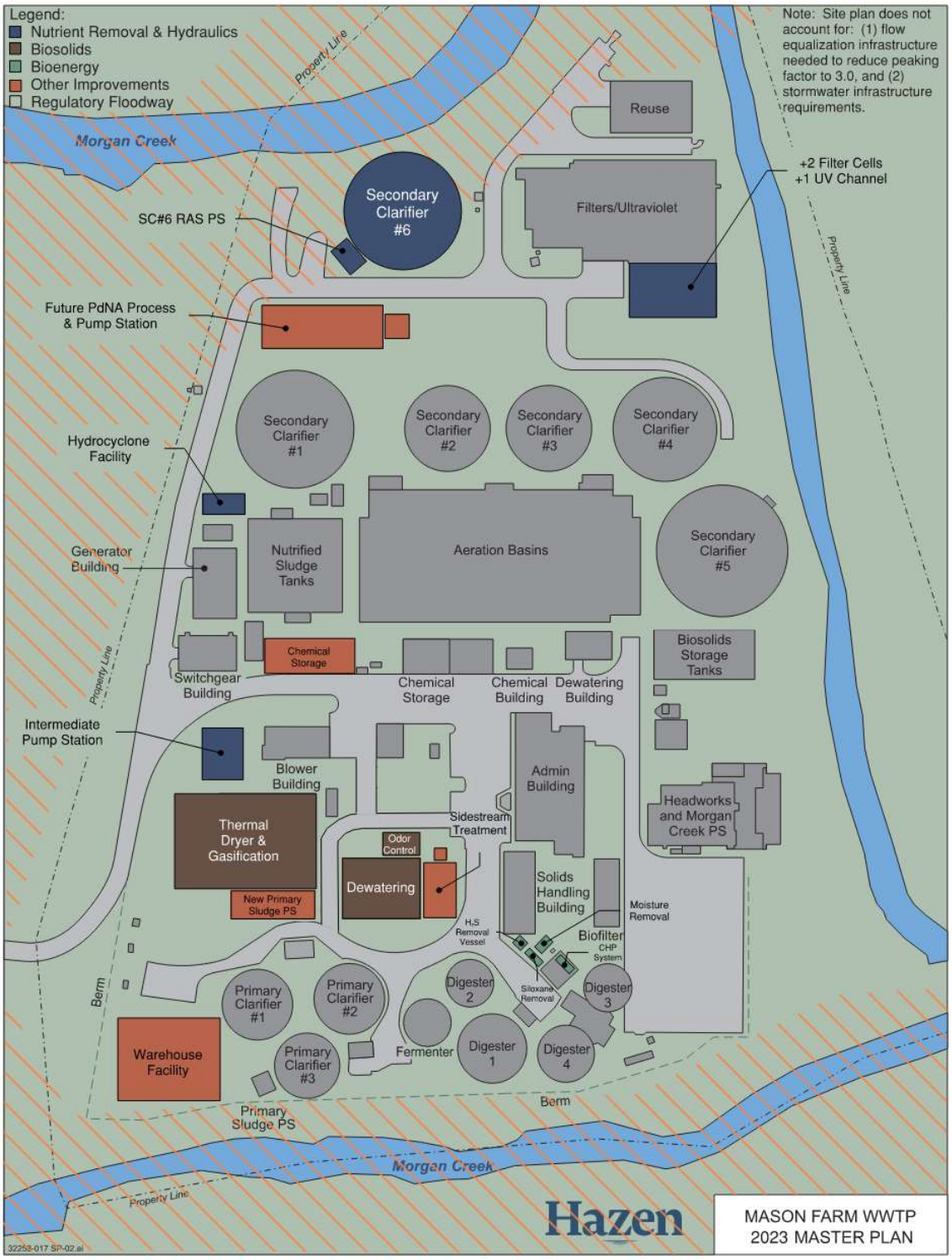


Figure 4-2: Overall Site Plan with Future Upgrades (Thermal Drying & Gasification)

Appendix A: Mason Farm WWTP Core Objectives (March 2023)

Mason Farm WWTP Core Objectives
(15- and 50-year planning horizons)
March 2023

OWASA Vision: to be our community's trusted partner for clean water and environmental protection.

- Mason Farm WWTP Role in OWASA Vision: to provide reliable wastewater treatment and reclaimed water services that protect public health and the environment, while also being responsive to the needs of the community and preparing for potential future regulations.

Core Plant Objectives:

1. **Liquid Stream:** meet all NPDES (National Pollutant Discharge Elimination System) requirements and nutrient discharge limits,
2. **Solids Management:** prepare for compliance with potential regulation of contaminants of concern, operate our land application program in a cost-effective manner with a focus on land disposal for the next 15 years,
3. **Site Constraints:** operate within the existing property boundary and not consider new sites for wastewater treatment,
4. **Odor Control:** monitor and abate off-site odors,
5. **Climate Adaptation:** prepare for more frequent and larger storms at the plant and in the system

The following are the detailed elements of the core objectives above.

1) Liquid Stream
   a. OWASA will meet our NPDES permit requirements.
   b. When annual nutrient mass discharge exceeds 80% of permitted limits (e.g., 80% of Total Nitrogen annual mass limits) OWASA will evaluate the need for design of new capital improvements or take operational measures to reduce discharge below the 80% threshold.
   c. Those measures will be under construction or in practice at or before such time as OWASA reaches an annual discharge of 90% of its permit limits.
   d. Regarding potential future regulations for Contaminants of Emerging Concern (e.g., PFAS and 1,4 Dioxane), OWASA will prepare for compliance but will not pursue voluntary standards through substantial operational or capital investments.
   e. OWASA will meet our Reclaimed water permit requirements.

2) Solids Management
   a. OWASA will continue to operate its land application program (Class A Biosolids) with the expectation of phasing out land application (regulations pending) over the planning period. .
   b. OWASA will consider cost effectiveness in the ratio of land application to composted disposal annually in accordance with board directives and continue to target a 75%/25% land disposal to composting ratio.
   c. OWASA anticipates land application will not be a viable option and expects to have alternative methods of disposal or elimination of biosolids become the primary method of biosolids management.

3) Site constraints

a. OWASA will continue to operate its Mason Farm WWTP within the existing property boundary.
b. Collection system wet weather flow reduction or equalization can be considered in comparison to on site alternatives.
c. OWASA will not consider new sites for wastewater treatment in the next 50 years.

4) <u>Odor Control</u>

a. Planning of capital investments shall consider the odor control requirements included in the Special Use Plan for the Mason Farm site. OWASA will target zero odor complaints.

5) <u>Climate Adaptation</u>

a. OWASA will prepare for more frequent and larger storms at the plant and in the collection system
b. Energy saving investments will need to pay for themselves through the net present value over the life of the asset and the social cost of carbon when selecting alternatives for OWASA's plant and operations.
c. OWASA will stay abreast of greenhouse gas regulations and meet industry standards as applicable.

Appendix B: TM 2 – Hydraulic Capacity Analysis

Hazen *Technical Memorandum*

October 27, 2023

To: Allison Spinelli, PE
Wil Lawson
Marcus Hill
Simon Lobdell, PE

From: Elisa Arevalo, PE
Lamya King, PE
David Nailor, PE
Patricia Drummey Stiegel, PE

Mason Farm WWTP Master Plan
TM 2 – Hydraulic Capacity Assessment

FINAL

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd). In 2010, Hazen completed a Hydraulic and Treatment Capacity Study (2010 Study) which evaluated existing facilities and provided recommendations to address hydraulic and treatment constraints at the Mason Farm WWTP.

Since 2010, the Mason Farm WWTP has undergone upgrades that have improved treatment performance and the condition of existing infrastructure. The purpose of this task is to update the hydraulic profile and incorporate the work completed at the WWTP since 2010. The results of this hydraulic capacity assessment are presented in this TM.

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1. Introduction and Objectives

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd). In 2010, Hazen completed a Hydraulic and Treatment Capacity Study (2010 Study), which included an evaluation of existing facilities and provided recommendations to address hydraulic and treatment constraints at the Mason Farm WWTP. The results of the study provided numerous nutrient removal, biosolids treatment, and capacity expansion alternatives and recommended improvements to optimize treatment while minimizing operational costs. Some of the recommended improvements identified in the 2010 Study were implemented, which has resulted in significant savings in operational costs realized by OWASA.

Several changes have occurred within the wastewater treatment industry since the 2010 Study, such as being in a different regulatory climate and the development of advanced treatment technologies. Furthermore, the Mason Farm WWTP has undergone upgrades that have improved treatment performance and the condition of existing infrastructure. Due to these ongoing changes, OWASA contracted Hazen to develop a new master plan (Master Plan). The primary objective of this Master Plan is to identify near and long-term improvement projects that will help OWASA provide reliable and efficient wastewater treatment. Ultimately, the Master Plan will be used to assist OWASA in making capital improvement decisions based on optimizing performance, reducing resource consumption, and accommodating flow and load conditions within the service area, all while considering regulatory implications.

The hydraulic capacity assessment task is the second in a series of tasks within the Master Plan. The purpose of this task is to:

- Update the hydraulic profile developed in 2010 to incorporate all hydraulic-related changes made at the WWTP since 2010.
- Calibrate the hydraulic profile using water elevation measurements taken at the WWTP.
- Identify bottlenecks at the peak flow of 43.5 mgd and provide a summary of improvements that will be required to expand to 18.5 mgd and associated peak flow of 55.5 mgd.
- Identify other areas that can be further optimized and improved for general hydraulics and distribution at the permitted treatment capacity of 14.5 mgd and the future capacity of 18.5 mgd.
- Develop cost estimates for the hydraulic improvements recommended for a peak flow of 43.5 mgd.
- Develop cost estimates for the hydraulic improvements needed at a future capacity of 18.5 mgd and the associated peak flow of 55.5 mgd.

Results of the hydraulic capacity assessment task are summarized in this technical memorandum (TM), and they include a summary of the hydraulic improvements needed to treat a maximum month flow of 18.5 mgd and a wet weather peak flow of 55.5 mgd, given the proposed process improvements recommended in TM 3 – Nutrient Removal and Recovery.

2. Hydraulic Profile Update

Several changes have occurred at the Mason Farm WWTP since Hazen evaluated the hydraulic capacity of the plant in 2010. The modifications that were incorporated into the updated hydraulic profile are listed below, as well as additional assumptions that were made in the development of the hydraulic profile:

- Upgrades to Secondary Clarifiers #2 and #3 from Secondary Clarifier Rehabilitation Project completed in 2021: the hydraulic profile was updated to reflect the v-notch weir elevation that was specified in the project.
- Upgrades to Secondary Clarifier #4 (currently under construction): As part of these improvements, Clarifier #4 will be converted from an organ pipe to a suction header mechanism, and the inset launder will be replaced with a traditional inboard launder.
- 2009 survey elevations: Survey elevations from 2009 were used in lieu of elevations listed on the record drawings. The survey was contracted by Hazen and Sawyer as part of the 2010 Master Plan.
- Step feed: The implementation of step feed operation, during which primary effluent flow is fed to the first and second cells of each aeration basin train in service, is incorporated into the profile.
- Updated the level at the Intermediate Pump Station (IPS) #2 wetwell from 249.0 ft to 242.75 ft (5.5 ft of depth) to reflect current operations. The level at the intermediate pump station was lowered to reduce frequent cycling of pumps at IPS #1.
- Up to 14 mgd Primary Clarifier bypass was assumed to be available at peak flow. Although the 24" bypass line has never been flow tested, this is consistent with the value calculated by Brown and Caldwell in May 2020.
- Includes recommendations made in TM 3 – Nutrient Removal and Recovery, including NRCY and step feed operation at 18.5 mgd and its corresponding peak of 55.5 mgd.
- A Hazen & Williams C Coefficient of 100 was used for all existing pipes.
- A Manning Coefficient of 0.015 was used for all channels.

For the development of the hydraulic profile, it was assumed 1Q RAS up to max month flow and step feed operation for the current flows, but a higher (~1.3Q) RAS rate for the future peak flow in accordance with the recommendations from TM 3 - Nutrient Removal and Recovery. See **Table 2-1** for a summary of flow conditions that were evaluated. The treatment units that were assumed to be in service in the hydraulic profile are listed in **Table 2-2**.

Table 2-1: Design Flows

Flow Condition	Current Max Monthly Flow, mgd	Current Peak Flow, mgd	Future Max Monthly Flow, mgd	Future Peak Flow, mgd
Plant Influent Flow	14.5	43.5	18.5	55.5
Return Activated Sludge (RAS) Flow	14.5	14.5	18.5	24*

*RAS rate corresponds to DAS/SF option (reference TM 3 – Nutrient Removal and Recovery)

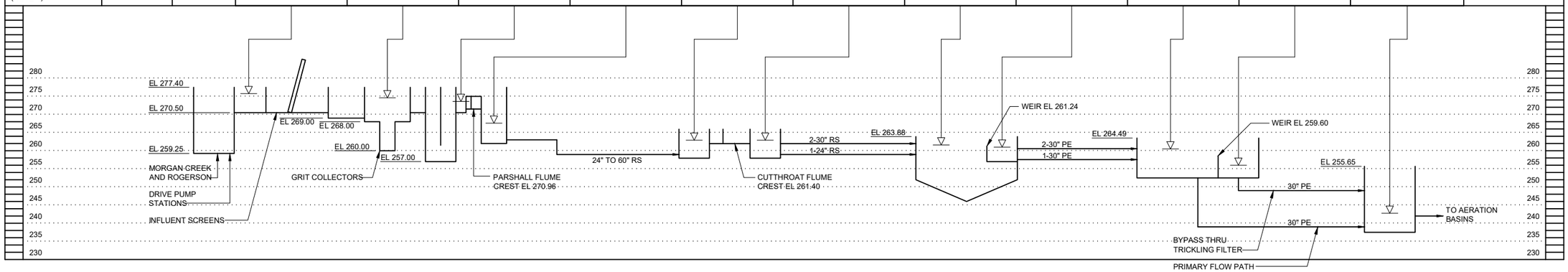
Table 2-2: Treatment Units Assumed to be in Service for the Hydraulic Profile Update

	Current Max Month Flow*	Future Max Month Flow*	Current Peak Flow	Future Peak Flow
Plant Influent Flow, mgd =	**14.5 mgd**	**18.5 mgd**	**43.5 mgd**	**55.5 mgd**
# Post Aeration Tanks in Service =	2 of 2	2 of 2	2 of 2	2 of 2
# UV Channels in Service =	1 of 3	1 of 3	3 of 3	3 of 3
# Filters in Service =	5 of 6	5 of 6	6 of 6	6 of 6
# Secondary Clarifiers in Service =	4 of 5	5 of 6	5 of 5	6 of 6
# Aeration Basin Trains in Service =	2 of 3	2 of 3	3 of 3	3 of 3
# Primary Clarifiers in Service =	2 of 3	2 of 3	3 of 3	3 of 3
# Grit Collectors in Service =	1 of 2	1 of 2	2 of 2	2 of 2
# Bar Screens in Service =	2 of 3	2 of 3	3 of 3	3 of 3

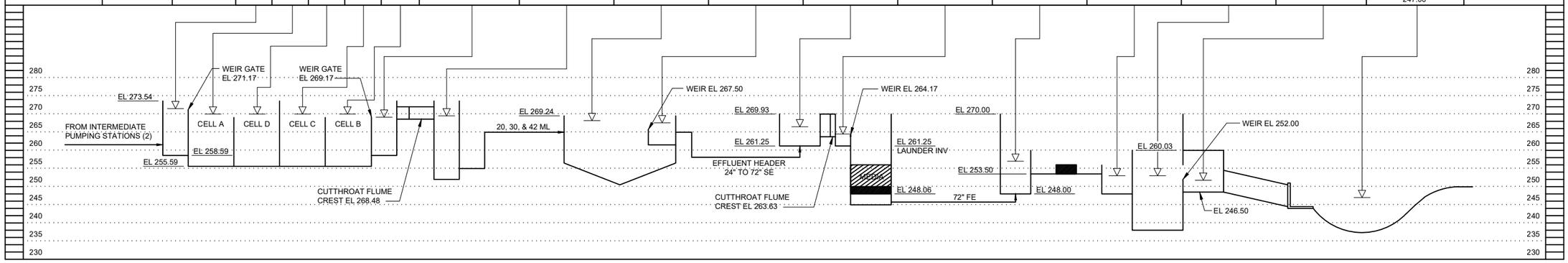
* For the Max Month Flow scenarios, the largest treatment unit was assumed to be in service to represent firm capacity

Figure 2-1 presents the updated hydraulic profile for the Mason Farm WWTP starting at the receiving stream and working up to the headworks facility. The hydraulic profile figure presents the profile at the calibration flow of 7.25 mgd, max month flow of 14.5 mgd and peak flow of 43.5 mgd. The hydraulic profile calibration effort is discussed in **Section 3** of this TM. **Figure 2-2** presents the hydraulic profile for max month flow of 18.5 mgd and peak flow of 55.5 mgd, assuming that recommended solutions discussed in this TM have been implemented.

CONDITION	PLANT FLOW	RAS FLOW	HEADWORKS		INFLUENT FLUME		SPLITTER BOX 1		PRIMARY CLARIFIERS (NOTE 1)		SPLITTER BOX 2		INTERMEDIATE PUMP STATION	CONDITION
PEAK FLOW (NOTE 2)	43.5 MGD	14.5 MGD	275.82	274.22	273.45	270.54	264.45	262.22	261.43	260.88	260.44	254.73	249.00	PEAK FLOW
MAX MONTH FLOW (NOTE 3)	14.5 MGD	14.5 MGD	274.14	272.56	272.19	264.53	263.87	261.83	261.41	260.39	260.12	249.69	249.00	MAX MONTH FLOW
CALIBRATION FLOW (NOTE 4)	7.25 MGD	6.19 MGD	273.41	272.06	271.84	264.40	264.16	262.00	261.42	260.34	259.97	241.62	241.37	CALIBRATION FLOW



CONDITION	PLANT FLOW	RAS FLOW	AERATION BASINS							SECONDARY CLARIFIERS		EFFLUENT FILTERS		UV DISINFECTION		POST-AERATION		MORGAN CREEK	CONDITION
PEAK FLOW	43.5 MGD	14.5 MGD	272.08	271.61	271.56	271.31	270.91	269.91	270.34	267.63	266.85	266.11	264.26	257.12	253.16	253.01	N/A	(100 YR FLOOD) 262.00	PEAK FLOW
MAX MONTH FLOW	14.5 MGD	14.5 MGD	271.73	271.22	271.18	270.98	270.65	269.56	268.74	267.60	266.13	265.03	264.21	257.11	252.50	252.49	251.07	(4 FT ABOVE NORMAL LEVEL) 251.00	MAX MONTH FLOW
CALIBRATION FLOW	7.25 MGD	6.19 MGD	271.40	270.39	270.37	270.25	269.94	269.26	268.04	267.58	266.04	264.53	264.20	257.11 (NOTE 5)	252.35	252.34	247.03	(NORMAL WATER LEVEL) 247.00	CALIBRATION FLOW



NOTE:

1. PEAK FLOW PROFILE UPSTREAM OF INTERMEDIATE PUMP STATION ASSUMES UP TO 14 MGD PC BYPASS
2. ALL UNITS IN SERVICE.
3. ONE UNIT OUT OF SERVICE.
4. UNITS IN SERVICE: BAR SCREENS #1 AND #2, GRIT COLLECTOR #2, PRIMARY CLARIFIER #1, ALL AERATION BASINS, SECONDARY CLARIFIERS #1, #3, AND #5, ALL FILTERS, UV CHANNEL #2.
5. THE UV EFFLUENT WEIR GATES MAINTAIN THE LEVEL IN THE UV CHANNELS. AT LOWER FLOWS THE HEADLOSS IN THE UV INFLUENT CHANNEL IS INSIGNIFICANT, RESULTING IN THE SAME WSE.

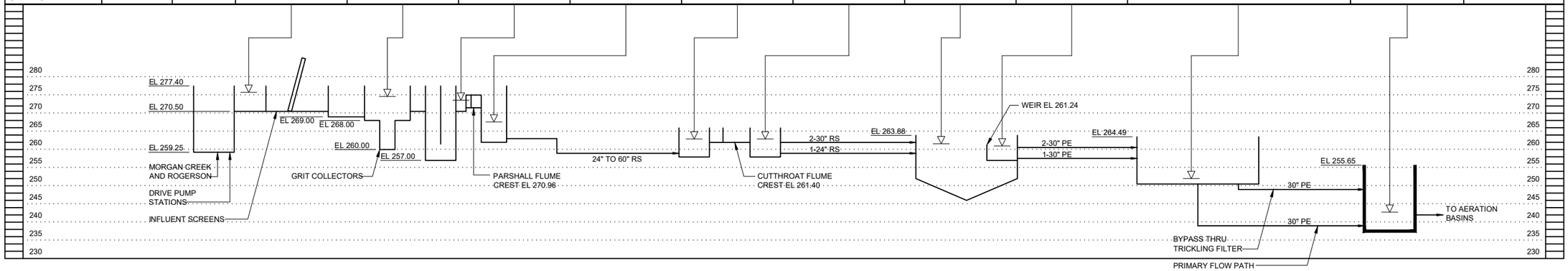
Hazen
HAZEN AND SAWYER
4011 WESTCHASE BOULEVARD, SUITE 500
RALEIGH, NORTH CAROLINA 27607
LICENSE NO. : C-0381

MASON FARM WWTP

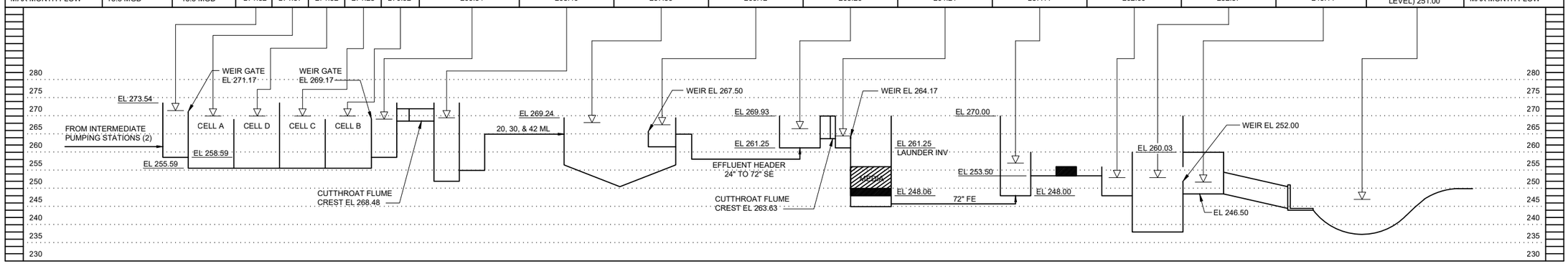
EXISTING PLANT HYDRAULIC PROFILE

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CONDITION	PLANT FLOW	RAS FLOW	HEADWORKS		INFLUENT FLUME		SPLITTER BOX 1		PRIMARY CLARIFIERS (NOTE 1)		SPLITTER BOX 2	INTERMEDIATE PUMP STATION	CONDITION
PEAK FLOW (NOTE 2)	55.5 MGD	24.0 MGD	276.61	274.87	274.02	272.57	265.37	263.22	261.47	260.10	255.20	241.37	PEAK FLOW
MAX MONTH FLOW (NOTE 3)	18.5 MGD	18.5 MGD	274.60	272.87	272.46	265.23	264.29	262.10	261.43	259.58	244.31	241.37	MAX MONTH FLOW



CONDITION	PLANT FLOW	RAS FLOW	AERATION BASINS							SECONDARY CLARIFIERS		EFFLUENT FILTERS		UV DISINFECTION		POST-AERATION		MORGAN CREEK	CONDITION
PEAK FLOW	55.5 MGD	24.0 MGD	271.34	272.16	272.10	271.80	271.34	269.89	269.55	267.63	267.43	266.52	264.26	257.12	253.43	253.19	N/A	(100 YR FLOOD) 262.00	PEAK FLOW
MAX MONTH FLOW	18.5 MGD	18.5 MGD	271.82	271.57	271.52	271.28	270.92	269.54	268.40	267.59	266.12	265.26	264.21	257.11	262.60	252.57	249.11	(4 FT ABOVE NORMAL LEVEL) 251.00	MAX MONTH FLOW



NOTE:
1. PEAK FLOW PROFILE UPSTREAM OF INTERMEDIATE PUMP STATION ASSUMES UP TO 14 MGD PC BYPASS
2. ALL UNITS IN SERVICE.
3. ONE UNIT OUT OF SERVICE.

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MASON FARM WWTP

FUTURE HYDRAULIC PROFILE

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2.1 Hydraulic Evaluation at 43.5 mgd Peak Flow

The goal of the hydraulic evaluation is to identify hydraulic constraints or "bottlenecks" in the existing plant that may impact plant performance by submerging critical hydraulic control points. Critical hydraulic control points are defined as those hydraulic elements where the water level is somehow fixed or those points that, if submerged, could lead to significant process upsets, like weirs or flumes.

The segment of the hydraulic profile between each set of hydraulic control points was analyzed to predict performance under the design flow conditions, to determine the maximum hydraulic capacity of the segment and identify "bottlenecks" in the existing unit processes and yard piping.

2.1.1 Hydraulic Capacity

To determine the existing hydraulic capacity of each segment between hydraulic control points, the hydraulic profile was modeled with all process units in service and with one process unit out of service at peak flow. The capacity of the segment with one unit out of service was evaluated for informational purposes only. It is expected that all process units would be placed in service should peak flow conditions arise. Note that this section evaluates the hydraulic capacity and not the treatment capacity, which in some cases could be less than the hydraulic capacity; for example, the hydraulic capacity of Segment A2 is 101 mgd, however, the treatment capacity is less and dictated by the UV Channels currently rated for 16 mgd each. Profile segments are identified in **Table 2-3**, with the corresponding hydraulic capacity.

Table 2-3: Mason Farm WWTP Hydraulic Segments and Corresponding Capacity at 43.5 mgd

WWTP Segment	Description	Capacity with All Units in Service*	Capacity with One Unit Out of Service
I	Headworks Influent Channel to Influent Parshall Flume	64.0 mgd	40.0 mgd
H	Influent Parshall Flume to Splitter Box 1	65.0 mgd	50.0 mgd
G	Primary Clarifier Influent Distribution Flumes to PC Effluent Weirs	58.0 mgd**	45.5 mgd**
F	Primary Clarifier Effluent Weirs to Intermediate Pump Station	43.5 mgd**	37.0 mgd**
E	Aeration Basin Influent Channel to Mixed Liquor Distribution Flumes	97.5 mgd***	60.5 mgd***
D	Mixed Liquor Distribution Flumes to Secondary Effluent Weirs	37.5 mgd	21.0 mgd
C	Secondary Effluent Weirs to Filter Influent Flumes	47.0 mgd	37.0 mgd
B	Filter Influent Flume to UV Influent Channel	52.0 mgd	43.5 mgd
A2	UV Disinfection to Effluent Weir	101 mgd	60.0 mgd
A1	Effluent Weir to Outfall	95.0 mgd	N/A

* Table lists hydraulic capacity, which in some cases (e.g., UV Disinfection and Filters) is higher than treatment capacity
** Assumes PC bypass of 14 mgd
*** PE flow, does not include RAS flow

2.1.2 Hydraulic Bottlenecks

Table 2-4 lists the hydraulic bottlenecks that were identified for the Mason Farm WWTP at a peak flow of 43.5 mgd. A description of the bottleneck as well as a suggested solution is included in the table. Additionally, **Figure 2-1**, can be used as a reference to locate the bottlenecks at the plant site.

Table 2-4: Hydraulic Bottlenecks for the Mason Farm WWTP at 43.5 mgd

WWTP Segment	Bottleneck Description	Suggested Solution	Bottleneck Ref #
I	No bottlenecks were identified	NA	NA
H	As long as downstream bottlenecks are alleviated, the influent Parshall flume will remain unsubmerged. No bottlenecks were identified in this segment.	NA	NA
G	The 24" influent line to PC #3 results in high head loss under peak flow conditions. However, as long as bottlenecks from Segment F (see below) are alleviated, the cutthroat flume will remain unsubmerged. Note that top of wall freeboard at Splitter Box 1 will only be approximately 8" at peak flow.	If more freeboard is desired at Splitter Box 1, a portion of the 24" influent pipe located in the yard could be upsized to 30" (the 24" under the clarifier will be difficult to address without modifying the slab). Alternatively, PC#3 energy dissipating inlet and influent port configuration could potentially be modified. Since there is 8" of freeboard at peak flow, this suggestion was not included in the cost estimate.	1
F	The PC#1 – PC#3 effluent weirs are submerged at peak flows.	A total bypass of 14 mgd should be utilized around the primaries.	2
E	No bottlenecks were identified	NA	NA
D	Cutthroat flumes to SC#1 and SC#3 are submerged beyond 80% at peak flow, which does not allow for proportional flow distribution to the clarifiers[1].	Increase the portion of the SC#1 30" influent line in the yard to a 42" pipe[2]. Add parallel 20" influent piping to SC#3.	3
C	No bottlenecks were identified	NA	NA
B	No bottlenecks were identified	NA	NA
A2	No bottlenecks were identified	NA	NA
A1	No bottlenecks were identified	NA	NA

[1] A cutthroat flume of this size (9' length) may be submerged up to 80%.

[2] A 36" pipe would alleviate this bottleneck at 43.5 mgd; however, for a peak flow of 55.5 mgd a 42" line is needed (ref **Table 2-5**).

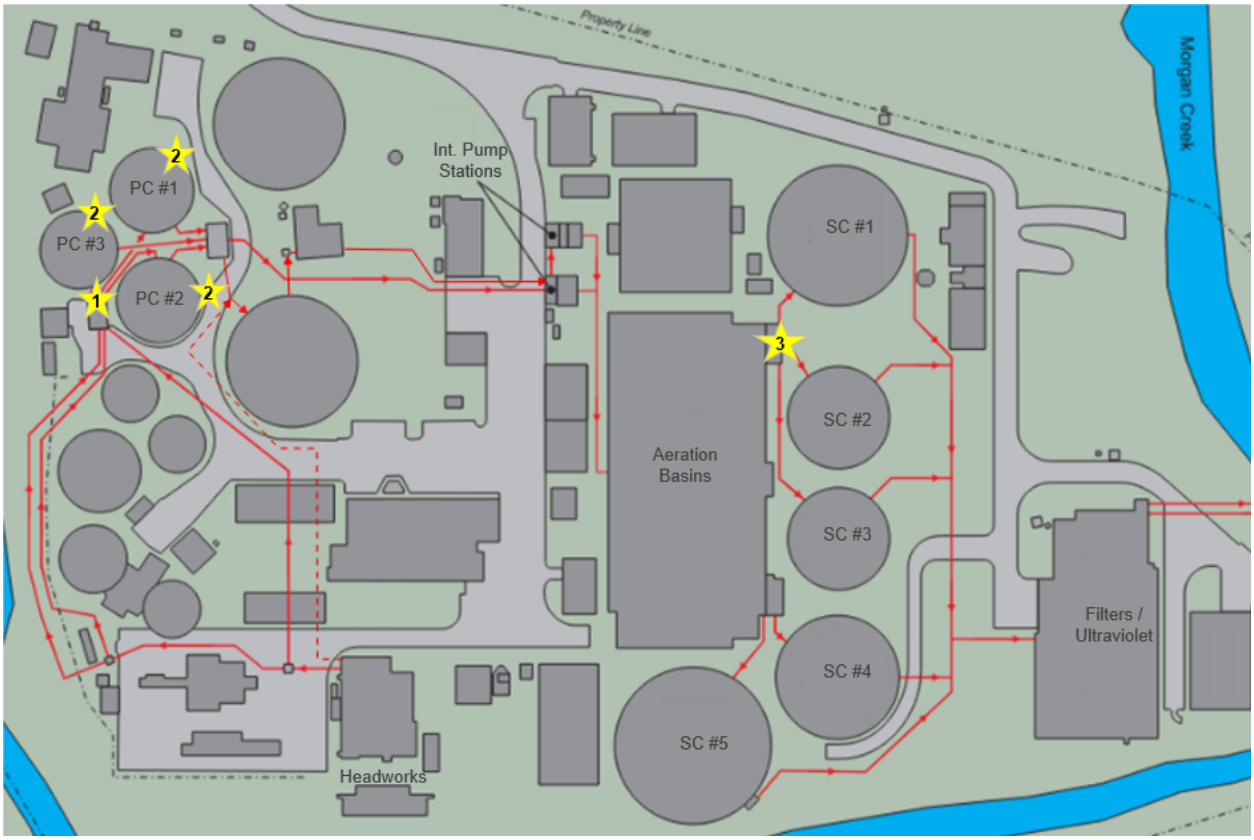


Figure 2-1: Hydraulic Bottlenecks at 43.5 mgd Reference (See Bottleneck Ref # in Table 2-4)

2.2 Hydraulic Evaluation at 55.5 mgd Peak Flow

Hydraulic bottlenecks were also identified for future peak flow of 55.5 mgd (see **Table 2.5**). No hydraulic bottlenecks were identified at 18.5 mgd. This hydraulic evaluation assumes that a new 120-ft diameter clarifier (future Secondary Clarifier #6) would be added to the Mason Farm WWTP for 18.5 mgd. Furthermore, the pipeline beneath Trickling Filter #2 is not modeled in the future hydraulic profile because it is assumed that the trickling filters, and associated piping, will be demolished when the WWTP expands to 18.5 mgd. **Figure 2-2** can be used as a reference to locate the bottlenecks at the plant site.

Table 2-5: Hydraulic Bottlenecks for the Mason Farm WWTP at 55.5 mgd

WWTP Segment	Bottleneck Description	Suggested Solution	Bottleneck Ref #
I	No bottlenecks were identified.	NA	NA
H	The influent Parshall flume will become more than 70% submerged at peak flow[1].	If at least 2 mgd are bypassed around the primary clarifiers during peak flows, this bottleneck will be alleviated. Note that the capacity of the existing Parshall flume is only 55.3 mgd, recommend using the nested 7-ft flume.	1
G	PC #2 and #3 cutthroat flumes become more than 80% submerged at peak flow[2].	If at least 11 mgd are bypassed during peak flows, this bottleneck will be alleviated.	2
F	The 30" pipe between Splitter Box 2 and the IPS is inadequate to carry the peak flow (velocity in the pipe is 13.1 fps); therefore, the PC#1 – PC#3 effluent weirs become submerged.	A new IPS will be needed to alleviate this bottleneck and because the current firm capacity of the IPS is 43.5 mgd. Also, it is recommended to remove the weir wall in Splitter Box 2. This weir is not needed since the trickling filters have been abandoned. Removal of the weir wall is not included in the cost estimate; it is assumed that OWASA could do this on their own during low flows.	3
E	No bottlenecks were identified	NA	NA
D	Cutthroat flumes to SC#1, SC#2, and SC#3 are submerged beyond 80% at peak flow, which does not allow for proportional flow distribution to the clarifiers[2].	In addition to the recommended solutions in Table 2-4, it is recommended to increase the portion of the SC#2 20" influent line in the yard to a 24" pipe.	4
C	SC#4 effluent weir is submerged at peak flow. SC#2 and SC#3 effluent weirs are not submerged but there is only about 1" of weir freeboard.	Add a parallel 30" SC#4 effluent pipe.	5
B	No bottlenecks were identified	NA	NA
A2	No bottlenecks were identified[4]	NA	NA
A1	No bottlenecks were identified	NA	NA

[1] A Parshall flume may be submerged up to 70% without affecting its flow measurement accuracy.

[2] A cutthroat flume of this size (9' length) may be submerged up to 80%.

[3] Per OWASA Staff from previous evaluation by Brown and Caldwell.

[4] Although no hydraulic bottlenecks were identified, a new UV channel will be needed to treat future flows of 18.5 mgd and the 55.5 mgd peak.

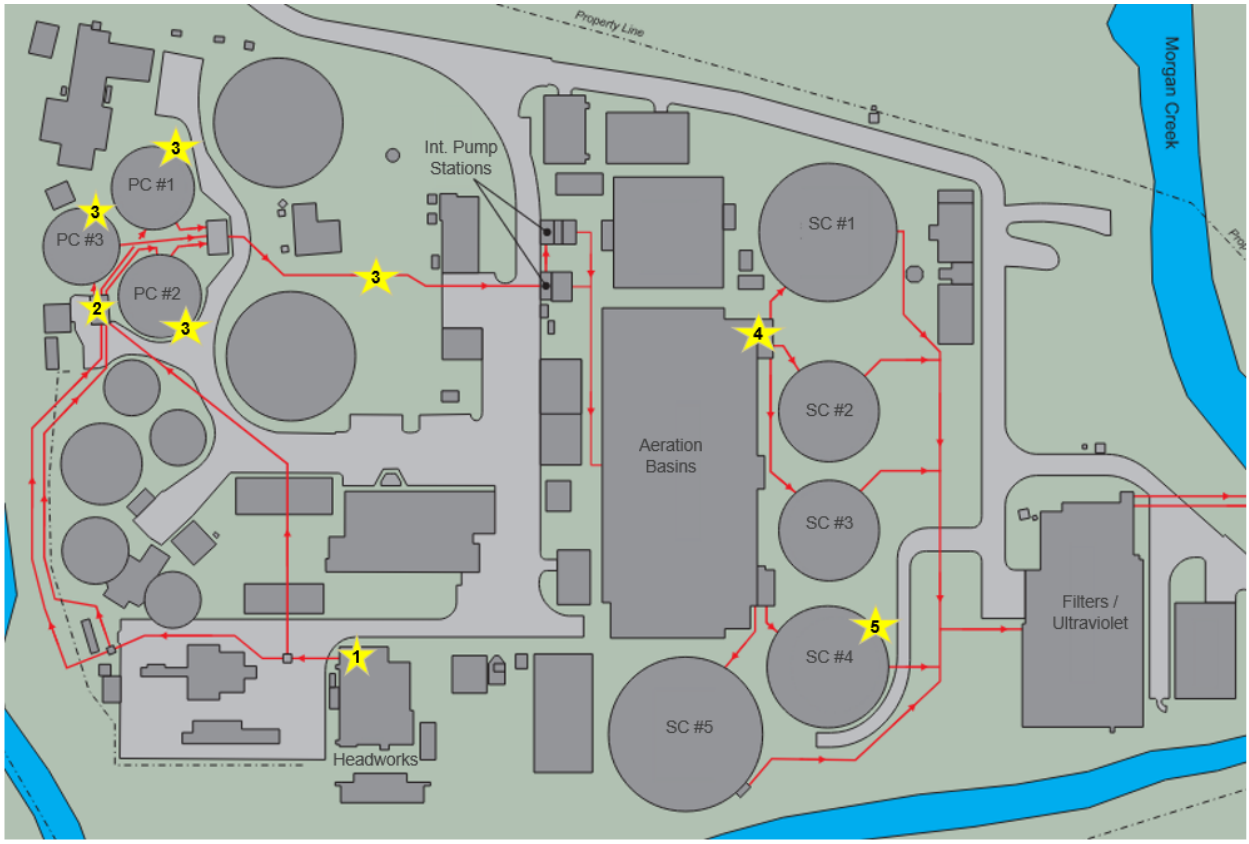


Figure 2-2: Hydraulic Bottlenecks at 55.5 mgd Reference (See Bottleneck Ref # in Table 2-5)

2.3 Additional Hydraulic Considerations

2.3.1 Secondary Clarifier No. 1 Hydraulic Restriction

In addition to the bottlenecks identified in **Table 2-2,** Secondary Clarifier 1 has a hydraulic restriction caused by the sludge withdrawal header being tied into the RAS pipe located within the center column. In 2018, OWASA inspected the 30" mixed liquor (ML) line and it was determined that the 30" ML pipe cross sectional area was reduced by at least one third, as presented in **Figure 2-3**. Additional observations related to this inspection were included in the "Mason Farm WWTP 2017-2018 Secondary Treatment Evaluations Compilation TM" dated January 22, 2019. The plant hydraulic profile currently accounts for this hydraulic restriction.



Figure 2-3: Clarifier 1 ML Influent Pipe Survey

2.3.2 NRCY Evaluation

As recommended in TM 3 - Nutrient Removal and Recovery, the addition of NRCY at the Mason Farm WWTP was considered and modeled to identify any hydraulic issues. For hydraulic modelling, it was assumed that NRCY would be recycled from Cell 4 to Cell 1 in each treatment train, and that step feed operation was not being used to represent a worst-case hydraulic condition. **Table 2-6** lists the flows that were modeled for this evaluation.

Table 2-6: Design Flows – NRCY Evaluation

Flow Condition	Current Max Monthly Flow, mgd	Current Peak Flow, mgd	Future Max Monthly Flow, mgd	Future Peak Flow, mgd
Plant Influent Flow	14.5	43.5	18.5	55.5
Return Activated Sludge (RAS) Flow	14.5	14.5	18.5	24
Nitrified Recycled (NRCY) Flow	0	0	27.75	27.75

No hydraulic issues were found; however, there would only be 6 inches of TOW freeboard at the BNR Basins Influent Channel at a peak flow of 55.5 mgd. Using step feed operation or increasing wall openings in the walls between cells would decrease the headloss and increase the amount of freeboard.

In 2017 Hazen evaluated the feasibility of adding NRCY pumps to the Mason Farm WWTP. At the time it was assumed a NRCY flow of 14.5 mgd per train instead of the 9.25 mgd included in the current evaluation, which resulted in a recommendation to add new gates and openings to reduce headloss in-between each cell. The lower NRCY flow required for the current evaluation results in less hydraulic constraints through the BNR Basins.

2.3.3 Additional Considerations

Other areas at the plant that can be further optimized and improved for general hydraulics and distribution at the permitted treatment capacity of 14.5 mgd and the future capacity of 18.5 mgd were identified and are listed below:

- The approximately 4-ft long screening channel, upstream of the screens, sees water velocities lower than 1 fps at plant flows lower than 18.5 mgd. Similarly, velocities lower than 1 fps occur in the grit collector effluent channel at flows lower than 13.5 mgd. Ideally at screenings and grit facilities, velocities should be maintained higher than 1 fps to avoid grit settling. However, these low velocities do not seem to create a problem for the plant. OWASA staff confirmed that they have performed two inspections in 2021/2022 and did not see any excess grit buildup in the screenings or grit chambers.
- At all flows lower than 13.5 mgd, velocities are less than 2 fps in the parallel pipes carrying flow between the headworks and Splitter Box 1. Ideally, velocities in pipes carrying solids are maintained at 2 fps or higher to maintain scour and prevent solids from settling. However, these low velocities do not seem to create a problem for the plant and will be less of an issue as flows increase.

Distribution to the aeration basins was also reviewed and no issues were identified.

3. Hydraulic Profile Calibration

On February 16th, 2022, Hazen staff conducted a site visit to the OWASA Mason Farm WWTP to take water elevation measurements where accessible, with the purpose of calibrating the hydraulic profile model. This was a typical day in terms of flows and weather. At 8:10 AM, when Hazen staff arrived at the plant, the influent flow was 5.42 mgd, while at the end of the site visit, the flow had increased to 8.60 mgd. The average influent flow across the measurement period was 7.25 mgd, and the average RAS flow was 6.19 mgd. These were the flows used in the hydraulic profile to compare field measured water surface elevations with calculated water surface elevations. The units that were in service during the site visit, and other pertinent information, are listed below:

- Bar Screens #1 and #2 in service
- Grit Unit #2 in service
- Primary Clarifier #1 in service
- All aeration basins and all cells in service
- Secondary Clarifier #1, #3, and #5 in service
- All six filters in service
- UV Channel #2, Bank A in service
- Depth at Intermediate Pump Station #2: 4.12 feet

Table 3-1 presents the measurements, as well as the calculated water surface elevations. **Figure 3-1** presents a plan view of where the measurements were taken as depicted by red circles.

Table 3-1: Hydraulic Profile Calibration Results

Location	Time of field measurement	Field Measured WSEL, ft.	Calculated WSEL, ft	Difference, in	Concrete EL Ref
Primary Clarifier 1 Launder	8:29 AM	260.60	260.34	3.1	2009A Record Drawings
Splitter Box 2	8:32 AM	260.03	259.97	0.7	2009 Survey
Aeration Basin Influent Channel	8:37 AM	271.31	271.40	1.1	2009 Survey
Aeration Basin Effluent Channel	8:50 AM	269.41	269.29	1.5	14.5 mgd Expansion
Cutthroat Flume Clarifier 5 Influent	8:53 AM	269.37	269.28	1.0	14.5 mgd Expansion
Secondary Clarifier 5 Launder	8:58 AM	264.84	264.74	1.2	2009 Survey
Cutthroat Flume Clarifier 3 Influent	9:10 AM	269.29	269.26	0.4	14.5 mgd Expansion
Secondary Clarifier 3 Launder	9:06 AM	266.08	266.04	0.5	2019 Shop Drawing
Cutthroat Flume Clarifier 1 Influent	9:13 AM	269.12	269.17	0.6	14.5 mgd Expansion
Secondary Clarifier 1 Launder	9:15 AM	265.98	266.08	1.2	1976A Record Drawings
Filter Influent Trough	9:24 AM	264.35	264.20	1.8	2009 Survey
Filters	9:25 AM	257.14	257.26	1.4	2009 Survey
Post Air Effluent Channel	9:28 AM	252.20	252.34	1.7	2009 Survey

In general, the calculated water surface elevations are within a few inches of the field measured water surface elevations, this is considered to be within the margin of error for hydraulic profile calculations. It is important to note that at lower flows the error of measurement is more significant than at higher flows. At higher flows, there is higher headloss, and therefore lower error of measurement.

Only for the Primary Clarifier 1 Launder is the difference between the calculated and the field measurement higher than 3 inches. This can, in part, be due to field measurements taken in relation to the clarifier odor control cover, for which the elevations are not indicated in the record drawings. Although Hazen staff measured the distance from the clarifier top of wall to the top of cover, error of measurement could potentially have affected the calculated water surface elevation.

In addition to the deductions described above, there are general precautions that should be noted when performing hydraulic profile calibrations. The first is related to flowrate; the average flow of 7.25 mgd does not exactly correspond to the flow that each process unit was treating at the time of measurement due to flow attenuation. For example, if the influent flow measured at the headworks facility was 5.42 mgd at the beginning of the site visit, the flow going through the secondary clarifiers at the time at which field measurements were taken likely did not correspond to a flow of 5.42 mgd. Secondly, water surface elevations were measured in the field by measuring the distance from the top of concrete, or

platform, to the water surface. Since a field survey was not conducted for this calibration, this calibration relied on top-of-concrete elevations drawn from record drawings and the survey performed in 2009. Concrete along top of slabs is never uniformly level and usually has slight slopes to allow for drainage, which may account for minor variability in measured water surface elevations, and consequently differences between the elevations that were measured and those being calculated in the hydraulic profile.

The calculated hydraulic profile is generally in line with the measurements taken in the field. As such, no changes were made to the hydraulic profile calculations as a result of the calibration effort.



Figure 3-1: Calibration Field Measurement Locations

4. Cost Estimate

An opinion of probable cost for each of the recommended improvements needed to pass a peak flow of 43.5 mgd without submerging weirs or flumes, as listed in **Table 2-4**, are summarized in **Table 4-1**. The recommended improvements for a peak flow of 55.5 mgd, as listed in **Table 2-5,** are listed in **Table 4-2**. The cost estimates presented herein present a Class 5 AACE International Cost Estimate Classification System and are associated with an accuracy range of –(20-50%) and +(30-100%). The assumptions and contingencies applied in developing the cost estimate are as follows:

- 15% of mechanical subtotal for sitework
- 40% of mechanical subtotal for electrical and I&C design
- 5% of construction subtotal for general conditions and mobilization
- 15% of construction subtotal for contractor overhead and profit
- 2% of construction subtotal for bonds and insurance
- 40% of Subtotal #1 for contingencies
- 20% of Subtotal #2 for engineering services
- 10% of Subtotal #2 for construction management services

The cost estimates were also developed with the assumption that each improvement is part of a larger construction project and that some economies of scale would be applied.

Table 4-1: Cost Opinion for Recommended Hydraulic Improvements at 43.5 mgd

Item	%	Bottleneck #4: Increase the portion of the SC#1 30" influent line in the yard to a 42" pipe. Increase the portion of the SC#2 20" influent line in the yard to a 24" pipe. Add parallel 20" influent piping to SC#3.
Materials and Labor Subtotal	-	$729,000
General Conditions / Mobilization	5%	$36,450
Contractor OH&P	15%	$109,350
Bonds and Insurance	2%	$15,000
Subtotal 1	**-**	$889,800
Contingencies	40%	$355,920
Subtotal 2	**-**	$1,245,720
Engineering	20%	$249,000
Construction Management	10%	$125,000
Total for All 43.5 mgd Hydraulic Improvements (2023)		**$1,620,000**

Table 4-2: Cost Opinion for Recommended Hydraulic Improvements at 55.5 mgd

Item	%	Bottleneck #3: New Intermediate PS	Bottleneck #5: Add a parallel 30" SC#4 effluent pipe
Materials and Labor Subtotal	-	$10,310,000	$112,000
General Conditions / Mobilization	5%	$516,000	$6,000
Contractor OH&P	15%	$1,547,000	$17,000
Bonds and Insurance	2%	$206,000	$2,000
Subtotal 1	**-**	$12,579,000	$137,000
Contingencies	40%	$5,032,000	$55,000
Subtotal 2	**-**	$17,611,000	$192,000
Engineering	20%	$3,522,000	$38,000
Construction Management	10%	$1,761,000	$19,000
Total (2023)		**$22,894,000**	**$249,000**
Total for All 55.5 mgd Hydraulic Improvements (2023)		**$23,143,000**	
Total for All Hydraulic Improvements (2023)		**$24,760,000**	

5. Recommendations

Along with the recommendations listed in **Table 2-4** and **Table 2-5**, it is recommended that OWASA conduct a new survey of the entire plant to confirm elevations of weirs and flumes, as well as having a surveyor out to set and record the elevation of all weir gates in the BNR Basins. It will be important to clearly mark settings so that the gates can be returned to their exact positions after being closed and reopened.

A summary of trigger-based hydraulic recommendations, which will be incorporated into Task 7, are listed below. These recommendations are based on the hydraulic calculations performed with all units in service at peak flow:

- Modifications to Secondary Clarifier No.1 and Secondary Clarifier No.3 influent lines for peak flows greater than 37.5 mgd.
- Use of 14 mgd of primary bypass and removal of Splitter Box weir wall for peak flows greater than 43.5 mgd.
- A new Intermediate Pump Station will be needed for peak flows greater than 43.5 mgd.
- Design and construction of Secondary Clarifier No. 6 when flows begin to approach 47 mgd; the cost opinion for Secondary Clarifier No. 6 is included in TM 3 – Nutrient Removal and Recovery.
- Increase the portion of the Secondary Clarifier No.2 20” influent line in the yard to a 24” pipe for peak flows greater than 52 mgd. It is recommended that this improvement be completed at the same time as the influent pipe improvements for Secondary Clarifiers No. 1 and No. 3.
- Add a parallel 30” Secondary Clarifier No.4 effluent pipe for peak flows greater than 52 mgd.
- Use larger nested influent Parshall flume for peak flows greater than 55 mgd.

Appendix C: TM 3 – Nutrient Removal & Recovery

November 29, 2023

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Mason Farm WWTP Master Plan
TM 3 – Nutrient Removal and Recovery

FINAL

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd). Hazen is contracted to complete a Master Plan to identify near and long-term improvement projects that will help OWASA provide reliable and efficient wastewater treatment. One of the most pivotal tasks that will define the outcome of this Master Plan is to evaluate nutrient removal alternatives that will ensure OWASA's continued compliance with permit limits, while supporting OWASA's core objectives.

The purpose of this task is to evaluate various nutrient removal technologies and identify those that are most feasible for OWASA. This TM summarizes both the high-level (tier 1) and more detailed (tier 2) evaluations that were conducted, and includes process modeling results, cost opinions, site plans, as well as a comparison of alternatives using a multi-criteria decision analysis approach.

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Acronyms and Abbreviations

2010 Study	2010 Hydraulic and Treatment Capacity Study	**NOB**	Nitrite Oxidizing Bacteria
AA	Annual Average	**NPC**	Net Present Cost
AACE	Association for the Advancement of Cost Engineering	**NPDES**	National Pollutant Discharge and Elimination System
ABAC	Ammonia Based Aeration Control	**NRCY**	Nitrified Recycle
AnAOB/Anammox	Anaerobic Ammonia Oxidation	**NSL**	Nutrified Sludge
AOB	Ammonia Oxidizing Bacteria	**O&M**	Operations & Maintenance
aSRT	Aerobic Solids Retention Time	**OWASA**	Orange Water and Sewer Authority
DAS	Densified Activated Sludge	**PdNA/PANDA**	Partial Nitrification-Denitrification-Anammox
DO	Dissolved Oxygen	**ppd**	Pounds per day
EQ	Equalization	**psig**	Pounds per square inch gauge
F:F	Feast-to-Famine	**RAS**	Return Activated Sludge
F:M	Food-to-Microorganism	**rbCOD**	Readily Biodegradable COD
gpd	Gallons per day	**SBR**	Sequencing Batch Reactor
gpm	Gallons per minute	**SPA**	State Point Analysis
MCDA	Multi-criteria Decision Analysis	**SVI**	Sludge Volume Index
mgd	Million gallons per day	**SVI_{30}**	30-minute Sludge Volume Index
MLE	Modified Ludzack-Ettinger	**TN**	Total Nitrogen
MLSS	Mixed Liquor Suspended Solids	**TP**	Total Phosphorus
MM	Maximum Month	**WAS**	Waste Activated Sludge
NH_3-N	Ammonia	**WWTP**	Wastewater Treatment Plant
NO_3-N	Nitrate		

1. Introduction and Objectives

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd) as a maximum month flow. Hazen completed a Hydraulic and Treatment Capacity Study in 2010 (2010 Study), which evaluated existing facilities and provided recommendations to address hydraulic and treatment constraints at the Mason Farm WWTP. The results of the study evaluated numerous nutrient removal and biosolids treatment alternatives and recommended improvements to optimize treatment while minimizing operational costs. Some of the recommended improvements identified in the 2010 Study were implemented, which has resulted in significant savings in operational costs.

Several changes have occurred in the wastewater treatment industry since the 2010 Study, such as the increasing concern for treating emerging contaminants and the development of advanced treatment technologies. Furthermore, the Mason Farm WWTP has undergone upgrades and operational changes that have improved treatment performance and the condition of existing infrastructure. Due to these ongoing changes, OWASA contracted Hazen to develop a new master plan (Master Plan). The primary objective of this Master Plan is to identify near and long-term improvement projects that will help OWASA provide reliable and efficient wastewater treatment. The Master Plan will ultimately be used to assist OWASA in making capital improvement decisions based on optimizing performance, reducing resource consumption, and accommodating flow and load conditions within the service area, all while considering regulatory implications.

The nutrient removal and recovery task is the third in a series of tasks within the Master Plan. The purpose of this task is to:

- Evaluate, at a conceptual level, numerous conventional and emerging technologies (tier 1 alternatives) to determine long-term feasibility of each technology at the Mason Farm WWTP.
- Out of the list of tier 1 alternatives, select two based on feasibility at the Mason Farm WWTP and alignment with OWASA's goals to be further evaluated as tier 2 alternatives.
- Complete BioWin™ modeling, develop site plans, calculate life-cycle cost estimates, and perform a multi-criteria decision analysis (MCDA) to compare the tier 2 alternatives and provide guidance on how they play a role in OWASA's long-term wastewater treatment goals.

The following appendices are included in this TM:

- Appendix A: Meeting minutes and slides from the Tier 1 Alternatives Evaluation Workshop
- Appendix B: Meeting minutes and slides from the Tier 2 Alternatives Evaluation Workshop
- Appendix C: BioWin Modeling Results

2. Tier 1 Alternative Evaluation

As part of the tier 1 alternative evaluation, twenty technologies and operational strategies were presented and reviewed at a conceptual level to determine the long-term feasibility of each. The tier 1 alternatives were organized into the following categories: site optimization, nutrient removal optimization, secondary treatment intensification, novel technologies, resource recovery, and sidestream treatment. Each treatment technology was evaluated to consider the holistic impacts on the plant in terms of effluent quality, site implications, energy consumption, odor control, and biogas production. All alternatives assume denitrification filters will be required in the future to meet the increasingly stringent effluent total nitrogen (TN) limits. **Figure 2-1** displays the technologies and operational strategies considered for the tier 1 alternative evaluation. For more detailed information on each technology, refer to the Tier 1 Workshop slides provided as **Appendix A**.

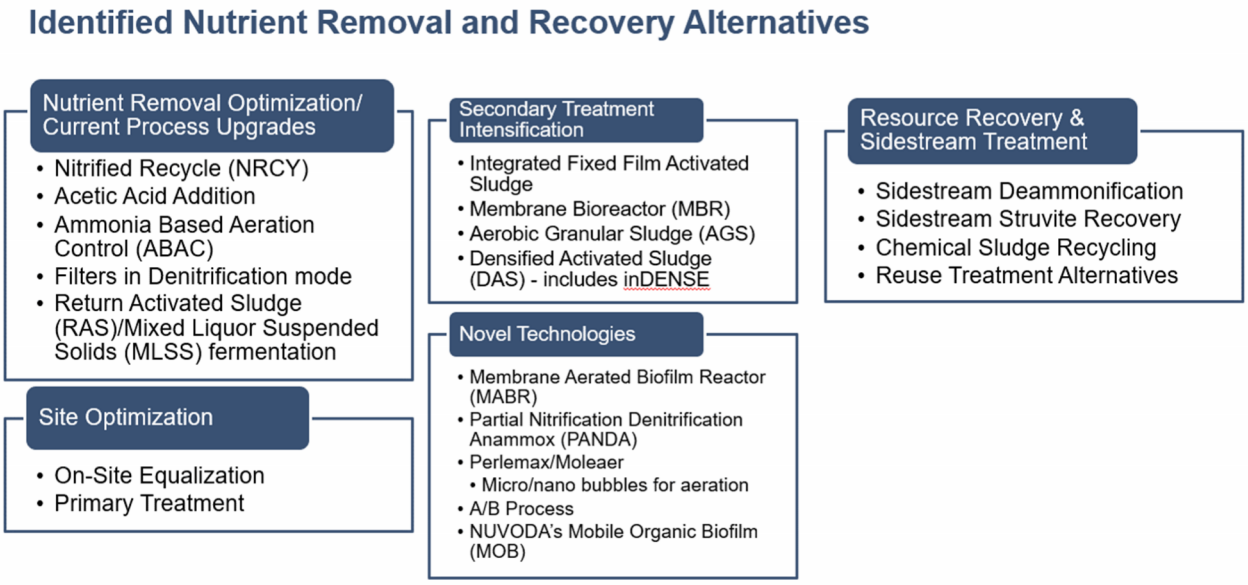


Figure 2-1: Identified Nutrient Removal and Recovery Alternatives

Five initial recommendations by Hazen for the shortlist of potential technologies were provided to OWASA for review. The recommended alternatives for the tier 2 evaluation are listed below:

1. Modified Ludzack-Ettinger (MLE) conventional treatment configuration, i.e. nitrified recycle (NRCY), with Ammonia Based Aeration Control (ABAC)
    - This alternative will optimize the existing process in terms of effluent TN and represents the plant's baseline solution.
2. Densified Activated Sludge (DAS) with Step Feed
    - This alternative will increase plant capacity while using the existing footprint and reducing infrastructure requirements. Hydrocyclones to enhance settleability are included as part of this solution.

3. DAS without Primary Clarifiers
    - The goal of this alternative is to capitalize on the site space that would be available for new processes by removing primary clarifiers and the benefits of DAS with reduced carbon feed in the treatment process. Hydrocyclones to enhance settleability are included as part of this solution.
4. Partial Nitrification-Denitrification-Anammox (PdNA/PANDA) with Primary Filtration
    - This alternative can maximize the carbon sent to biosolids while reducing external carbon needs for nitrogen removal in the mainstream.
5. On-site Equalization (EQ)
    - The goal of this alternative is to reduce the wet weather peaking factor to 3.0, avoiding over-design and costly impacts of sizing a facility for a peaking factor greater than 3.0.

OWASA staff reviewed the shortlisted recommendations and selected alternatives 1 and 2 listed above: conventional treatment with ABAC and NRCY (i.e. MLE/NRCY), and Densified Activated Sludge (i.e. DAS/Step Feed). Alternatives 3, 4, and 5 were eliminated from further consideration for the following reasons:

1. The implementation of DAS without primary clarifiers would not leverage the capital and operating investments that have already been made in the existing primary clarifiers. Significant impacts to anaerobic digestion would occur with the redirection of carbon to the aeration basins. A large increase in basin capacity would be required to treat the increased carbon load.

2. PdNA/PANDA is a novel technology that is currently being piloted at several facilities in the United States; therefore, full-scale operating data is limited.

3. One of OWASA's core objectives is to stay within the Mason Farm WWTP property boundary. Adding on-site wet weather flow equalization while providing the facilities needed to meet future needs and growth within OWASA's service area will be challenging. Therefore, the detailed evaluation of on-site equalization at the Mason Farm WWTP was not further considered as part of this evaluation. However, the development of site plans as part of this Master Plan will inform OWASA of the feasibility of adding on-site equalization in addition to implementing the evaluated nutrient removal and biosolids alternatives based on available site footprint. The selected peak flowrate already assumes equalization of some type, likely within the collection system, to reduce the peaking factor to 3.0.

3. Tier 2 Alternative Evaluation

The tier 2 alternative evaluation includes a more detailed analysis of the two selected alternatives: MLE/NRCY and DAS/Step Feed. ABAC is assumed to be included in both alternatives and will be discussed further in Section 4. Both selected tier 2 alternatives assume denitrification filters will be required in the future to meet the increasingly stringent effluent TN limits. Furthermore, the tier 2 alternatives are not mutually exclusive and could be implemented at the same time or in series. As a reminder, Table 3-1 summarizes the selected near term and long-term flows analyzed in the Master Plan.

Table 3-1: 2037 and 2070 Master Plan Flows

Year	AADF (mgd)	MMADF Peaking Factor	MMADF Flow (mgd)
2037	9.52	1.25	11.90
2070	13.49	1.25	16.86

3.1 MLE/NRCY Overview

The MLE/NRCY alternative includes modifications to operate in a MLE configuration. This alternative modifies the existing process from a step-feed configuration to a plug flow configuration as all aeration basin influent and return activated sludge (RAS) is returned to the first cell in each train. **Figure 3-1** displays the aeration basins in the MLE configuration. The goal of this configuration is to return nitrified flow back to the anoxic zones (orange cells) to promote denitrification. NRCY will be sent from the last cell to the first cell in each train. The first two cells of each train are expected to operate anoxically under annual average (AA) conditions. The second cell will be required to operate aerobically at maximum month (MM), minimum week temperature conditions. NRCY flowrates are assumed to be three times the forward flow at AA conditions and one and a half times the forward flow at MM conditions. RAS is still conditioned in the Nutrified Sludge (NSL) cells before being sent to the aeration basins.

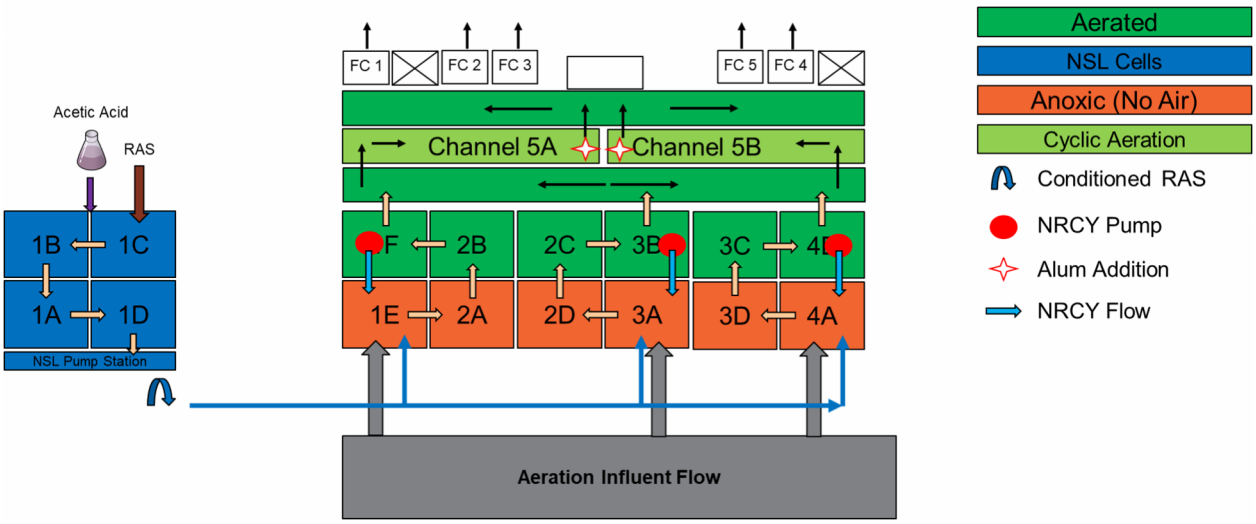


Figure 3-1: Mason Farm WWTP MLE Configuration with NRCY

3.2 Densification Overview

Densification, or densified activated sludge, is a non-proprietary enhancement of conventional BNR treatment to achieve improved settling. The goal of densification is to utilize a combination of biological and physical selection to improve the settleability of the sludge (i.e., decrease the sludge volume index (SVI)). A better settling sludge increases a facility's ability to treat elevated wet weather peak flows and allows the facility to operate at a higher mixed liquor suspended solids (MLSS) concentration (4,500 to

5,500 mg/L) to reduce infrastructure requirements. Densified settling characteristics target 30-minute SVIs (SVI_{30}) in the range of 50 to 80 mL/g. Densification requires kinetic selection, which can be achieved under anaerobic, anoxic, or aerobic conditions. In cases where meeting nitrogen and phosphorus limits is critical, kinetic selection needs to be combined with metabolic selection (i.e., in anaerobic and anoxic zones).

3.2.1 Techniques for Densifying Activated Sludge

The goal of densification is to utilize both biological and physical selection to improve the settleability of the sludge. Biological selection has been observed as the primary driver for densifying MLSS with physical selection providing supplemental benefit to biological selection. Physical selection can be completed through multiple means such as surface wasting and/or hydrocyclones. Hydrocyclones are assumed to be required to provide densification at the Mason Farm WWTP. Due to the highly site-specific nature of densification, full-scale piloting may be necessary to verify the degree of benefit and need for hydroyclones or other means of physical selection.

3.2.1.1 BIOLOGICAL SELECTION

Biological selection, which includes metabolic and kinetic selection, is completed by promoting a strong food-to-microorganism (F:M) ratio gradient through the upfront zones of the BNR basin and a low feast-to-famine (F:F) ratio. The F:M ratio at the beginning of the BNR basin is critical in exerting the selective pressure necessary for carbon uptake and nutrient removal by the targeted biomass and metabolic pathways. The F:F ratio defines the time the readily biodegradable COD (rbCOD) is being rapidly consumed by the biology (feast) compared to the time rbCOD is fully consumed and there is little to no change in the measurement (famine). A low F:F ratio, less duration of feast compared to famine, has been correlated with lower SVIs.

3.2.1.2 HYDROCYCLONES

Hydrocyclones are a form of gravimetric selection for retaining denser biomass while wasting the lighter fraction of the MLSS. Applying hydrocyclones for densification is currently licensed by WorldWaterWorks, marketed as inDENSE™ technology. The increased density of retained solids improves settling characteristics and aids in prevention of biomass loss and treatment disruption, especially during wet weather. **Figure 3-2** and **Figure 3-3** display the process flow diagram, skid rendering, and location of the hydrocyclones within the treatment process.

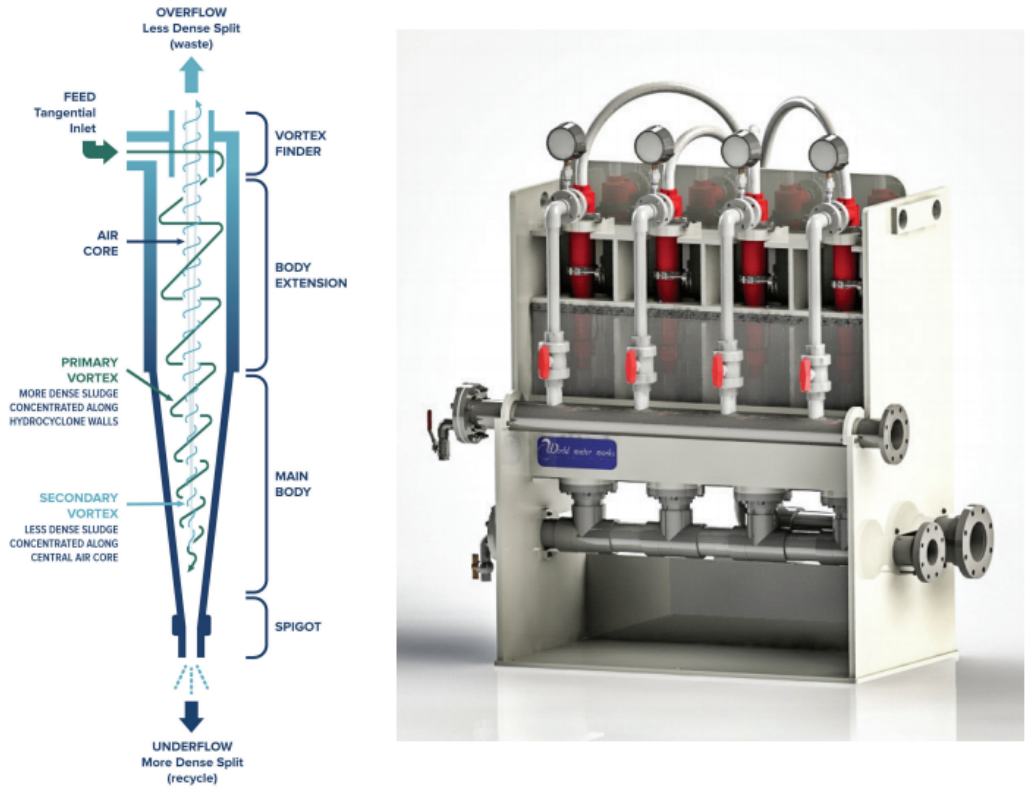


Figure 3-2: Hydrocyclone Process Flow Diagram and Skid Rendering from WorldWaterWorks

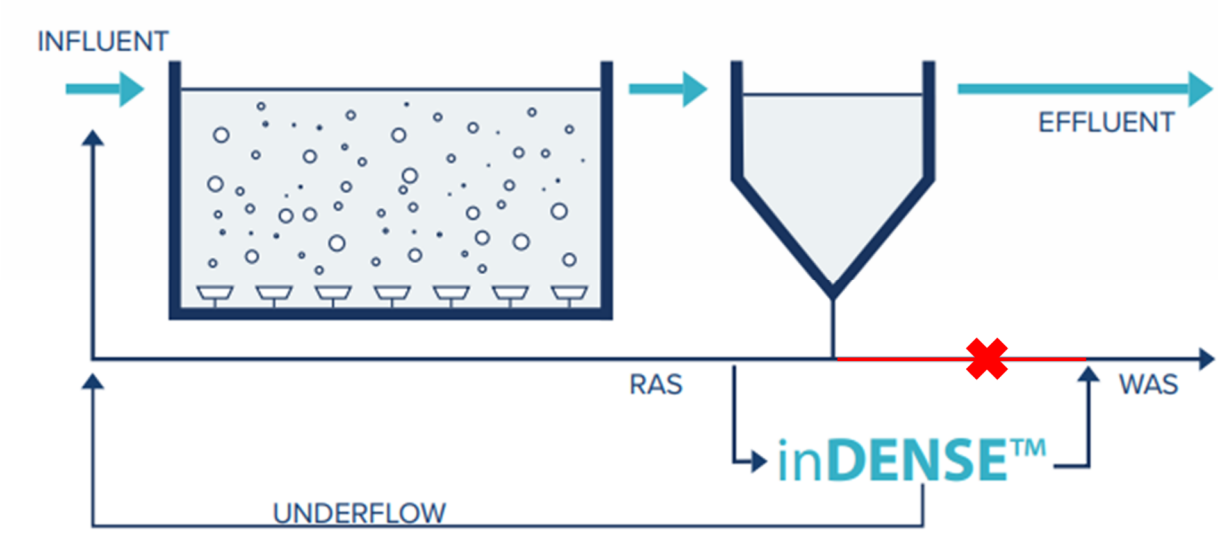


Figure 3-3: Hydrocyclone Location within the Treatment Process from WorldWaterWorks

Hydrocyclones require a target feed pressure of 35 pounds per square inch gauge (psig) with an allowable range of 32 – 37 psig. Higher operating pressures increase selection of dense particles while lower

operating pressures decrease selection of dense particles. Hydrocyclones force denser solids to the cyclone walls and down through the underflow to be recycled to the main process while lighter solids migrate towards the center of the cyclone and are pushed upwards through the overflow to be wasted. In standard practice, waste activated sludge (WAS) is sent to the hydrocyclones ahead of solids handling to separate and retain the denser particles. The overflow of lighter material is sent to solids handling and makes up the daily mass wasted from the process. The RAS concentration heavily impacts the required number of hydrocyclones to meet the daily wasting requirements.

Typical flow splits from the hydrocyclone have been observed at 80% overflow to 20% underflow. A conservative design mass split assumption of 50% overflow to 50% underflow was used due to observed variability. WorldWaterWorks designs are based off a mass split of 65% overflow to 35% underflow, which would produce a lower number of required hydrocyclones. A four-cyclone skid was assumed in the number of skids; however, WorldWaterWorks can provide 5-cyclone and 10-cyclone skids. **Table 3-2** presents a summary of minimum hydrocyclone requirements to meet AA and MM wasting requirements.

Table 3-2: Hydrocyclone Requirements and Design Parameters

Parameter	Near Term		Existing Capacity		Buildout Capacity	
	AA	MM	AA	MM	AA	MM
Required Wasting Load, ppd	10,430	13,820	12,890	17,210	17,160	22,500
No. of Duty Hydrocyclones	6	7	6	7	6	7
Hydrocyclone Feed Flow, gpm	263	293	263	293	258	286
Hydrocyclone Feed TSS, mg/L	6,620	7,850	8,180	9,780	11,100	13,100
Hydrocyclone Overflow Flow, gpm	210	234	210	234	207	229
Hydrocyclone Overflow TSS, mg/L	4,140	4,910	5,100	6,100	6,900	8,190
Hydrocyclone Underflow Flow, gpm	52	59	52	59	52	57
Hydrocyclone Underflow TSS, mg/L	16,500	19,600	20,400	24,400	27,700	32,700

3.3 Nutrient Removal Performance

3.3.1.1 MODELING ASSUMPTIONS

Performance of the two selected alternatives was evaluated with the validated process model at the design influent flows and loads presented in TM 1. Models for the near term, current capacity, and buildout capacity AA and MM conditions were developed.

Table 3-3 presents the operating assumptions for the dry weather modeling. The assumed aerobic solids retention times (aSRT) are based on model simulations and on past operating experience at Mason Farm. Maintaining an aSRT of at least 7 days at the MM load and minimum week temperature is required to maintain complete nitrification. The RAS flow in all models was assumed to be equal to the forward flow.

A conservative ammonia oxidizing bacteria (AOB) growth rate of 0.8 day^{-1} was selected. The model predicts filtered secondary effluent quality but does not account for tertiary nitrate removal through future denitrification filter operation due to the extensive sampling and calibration required to accurately model denitrification filter performance.

Table 3-3: Design Dry Weather Modeling Assumptions

Parameter	Annual Average	Maximum Month
Temperature	20 ºC	13 ºC
Primary Clarifier Removal	60%	
Trains in Service	All in Service	
Minimum aSRT	6 days	7 days

The effluent nutrient concentration limits based on the permitted mass allocation the Mason Farm WWTP must meet at each flow milestone are described in **Table 3-4**. It should be noted that to achieve the effluent nitrogen limits, denitrification filters are required for each flow scenario, however, timing for each scenario may be different. Based on the historical 2021 effluent TN concentration of 7.0 mg/L, supplemental carbon addition to the existing denitrification filters will be required in order to achieve meet the required TN mass load allocation at approximately 6.25 mgd of discharged effluent. The BioWin™ model was utilized to predict the nitrate concentration that would need to be reduced by the denitrification filters. Discussion on carbon usage associated with denitrification filters is in Section 4.2.1.

Table 3-4: Effluent Nutrient Limits at Each Flow Milestone

Parameter	Total Nitrogen	Total Phosphorus
Permit Load Allocation	134,375 lb/yr	10,188 lb/yr
Near Term AA – 9.5 MGD	4.63 mg/L	0.35 mg/L
Near Term MM – 11.9 MGD	3.71 mg/L	0.28 mg/L
Existing Capacity AA – 11.6 MGD	3.81 mg/L	0.29 mg/L
Existing Capacity MM – 14.5 MGD	3.04 mg/L	0.23 mg/L
Buildout Capacity AA – 14.8 MGD	2.98 mg/L	0.23 mg/L
Buildout Capacity MM – 18.5 MGD	2.39 mg/L	0.18 mg/L

3.3.1.2 ALTERNATIVE MODELING RESULTS COMPARISON

The performance of the two selected alternatives at the different flow milestones was compared using the process model. **Table 3-5** summarizes the predicted MLSS concentrations for the two alternatives. The predicted MLSS concentrations for the MLE/NRCY alternative are approximately 10% greater than the DAS/Step-Feed alternative. The lower MLSS concentration under the DAS/Step-Feed alternative is due to the step-feed distribution of aeration basin influent. This results in a greater MLSS concentration in the first cell of each train, which is then diluted with the remaining aeration basin influent in the second cell.

The MLSS concentrations under MLE/NRCY exceed typical maximum design values (4,000 to 4,500 mg/L) for conventional settling at current and future buildout capacities. DAS allows operation at increased MLSS concentrations (between 5,500 and potentially up to 6,500 mg/L), allowing current capacity to be maintained with limited additional infrastructure and reducing future capacity improvements at buildout.

Table 3-5: Predicted MLSS Values for Each Alternative

Flow Condition	MLE / NRCY (mg/L)	DAS / Step-Feed (mg/L)
Near Term AA – 9.5 MGD	3,660	3,280
Near Term MM – 11.9 MGD	4,250	3,900
Existing Capacity AA – 11.6 MGD	4,570	4,060
Existing Capacity MM – 14.5 MGD	5,270	4,860
Buildout Capacity AA – 14.8 MGD	6,140	5,500
Buildout Capacity MM – 18.5 MGD	7,090	6,520

Table 3-6 presents the secondary effluent ammonia (NH_3-N) concentration for each flow and alternative. Predicted performance in both models is comparable and shows both configurations fully nitrifying at the selected aSRTs and conditions. The slightly higher effluent ammonia under DAS/Step-Feed is likely due to step feed operation.

Table 3-6: Predicted Secondary Effluent NH_3-N for Each Alternative

Flow Condition	MLE / NRCY (mg/L)	DAS / Step-Feed (mg/L)
Near Term AA – 9.5 MGD	< 0.1	0.12
Near Term MM – 11.9 MGD	0.23	0.23
Existing Capacity AA – 11.6 MGD	0.08	0.13
Existing Capacity MM – 14.5 MGD	0.26	0.28
Buildout Capacity AA – 14.8 MGD	0.08	0.14
Buildout Capacity MM – 18.5 MGD	0.29	0.37

Table 3-7 and **Table 3-8** provide the predicted secondary effluent nitrate (NO_3-N) and TN concentrations. Operating in the MLE configuration is expected to reduce secondary effluent nitrate and TN by 2 to 3 mg/L compared to step feed. The main benefit of operating in a configuration with NRCY is the reduction in nitrate to the denitrification filters. Implementing MLE/NRCY may delay the need to feed supplemental carbon to the filters to operate in denitrification mode while maintaining compliance with effluent TN limits.

Table 3-7: Predicted Secondary Effluent NO_3-N for Each Alternative

Flow Condition	MLE / NRCY (mg/L)	DAS / Step-Feed (mg/L)
Near Term AA – 9.5 MGD	7.5	10.0
Near Term MM – 11.9 MGD	11.4	13.2
Existing Capacity AA – 11.6 MGD	7.6	10.3
Existing Capacity MM – 14.5 MGD	11.6	13.6
Buildout Capacity AA – 14.8 MGD	7.9	10.5
Buildout Capacity MM – 18.5 MGD	11.7	14.4

Table 3-8: Predicted Secondary Effluent TN for Each Alternative

Flow Condition	MLE / NRCY (mg/L)	DAS / Step-Feed (mg/L)
Near Term AA – 9.5 MGD	8.8	11.4
Near Term MM – 11.9 MGD	12.8	14.6
Existing Capacity AA – 11.6 MGD	8.9	11.6
Existing Capacity MM – 14.5 MGD	13.1	15.1
Buildout Capacity AA – 14.8 MGD	9.2	11.8
Buildout Capacity MM – 18.5 MGD	13.3	16.0

Table 3-9 displays the filtered secondary effluent total phosphorus (TP). The predicted effluent TP concentrations are comparable between the two alternatives with similar rates of alum addition. The required effluent TP concentration decreases with increased effluent flow.

Table 3-9: Modeled Secondary Effluent TP for Each Alternative

Flow Condition	MLE / NRCY (mg/L)	DAS / Step-Feed (mg/L)
Near Term AA – 9.5 MGD	0.26	0.32
Near Term MM – 11.9 MGD	0.26	0.27
Existing Capacity AA – 11.6 MGD	0.29	0.29
Existing Capacity MM – 14.5 MGD	0.22	0.22
Buildout Capacity AA – 14.8 MGD	0.24	0.21
Buildout Capacity MM – 18.5 MGD	0.24	0.21

Alum feed was adjusted until the ortho-phosphate was less than 0.1 mg/L. The rate of chemical addition to remove additional soluble phosphorus beyond 0.1 mg/L increases substantially. It is recommended to include multi-point alum addition to optimize the required alum to meet the future limits when the Mason Farm WWTP is nearing the expansion to 18.5 mgd. Reducing the ortho-phosphate to less than 0.1 mg/L as flows begin nearing 11.6 mgd will be required to meet the effluent TP limit assuming an effluent TSS of 3 mg/L and a phosphorus concentration within the solids of 6%.

3.4 Chemical Usage

All simulations included caustic addition to primary effluent, 20% acetic acid addition to the NSL cells, and alum addition to channels 5A and 5B.

- Caustic addition was held at 3,000 gallons per day (gpd) for all scenarios to ensure enough alkalinity was available for nitrification. External alkalinity addition would be reduced by a few hundred gallons with MLE/NRCY due to denitrification producing alkalinity.

- The 20% acetic acid to the NSLs was set at 1,800 gpd to denitrify RAS being recycled to the process. In actual operation, DAS/Step Feed will have increased acetic acid requirements compared to MLE/NRCY due to the reduced nitrate recycled in the RAS. Assuming the average difference in secondary effluent nitrate, DAS/Step Feed will require approximately 60 gallons per day per million gallons treated more than MLE/NRCY.

- The predicted alum usage increased with each flow scenario to meet the progressively more stringent TP limits. The required daily volume was predicted to be similar between the two alternatives, ranging between 1,000 and 3,400 gpd.

3.5 Secondary Clarifier Capacity Evaluation

There is a critical importance in understanding secondary clarifier operation at various flow, MLSS, and SVI to compare performance of each alternative and identify associated required clarifier and RAS improvements. State point analyses (SPA) were completed to determine clarifier performance for each simulated flow and predicted MLSS. **Table 3-10** displays the historical 2020 SVI_{30}. The Mason Farm WWTP already has well settling sludge with an average SVI_{30} of 87 mL/g. The SPA completed compared the 95th percentile SVI_{30} of 110 mL/g to a densified SVI_{30} of 80 mL/g. Maximum month and peak flows (PF = 3.0) for the current capacity and buildout capacity were utilized in the SPA. SPA were completed with all existing clarifiers assumed to be online and the future sixth clarifier online. The sixth clarifier would match the existing 110-foot diameter Secondary Clarifier 1. RAS was assumed to equal forward flow at maximum month conditions, while at peak flows RAS was set at existing max pump capacity.

Table 3-10: Historical 2020 30-minute Sludge Volume Index

Parameter	2020 SVI_{30} (mL/g)
Average	87
50th	84
80th	98
90th	102
95th	110

Table 3-11 displays the predicted maximum acceptable MLSS from the SPA. Reducing the SVI_{30} from 110 mL/g to 80 mL/g increases the acceptable MLSS concentration by approximately 28%. The 28%

increase in acceptable MLSS shows that densifying at Mason Farm WWTP could increase the plant's capacity. Wet weather flows significantly reduce the limiting MLSS concentration. The additional sixth clarifier provides an approximate 5% to 15% capacity increase, with the larger impact during wet weather events. It is recommended Clarifier 6 to be constructed within the near-term period (before 2037) due to the risks associated with MLSS concentrations at peak flows. The sixth clarifier is needed to mitigate breakthrough or washout of MLSS at peak events. Densification could potentially offset when the additional clarifier is required, but even with densification, additional clarifier capacity will be needed.. At the 18.5 mgd buildout capacity, additional clarifier capacity beyond the sixth clarifier is likely required to pass peak flows of 55 mgd. Due to significant site constraints, reducing the peak flow should be completed outside of the plant site unless OWASA is able to acquire additional land next to the plant.

Table 3-11: Maximum Acceptable MLSS Concentration based on State Point Analysis

Total Flow (mgd)	Clarifiers In Service (No.)	SVI_{30} = 110 mL/g	SVI_{30} = 80 mL/g
14.5	5	5,900	7,600[1]
43.5	5	3,200	4,100
14.5	6	6,300	8,000[1]
43.5	6	3,700	4,700
18.5	6	5,900	7,500[1]
55.5	6	3,100	4,000

[1]MLSS based on SPA are not necessarily realistic operating values.

3.6 WWTP Capacity

Each alternative provides different benefits to the WWTP. However, MLE/NRCY is only an optimization strategy and does not provide a capacity increase. Beyond the existing plant rated capacity, additional aeration basins will be required if the only alternative selected is MLE/NRCY. Process modeling indicates the MLSS concentration will approach 5,300 mg/L at the existing capacity maximum month conditions with all basins in service. As flows and loads increase beyond the 14.5 mgd conditions, additional basin capacity would be required to reduce the MLSS concentration. It would be recommended to provide additional basin capacity before exceeding the existing capacity's annual average loading at 11.6 mgd. The limited site space that is currently available must be allocated strategically to encompass the holistic needs of the WWTP. Therefore, due to the limited site space for additional aeration basins, only implementing MLE/NRCY in the long-term is not feasible for OWASA.

These two alternatives are not mutually exclusive and can be combined into one strategy to provide an optimal solution for the plant. MLE/NRCY can be incorporated with densification to provide the reduction in chemical to the denitrification filters, while DAS provides the capacity increase, resiliency in settling, and reduced risk at higher flows in a smaller footprint than equalization. Moving forward with both alternatives also provides additional flexibility in treatment configurations.

3.7 Site Plans

A single site plan is shown for the combination of the two alternatives. The addition of NRCY to the basins impacts only the interior of the aeration basins and does not require any available site space. Densification has a slightly larger site impact with the new hydrocyclone building that could be located near Secondary Clarifier No. 1 and the NSL Tanks. Site work for the new piping associated with the hydrocyclone feed, underflow, and overflow would be required. Secondary Clarifier No. 6 would be installed in the location previously selected across the road from the abandoned chlorine contact tanks, near Morgan Creek. A new RAS pump station would be built with the new clarifier. **Figure 3-4** presents the site plan of the two alternatives.

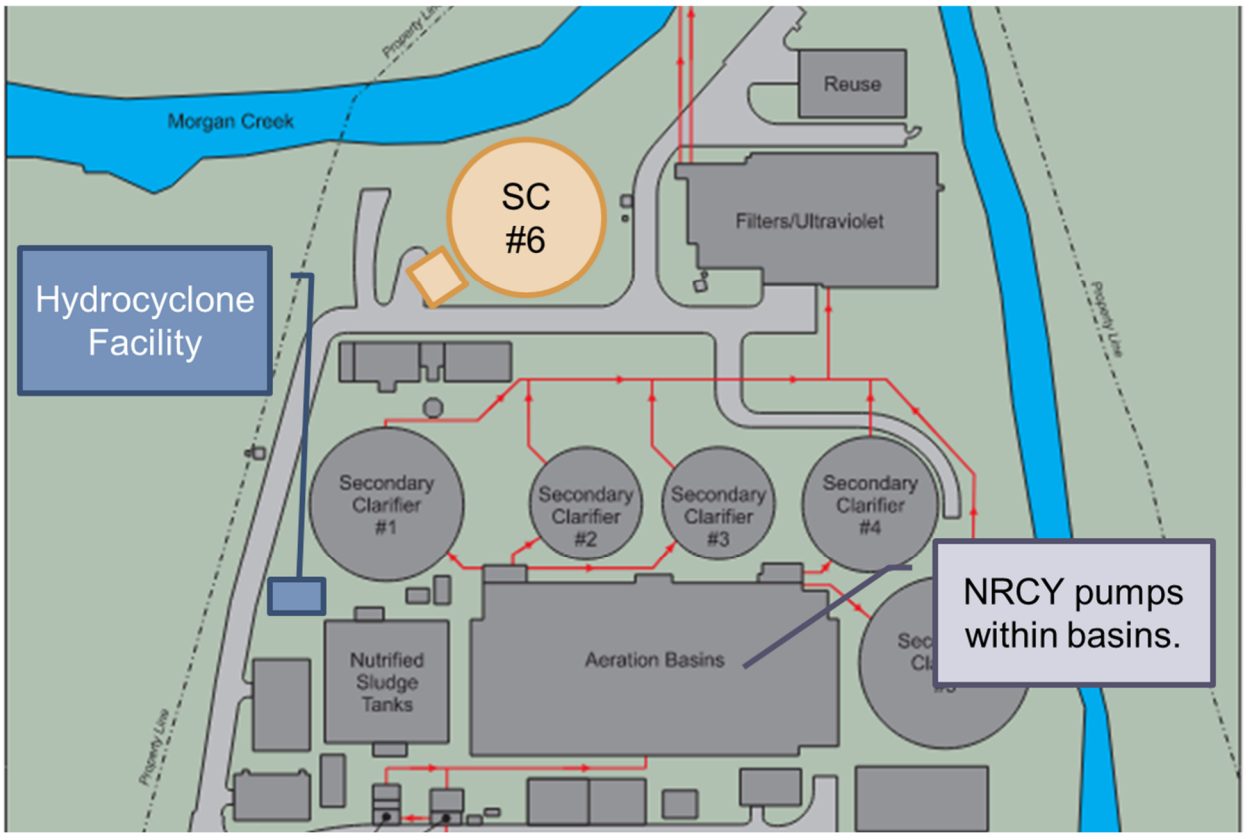


Figure 3-4: Partial Site Plan for Tier 2 Alternatives

3.8 Cost Opinion Comparison

Differential capital cost opinions were developed for each alternative based on the Class 5 Association for the Advancement of Cost Engineering (AACE) International Cost Estimate Classification System. **Figure 3-5** summarizes the assumptions of the capital cost opinions for each alternative. Since ABAC is assumed to be included in both alternatives, the cost associated with the sensors and controllers to install ABAC is not included in this comparison. The cost associated with Secondary Clarifier 6 is included in both alternatives presented in **Table 3-11**.

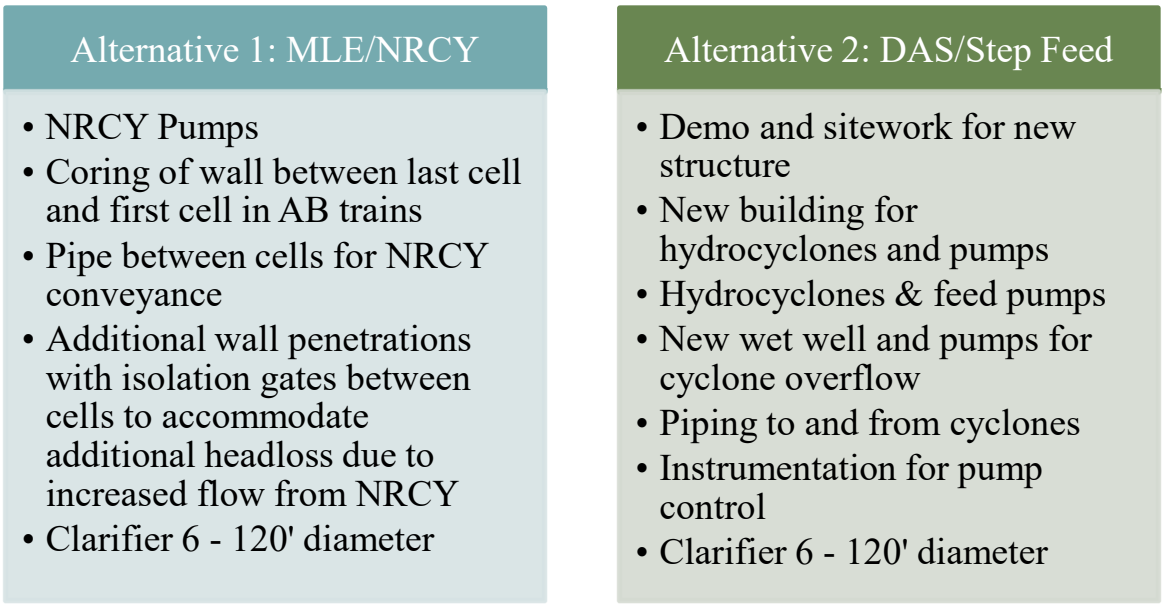


Figure 3-5: Cost Opinion Assumptions and Included Items for Each Alternative

Table 3-12 presents the capital costs for the two alternatives. The primary difference in the two cost opinions is the new hydrocyclone facility and site work associated with the building.

Table 3-12: Capital Cost Opinions for the Selected Tier 2 Alternatives

Item	%	Alternative 1: MLE/NRCY	Alternative 2: DAS/Step Feed
Materials and Labor Subtotal	-	$4,990,000	$8,830,000
General Conditions / Mobilization	5%	$250,000	$442,000
Contractor OH&P	15%	$748,000	$1,330,000
Bonds and Insurance	2%	$100,000	$177,000
Subtotal 1	**-**	**$6,080,000**	**$10,780,000**
Contingencies	40%	$2,440,000	$4,310,000
Subtotal 2	**-**	**$8,510,000**	**$15,080,000**
Engineering	20%	$1,710,000	$3,020,000
Construction Management	10%	$851,000	$1,510,000
Total (2023)		**$11,070,000**	**$19,610,000**

Note: Cost items are rounded to the nearest $1,000 and subtotals are rounded to the nearest $10,000.

The capital cost opinions were incorporated into a life cycle analysis to include the differential operation and maintenance (O&M) costs associated with each alternative. The assumptions implemented for the life cycle cost evaluation include:

- A financing interest rate of 5% and a rate of inflation of 3% were used in the lifecycle cost analysis. An assumed electrical cost of $0.070/kW-hr was utilized. A maintenance percentage of 2% of mechanical equipment cost was assumed.
- For the MLE/NRCY alternative, three NRCY pumps of 15 horsepower each were assumed to be in service. For the DAS/Step Feed alternative, four pumps at 20 horsepower each for the hydrocyclone feed and overflow, were assumed to be in service for the lifecycle cost analysis.
- An acetic acid cost of $1.69 per gallon was assumed in the denitrification filter carbon feed calculations. The calculations utilized the 2021 average effluent flow and nitrate from the daily monitoring report. The DAS/Step Feed alternative directly used the 2021 average effluent nitrate of 6.3 mg/L, while the MLE/NRCY alternative used a reduced concentration based on the average difference of 2.4 mg/L in the predicted secondary effluent nitrate from the model runs. The target effluent nitrate concentration was 3.0 mg/L in the calculations.
- A 20-year timeframe was used in the lifecycle cost analysis.

Table 3-13 summarizes the lifecycle cost for each alternative.

Table 3-13: Lifecycle Costs for the Each Alternative

	Alternative 1: MLE/NRCY	Alternative 2: DAS/Step Feed
Maintenance NPC	*$1,420,000*	*$1,570,000*
Energy NPC	*$370,000*	*$650,000*
Carbon NPC	*$4,870,000*	*$7,870,000*
Total O&M NPC	$6,640,000	$10,080,000
Capital NPC	$11,070,000	$19,610,000
Lifecycle Cost	**$17,700,000**	**$29,680,000**

3.9 Multi-Criteria Decision Analysis: HazenConverge

As part of the Master Plan, a multi-criteria decision analysis (MCDA) tool, HazenConverge, was utilized to provide pairwise comparison of the alternatives based on criteria weighting that reflect OWASA's goals and objectives. OWASA provided a list of core objectives regarding plant operation goals and visions to be incorporated within the MCDA. From the list of core objectives, a list of potential criteria to be used in the HazenConverge were developed. **Figure 3-6** summarizes the core objectives for the liquid stream of Mason Farm WWTP and the selected criteria for the MCDA. The criteria were selected to capture the true differences between the two alternatives and reduce any potential overlap between them.

Core Objectives	Selected Criteria
• Meeting NPDES permit requirements • Future regulations of emerging contaminants • Meeting reclaimed water requirements • Operate within existing property boundary for the next 50 years • Preparation for more frequent and larger storms • Energy savings	• Technology reliability • Ease of operation • Ease of expansion (constructability) • Resiliency to wet weather (climate change) • Site footprint • Leveraging existing assents • Lifecycle cost • Increases treatment capacity

Figure 3-6: OWASA's Core Objectives for Mason Farm WWTP and Potential MCDA Criteria

Within each criteria, further qualifying points were developed in order to assist with the scoring of the alternatives within the MCDA criteria. **Figure 3-7** displays the qualifying points for each criteria used in the MCDA.



Figure 3-7: MCDA Criteria Qualifying Points

HazenConverge allows the user to define weightings for each criterion to reflect the extent to which a criterion drives the decision-making process. The selected weightings for each criterion are displayed in **Table 3-14**. The relative weightings of the criteria are especially important as the results of the MCDA can vary based on the level of importance placed on certain criteria. The two criteria with the highest weightings are Life Cycle Costs and Increase in Treatment Capacity. The criteria "Increase in Treatment Capacity" accounts for the fact that DAS/Step Feed increases the WWTP plant capacity, while MLE/NRCY does not. The addition of process volume and the appurtenances (i.e. site plan space, equipment, power, etc.) that would be needed to support that process volume would require a significant capital investment, which is why this criteria is weighted equally to Life Cycle Costs.

Table 3-14: User-Assigned Weightings for the Selected MCDA Criteria

Criteria	User-Assigned Weightings
Technology Reliability	20
Ease of Operation	20
Ease of Constructability	5
Resiliency to Wet Weather	10
Site Footprint	20
Repurposing of Existing Infrastructure	5
Life Cycle Cost	40
Increase in Treatment Capacity	40

Scores were provided to each criterion for the two alternatives based on how each alternative answers the qualifying points. Each criterion has a positive or negative correlation. For example, capital cost was given a negative correlation meaning the lower the capital cost, the higher score the alternative is given. The results of the MCDA based on the selected criteria and weightings are shown in **Figure 3-8**. DAS/Step Feed earned a higher score compared to MLE/NRCY due to the criteria of increasing treatment capacity.

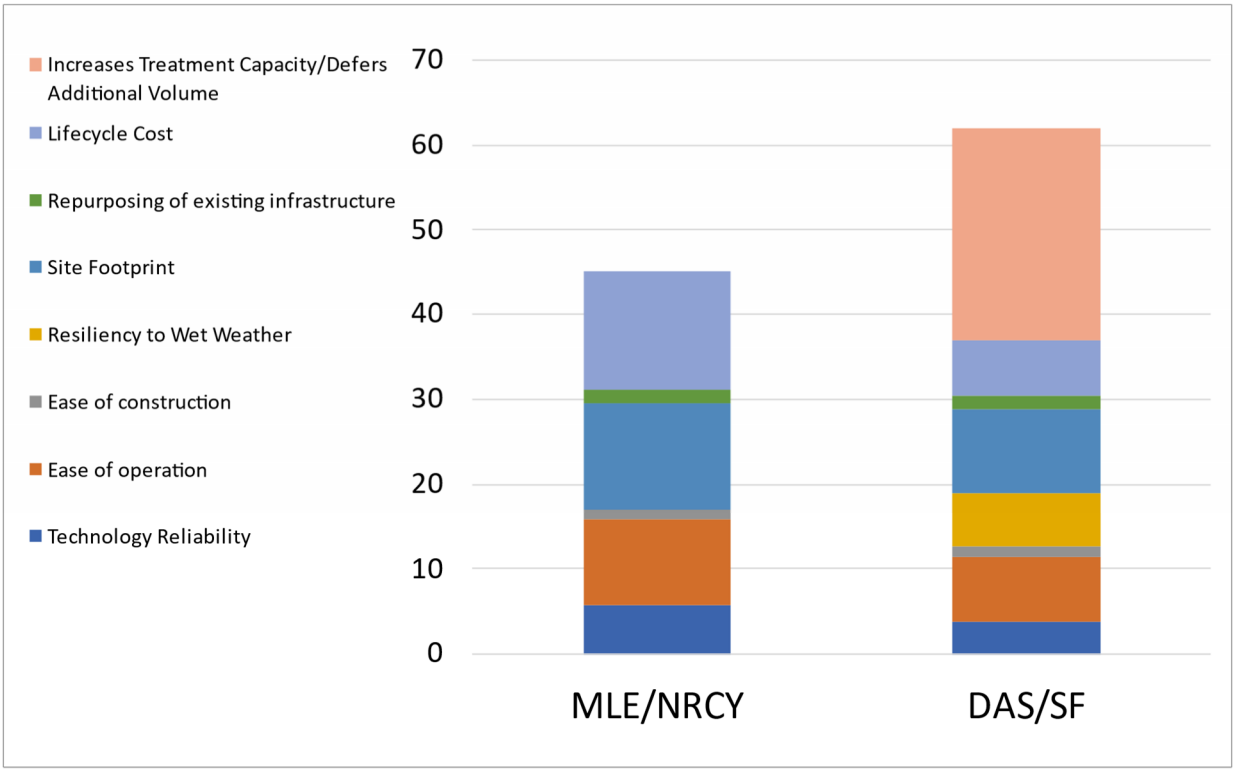


Figure 3-8: MCDA Results for Each Alternative

4. Additional Considerations

To provide a holistic and multi-solution strategy for OWASA, additional operational strategies and technology considerations were evaluated and are discussed below. Two of these strategies are currently assumed to be part of the future of the WWTP: ABAC and denitrification filters. ABAC is a control strategy that can be implemented with both alternatives to optimize nitrogen removal efficiency. The existing denitrification filters, when denitrification mode will be needed, and their carbon requirements are discussed below. The other two additional considerations, PdNA and sidestream deammonification, are technologies that can provide supplementary nitrogen removal to reduce external carbon usage and stress on the secondary treatment process and denitrification filters. It is recommended that OWASA monitors PdNA and sidestream treatment in reference to their own treatment processes and goals. These additional considerations will be included in the trigger-based roadmap, which is described further in Section 5.

4.1 Ammonia Based Aeration Control

ABAC is an aeration control strategy used to optimize the aeration and DO requirements to meet a target ammonia concentration. In this control strategy, the operator inputs an ammonia concentration setpoint to be targeted at the end of the aeration zone. The functional program will change the dissolved oxygen (DO) setpoint if the measured ammonia at the end of the aeration zone is above or below the target. The benefits of ABAC include:

- Optimized nitrogen removal efficiency
- Minimized airflow and energy use
- Reduction in carbon usage due to less DO entering the post-anoxic zone (if configured this way)
- Can maximize simultaneous nitrification and denitrification (SND) at the lower DO

Figure 4-1 displays a graphical representation of how the control strategy optimizes nitrification in ABAC operation. A wet chemical analyzer is required at the end of the aeration zone to accurately measure the low ammonia concentrations. DO is controlled by designated zones to optimize nitrification throughout the aeration basins. Probes to monitor the DO concentration in each zone are recommended, at minimum in the first and last zones. For a feedforward-feedback program, an ion-selective electrode probe for ammonia is required at the front of the aeration basins in addition to the wet chemical sensor at the end.

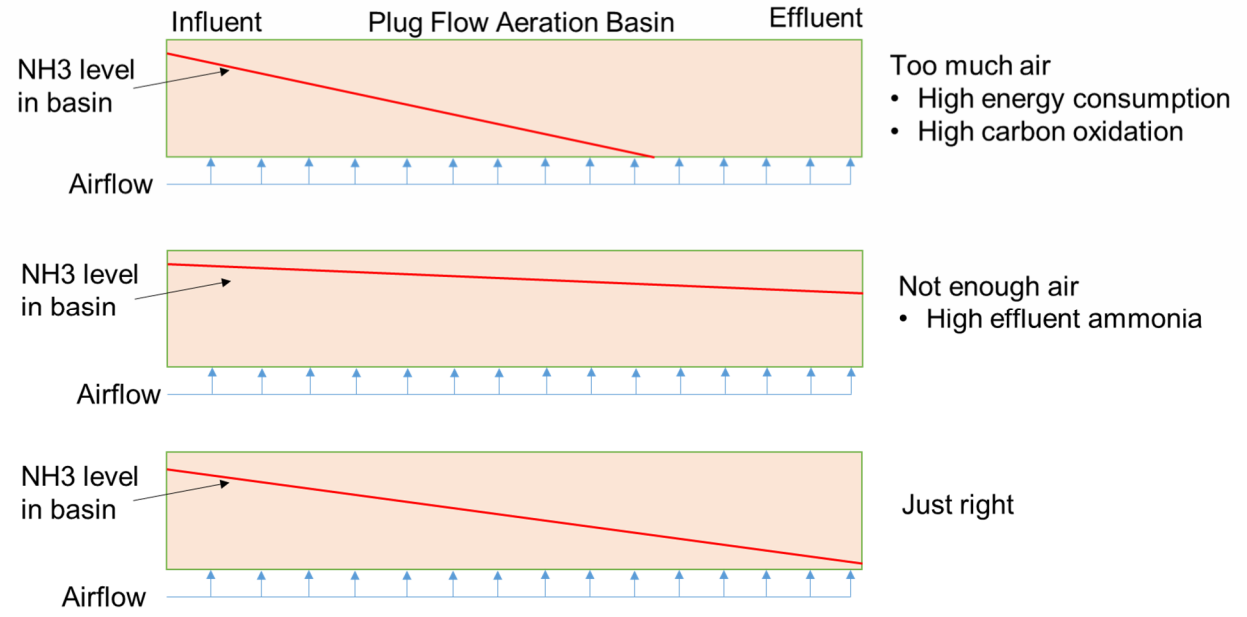


Figure 4-1: Representation of an Optimized ABAC Program

4.2 Denitrification Filters

The Mason Farm WWTP utilizes deep-bed filters for tertiary filtration prior to UV disinfection. The deep-bed filters were previously designed to support biological denitrification with supplemental carbon addition driving denitrification to meet anticipated TN discharge limits. While operating in denitrification mode, nitrogen gas bubbles will accumulate in the pores of the filter media, causing increased head loss. Routine nitrogen release cycles ("bump cycles") are required to remove accumulated nitrogen. In addition to full backwash cycles every 1-2 days, the nitrogen release cycle consists of a short 2-5 minute backwash bump cycle at an interval of 2-4 hours.

It is recommended that additional online nutrient measurement capabilities be added when the filters are converted to denitrification filters. Nitrate measurement probes are recommended for the filters to allow for accurate dosing of supplemental carbon. Nitrate probes can be installed in the filter influent channel upstream of the supplemental carbon feed point and downstream of the filters in UV influent channel. Additionally, it is anticipated that future effluent TP limits may necessitate multi-point alum addition at the WWTP. As part of the multi-point alum feed strategy, the capability to feed alum to the filter influent channel can be added when the filters are converted to denitrification filters. Thus, ortho-phosphate analyzers would be recommended upstream and downstream of the filters to allow for accurate dosing of alum to the filter influent for phosphorus removal.

4.2.1 Denitrification Filter Carbon Requirements

The final Jordan Lake nutrient rules require that the Mason Farm WWTP meet effluent annual mass limits for TN and TP equivalent to performance at concentrations of 3.0 mg/l and 0.23 mg/l, respectively, at the

14.5 mgd maximum month capacity. Based on the historical 2021 effluent TN concentration of 7.0 mg/L, supplemental carbon addition to the existing denitrification filters will be required in order to achieve meet the required TN mass load allocation at approximately 6.25 mgd of discharged effluent.

The Mason Farm WWTP currently feeds acetic acid (20% by weight) to the NSL basin to supplement fermentate to promote biological phosphorus removal and can also be fed to the denitrification filters (when operating in denitrification mode) as a carbon source for denitrification. For this Master Plan, it was assumed the existing 20% acetic acid would be used as the carbon source to the filters. Filter influent DO was assumed to be 6.0 mg/L in the calculations for carbon requirements. **Table 4-1** and **Table 4-2** summarize the different concentrations of nitrate removal through the denitrification filters and the volume of 20% acetic acid for the MLE/NRCY alternative and DAS/Step-feed alternative, respectively.

Table 4-1: Denitrification Filter Carbon Requirements – MLE/NRCY

Flow Milestone	Predicted SC Effluent NO_3-N (mg/L)	Target Final Effluent NO_3-N (mg/L)	Required NO_3-N Removal (mg/L)	20% Acetic Acid Usage (gpd)
Near Term AA	7.5	3.3	4.2	1,710
Near Term MM	11.4	2.3	9.1	3,620
Existing Capacity AA	7.6	2.5	5.1	2,360
Existing Capacity MM	11.6	1.6	10.0	4,740
Buildout Capacity AA	7.9	1.6	6.3	3,430
Buildout Capacity MM	11.7	0.8	10.9	6,430

Table 4-2: Denitrification Filter Carbon Requirements – DAS/Step-Feed

Flow Milestone	Predicted SC Effluent NO_3-N (mg/L)	Target Final Effluent NO_3-N (mg/L)	Required NO_3-N Removal (mg/L)	20% Acetic Acid Usage (gpd)
Near Term AA	10.0	3.3	6.7	2,110
Near Term MM	13.2	2.3	10.9	3,890
Existing Capacity AA	10.3	2.5	7.8	2,890
Existing Capacity MM	13.6	1.6	12.0	5,150
Buildout Capacity AA	10.5	1.6	8.9	4,080
Buildout Capacity MM	14.4	0.8	13.6	7,300

Typically, methanol is used as the external carbon source for denitrification in tertiary filters. Acetic acid and other supplemental carbon sources have been utilized for denitrification filters but have disadvantages like increased backwashing rates due to faster microbial growth and higher chemical requirements. It is recommended to complete a carbon study within the next few years to determine an effective and economical carbon source to be used for denitrification in the filters. Material compatibility, safety concerns, feed pump types, and insulation are all things to consider in selecting a carbon source. Appendix J in the 2010 Study provides a review on supplemental carbon sources. Mason Farm WWTP

staff is currently piloting MicroC 2000, a glycerin-based carbon source, for multiple uses throughout the plant.

4.3 Partial Nitrification-Denitrification-Annamox

Partial Nitrification-Denitrification-Anammox (PdNA/PANDA) is an innovative process that partially nitrifies ammonia to nitrate while leaving an ammonia residual. Nitrate is then partially denitrified to nitrite (denitratation) utilizing a small amount of external carbon. The ammonia residual and the nitrite generated by partial denitrification will be removed via anaerobic ammonia oxidizing (Anammox). **Figure 4-2** displays the different nitrogen conversion pathways and potential savings associated with PdNA and deammonification compared to conventional nitrification and denitrification.

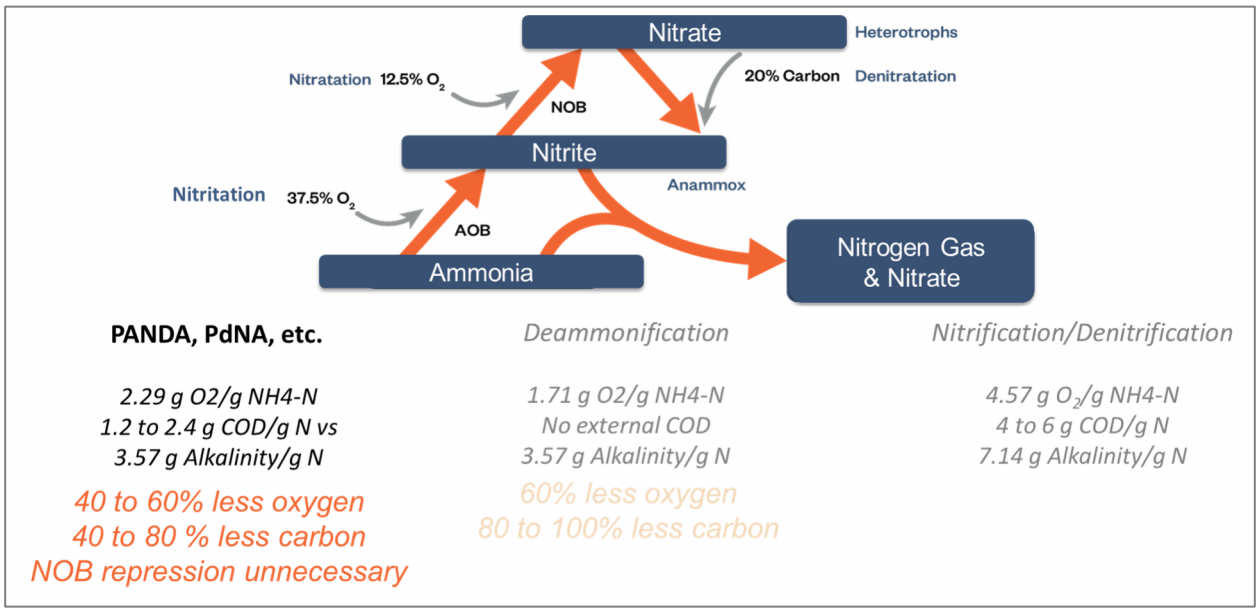


Figure 4-2: Biological Nitrogen Conversion Pathways and Potential Savings with PdNA

To incorporate PdNA at the Mason Farm WWTP, a tertiary moving bed biofilm reactor (MBBR) would be installed in between the secondary clarifiers and the tertiary filters. A desired concentration of ammonia from the aeration basins would be bled through the process to provide the ammonia source for PdNA to occur. The goal of this process would be to minimize the TN required to be removed through the denitrification filters, subsequently reducing the required external carbon usage. Bleeding ammonia through would reduce aeration requirements within the basin and the MLSS required to nitrify, lessening the strain on the secondary clarifiers. It is recommended to continue monitoring this process as it evolves and becomes a more definitive treatment technology that can help the WWTP meet future TN limits while reducing reliance on external chemicals.

4.4 Sidestream Deammonification

With any of the alternate biosolids technologies being considered, constant dewatering would be required. Currently, the WWTP dewaters up to 50% of the calendar year. During these periods, up to 20% of the influent nitrogen load to the process can be generated from the digested sludge dewatering sidestream. Sidestream treatment utilizing the deammonification pathway to remove nitrogen has been shown to be more energy and cost effective than the traditional secondary treatment-based nitrogen removal pathway employed at activated sludge facilities. This process can reduce the recycled sidestream nitrogen load by 75% to 85%. The deammonification pathway relies on slow-growing microorganisms, anaerobic ammonia oxidizers (AnAOB's, or anammox), that thrive in nutrient rich, warm temperatures typical of dewatering sidestreams. Sidestream deammonification will also improve the capacity and reliability of the mainstream biological nutrient removal process, providing another layer of protection for complying with the total inorganic nitrogen (TIN) limits. Equalization of the sidestream flow is recommended upstream of the sidestream deammonification reactors to provide a consistent nitrogen load to the process.

The deammonification process requires conversion of approximately 50% of the influent ammonia into nitrite by ammonia oxidizing bacteria (AOB) using nitritation. Simultaneous ammonia and nitrite removal to nitrogen gas is then performed by Anammox bacteria, per the equation below.

$$NH_4^+ + 1.32\ NO_2^- + 0.066HCO_3^- + 0.13H^+ \rightarrow 1.02N_2 + 0.26NO_3^- + 0.066CH_2O_{0.5}N_{0.15} + 2.03H_2O$$

Using this process, a theoretical savings of 62.5% in aeration, 50% in alkalinity, and 100% in supplemental carbon are possible relative to complete nitrification and denitrification. For deammonification processes to be successful, stable production of nitrite is needed. To accomplish this, the deammonification process represses the growth of nitrite oxidizing bacteria (NOB) which are responsible for converting nitrite to nitrate in the nitrification process. Further, since anammox bacteria have extremely low growth rates, deammonification processes must provide sufficiently long solids retention times (SRT) for anammox bacteria growth.

Several commercial sidestream deammonification treatment technologies are currently available. These can be installed into new or retrofitted plant tankage/infrastructure. In each of these existing processes, nitrite production is achieved using patented approaches for repressing NOB growth/activity using free ammonia, selective wasting strategies, and dissolved oxygen concentration gradients. These processes utilize sequential batch reactor (SBR) configurations (DEMON® SBR) with microscreens, continuous flow with microscreen (DEMON® flow through), fixed film media (ANITA™ Mox), IFAS ANITA™ Mox, or completely stirred reactors relying on granular biomass (AnammoPAQ™) with solids/media separating devices to provide sufficiently long SRTs for anammox bacteria growth. In all cases, technology providers utilize seed bacteria from existing reactors to start-up the process. If OWASA selects a biosolids alternative that requires constant dewatering, it is recommended that sidestream deammonification be considered as part of the solution.

5. Recommendations

It is recommended that both MLE/NRCY and DAS/Step Feed be integrated into a long-term, multi-solution approach for the liquid train treatment process. This approach will be illustrated in the trigger-based roadmap that will be submitted as part of Task 7. Each alternative provides different benefits that, in combination, will provide the best results for the WWTP. NRCY is only an optimization strategy and does not provide a capacity increase. It can be incorporated with densification to provide a reduction in chemical to the denitrification filters, while DAS/Step Feed provides the capacity increase, resiliency in settling, and reduced risk at higher flows while using a smaller footprint than equalization. Furthermore, moving forward with both alternatives provides additional flexibility in treatment configurations. The likely recommended pathway would begin with NRCY/MLE and then densify. ABAC, use of denitrification filters, and multipoint alum addition are also recommended solutions to aid in meeting future nutrient limits. PdNA and sidestream deammonification are technologies which OWASA should continue to follow and evaluate as treatment requirements change in the future. The trigger-based roadmap as part of Task 7 will include the phasing for each considered alternative and technology, including the addition of Clarifier No. 6. A summary of these trigger-based recommendations, which will be incorporated into Task 7, include (in no particular order):

1. Multi-point alum addition
2. Point at which MLE/NRCY should be considered
3. Point at which densification is required in existing footprint
4. Supplemental carbon addition to the existing denitrification filters and completion of a carbon study to determine an effective and economical carbon source
5. Consideration of implementation of ABAC
6. Consideration of implementation of PdNA and/or sidestream treatment
7. Point at which design of Secondary Clarifier No. 6 shall be initiated

Appendix A: Tier 1 Alternatives Evaluation Workshop Slides

Hazen



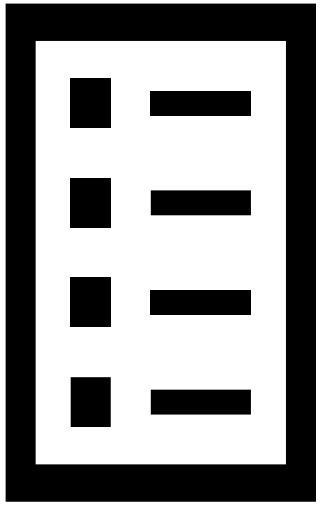
Mason Farm WWTP Master Plan
Tier 1 Alternatives Workshop

July 26, 2022 & August 8, 2022

OWASA

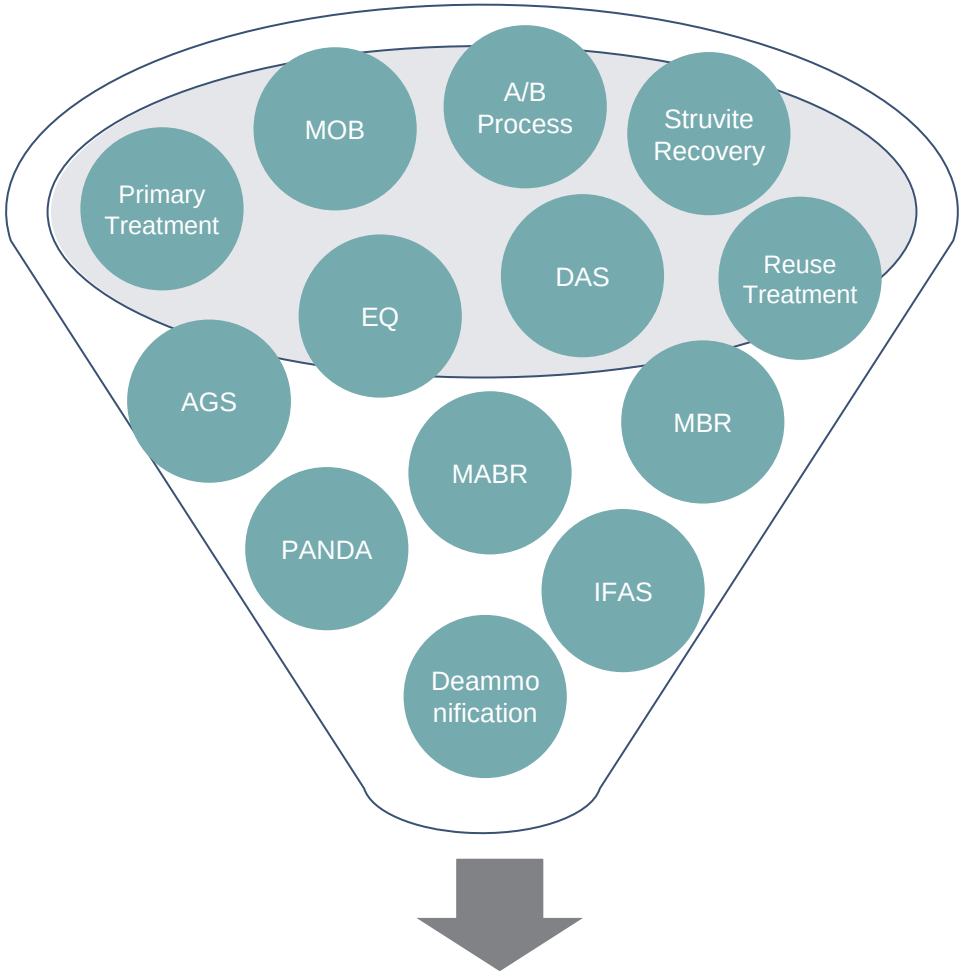
Meeting Purpose & Agenda

- Purpose is to:
  - **Review technologies**
  - **Narrow down, select 5 alternatives for Tier 2**
  - **Review/overview/preliminary scoring of HazenConverge for Tier 2**
- Agenda
  - **Tier 1 Alternatives – A High-Level Review**
  - **Alternative Selection**
  - **HazenConverge Examples & Proposed Scoring Matrix for Tier 2**



Task 3 Overview

- Tier 1 Evaluation
  - **Conceptual level to determine long-term feasibility**
  - **Consider holistic impacts on WWTP**
    - *Effluent quality*
    - *Site implications*
    - *Energy consumption*
    - *Odor control*
    - *Biogas production*
- Tier 2 Evaluation
  - **HazenConverge**
  - **BioWin modeling**
  - **Capital and O&M costs**
  - **Net present value / Lifecycle costs**



Select 5 technologies for Tier 2 Evaluation

Master Plan Flows

Year	AADF (mgd)	MMADF Peaking Factor	MMADF (mgd)	Rated Plant Capacity (mgd)
2037	9.52	1.25	11.90	14.5
2070	13.49	1.25	16.86	18.5

Effluent Limits - WQ0031506 expires 7/31/2025

Parameter	Units	Monthly Average	Weekly Average
Flow	mgd	14.5	
$cBOD_5$ (April-October)	mg/L	4.0	6.0
$cBOD_5$ (November-March)	mg/L	8.0	12.0
TSS	mg/L	30.0	45.0
NH_3-N (April-October)	mg/L	1.0	3.0
NH_3-N (November-March)	mg/L	2.0	6.0
Fecal Coliform	cfu/100 mL	200	400
pH		6-9	
Dissolved Oxygen	mg/L	>6.0 daily average	
Total Residual Chlorine	µg/L	18 daily maximum	
Nitrate as N	mg/L	Report	
Total Kjeldahl Nitrogen	mg/L	Report	
Nitrate/Nitrite	mg/L	Report	
Total Nitrogen	mg/L	Report	
Total Nitrogen Load	lb/year	134,375	
Total Phosphorus	mg/L	Report	
Total Phosphorus Load	lb/year	10,188	

TN Concentrations
@ 14.5 mgd → 3.04 mg/L
@ 18.5 mgd → 2.39 mg/L

TP Concentrations
@ 14.5 mgd → 0.23 mg/L
@ 18.5 mgd → 0.18 mg/L

Effluent Limits - WQ0031506 expires 7/31/2025

Parameter	Units	Monthly Average	Weekly Average
Flow	mgd	14.5	
$cBOD_5$ (April-October)	mg/L	4.0	6.0
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TSS	mg/L	30.0	45.0
NH_3-N (April-October)	mg/L	1.0	3.0
NH_3-N (November-March)	mg/L	2.0	6.0
Fecal Coliform	cfu/100 mL	200	400
pH		6-9	
Dissolved Oxygen	mg/L	>6.0 daily average	
Total Residual Chlorine	µg/L	18 daily maximum	
Nitrate as N	mg/L	Report	
Total Kjeldahl Nitrogen	mg/L	Report	
Nitrate/Nitrite	mg/L	Report	
Total Nitrogen	mg/L	Report	
Total Nitrogen Load	lb/year	134,375	
Total Phosphorus	mg/L	Report	
Total Phosphorus Load	lb/year	10,188	

Master Plan Assumptions

NH_3-N: 0.5 mg/L Summer
NH_3-N: 1.0 mg/L Winter

TN: 2.4 mg/L

TP: 0.18 mg/L

TN Concentrations

@ 14.5 mgd → 3.04 mg/L
@ 18.5 mgd → 2.39 mg/L

TP Concentrations

@ 14.5 mgd → 0.23 mg/L
@ 18.5 mgd → 0.18 mg/L

Technologies Overview

Identified Nutrient Removal and Recovery Alternatives

Nutrient Removal Optimization/ Current Process Upgrades

- NRCY
- Acetic Acid Addition
- Ammonia Based Aeration Control (ABAC)
- Filters in Denitrification mode
- RAS/MLSS fermentation

Site Optimization

- On-Site Equalization
- Primary Treatment

Secondary Treatment Intensification

- IFAS
- MBR
- AGS
- DAS - includes inDENSE

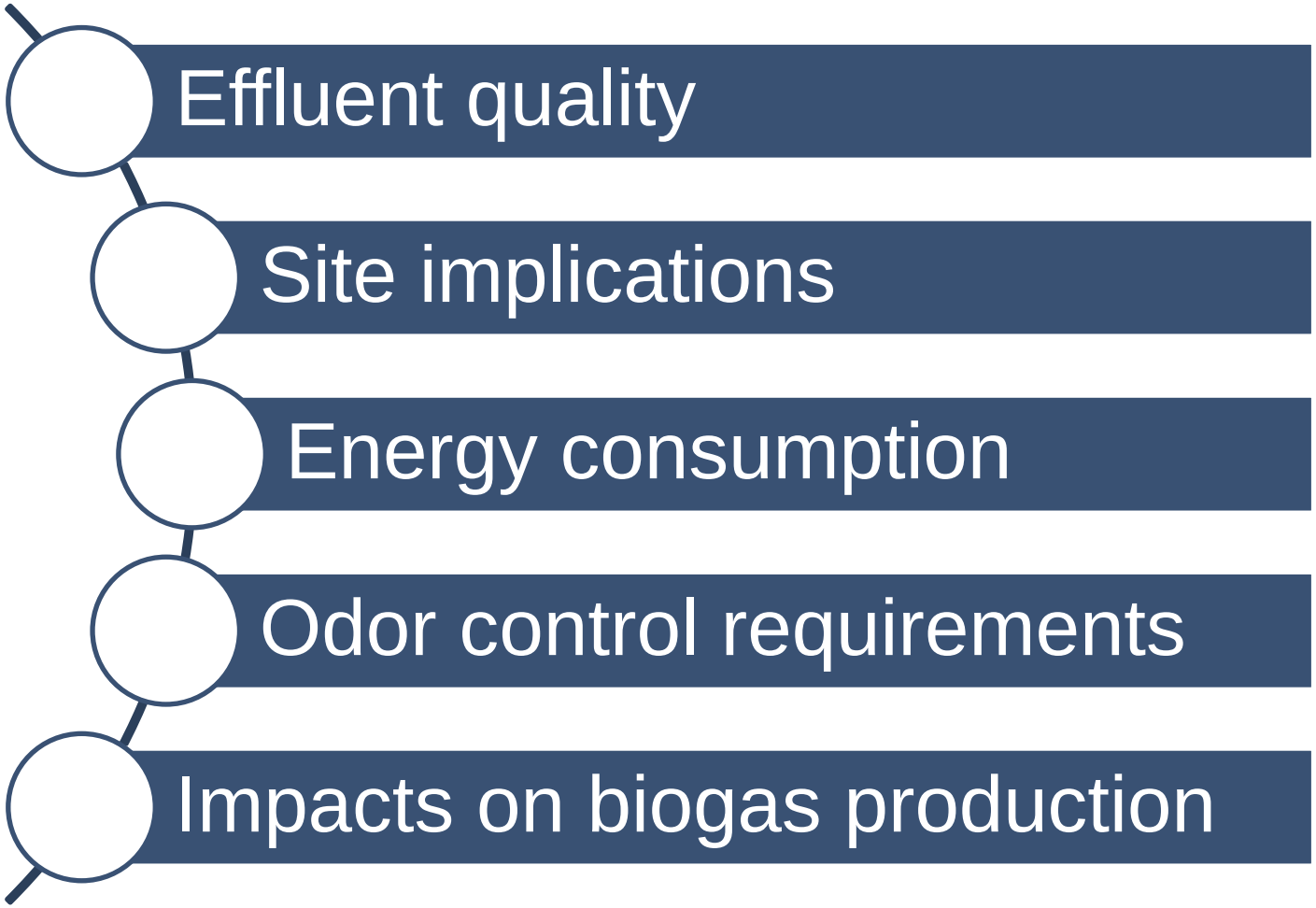
Novel Technologies

- MABR
- PANDA
- Perlemax/Moleaer
  - Micro/nano bubbles for aeration
- A/B Process
- NUVODA's MOB

Resource Recovery & Sidestream Treatment

- Sidestream Deammonification
- Sidestream Struvite Recovery
- Chemical Sludge Recycling
- Reuse Treatment Alternatives

Items to Consider for Each Technology



Nutrient Removal Optimization (Current Process Upgrades)

- NRCY
- Acetic Acid Addition
- Ammonia Based Aeration Control (ABAC)
- Filters in Denitrification mode
- RAS/MLSS fermentation





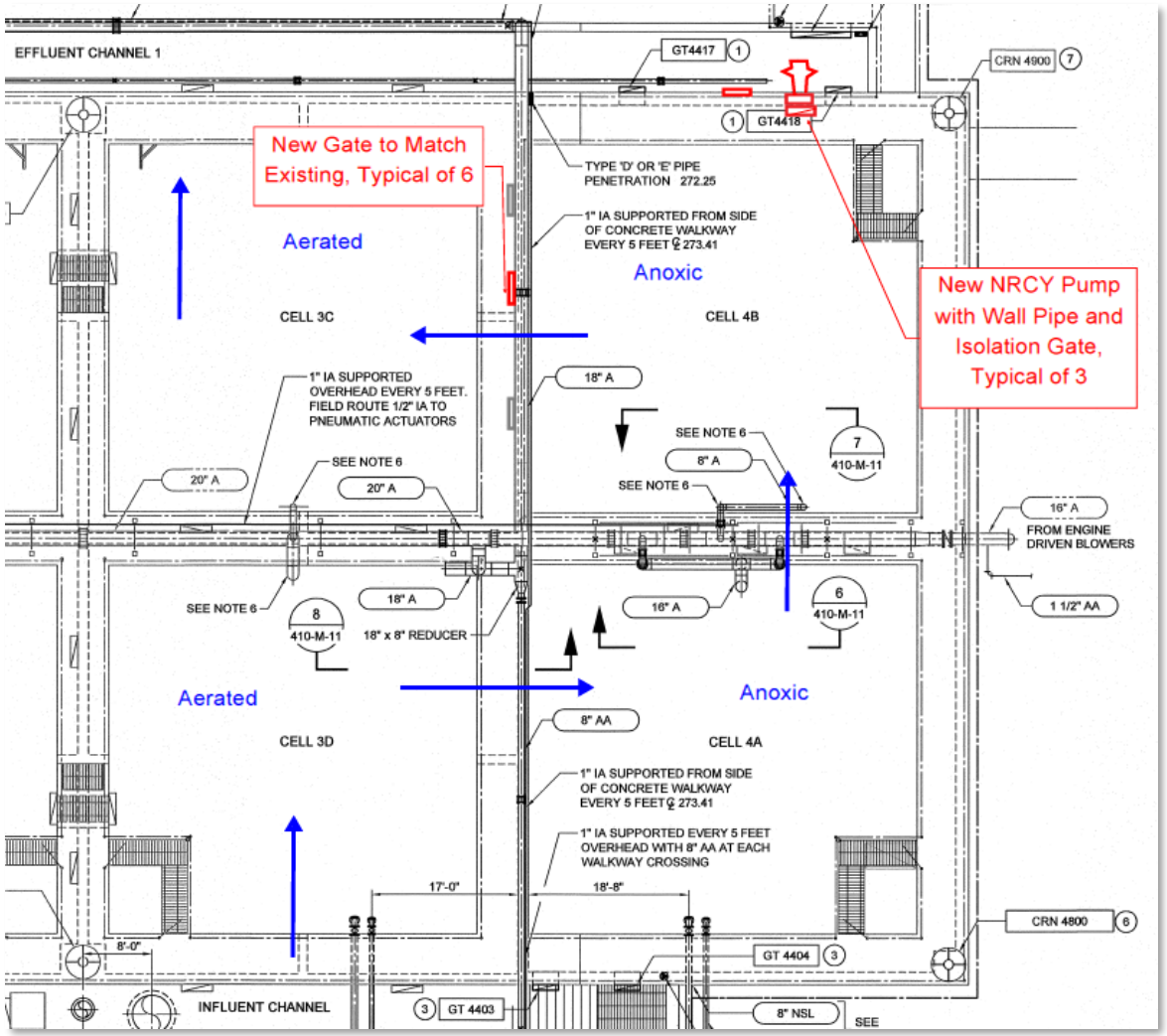
Hazen

NRCY

NRCY Pump Addition to Aeration Basins

- Evaluated in 2017





Ammonia Based Aeration Control (ABAC)

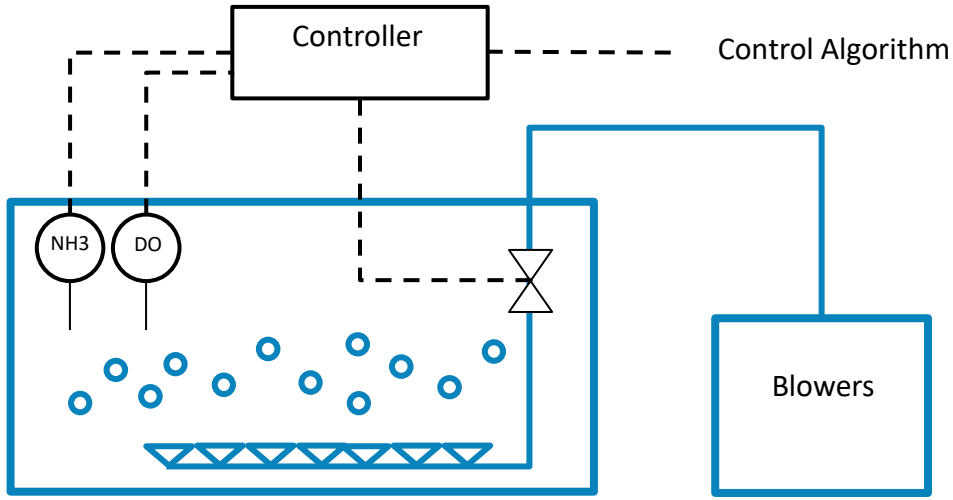
Ammonia Based Aeration Control (ABAC)

Concept

- Use an ammonia setpoint in the aerobic zone to determine the optimal DO setpoint

Benefits

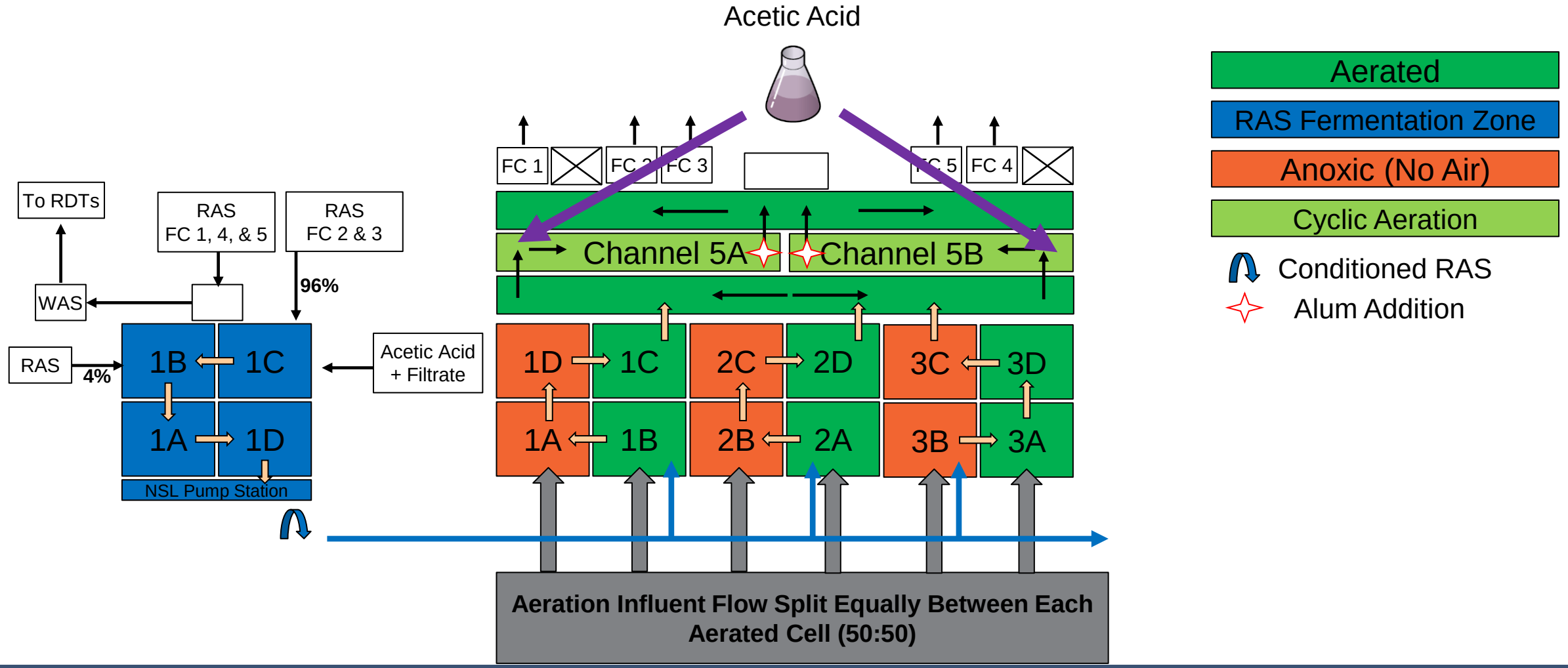
- Optimize nitrogen removal efficiency
- Minimizes airflow and energy use
- Reduces carbon usage due to less DO entering anoxic zones and
- Maximize simultaneous nitrification and denitrification (SND) at low DO



Acetic Acid Addition

Acetic Acid Addition

Improves denitrification and biological phosphorus removal



Filters in Denitrification Mode

Convert Existing Filters to Denitrification Filters

Concept

- Add carbon to filters to add denitrification as polishing step

Benefits

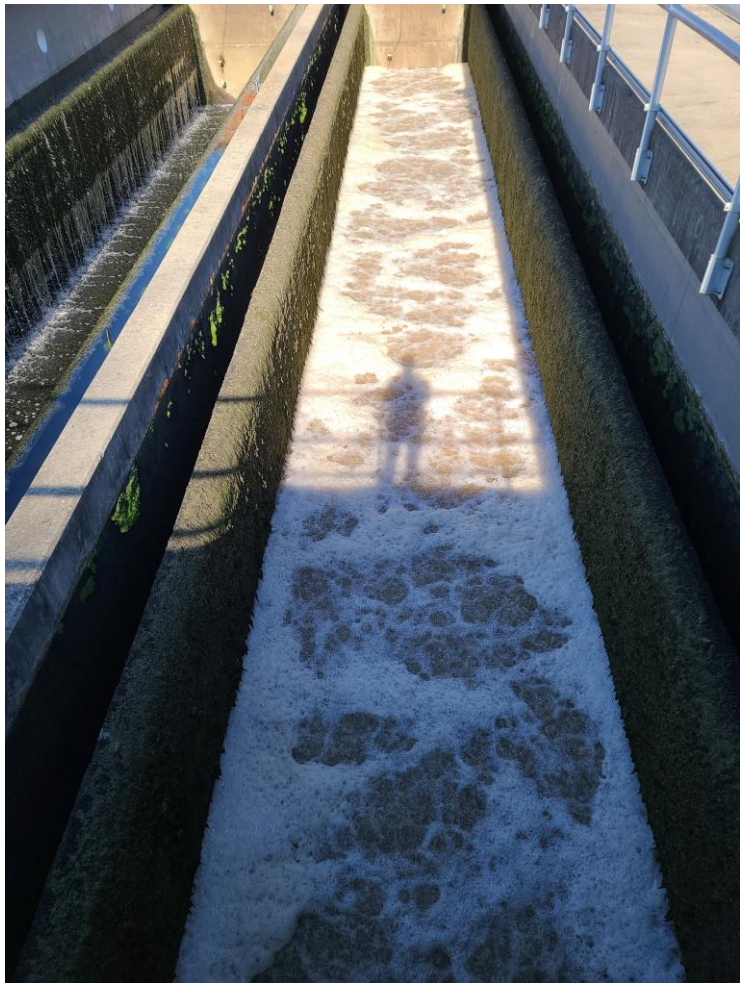
- Consolidates treatment and facilitates operation

Considerations / Applicability

- High chemical costs – carbon addition
- Typical hydraulic loading rate about half of conventional filtration





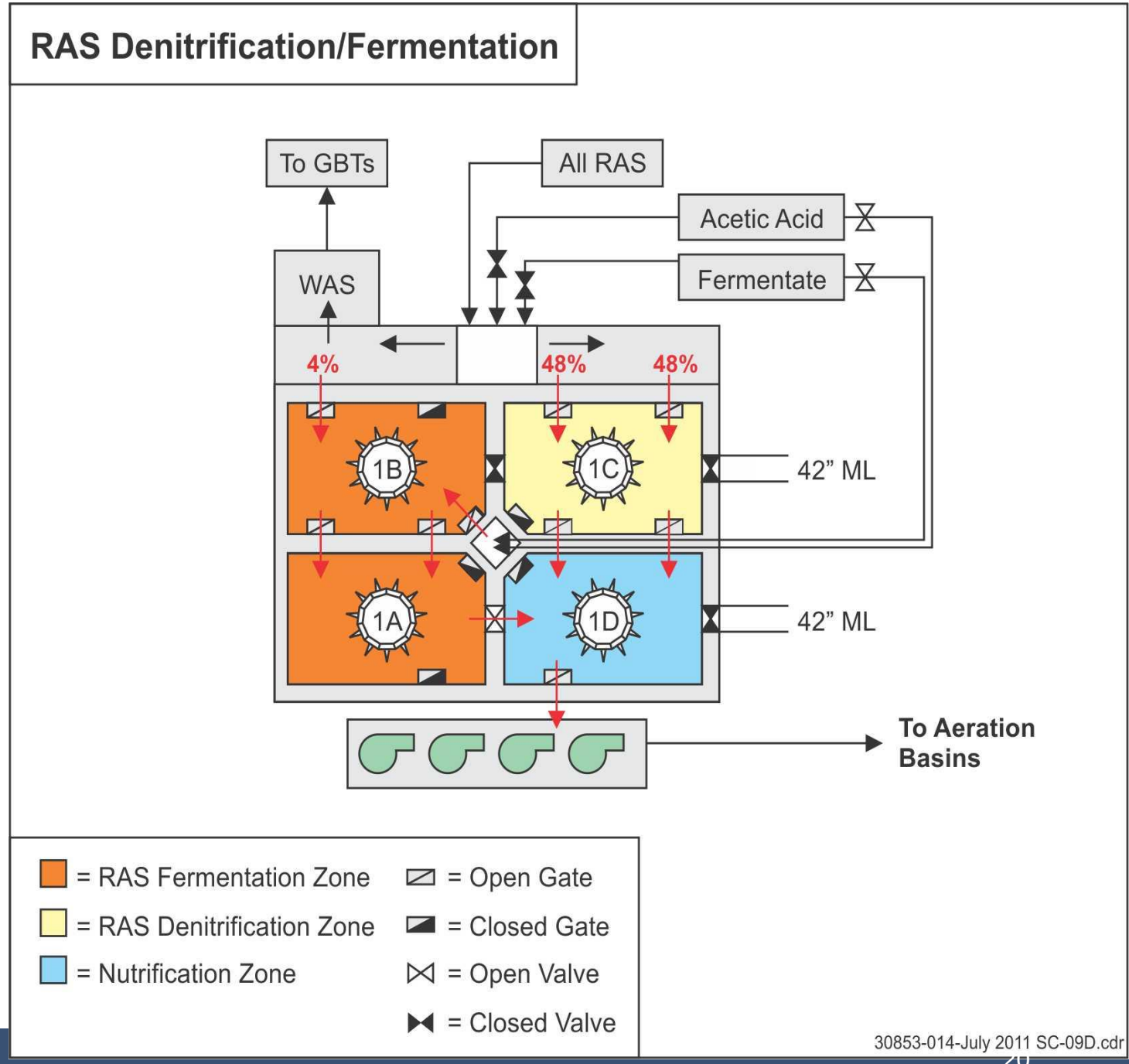


RAS/MLSS Fermentation

MLSS/RAS Fermentation

Definition: Zone designed to hold a portion of MLSS or RAS for an extended period to promote VFA Production

- Typically 5 - 10% of MLSS or RAS diverted to fermentation zone
- Holding time can range from 12 – 48 hours
  - **RAS will need to be held longer than MLSS → Relying on decay for VFA production**
  - **Carbon/PE can be added to "speed up" VFA Production**
- Can be implemented in many different process configurations



Secondary Process Intensification

- IFAS
- MBR
- AGS
- Densified Activated Sludge (DAS)



Integrated Fixed Film Activated Sludge (IFAS)

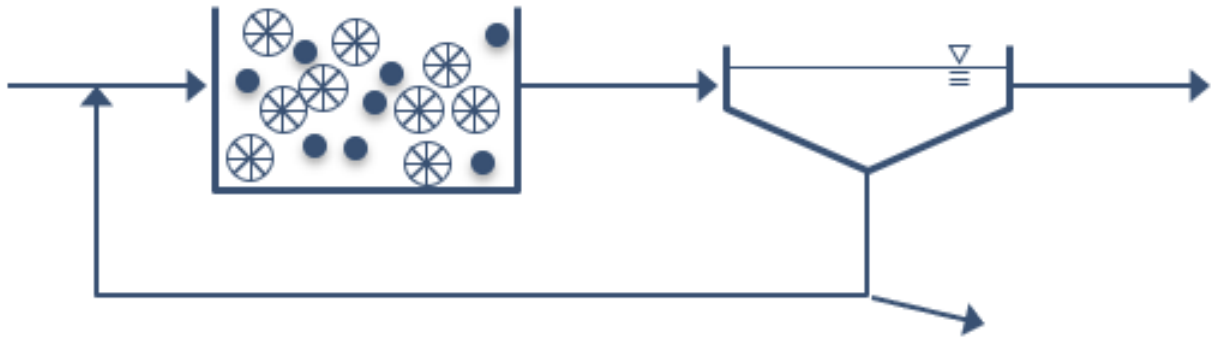
IFAS – Integrated Fixed Film Activated Sludge

Process Configuration and Overview





- Use carriers to sustain growth of biomass for biological treatment
- Biomass on media AND in suspended phase
- Re-seeding of suspended phase from attached phase
- Increased capacity in same volume due to higher biomass content



IFAS









Key Components

- Carriers/Media
- Media retention screens
- Diffusers for aeration/mixing
  - Typically coarse bubble aeration
  - Can use fine bubble aeration with supplemental mixing
- BNR Basins and Clarifiers
- Blowers

Supporting Facilities

- Fine screening to keep debris from accumulating
- Instrumentation
- Chemical Facilities

IFAS

Operational and Maintenance Considerations

Operational

- Robust Screening
  - **Whatever passes through screens will likely accumulate in IFAS system**
- Mixing
  - **Media can accumulate at surface with inadequate mixing energy**
- Foam
  - **Submerged screens create foam trap → Need top wall screens between zones**

Maintenance

- Tank accessibility
  - **Have to remove media to access diffusers or empty tank**



Wall top screen for passing foam from IFAS cells



Media accumulation at surface in area of low mixing energy

IFAS

Benefits

- Reduces aerobic volume by 20 – 30%
- Less susceptible to nitrifier washout
- Well established: hundreds of installations worldwide

Challenges

- Increased energy demand
  - **Coarse bubble diffusers – reduced aeration efficiency**
  - **Aeration used for mixing/keeping media in suspension**
- Hydraulic considerations
  - **Headloss through media retaining screens**
  - **Need for surface transport to move foam**
- Substantial foaming observed
- Media removal required to access tanks for maintenance

Membrane Bioreactors (MBRs)

Membrane Bioreactors

Overview

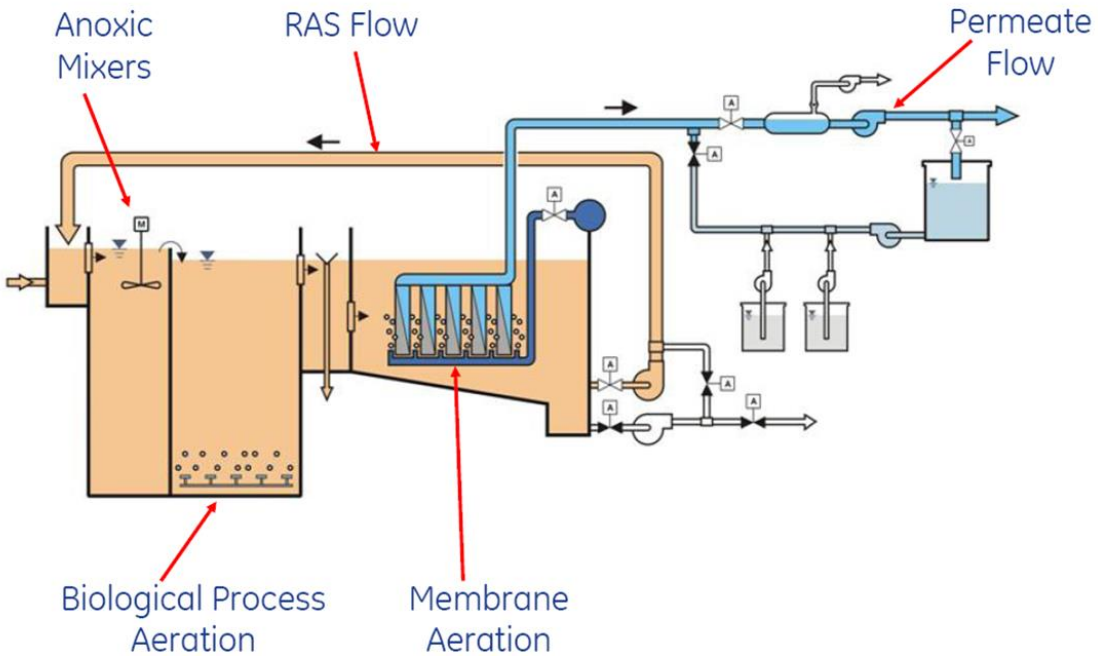
- Membrane bioreactors (MBRs) replace secondary clarifiers and filtration
- Operate at higher MLSS concentrations
  - **8,000 to 12,000 mg/L**
  - **Reduced BNR basin footprint**
- Provides a positive barrier to TSS removal
  - **Effluent TSS typically ≤ 1 mg/L**
  - **Reduces particulate N and P**
  - **Reuse quality effluent**



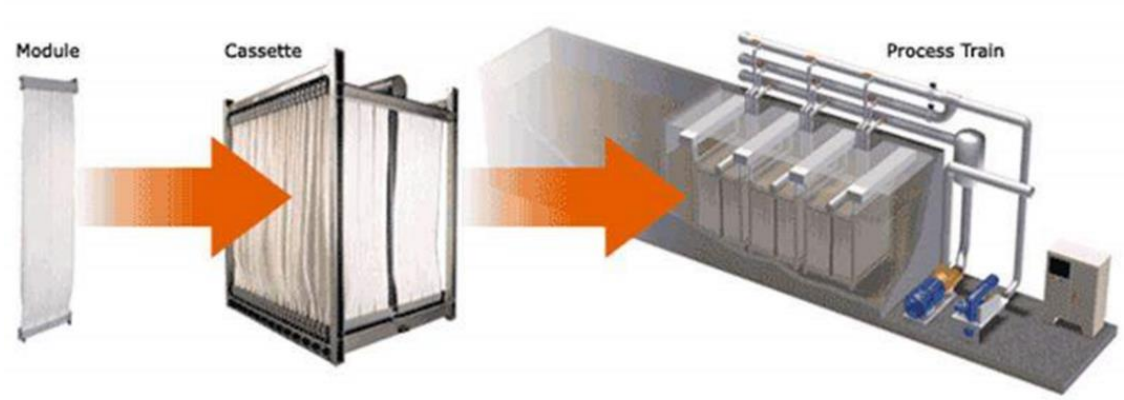
Membrane Bioreactors

Overview - Continued

- Typical BNR configurations can be used
- Pump or gravity flow MLSS from aeration basins to membrane tank
- Dedicated membrane tankage preferable for flexibility
  - **Utilize common wall construction and channels due to high recycle flow rates**
- Permeate pumped from membrane
- RAS return via gravity or pumped flow from membrane tank
  - **Typical 300% to 400% RAS rate**



Membrane Bioreactors







Key Components

- Membrane Cassettes
  - **Membranes configured as a fiber, tube or sheet, ceramic**
- Permeate Pumps
- BNR Basins
  - **Diffusers, Mixers**
- Blowers (Air Scour and Process)
- Equalization may be required
- Chemical Cleaning Facilities

Supporting Facilities

- Ultrafine (1-2 mm) screening important to keep debris from fouling and puncturing membranes
- Instrumentation
- Chemical Facilities

Membrane Bioreactors

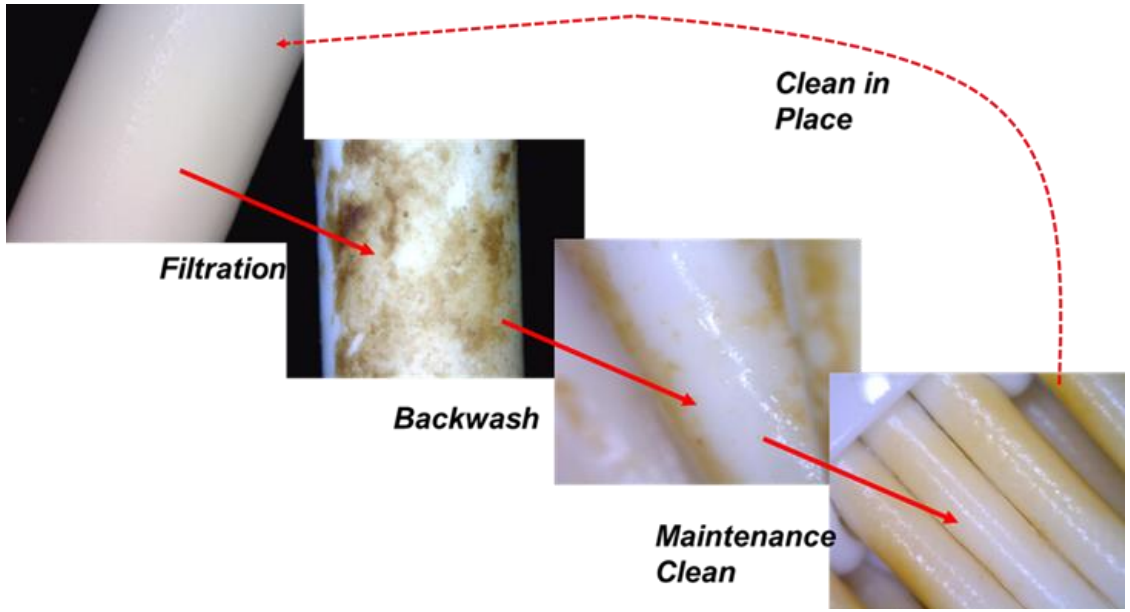
Operational and Maintenance Considerations





Operational

- Highly automated
  - Cleaning largely automated
- Sludge filterability testing
- Membrane inspection
  - Semi-annually or annually unless problems arise



Maintenance

- Membrane fouling management
- Cleaning procedures with increasing intensity

Membrane Bioreactors

Benefits

- Proven technology
- Smaller footprint
- Enhanced effluent quality
- Not dependent on solids settleability
- Can replace filters

Challenges

- Increased capital and O&M cost
- Preliminary treatment key
- Equalization may be required
- Additional operational and equipment requirements
  - **Air scour**
  - **Chemical cleaning**

Aerobic Granular Sludge (AGS)

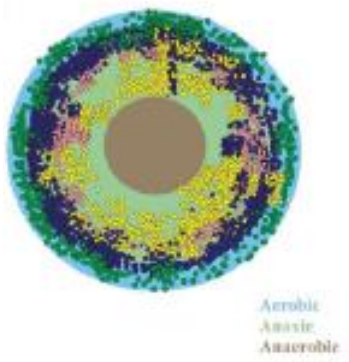
Aerobic Granular Sludge (AGS)

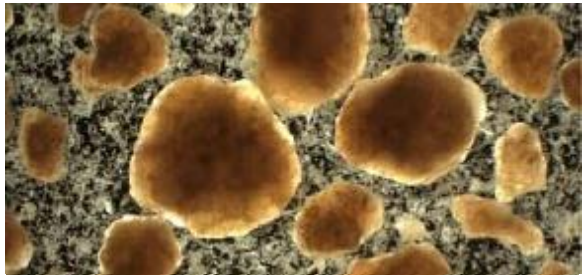
Overview

- Aerobic granular sludge relies on the development of dense aggregates
- Simultaneous biological N and P removal through formation of granules
- Settling characteristics superior to activated sludge





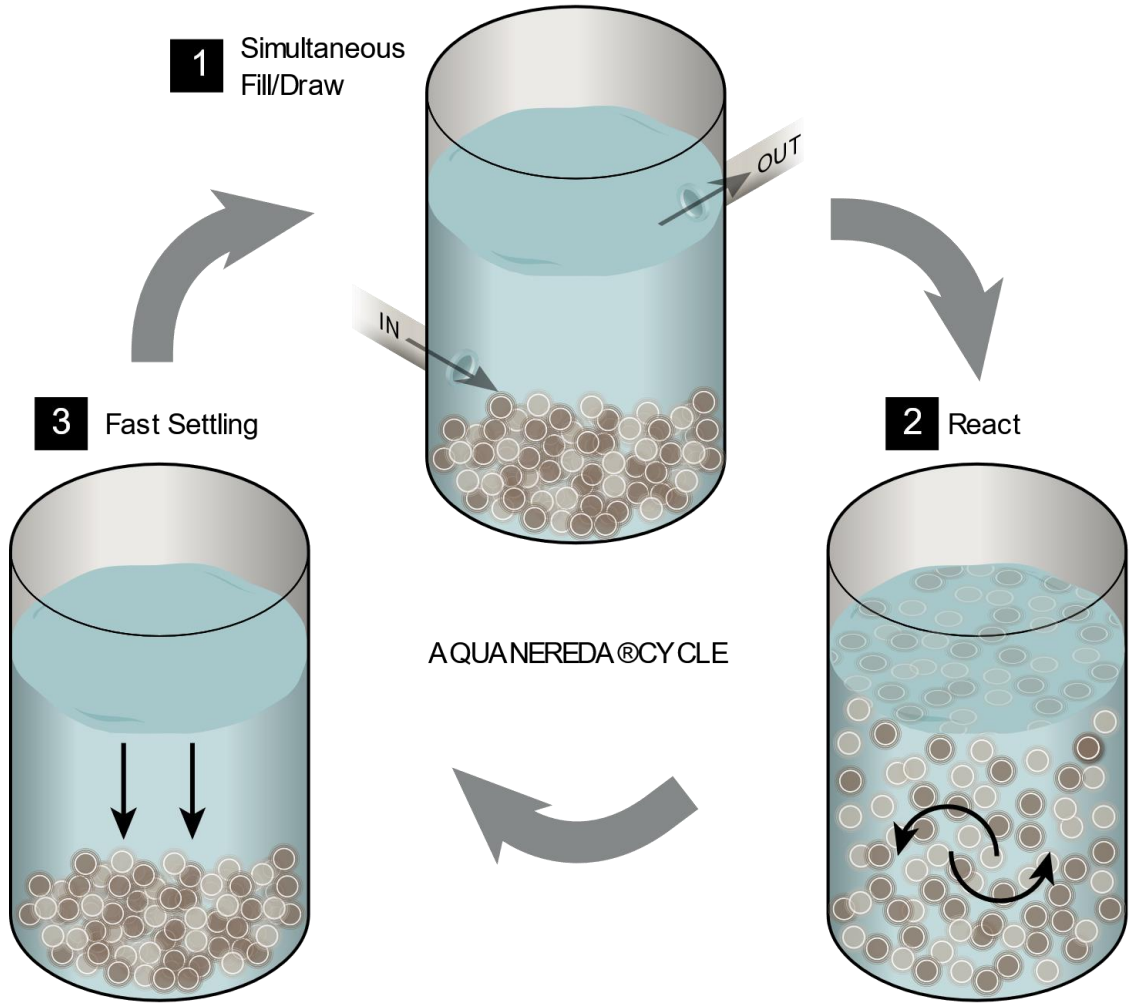




AquaNereda® AGS

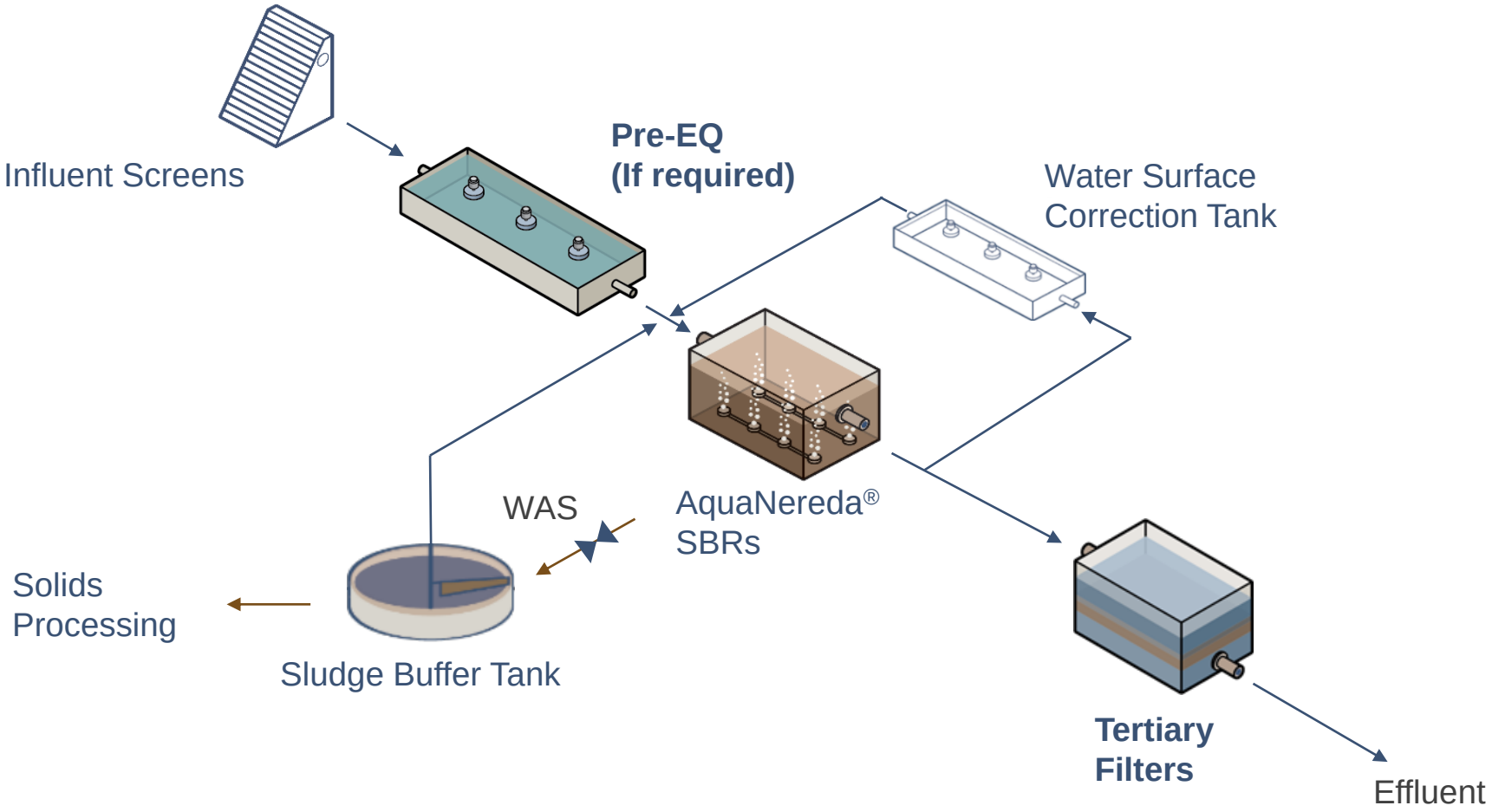
Overview - Continued

- AquaNereda® is an established commercial AGS technology
  - Technology by Royal Haskoning DHV (Netherlands)
  - Aqua Aerobic is the North American licensee
- AquaNereda® performs BNR intensification and solids separation in one-unit process
- AquaNereda® utilizes sequencing batch reactors (SBRs)



AquaNereda® AGS

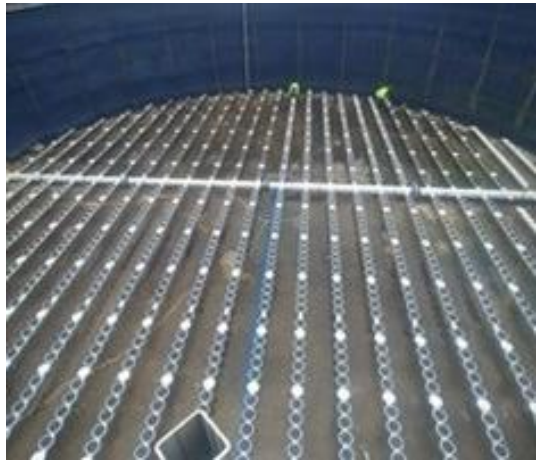
Process Configuration



AquaNereda® AGS









Key Components

- AquaNereda SBRs
  - **Diffusers**
  - **Fixed Weirs**
  - **Influent Distribution Manifold**
- Blowers
- Sludge Buffer and Water Surface Correction Tanks
  - **Associated pumps**

Supporting Facilities

- Instrumentation
- Chemical Facilities

AquaNereda® AGS

Installations

Over 60 Installations Worldwide

- Foley, AL, US – 4 mgd
- Rockford, IL, US – 0.2 mgd
- Idaho Springs, CO, US – 1.0 mgd
- Normal, OK, US – 0.35 mgd
- Wolcott, KS, US – 2.0 mgd
- Utrecht, NL – 20 mgd
- Garmerwolde, NL – 5.2 mgd
- Kendal, UK – 4.9 mgd
- Jardim Novo, BR – 6.4 mgd







AquaNereda® AGS

Benefits

- Reduced infrastructure
  - **Reduced reactor volume compared to conventional SBR**
  - **AquaNereda® combines settling and BNR into one unit process**
- Reduced energy consumption
  - **No RAS pumping**
  - **No mixing in basins**
- Less equipment to maintain

Challenges

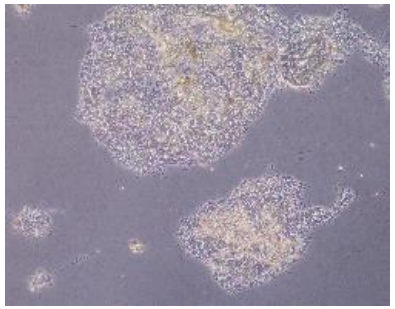
- Instrumentation reliance
  - **Instrumentation is integral to process performance**
- Separate sludge systems
  - **Multiple sludges and morphologies to track**
- Proprietary technology requiring sole source procurement
- Equalization may be required
- Deeper tanks required (20+ feet)
  - **Existing tanks are approximately 14 ft**
  - **Cannot accommodate in existing tankage**

Densified Activated Sludge (DAS)

How Does DAS Compare with Conventional and Granular Sludge?

non-patented AS

Compact AS (non-granular)



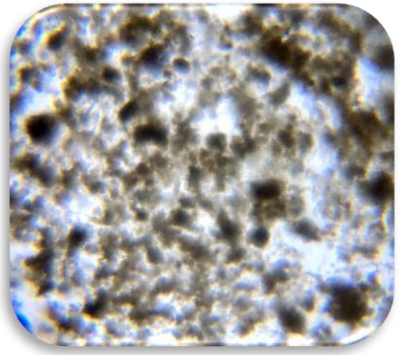
SVI_{30} 80 - 120 mL/g

$SVI_{10} > SVI_{30}$

Operating MLSS ~ 3,000 mg/L

non-patented AS

Densified AS (non-granular)



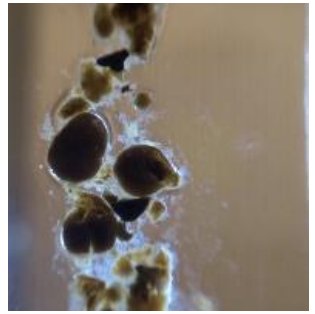
$SVI_{30} < 80$ mL/g

$SVI_{10} \sim SVI_{30}$

Operating MLSS ~ 5,000 – 6,000 mg/L

AquaNereda®

Densified AS (granular)

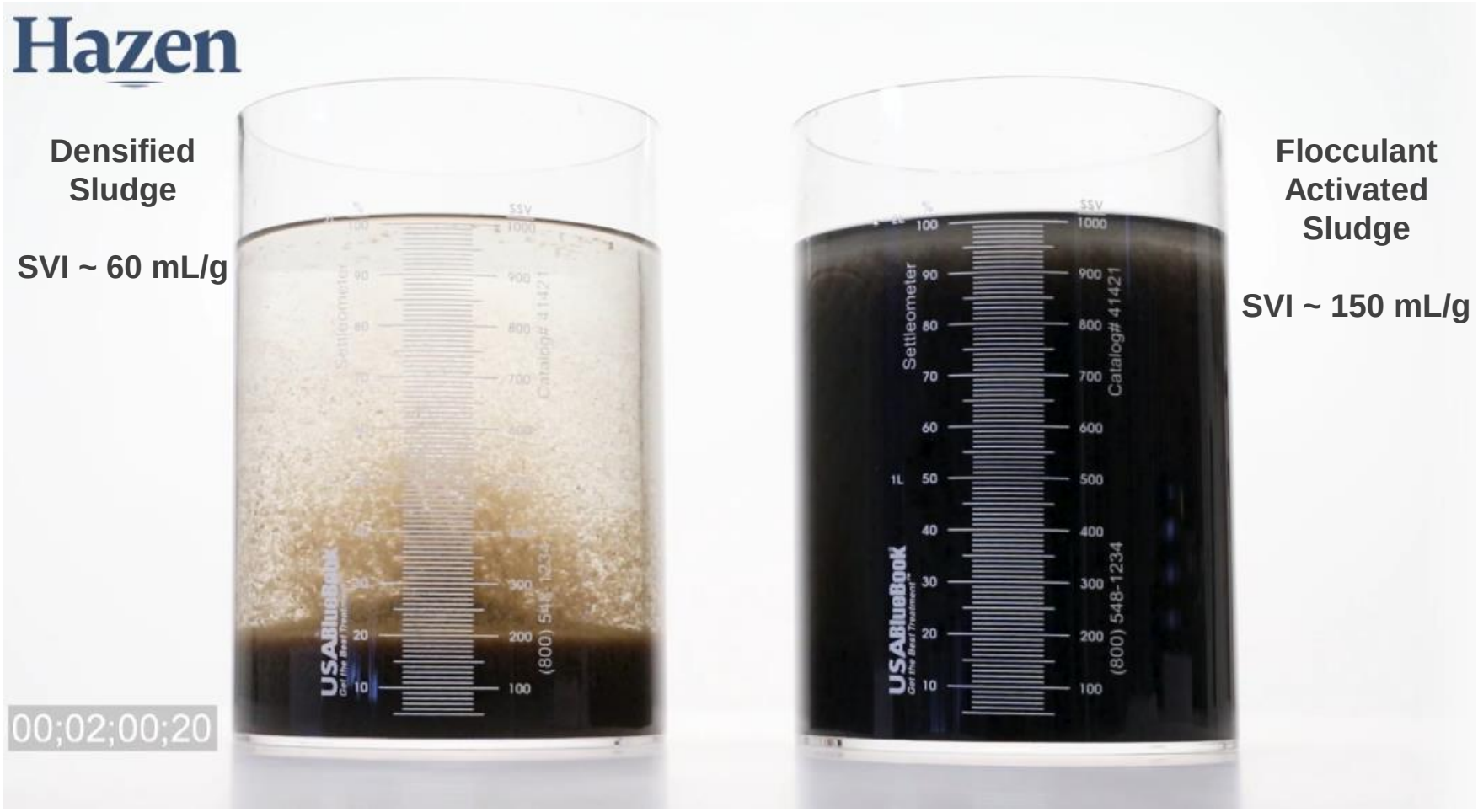


$SVI_{30} < 50$ mL/g

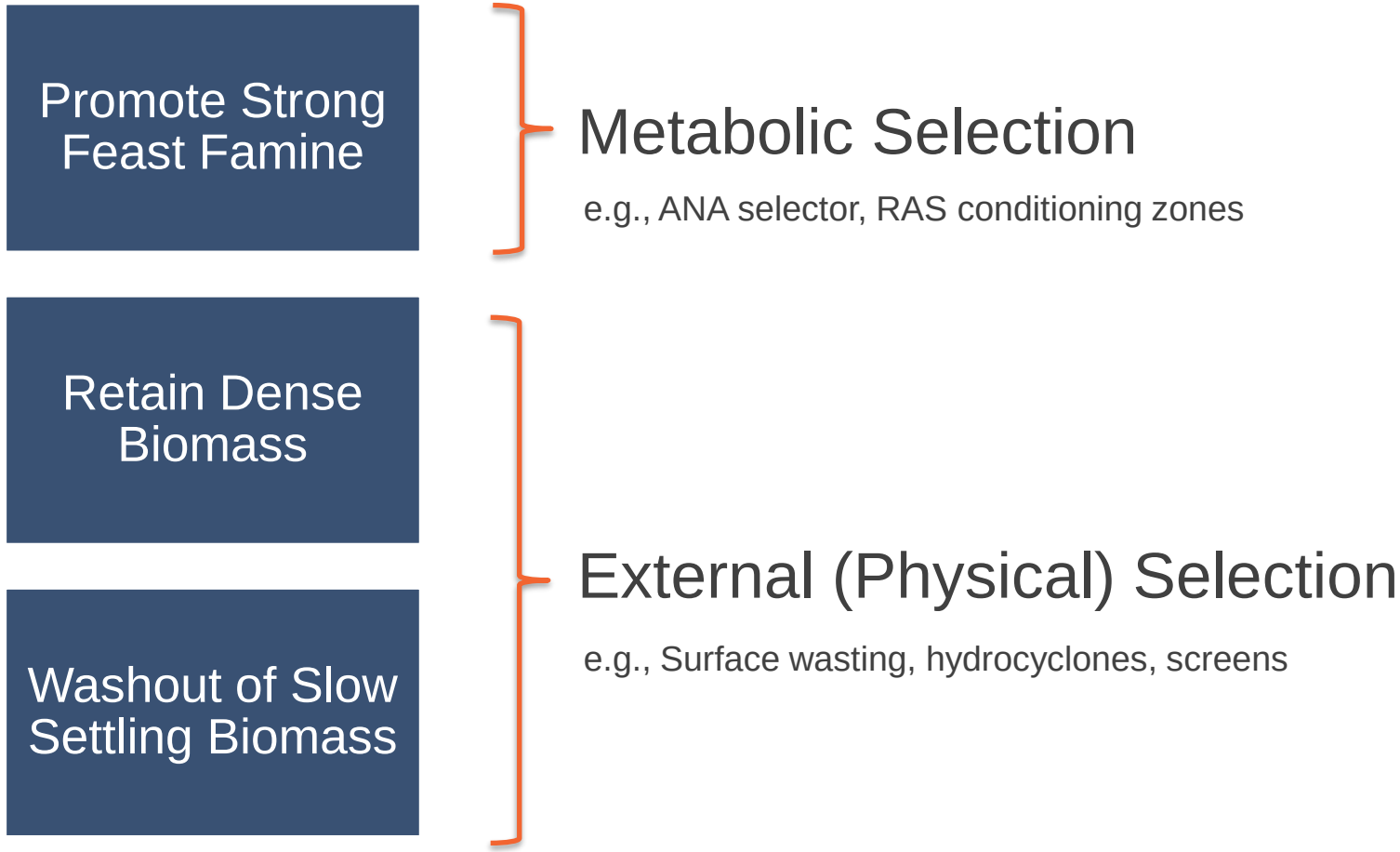
$SVI_5 \sim SVI_{30}$

Operating MLSS ~ 8,000 mg/L

What Does Good Settleability Look Like?



What are the Ingredients to Achieve Densified Activated Sludge (DAS)?

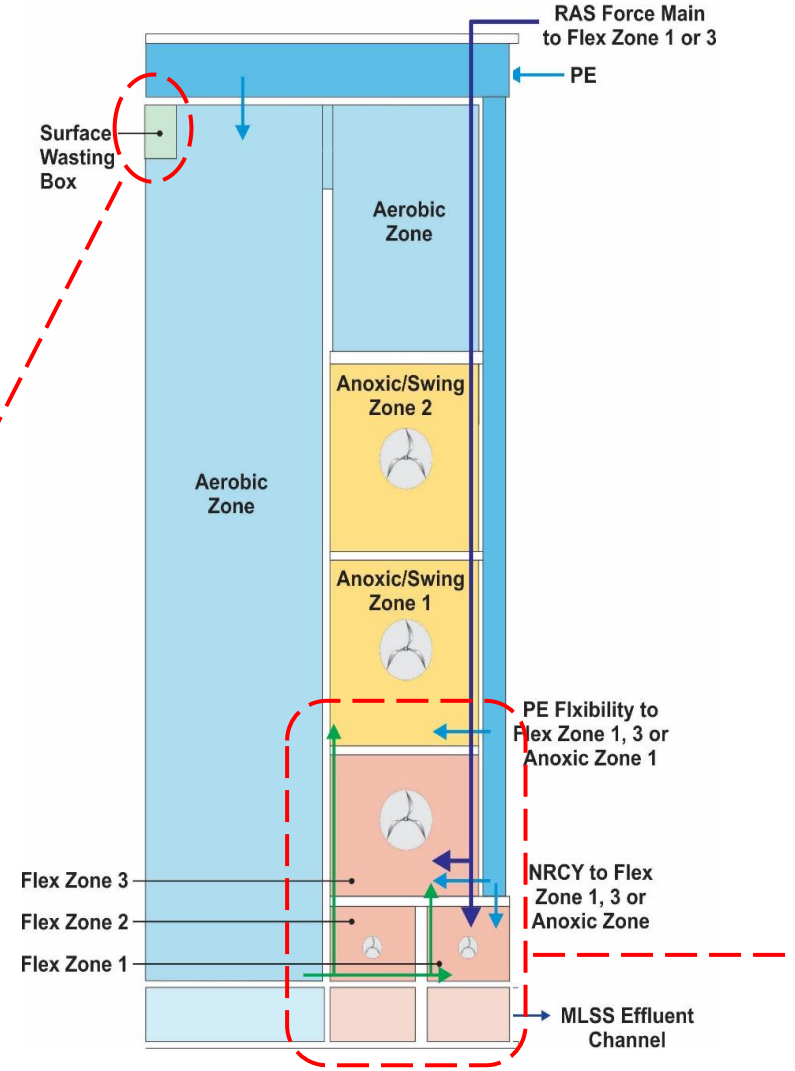


What Are the Ingredients to Achieve Densified Activated Sludge (DAS)?

External (Physical) Selection

e.g., Surface wasting, hydrocyclones, screens





Metabolic and Kinetic Selection

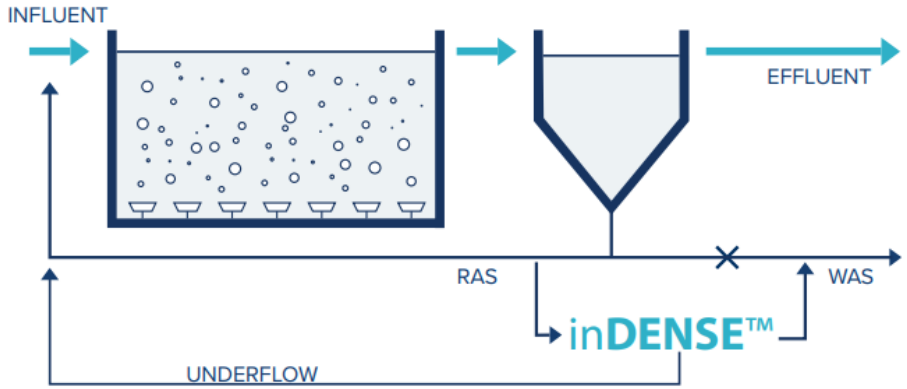
e.g., multi-compartment selector, RAS conditioning zones

Hydrocyclones: inDENSE™

- Improves settleability and increases treatment capacity
- Benefits:
  - **Retrofit existing infrastructure**
  - **Reduced tank volume due to increase in operating MLSS concentrations**
  - **Potential to enhance bioP removal**
  - **Improve sludge settling performance**
- Considerations:
  - **Proprietary process (inDense™)**







World water works
Clean Water and Energy from Wastewater

NEWhub

Densification

Benefits

- Achieves DAS in plug-flow configuration
- Compatible with multiple BNR configurations
- Reduced infrastructure
- Operation at higher MLSS can reduce BNR volume and/or Clarifier volume

Challenges

- Extent of densification dependent on site-specific influent
- Reduced safety factor compared to conventional BNR
- Increased operator attention

Potential inDENSE Approach at Mason Farm



NSL Basin

Novel Technologies

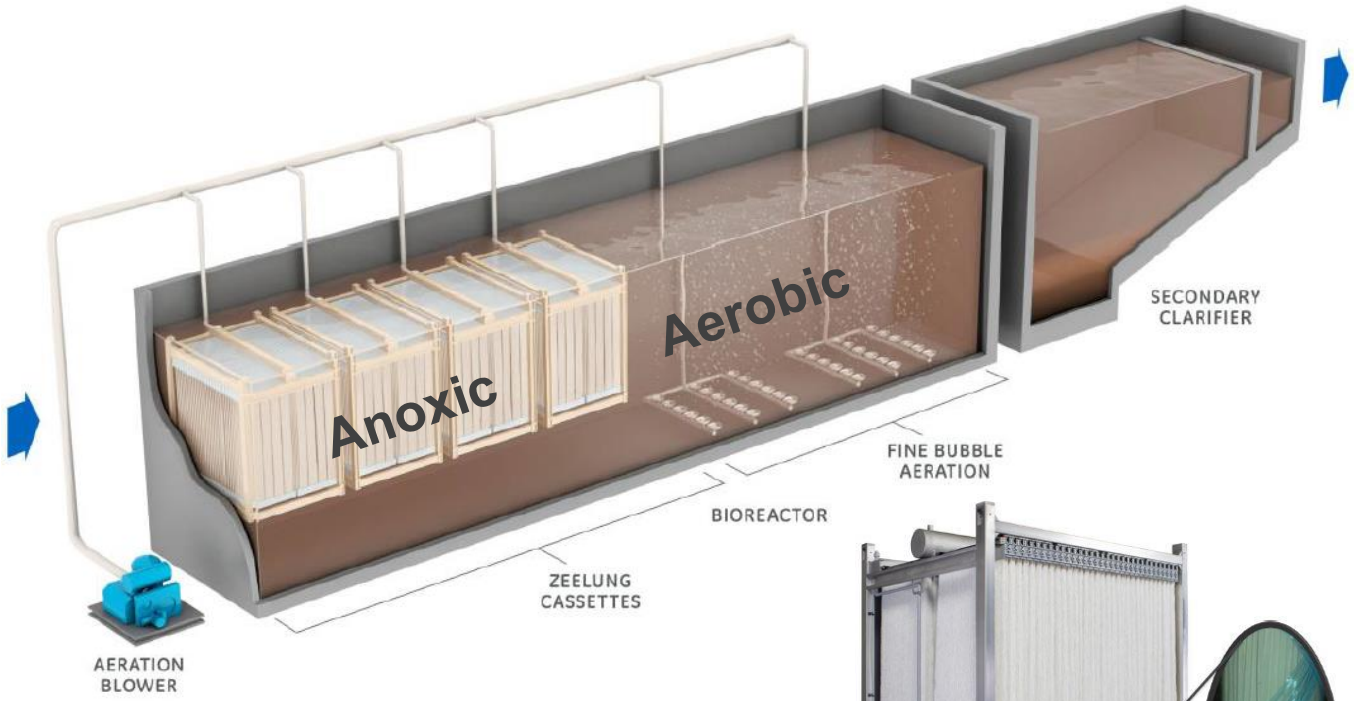
- MABR
- PANDA
- Perlemax/Molear (Micro/nano bubbles for aeration)
- A/B Process
- NUVODA's MOB

Membrane Aerated Biofilm Reactor (MABR)

Membrane Aerated Biofilm Reactor (MABR)

Process Configuration and Overview

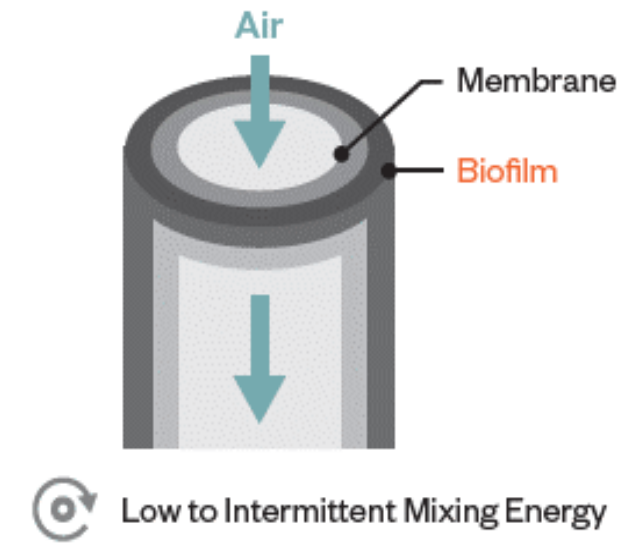
- MABR is a BNR intensification process
- MABR consists of membrane cassettes placed in biological reactors
  - **Not a solids separation membrane**
- MABR cassettes allow nitrifying biomass to grow in anoxic zones

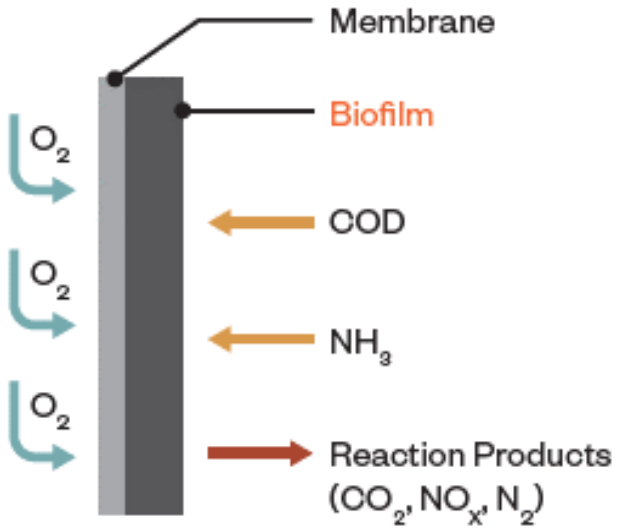


MABR

Overview

- MABR utilizes a gas transfer membrane to deliver oxygen to a biofilm
- Influent ammonia contacts the biofilm layer on the membrane surface and is nitrified
- Increased oxygen transfer efficiency for nitrification





MABR









Key Components

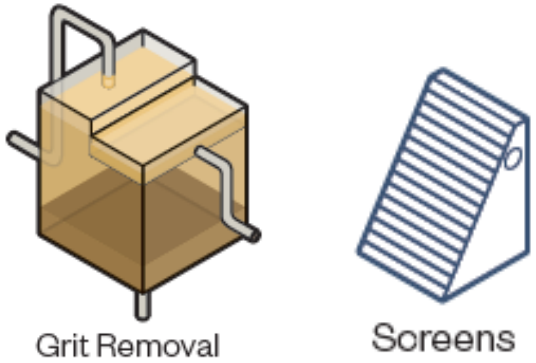
- MABR Cassettes
- BNR Basins and Clarifiers
- Blowers
- Additional screening

Supporting Facilities

- Instrumentation
- Chemical Facilities (if required)

MABR

Operations and Maintenance Considerations



Grit Removal and Fine Screens Reduce Debris Buildup on Biofilm



Grit and Fine Screening Requirements

- Buildup on biofilm will limit biofilm contact and performance

Membrane Inspection and Routine Maintenance

- Removal mechanism required for inspection or maintenance of membranes

MABR Manufacturers

Installation History



Suez Zeelung

Two municipal WWTP installations in North America



Dupont Oxymem

Cannot supply in US due to patent litigation



Fluence

Historically small package plants

MABR

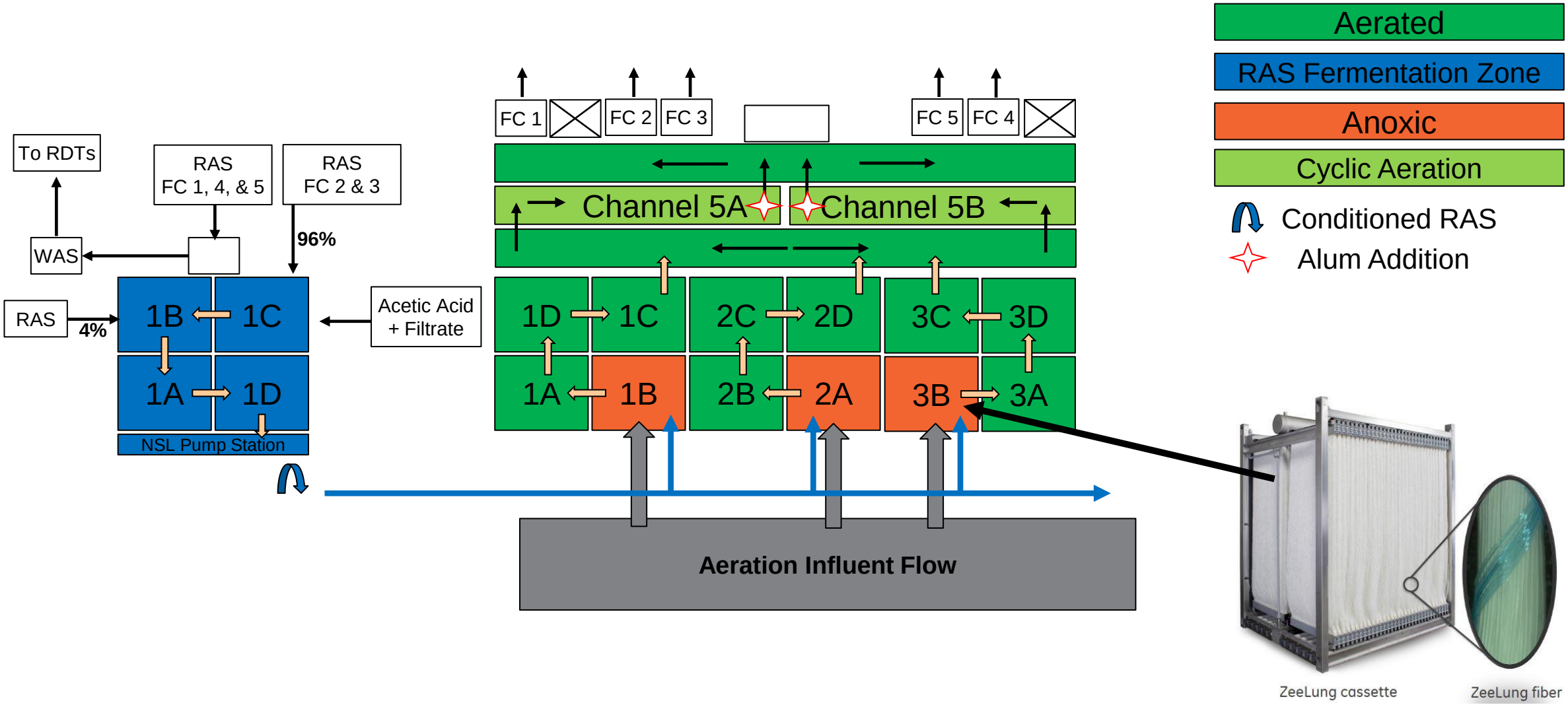
Benefits

- Reduced aeration basin volume
- Substantially higher oxygen transfer efficiency for nitrification
  - **Overall aeration savings estimated at 15% on Suez proposal for recent Hazen evaluation**
- Potential energy savings from reduced NRCY pumping and chemical savings from SND

Challenges

- No full-scale municipal installations similar in magnitude to the
- Proprietary technology likely requiring sole source procurement
- More robust screening needed

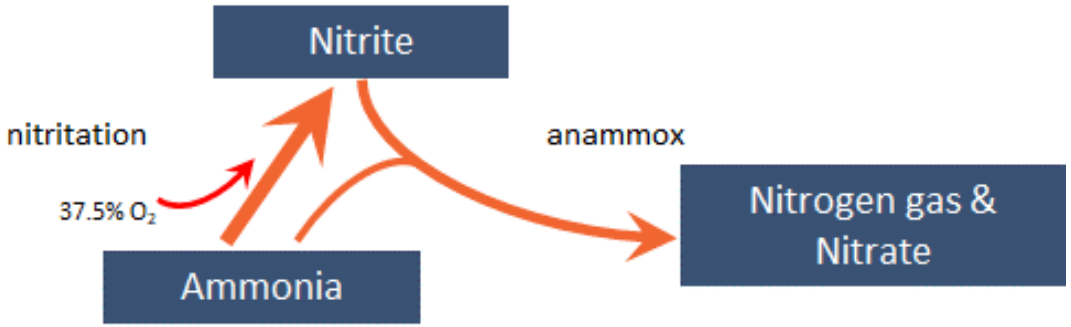
Potential MABR Approach at Mason Farm



Partial Denitrification-Anammox (PdNA, PANDA)

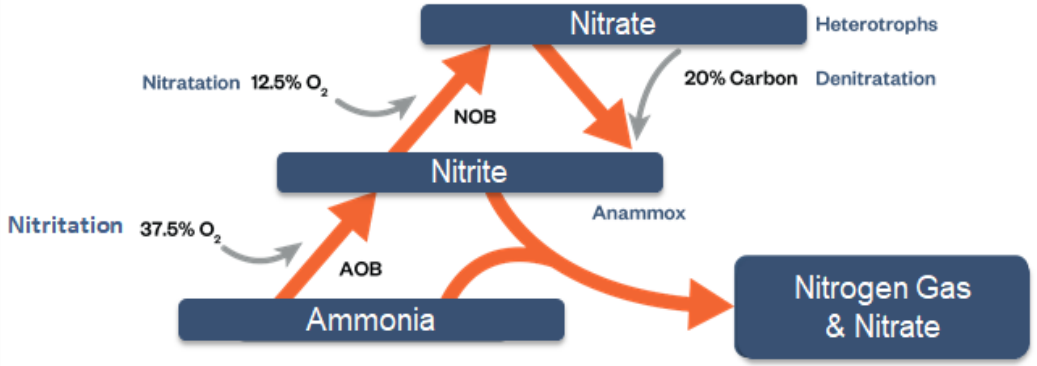
Two Main Approaches to Performing Mainstream Anammox

Partial nitrification-anammox



Low success in implementing approach in practice

Partial denitrification-anammox (PdNA, PANDA)



Higher success in implementing approach in practice

Partial Nitrification Denitrification Anammox (PANDA)

Concept

- Low energy pathway for TN removal
- Utilize process controls with conventional BNR

Benefits

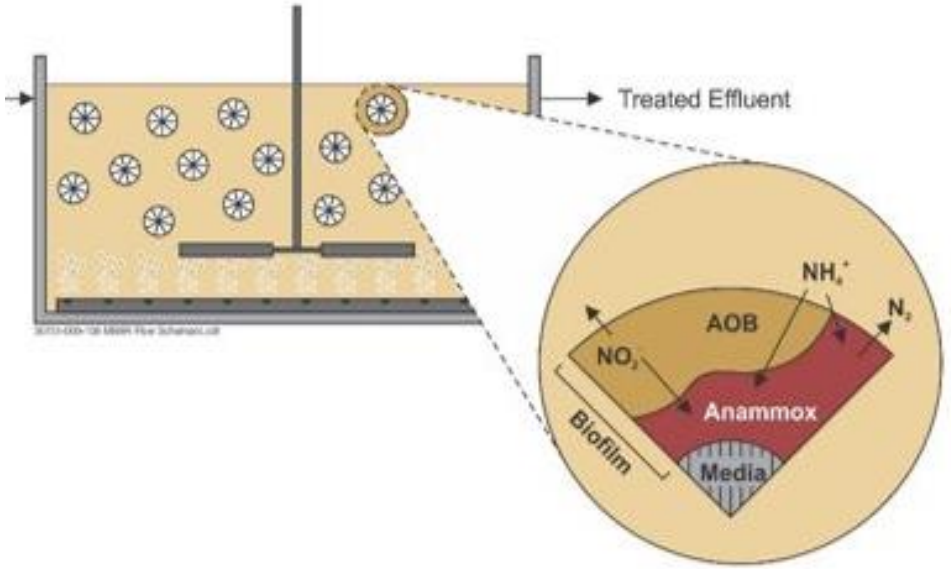
- Simplified control compared to full deammonification process
- Reduced aeration and carbon requirements

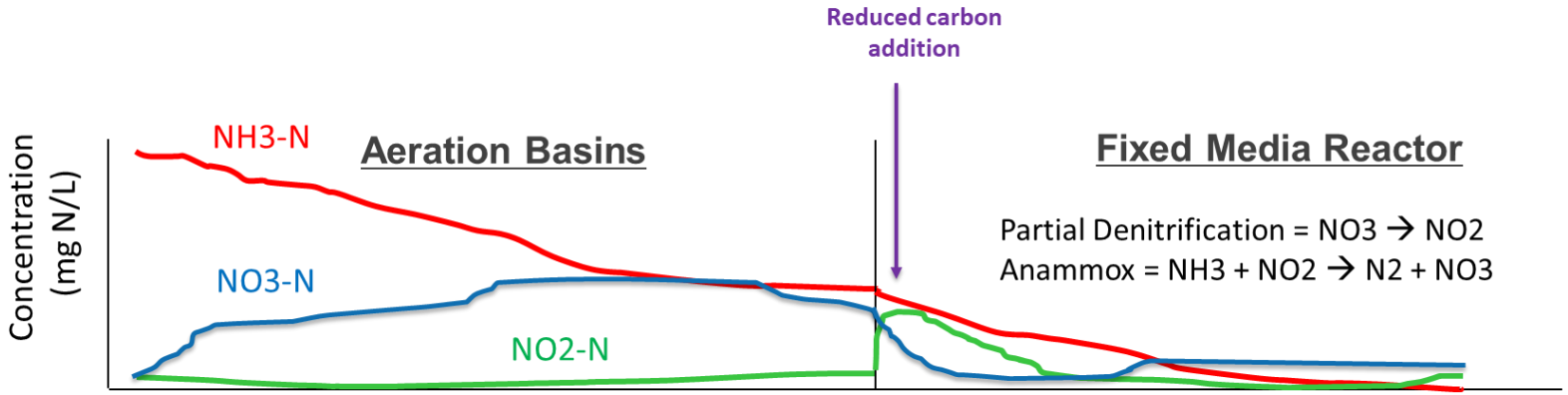
Installations

- No full-scale applications
- Piloting recommended

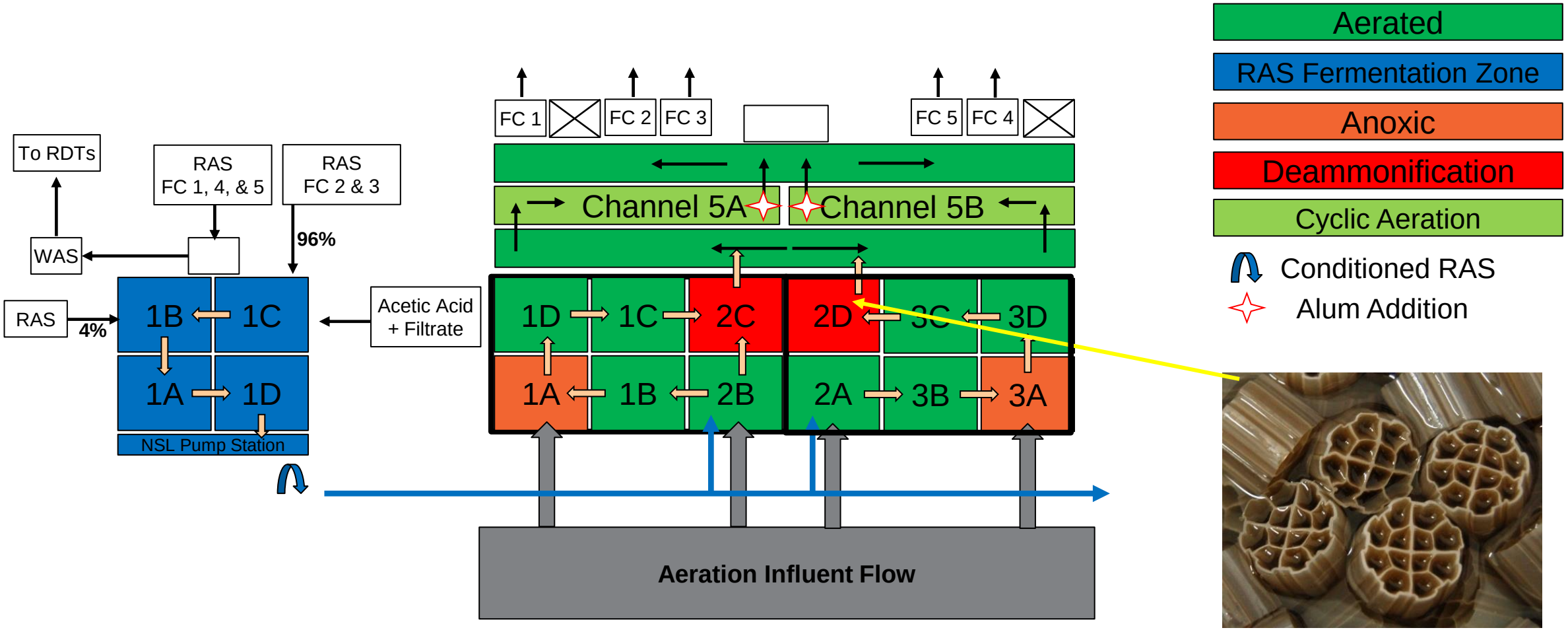
Applicability to Mason Farm

- Partial nitrification/denitrification in existing basins
- Add fixed film media for anammox retention





Potential PANDA at Mason Farm



Micro/Nano Bubbles for Aeration (Perlemax/Moleaer)

Micro/Nano Bubbles

Microbubbles (Perlemax)

- Increases efficiency of existing fine bubble diffusers
- Potential to be installed in existing piping



Nanobubbles (Moleaer)

- Supplemental aeration
- Improved oxygen transfer and efficiency

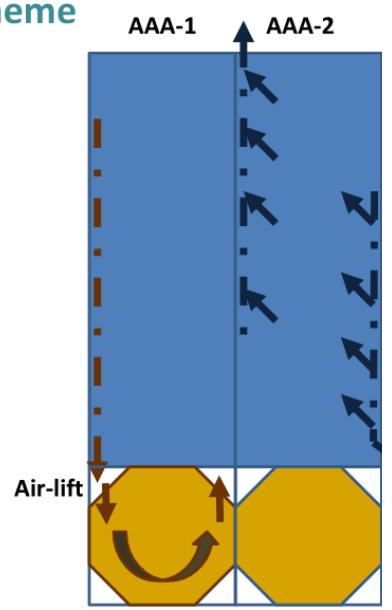


A/B Process

Two-Sludges Activated Sludge

- A-stage: Short SRT for BOD removal
- B-stage: Increased SRT for nitrification and nutrient removal
- Relies on supplemental carbon for denitrification & TN removal
- Reduce aeration tank volume for nitrification
- Increases clarifier footprint

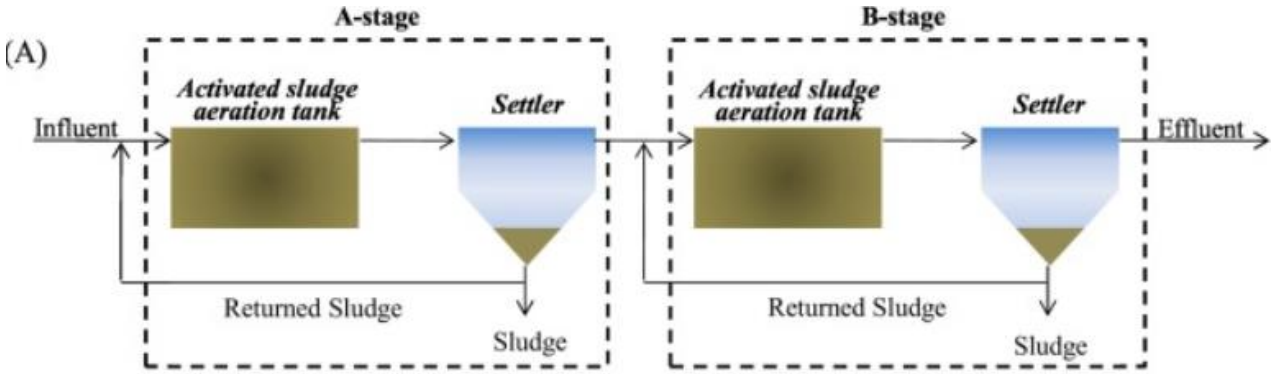
Scheme



TRIPLE A SETTLER

WWTP Sompunt/Alta Badia





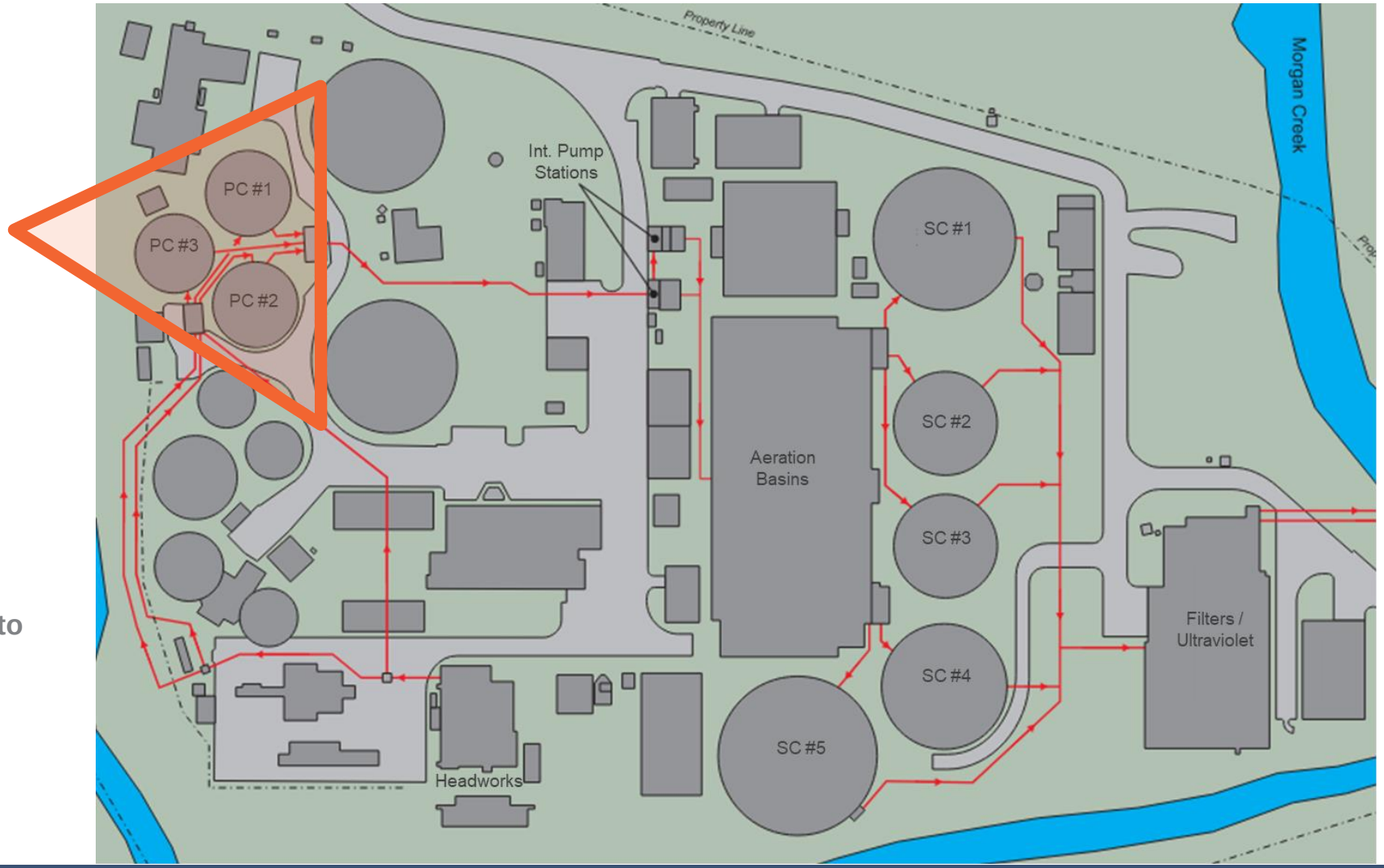
TRIPLE A SETTLER NEWhub

Triple A Settler at Mason Farm

- Retrofit of primary clarifiers
  - ~ 2 hr HRT, ~ 2 d SRT

- Control approaches
  - Sludge blanket feeding
  - Aeration
  - Airlift pumps
  - Airlock decanter

- Operational considerations:
  - Complete retrofit of PCs necessary
  - Increase carbon diversion from 40% to 70%
  - Increased A-stage sludge production (replaces PCS)



Mobile Organic Biofilm

Mobile Organic Biofilm

Overview

- Originally marketed as Kenaf
- Now: Nuvoda MOB™
- Media is cellulosic plant material (also known as Kenaf)
  - **500 um particle size**
  - **Renewable (harvested from the Kenaf Plant)**
- Media added to the BNR basins and used for biofilm growth
- **Media is recovered from the WAS recycled back to the BNR basins**

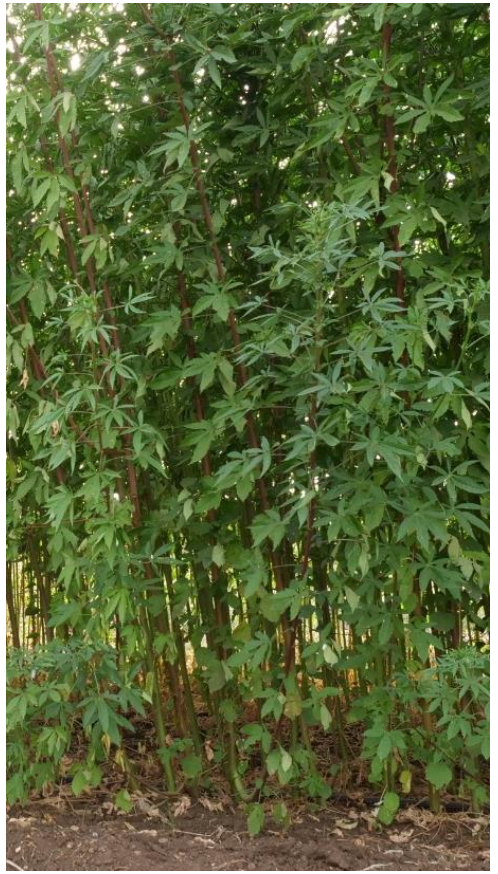




Image: Nuvoda

Mobile Organic Biofilm

Example Process Configuration

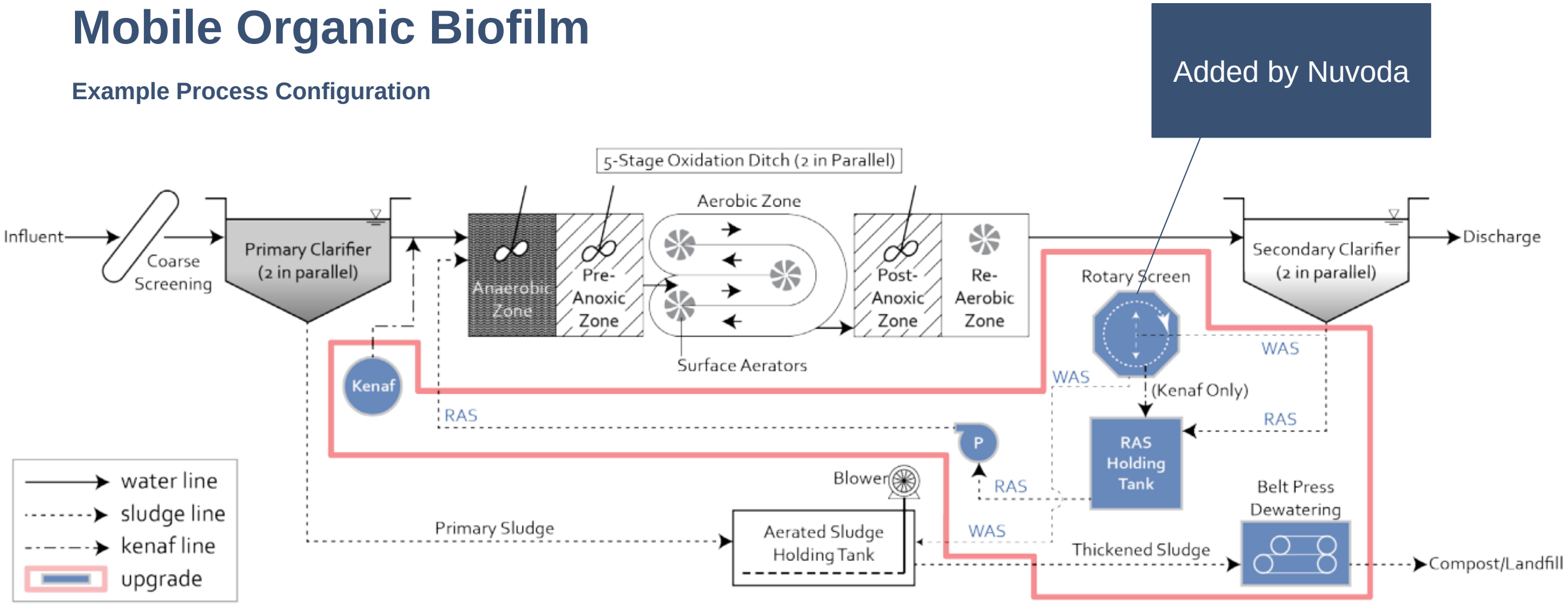
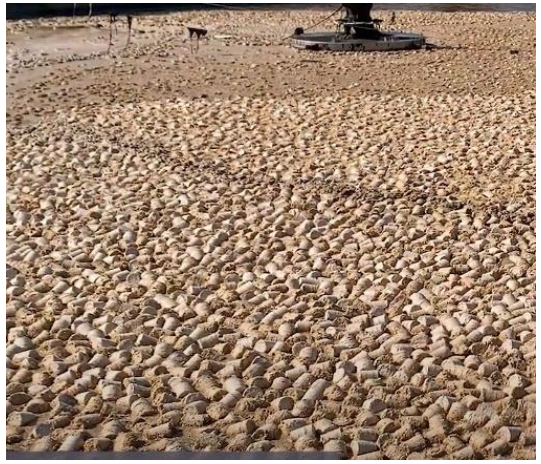


Image: Nuvoda

Mobile Organic Biofilm









Key Components

- Kenaf
- Rotary Drum for recovering Kenaf from WAS
- BNR Basins and Clarifiers
- Blowers

Supporting Facilities

- Instrumentation
- Chemical Facilities (if required)

Mobile Organic Biofilm

Operations and Maintenance Considerations

- Purchase of additional Kenaf
  - **Partial recovery from WAS**
  - **Degradation (organic product)**
- Increased mixing intensity
- Ensure pumps, aeration, mixing, final clarification equipment can handle increase solids concentrations

Mobile Organic Biofilm

Installation History

CLIENT/PROJECT	LOCATION		REACTOR TYPE	TYPE	GOALS	FLOW (MGD)	INDUSTRY	INSTALL YEAR
Edmonds WWTP	Edmonds	WA	Aeration Basins	Retrofit	Nutrient, Capacity	3.000	Municipality	2020
Forest Grove - Nutrient Retrofit	Forest Grove	OR	MLE	Retrofit	Nutrient, Capacity	2.400	Municipality	2019
Homestead Creamery - Greenfield	Wirtz	VA	Aeration Basins	Greenfield	Full Treatment, CNP	0.055	Dairy	2016
Mebane WRRF - Nutrient Cycle	Mebane, City of	NC	A/O	Retrofit	Nutrient, Capacity	3.000	Municipality	2009
Moorefield - BNR Retrofit	Moorefield, Town of	WV	Modified Bardenpho	Retrofit	Nutrient, Capacity	6.000	Municipality	2016
Norristown - Nutrient Retrofit	Norristown	PA		Retrofit	Nutrient, Capacity	4.000	Municipality	2019
UCSD - South West	Champaign	IL	A/O	Retrofit	Nutrient, Capacity	7.980	Municipality	2019
Washington Township - SBR Retrofit	Washington Township	PA	SBR	Retrofit	Nutrient, Capacity	0.250	Municipality	2019

Image: Nuvoda

Mobile Organic Biofilm

Benefits and Challenges

Benefits (Manufacturer's Claims)

- Increase MLSS concentration
- Improved settling with ballasted settling
- Improves sludge dewatering
- Remove/absorb industrial waste

Challenges

- Limited installations
- Organic material biodegrades over time → need to re-seed
  - **2% refill rate per year (from mfg)**
- Additional solids to keep suspended in aeration basins / channels / pipes

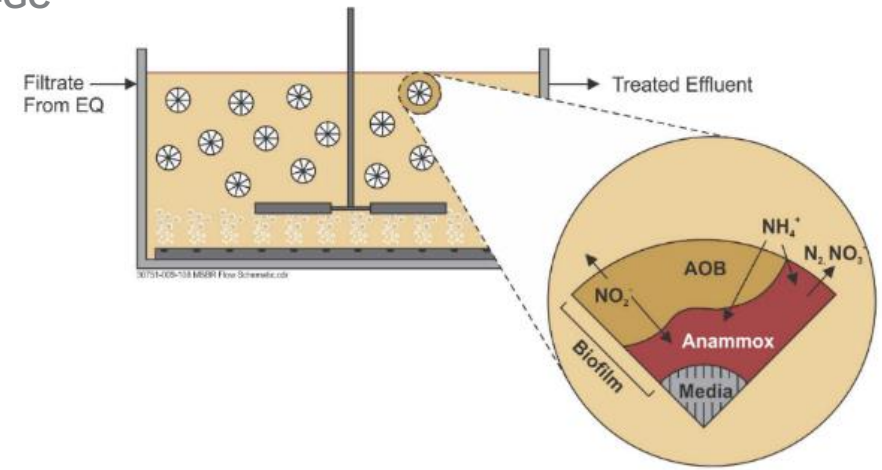
Resource Recovery & Sidestream Treatment

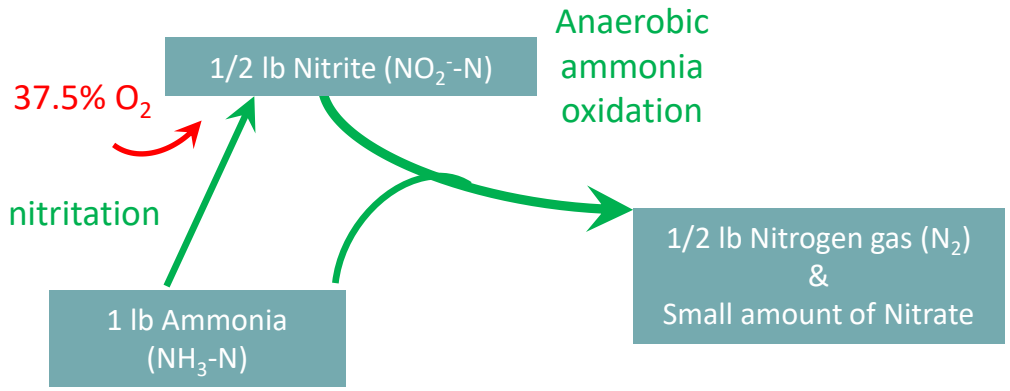
- Sidestream Deammonification
- Sidestream Struvite Recovery
- Chemical Sludge Recycling
- Reuse Treatment Alternatives

Sidestream Deammonification

Sidestream Deammonification

- Utilize deammonification to intercept and treat sidestream TKN load
  - **Reduces sidestream TKN load by 75 to 85%**
- Installations in US:
  - **HRSD**
  - **City of Durham**
  - **Pierce County**
  - **Nassau County**
  - **Metro Water Recovery**
  - **DC-Water**
  - **MWRD-GC**





	ANITA™ Mox MBBR
Reactor configuration	MBBR
Biomass characteristic	Biofilm
Proprietary retention strategy	Plastic carrier and screen

Sidestream Struvite Recovery

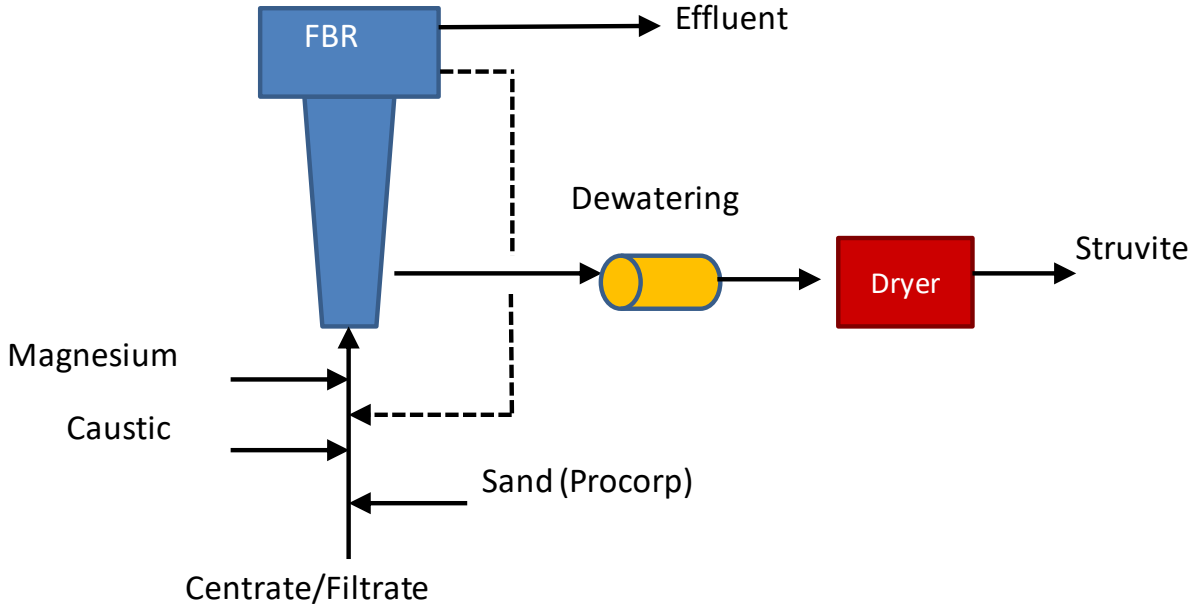
Phosphorus Recovery

Recovery of Phosphorus to:

- Minimize nuisance struvite
- Reduce operating costs
- Improve dewaterability
- Offset operating costs

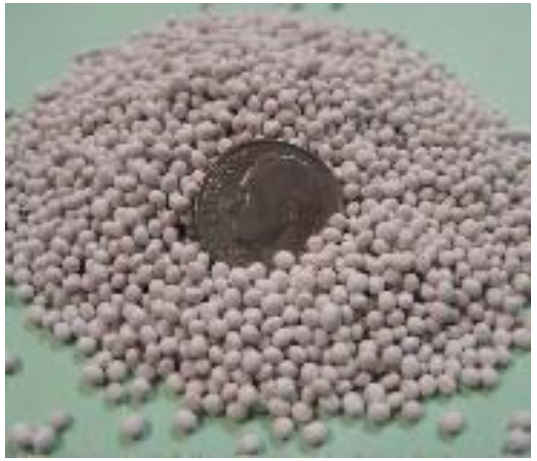
US Installations:

- Nansemond WWTP
  - *HRSD, Virginia*
- F. Wayne Hill WRC
  - *Gwinnett County, Georgia*







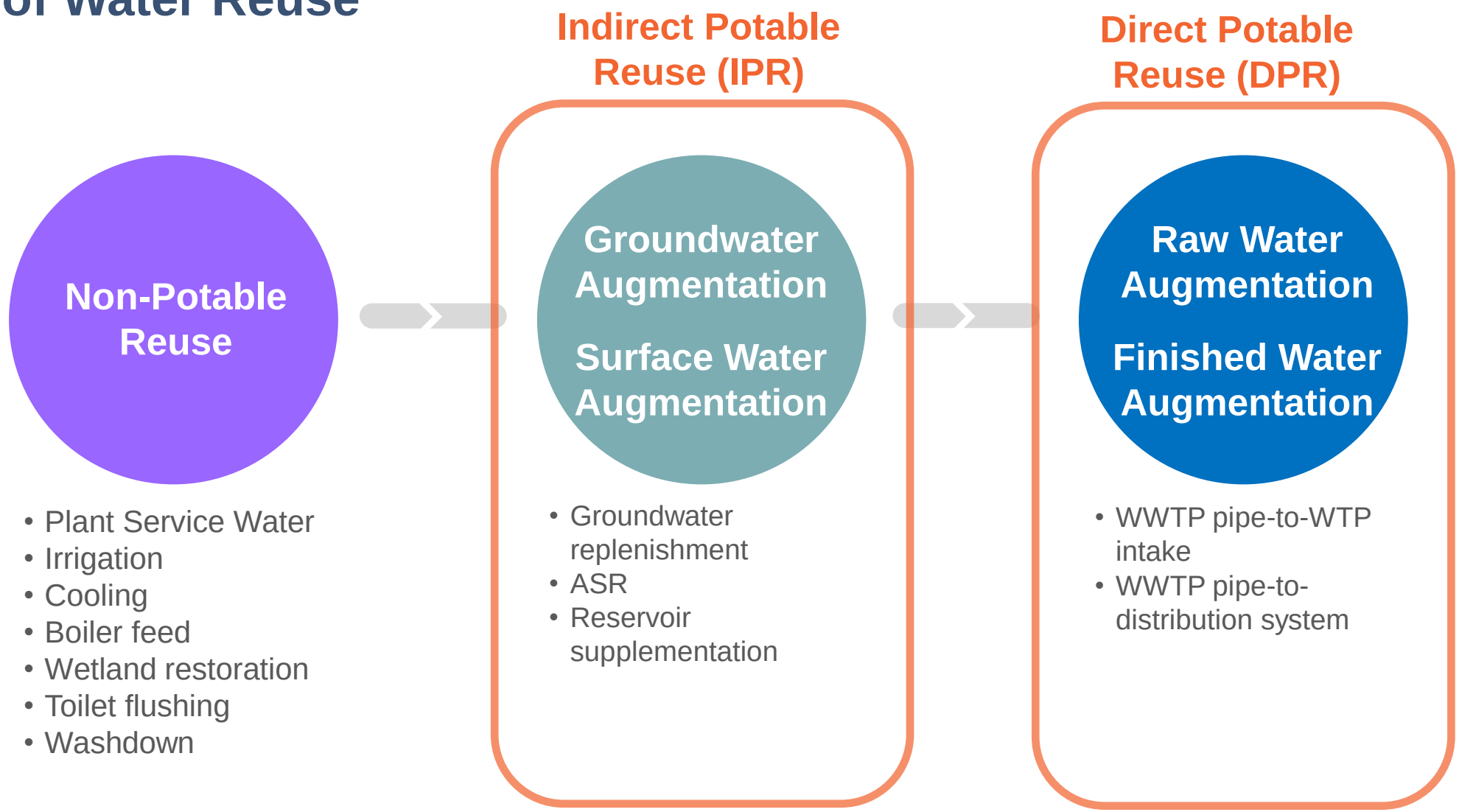




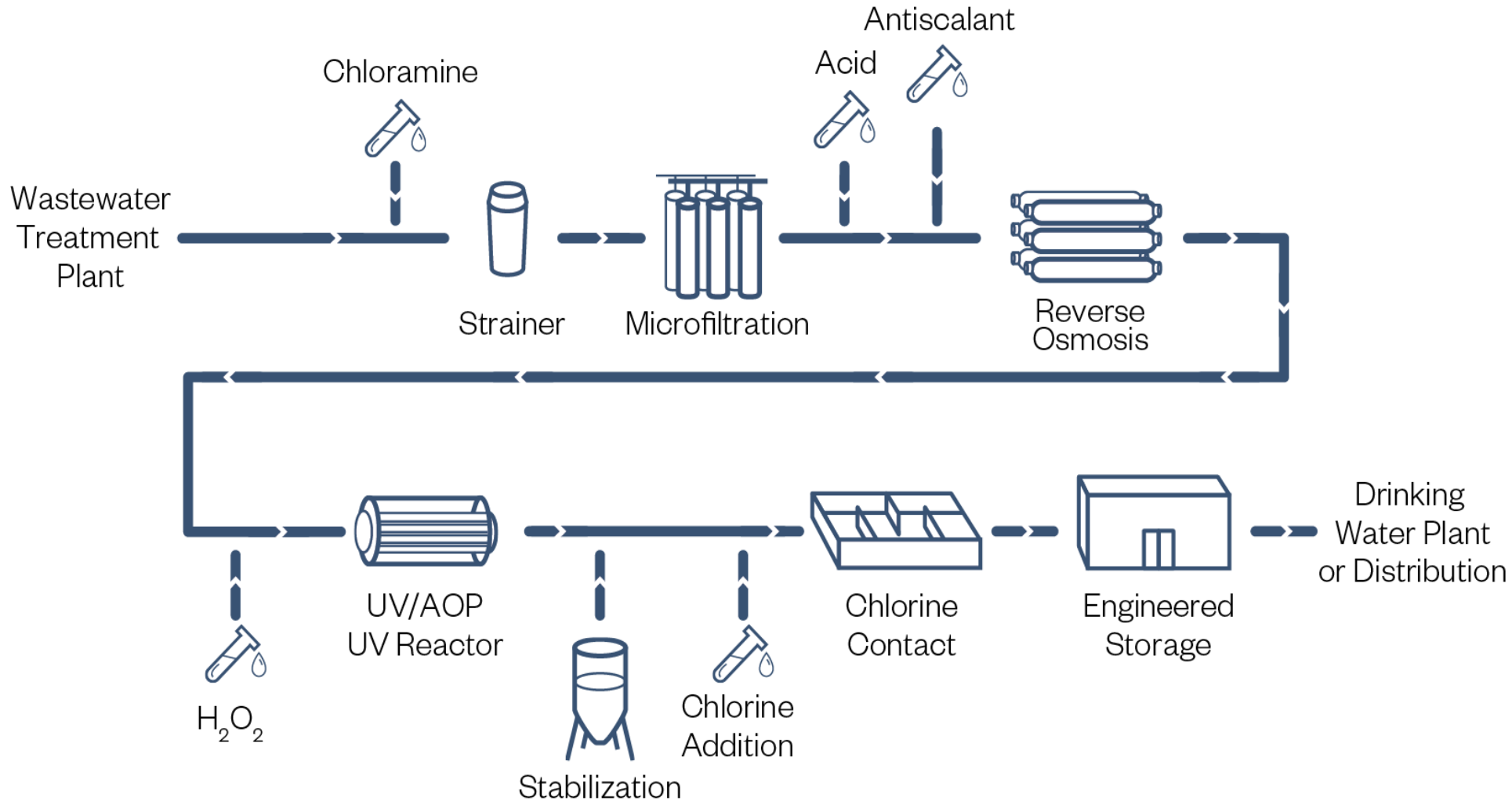
Chemical Sludge Recycling

Reuse Treatment Alternatives

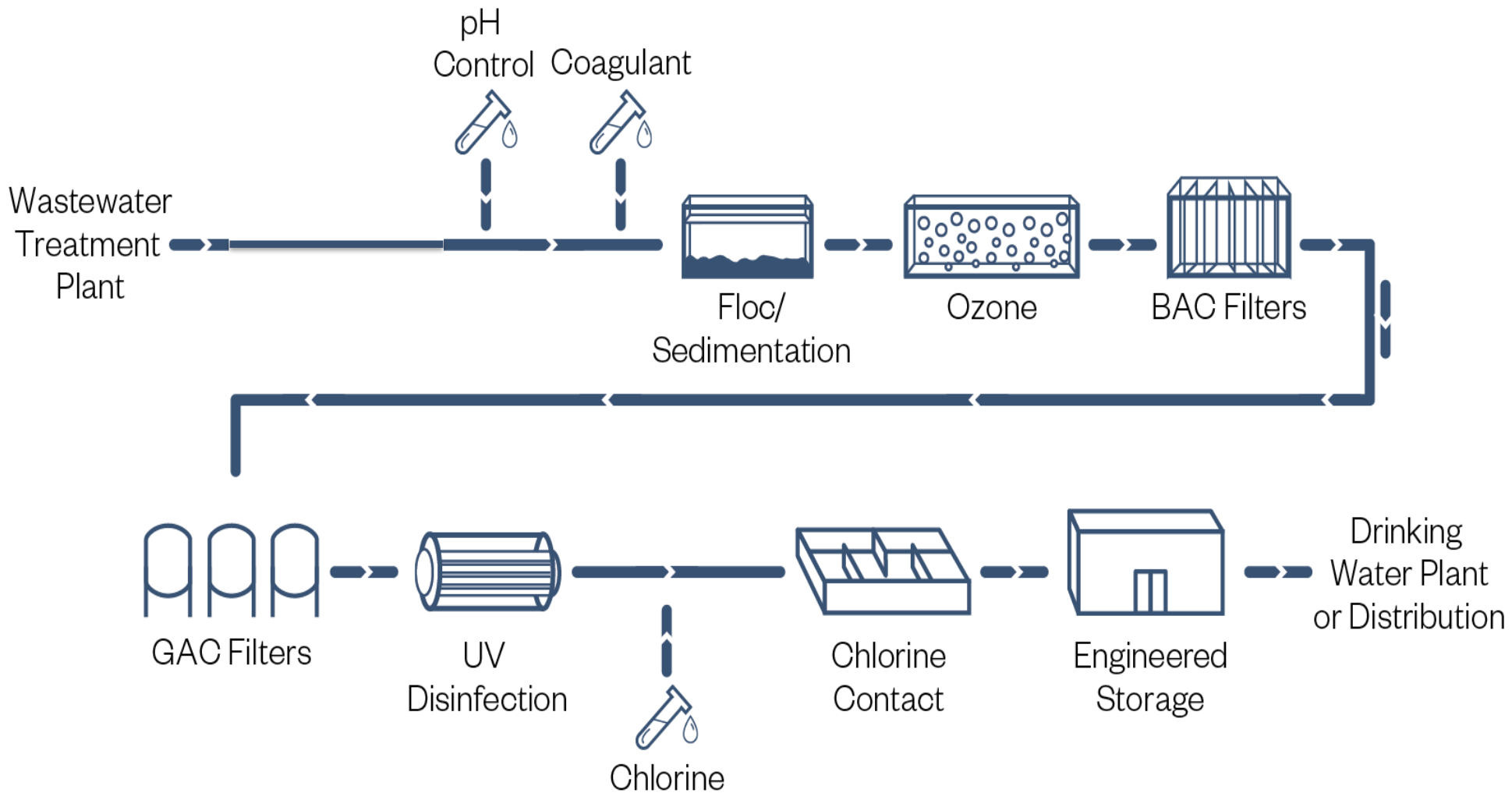
Types of Water Reuse



Membrane-Based Treatment



Non-Membrane Based Treatment



Site Optimization

- Equalization
- Primary Treatment



On-Site Equalization

Mason Farm Peak Hour Flow Development Review

Storm	Storm Dates	Peak Hour Flow (mgd)	AADF (mgd)	Hourly Peaking Factor
Hurricane Florence Sept 2018	9/14/18 – 9/21/18	39.7	8.05	4.9
Nov 2018	11/10/18 – 11/18/18	34.9	8.05	4.3
Feb 2020	2/4/20 – 2/15/20	36.7	7.70	4.8

Year	AADF (mgd)	Rated Plant Capacity (mgd)	PHF Peaking Factor	Peak Hour Flow (mgd)
2037	9.52	14.5	4.9	71.1
2070	13.49	18.5	4.9	90.65



Assuming an Hourly Peaking Factor of 3

Year	AADF (mgd)	Rated Plant Capacity (mgd)	PHF Peaking Factor	Peak Hour Flow (mgd)
2037	9.52	14.5	4.9	71.1
2070	13.49	18.5	4.9	90.65



Year	AADF (mgd)	Rated Plant Capacity (mgd)	PHF Peaking Factor	Peak Hour Flow (mgd)
2037	9.52	14.5	3	43.5
2070	13.49	18.5	3	55.5

Equalization sizing and siting will be performed if selected as a Tier 2 Alternative.

Primary Treatment

Primary Treatment: Three Considerations

Primary Clarifiers

Primary Filtration

No Primary Treatment

Circular and Rectangular Primary Clarification

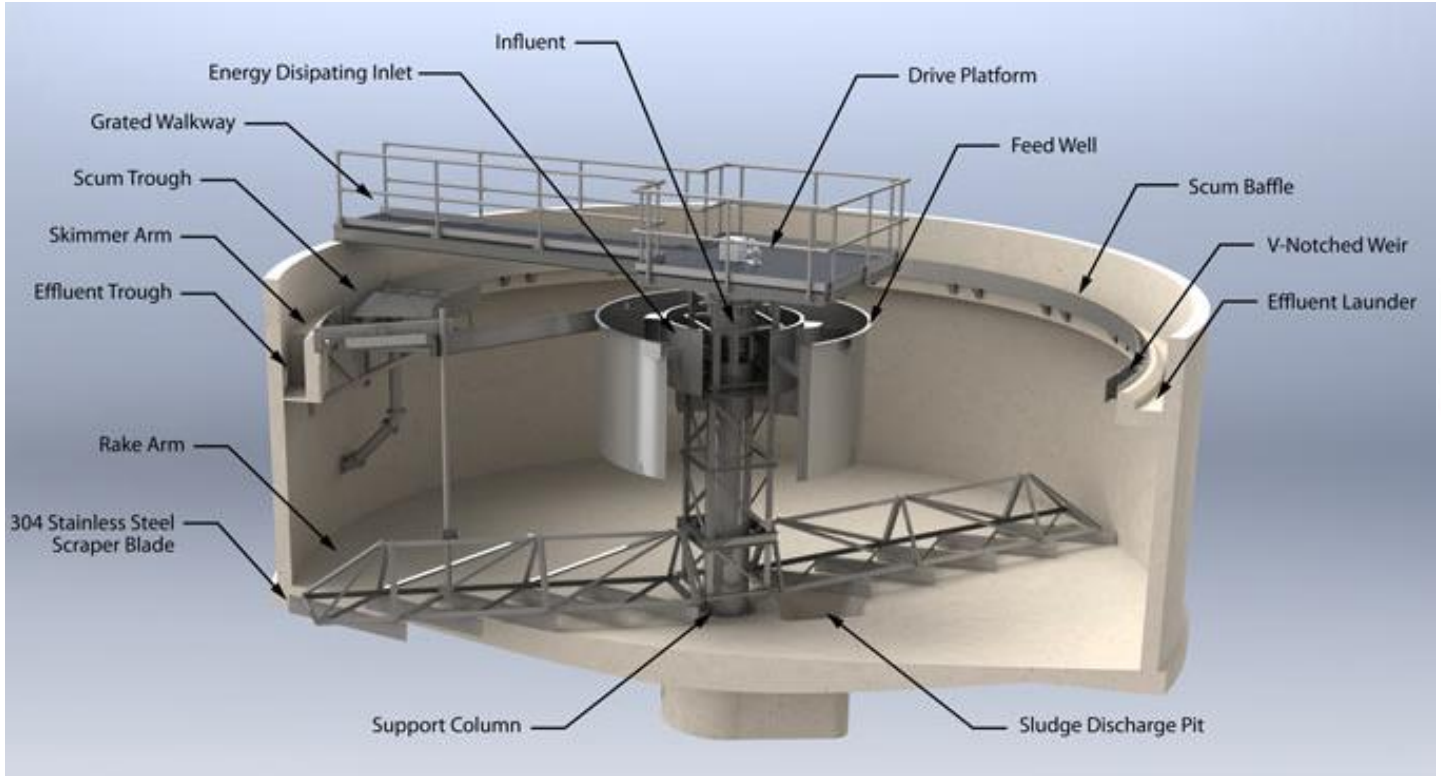


Image courtesy of: https://www.monroeenvironmental.com/

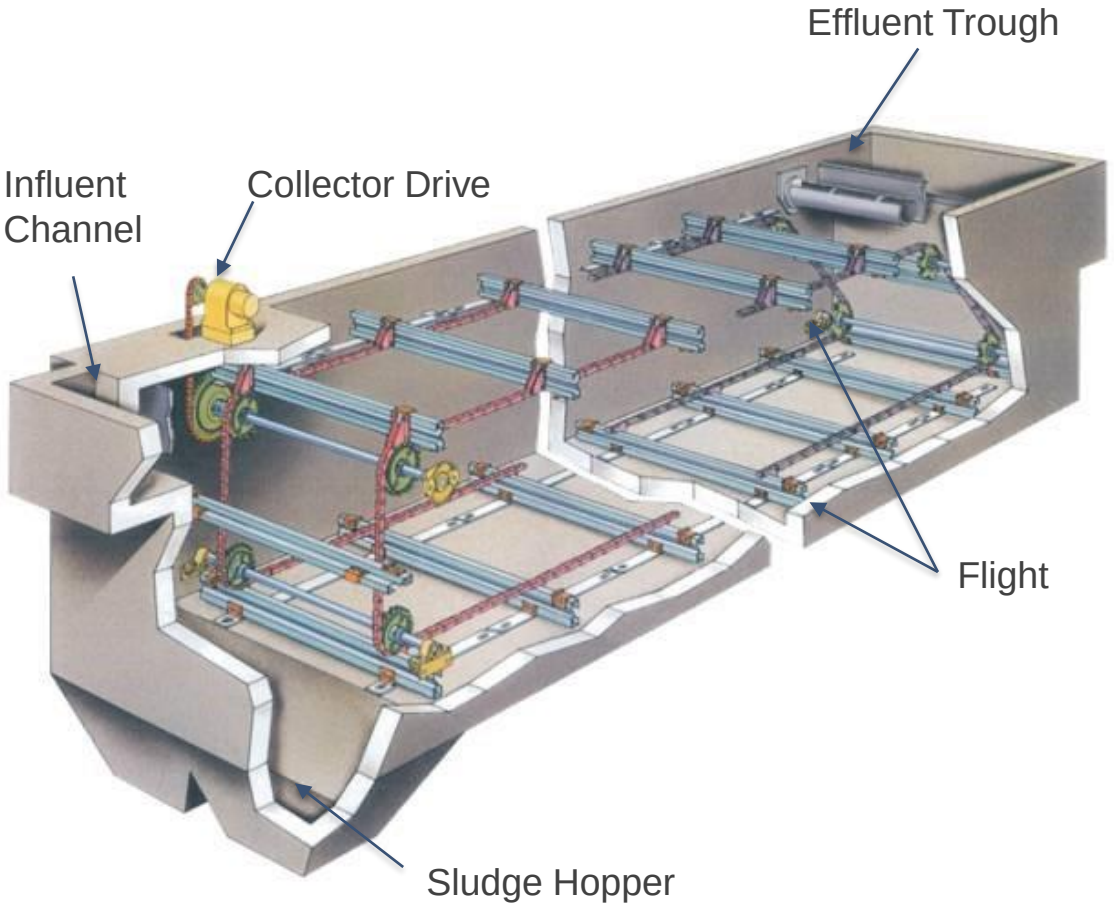
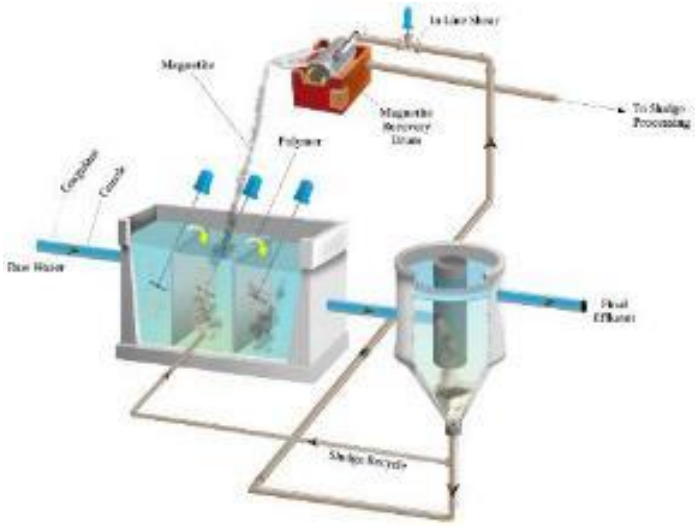


Image courtesy of: http://www.hydromatic.info/en/technical-plant/sludge-scraper/

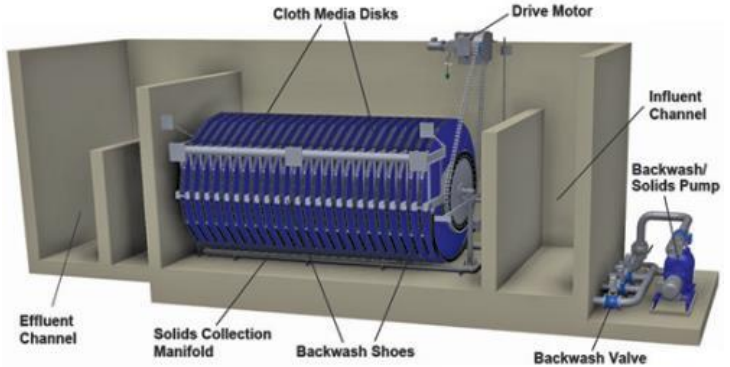
Alternative Primary Treatment Processes



- Magnetite-ballasted primary clarification (Co-Mag)



- Rotating Belt Filters



- Primary Filtration

Primary Treatment

Benefits

- Increased solids removal
- Reduced loading on secondary process
- Decreased operating MLSS
  - **Potentially increase capacity of secondary process**
- Ability to produce digester gas

Challenges

- Additional unit process to maintain
- Primary sludge operational considerations
- COD removal utilized for nutrient removal
- Impact of NFPA 820 classification requirements

Summary

Nutrient Removal and Recovery Alternatives

Nutrient Removal Optimization/ Current Process Upgrades

- NRCY
- Acetic Acid Addition
- Ammonia Based Aeration Control (ABAC)
- Filters in Denitrification mode
- RAS/MLSS fermentation

Site Optimization

- On-Site Equalization
- Primary Treatment

Secondary Treatment Intensification

- IFAS
- MBR
- AGS
- DAS - includes inDENSE

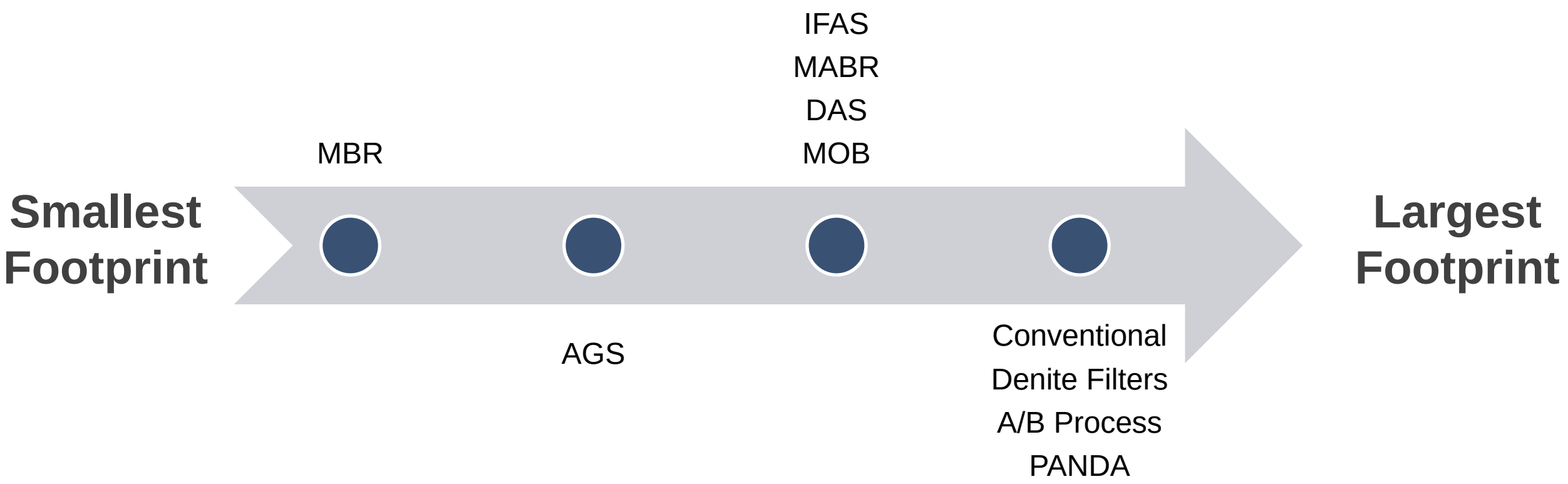
Novel Technologies

- MABR
- PANDA
- Perlemax/Moleaer
- A/B Process
- NUVODA's MOB

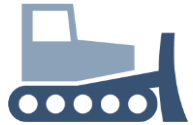
Resource Recovery & Sidestream Treatment

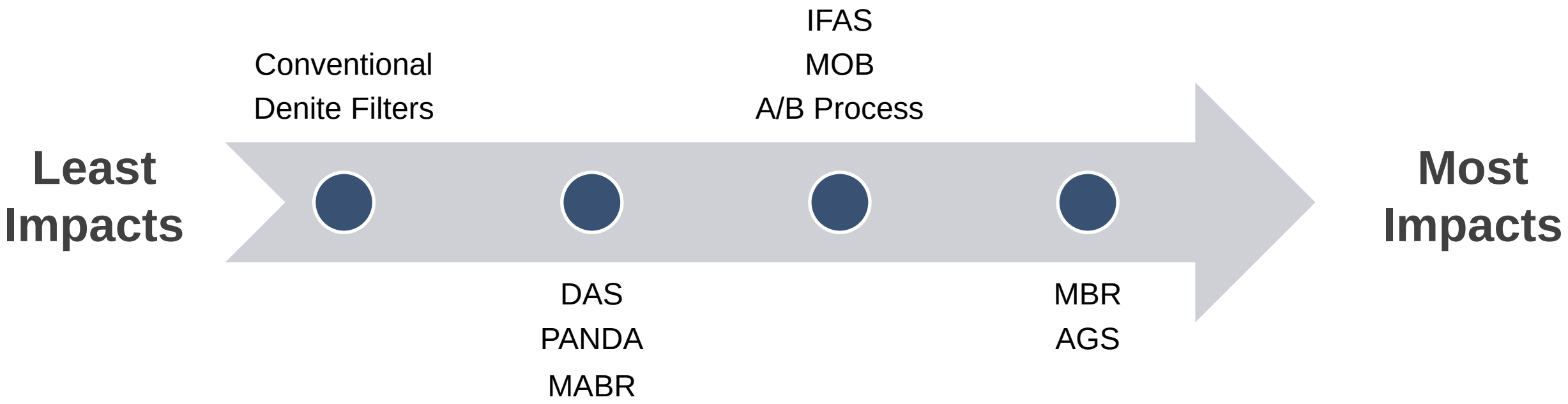
- Sidestream Deammonification
- Sidestream Struvite Recovery
- Chemical Sludge Recycling
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Site Footprint



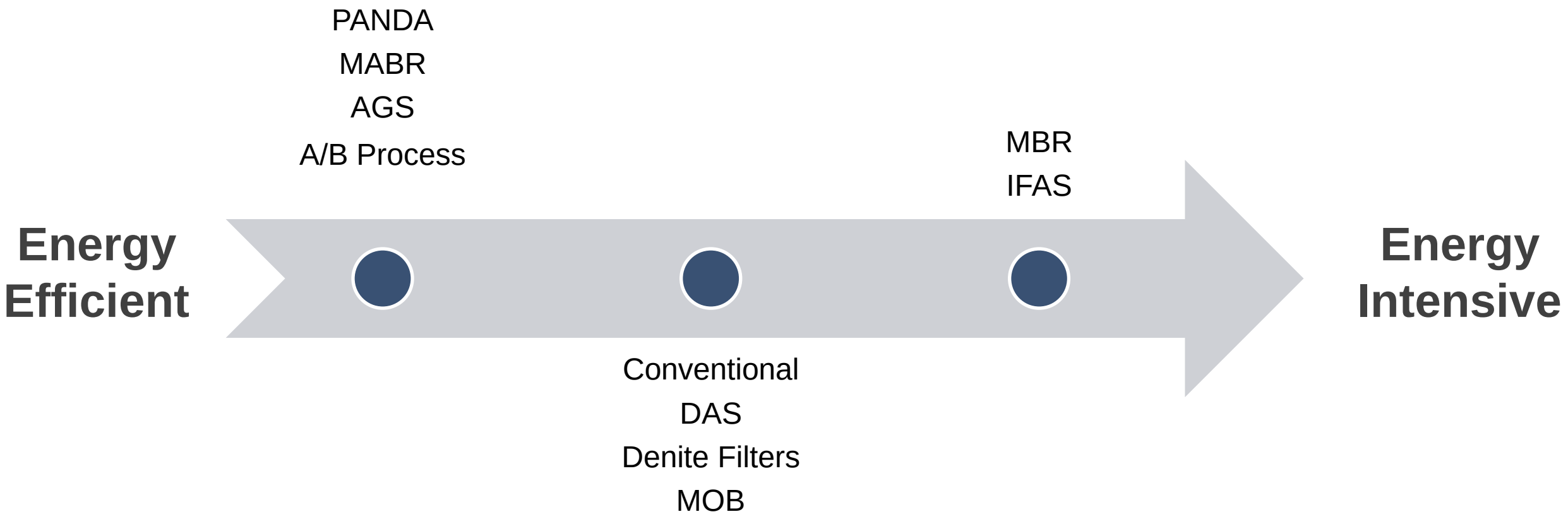
Constructability & Impacts on Operations





Energy Consumption





HazenConverge for Tier 2 Alternatives

What is HazenConverge?

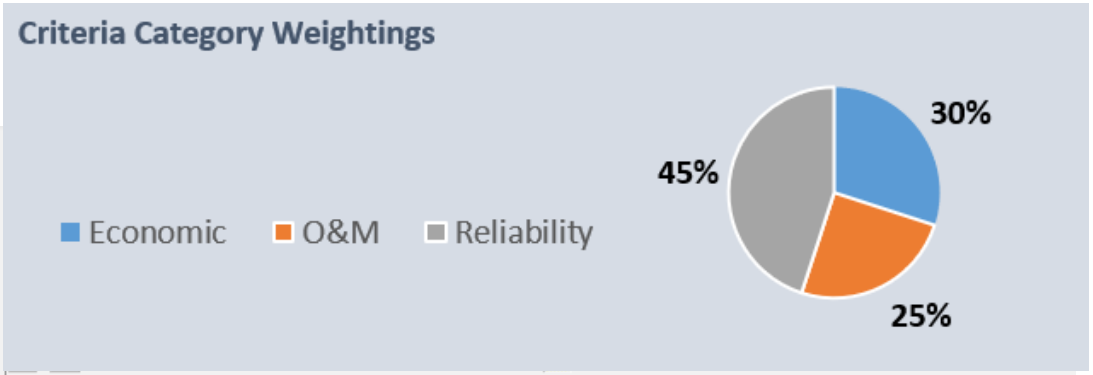
- MCDA: multi-criteria decision analysis
- Collective term for approaches that support decision-making by considering various factors in an explicit and transparent manner
  - **Complex problems are broken down into smaller and more consistent pieces**
  - **Competing pros and cons are documented**



Example HazenConverge Inputs

HazenConverge
Multi-Criteria Decision Tool
v1.2 Copyright Hazen and Sawyer, DPC. 2018

Open | Close | Instructions | Print Report

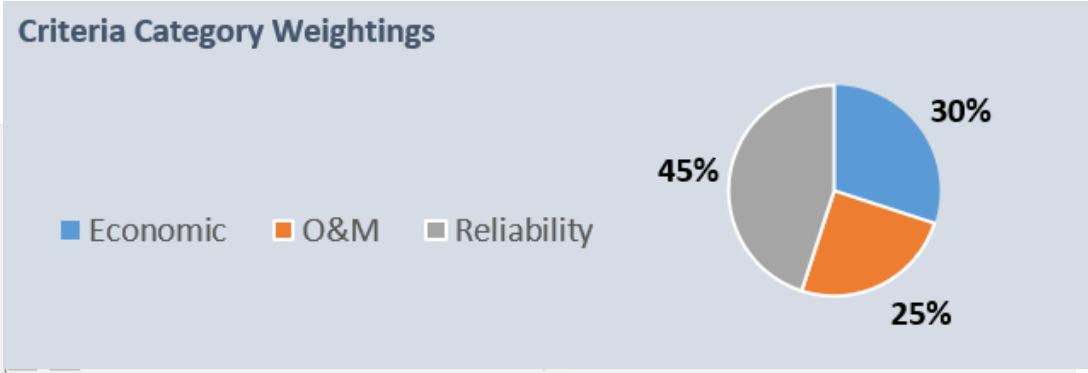


Criteria	1. Categories	2. Weighting	Relative Criteria Weight	Weight within Category	Weight within Total Score	3. Alternatives Scores	BNR Alt 1 IFAS/Conv	BNR Alt 2 Conv/Conv	BNR Alt 3 Densif/Densif	BNR Alt 4 MBR/MBR
Process Resiliency			15%	33%	15%		5.7	8.0	8.0	7.0
Technical Performance			15%	33%	15%		7.5	9.0	9.0	9.0
Number/Success of Previous Installations			15%	33%	15%		7.0	10.0	4.0	9.0
Capital Cost			10%	33%	10%		1.0	1.0	0.9	1.1
O&M Cost			10%	33%	10%		1.3	1.0	1.0	1.3
Footprint			10%	33%	10%		0.8	0.6	0.8	1.0
Ease of Operation			8.33%	33%	8%		4.2	10.0	8.0	7.0
Ease of Maintenance			8.33%	33%	8%		5.0	9.0	10.0	6.0
Safety			8.33%	33%	8%		10.0	10.0	10.0	8.0

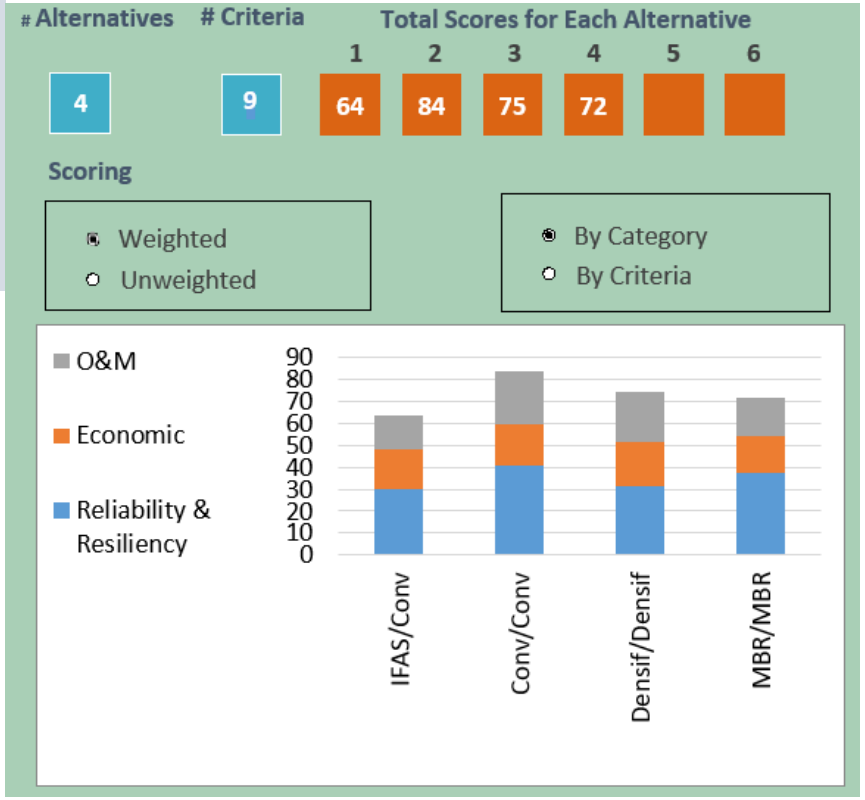
Example HazenConverge Inputs → Outputs

HazenConverge
Multi-Criteria Decision Tool
v1.2 Copyright Hazen and Sawyer, DPC. 2018

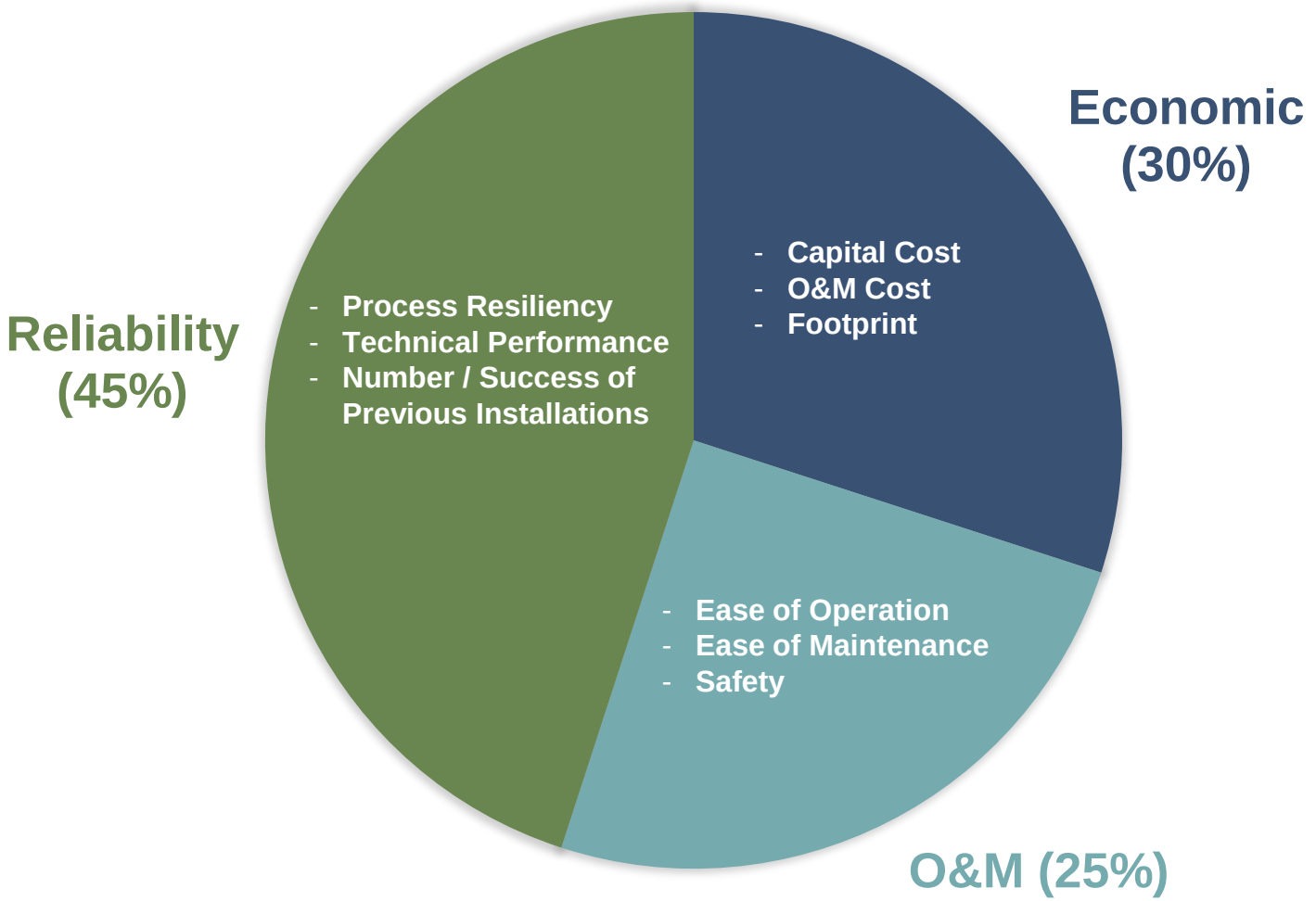
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Criteria	1. Categories	2. Weighting	Relative Criteria Weight	Weight within Category	Weight within Total Score	3. Alternatives Scores	BNR Alt 1 IFAS/Conv	BNR Alt 2 Conv/Conv	BNR Alt 3 Densif/Densif	BNR Alt 4 MBR/MBR
Process Resiliency			15%	33%	15%		5.7	8.0	8.0	7.0
Technical Performance			15%	33%	15%		7.5	9.0	9.0	9.0
Number/Success of Previous Installations			15%	33%	15%		7.0	10.0	4.0	9.0
Capital Cost			10%	33%	10%		1.0	1.0	0.9	1.1
O&M Cost			10%	33%	10%		1.3	1.0	1.0	1.3
Footprint			10%	33%	10%		0.8	0.6	0.8	1.0
Ease of Operation			8.33%	33%	8%		4.2	10.0	8.0	7.0
Ease of Maintenance			8.33%	33%	8%		5.0	9.0	10.0	6.0
Safety			8.33%	33%	8%		10.0	10.0	10.0	8.0

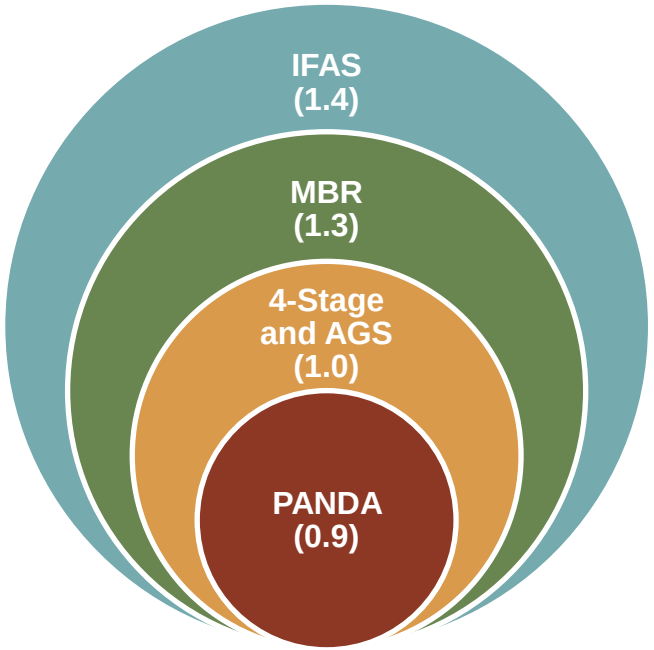


Percentages for Inputs
EXAMPLE

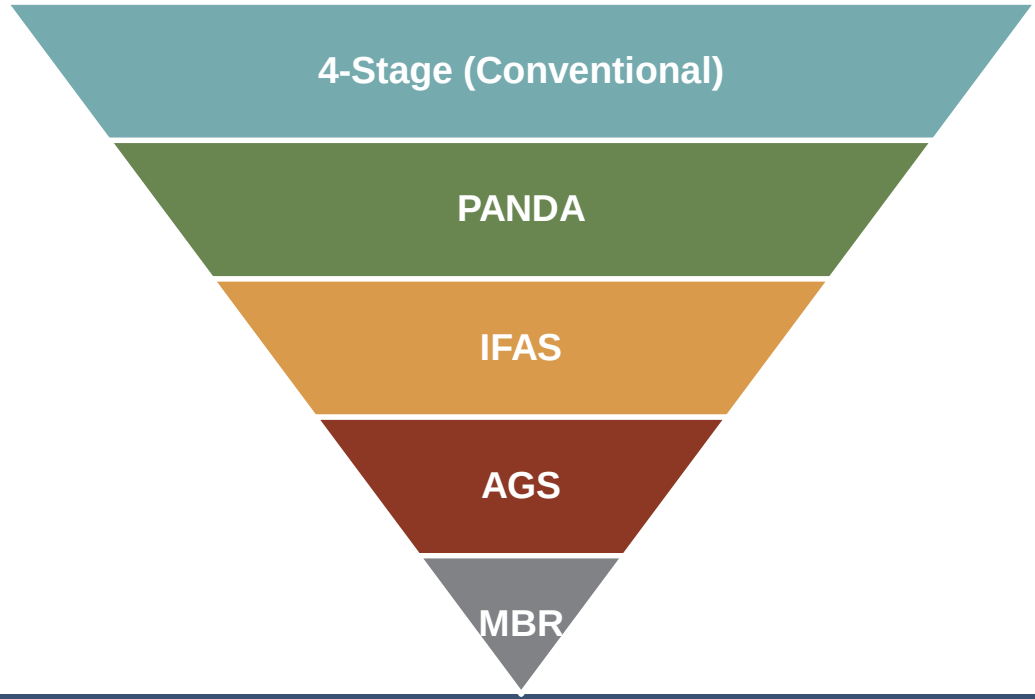


Approach to Economic Evaluation (30%)
EXAMPLE

Rankings for Operating Costs
(lower numbers are better)
1.4 – IFAS
1.3 – MBR
1.0 – 4-Stage BNR (Conventional)
1.0 – AGS
0.9 – PANDA(lowest O&M)



Points Assigned for Footpring
(higher numbers are better)
1 – 4-Stage BNR (Conventional)
2 – PANDA
3 – IFAS
4 – AGS
5 – MBR(smallest footprint)



Reliability and O&M Converge Ranking Categories & Scores by Unit Process
EXAMPLE

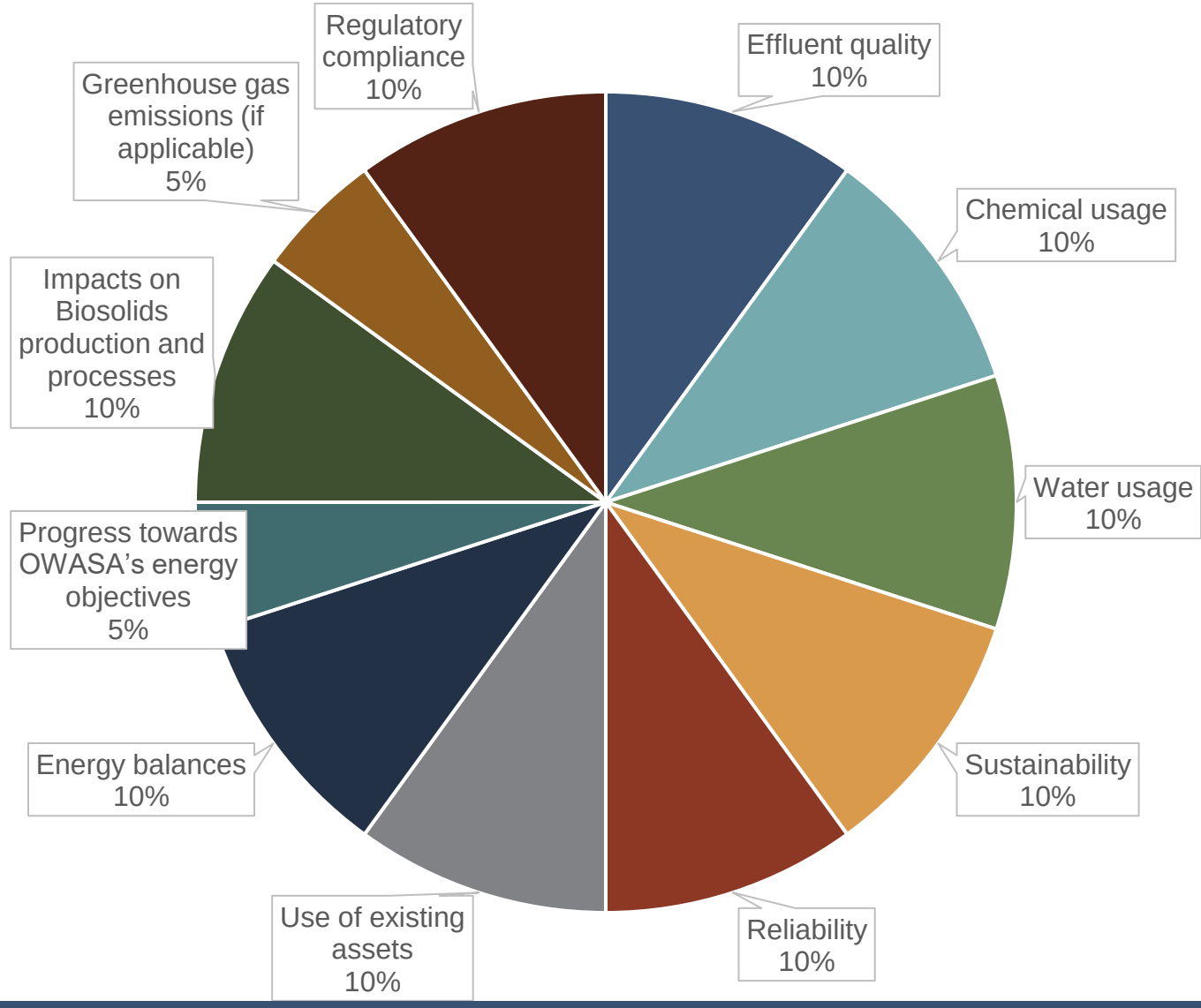
	Reliability (45%)			O&M (25%)		
	Process Resiliency	Technical Performance	Installations	Ease of Operation	Ease of Maintenance	Safety
IFAS	5	7	6	5	6	10
Conventional	8	9	10	10	10	10
MBR	7	9	9	7	6	8
AGS	5	5	3	6	7	10
PANDA	6	7	1	6	10	10

Default Criteria for Ranking

Category: Implementation	
Ease of integration	Utility crossings
Accessibility	Lead time requirement
Prevalence of confined spaces	Ease of regulatory approval
Consistency with other initiatives	Permitting requirements
Ease of construction	Sampling/monitoring requirements
Ease of expansion	Success of previous installations
Ease of maintenance	Implementation timeline
Ease of operation	
Category: Economy	
Capital cost	Cost risk factors
O&M cost	Impact to surrounded economic growth
Life cycle cost	
Category: Others	
Certainty of information	Resilience to natural and human threats
Availability of materials	Efficiency increase to existing infrastructure
Collaboration potential	Repurposing of existing infrastructure
Contractual requirements	Adaptability/flexibility
Redundancy	System recovery requirement
Vulnerability	Co-benefits and synergies
Durability	

Mason Farm Master Plan HazenConverge Input Selection from Scope

- Inputs included in Scope:
  - **Effluent quality**
  - **Chemical usage**
  - **Water usage**
  - **Sustainability**
  - **Reliability**
  - **Use of existing assets**
  - **Energy balances**
  - **Progress towards OWASA's energy objectives**
  - **Impacts on Biosolids production and processes**
  - **Greenhouse gas emissions (if applicable)**
  - **Regulatory compliance**



Thank you!

Appendix B: Tier 2 Alternatives Evaluation Workshop Minutes & Slides

Hazen *Meeting Minutes*

July 24, 2023

Location:	Mason Farm WWTP
Time:	10:00 AM EST
Project:	Mason Farm WWTP Master Plan
Subject:	Tier 2 Alternatives Evaluation Workshop

Meeting Attendees:

OWASA:	Hazen:
Wil Lawson	Lamya King
Allison Spinelli	Eric Polli
Monica Dodson	Joe Rohrbacher
Simon Lobdell	Amy Hanna
Travis Rich	
Vishnu Gangadharan	
Mary Darr	
Coleman Olinger	

Decisions made are *italicized* and action items are in **bold**.

Master Plan Recap

- A review of the Master Plan objectives, status of the ongoing tasks, and decisions made to-date was completed at the start of the meeting.
- OWASA asked Hazen if the November timeframe on finalizing the Master Plan was still achievable. Hazen responded that completing a draft of the Master Plan by the end of year is achievable.

Tier 2 Alternatives Evaluation

Alternatives Background

- The assumptions for the alternatives and BioWin modeling were presented.
- OWASA mentioned a MicroC 2000 study as an external carbon source to be added to the aeration basins (Cells 5A/5B) was starting soon.
- OWASA confirmed there is approximately a 2-mgd difference in their influent and effluent flowrate and mentioned that flow from every other backwash cycle is sent to the collection system and

Job no 32258-017

potentially being double-counted in the flow measurement. OWASA confirmed their effluent TN is still averaging near 7 mg/L.

Alternatives Comparison

- Alternative 1 is conventional treatment with NRCY in MLE configuration.
- Alternative 2 is densified activated sludge with hydrocyclones operated in the current (step-feed) configuration.
- For both alternatives, at the maximum month conditions, three cells of each train need to operate aerobically to fully nitrify.
- The hydrocyclone facility for Alternative 2 would be designed to send underflow by gravity back to the NSLs if feasible. The concern with pumping underflow immediately is the possibility of breaking the denser floc prior to mixing with the bulk MLSS.
- Key takeaways of the modeled performance:
    - The MLE configuration results in a higher MLSS concentration compared to the current step-feed configuration and subsequently a higher solids loading rate to the secondary clarifiers. Typically, we want to limit the solids loading rate (SLR) between 20 – 25 lb/ft^2-d at max month flows, and 35 lb/ft^2-d at peak flows.
    - Secondary effluent NOx-N was approximately 3 mg/L higher in the step feed models compared to the NRCY models.
    - Chemical addition was essentially the same between the two alternatives. It was recommended that multipoint chemical addition be considered in the future to meet the stringent phosphorous limits.
- OWASA confirmed there are DO probes in each cell of the treatment trains.
- Capital costs of equipment required for the two alternatives were presented. Costs associated with the other processes at the plant were not included in these costs. It was recognized there will be an additional cost for these other processes to meet buildout flow projections.
- The Multi-Criteria Decision Analysis (MCDA) tool, HazenConverge, was presented and discussed. OWASA confirmed the weightings of each criteria were acceptable.
- OWASA asked if the technology reliability criteria accounted for manufacturers potentially going out of business in the future. Hazen responded the criteria does not, however, all of the equipment used in the alternatives are commonly used and the technical knowledge is widely available.
- The full picture of required processes for future expansions and to meet the flow projections was discussed. **Hazen will include an additional criteria in the MCDA tool to account for the additional infrastructure that would be needed for Alternative 1.**
- **Hazen will implement triggers based on time for when studies, construction, and technology implementation are required within the roadmap as requested by OWASA.**
- **Hazen will include when Clarifier 6 is required within the roadmap.**

Additional Items & Considerations

- Four additional items and considerations were discussed at the end of the alternatives analysis section.

- Additional information on ammonia-based aeration control (ABAC) was provided. OWASA brought up the concern of driving the DO in the second row of cells low enough due to the control loop to maintain minimum mixing energy.
- Currently, the alternatives do not include reclaimed water and provide a more conservative (sooner) timeline. The submitted roadmaps will be based on this scenario, and will be noted to make that clear.
- Discussion on when supplemental carbon would be needed to be fed to the denitrification filters was held. Based on the 2021 effluent TN and historical influent and effluent flow difference, it was projected that the Mason Farm WWTP would need to feed supplemental carbon to the denite filters when discharging approximately 6.25 mgd, or around 2032. Analysis of recent performance and trends in influent/effluent flow from the past two years is recommended to see if flow has increased compared to 2020 and 2021.
- The Partial Nitrification-Denitratation-Anammox (PANDA or PdNA) process was discussed as a potential tertiary treatment to help reduce carbon costs in the future. Being able to bleed a small amount of ammonia through the aeration basins would also help with reducing the aSRT and MLSS required for treatment.
- Sidestream deammonification was recommended as a technology to consider because all of the biosolids alternatives being considered as part of the Master Plan would require continuous dewatering. Sidestream deammonification reduces the recycled TKN load to the aeration basins. OWASA clarified that under current practice dewatering 25% of the time was a target and in reality average 50/50 in terms of liquid solids vs dewatered cake. Plant staff observe a 2 to 3 mg/L increase in influent TN when dewatering.

Biosolids Alternatives Technology Overview

- A review of the biosolids technologies being considered for the Master Plan were discussed to provide a brief introduction to what will be presented in August's workshop. The technologies discussed were thermal drying, pyrolysis/gasification, and supercritical water oxidation.

Action Items

- Hazen immediate & long-term action items are:
    - Include additional criteria in the MCDA tool to account for additional infrastructure needed for Alternative 1.
    - Draft TM 3 to summarize the Tier 1 and Tier 2 alternatives analysis.
    - Determine triggers for the discussed items and alternatives as part of the roadmap:
        - Include trigger for when it would be recommended for OWASA to do a carbon study
        - Include triggers based on when studies should be implemented (rather than construction)
        - Include trigger for when filters should operate in denitrification mode (i.e., OWASA to start feeding carbon)
        - Include triggers for when OWASA should consider other treatment options such as:
            - ABAC

    - Sidestream deammonification
    - PANDA
- Identify triggers based on no reclaimed water flow (to be conservative).
- Include a trigger for when Clarifier 6 should be added.

Hazen



Mason Farm WWTP Master Plan
Tier 2 Alternatives Workshop

July 24, 2023

OWASA

Meeting Purpose & Agenda

- Purpose is to:
  - **Review Tier 2 evaluation, to include:**
    - *Site plans & diagrams*
    - *Cost estimates*
    - *Multi-criteria decision analysis*
- Agenda
  - **Master Plan Re-Cap**
  - **Tier 2 Alternatives Evaluation**
  - **Biosolids Alternatives Technology Overview**



Master Plan Recap

Master Plan Objectives

Near-term 2037
Long-term 2070



Develop near- and long-term roadmap of capital and non-capital improvement projects



Develop implementation timeline and cost estimates

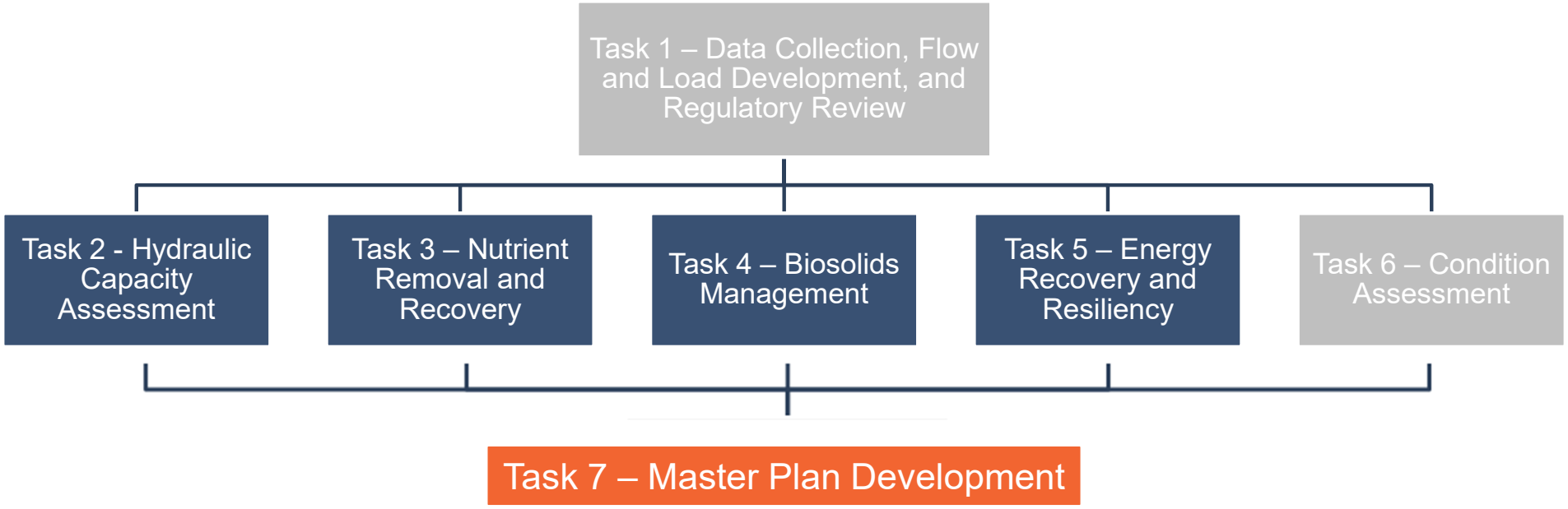


Meet current and anticipated permit requirements



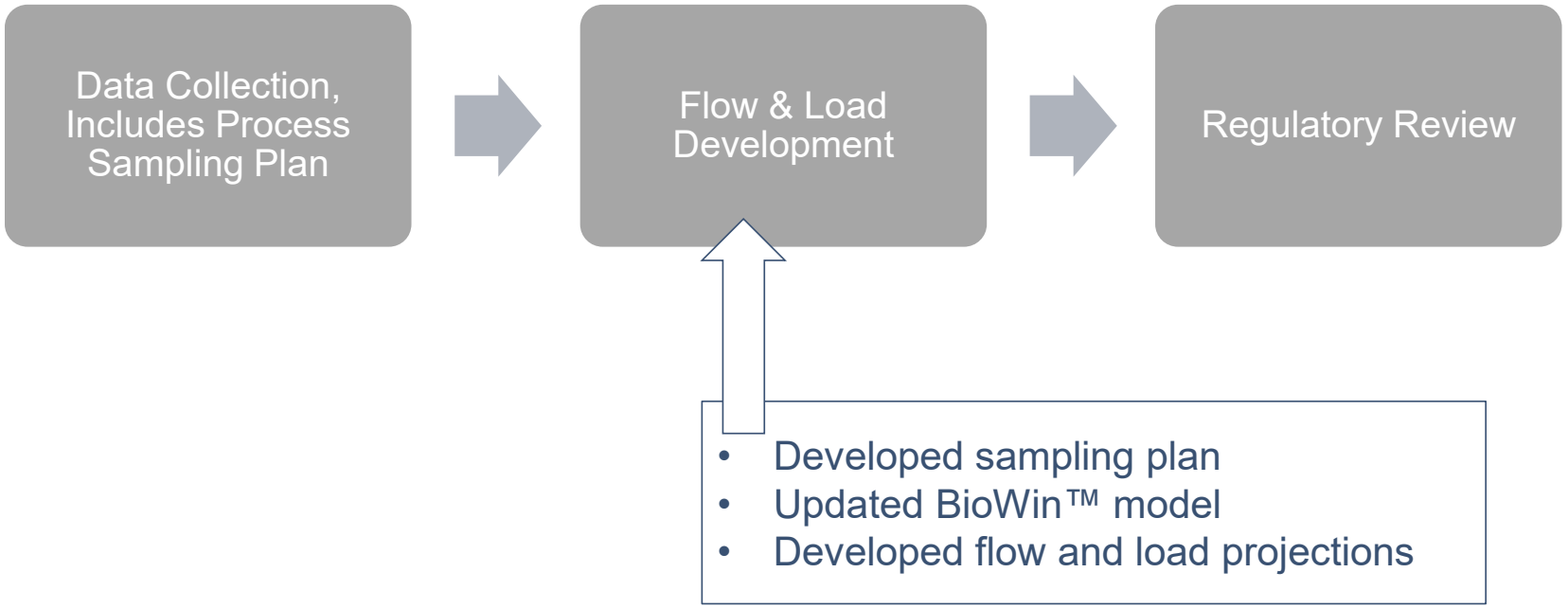
Accommodate future hydraulic and pollutant loading conditions

Master Plan Overview



Task 1 – Data Collection, Flow, Load, and Regulatory Review

Status = Complete



Task 1 Decision Made To-Date

Max Month Avg Day Flows

Year	AADF (mgd)		MMADF Peaking Factor		MMADF (mgd)	Rated Plant Capacity (mgd)
2037	9.52	✖	1.25	=	11.90	14.5
2070	13.49	✖	1.25	=	16.86	18.5

AADF = Annual Avg Daily Flow
MMADF = Max Month Avg Daily Flow

Task 1 Decision Made To-Date

Year	AADF (mgd)	Rated Plant Capacity (mgd)	PHF Peaking Factor	Peak Hour Flow (mgd)
2037	9.52	14.5	4.9	71.1
2070	13.49	18.5	4.9	90.65



Selected hourly peaking factor of 3

Year	AADF (mgd)	Rated Plant Capacity (mgd)	PHF Peaking Factor	Peak Hour Flow (mgd)
2037	9.52	14.5	3	43.5
2070	13.49	18.5	3	55.5

PHF = Peak Hourly Flow

Task 1 Decision Made To-Date – 2037 Loads

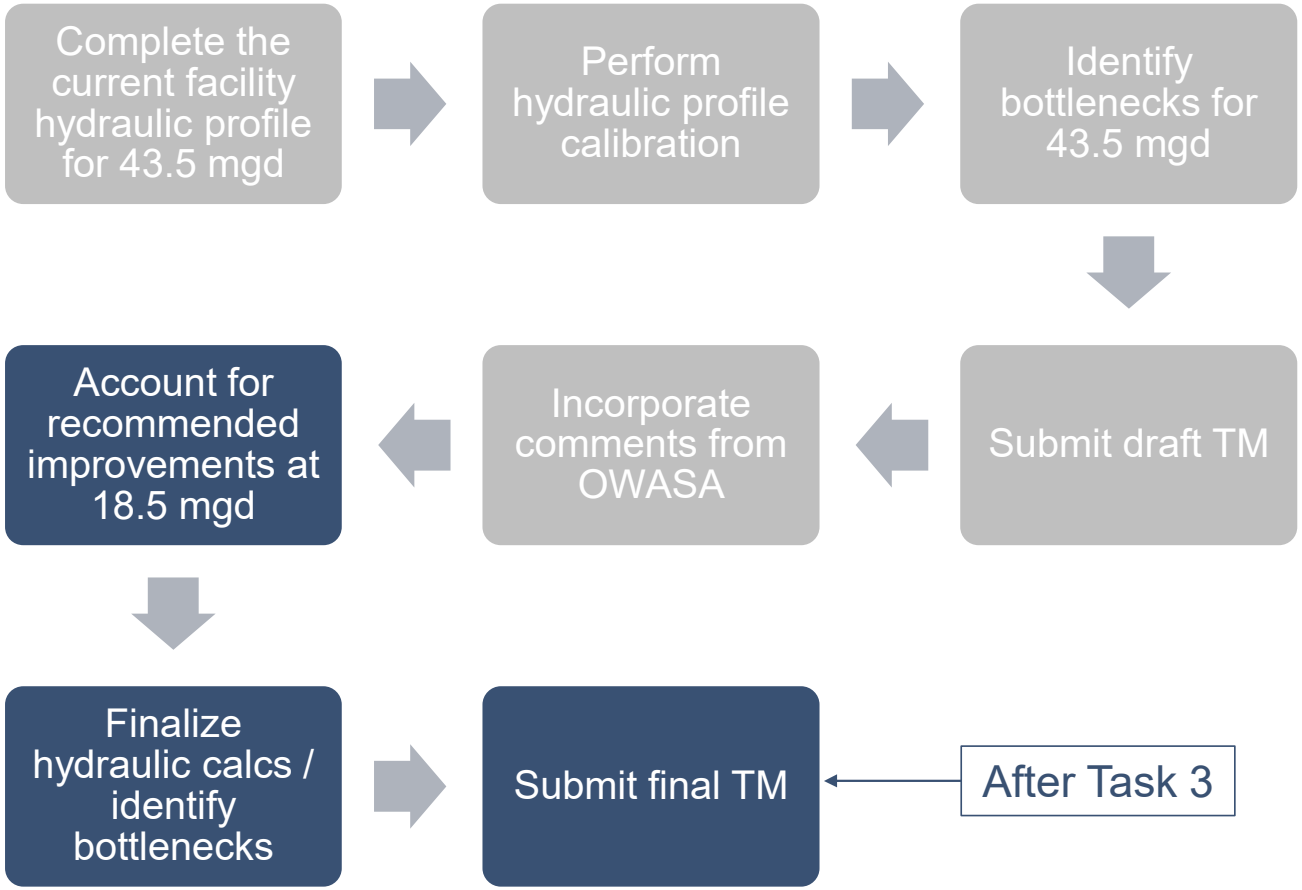
Parameter	$cBOD_5$	COD	TSS	TKN	NH_3-N	TP
AA Concentration (mg/L)	223	392	252	42.5	29.9	6.0
AA Load (ppd)	17,724	31,133	20,052	3,379	2,373	475
MM Load PF	1.3	1.3	1.5	1.3	1.3	1.3
MM Load (ppd)	23,041	40,473	30,077	4,393	3,085	617
MM Concentration (mg/L)	232	408	303	44.2	31.1	6.2

Task 1 Decision Made To-Date – 2070 Loads

Parameter	$cBOD_5$	COD	TSS	TKN	NH_3-N	TP
AA Concentration (mg/L)	223	392	252	42.5	29.9	6.0
AA Load (ppd)	25,105	44,099	28,403	4,786	3,362	673
MM Load PF	1.3	1.3	1.5	1.3	1.3	1.3
MM Load (ppd)	32,637	57,329	42,604	6,222	4,370	874
MM Concentration (mg/L)	232	408	303	44.2	31.1	6.2

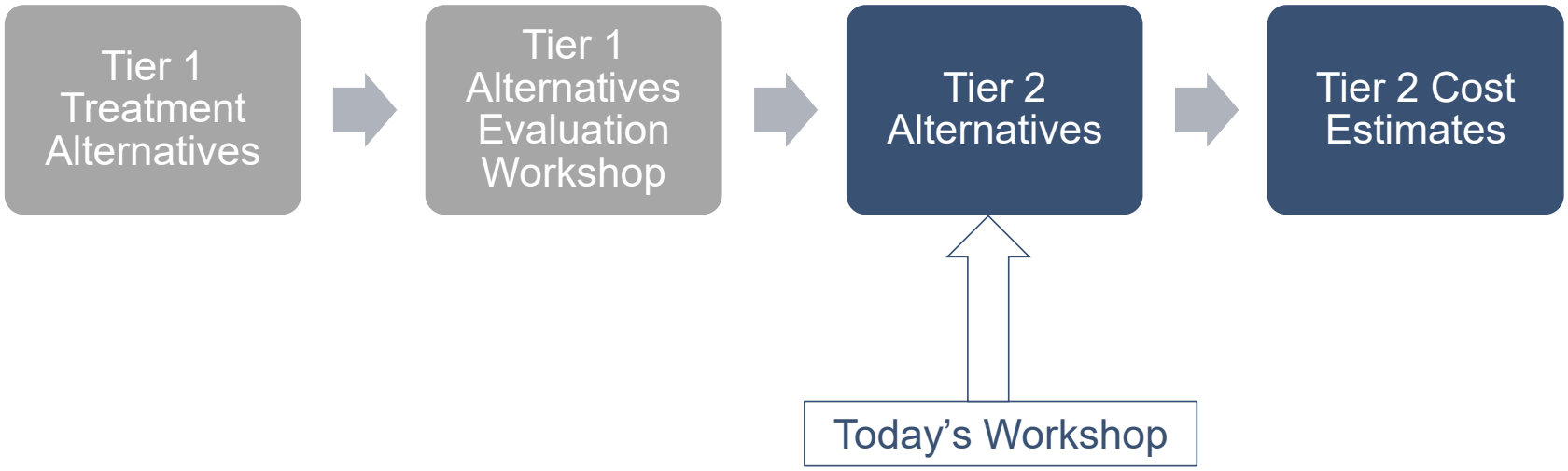
Task 2 – Hydraulic Capacity Assessment

Status = Ongoing



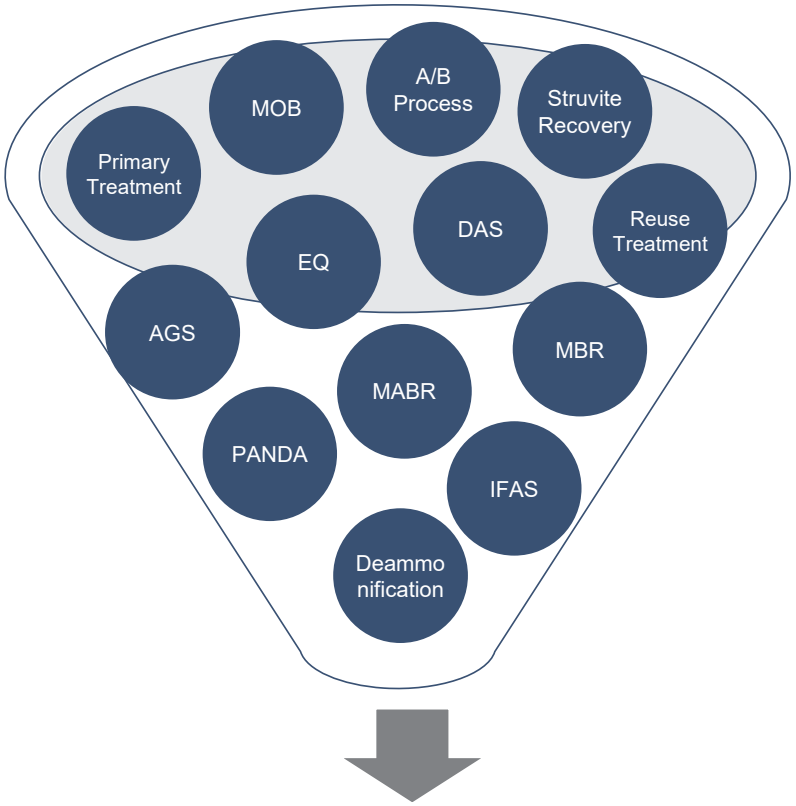
Task 3 – Nutrient Removal & Recovery

Status = Ongoing



Task 3 Overview

- Tier 1 Evaluation
  - **Conceptual level to determine long-term feasibility**
  - **Consider holistic impacts on WWTP**
    - *Effluent quality*
    - *Site implications*
    - *Energy consumption*
    - *Biogas production*
- Tier 2 Evaluation
  - **BioWin modeling**
  - **Cost opinions**
  - **Site plans**



Selected 2 Technologies for Tier 2 Evaluation

Nutrient Removal and Recovery Alternatives

Nutrient Removal Optimization/ Current Process Upgrades

- NRCY
- Acetic Acid Addition
- Ammonia Based Aeration Control (ABAC)
- Filters in Denitrification mode
- RAS/MLSS fermentation

Site Optimization

- On-Site Equalization
- Primary Treatment

Secondary Treatment Intensification

- IFAS
- MBR
- AGS
- DAS - includes inDENSE

Novel Technologies

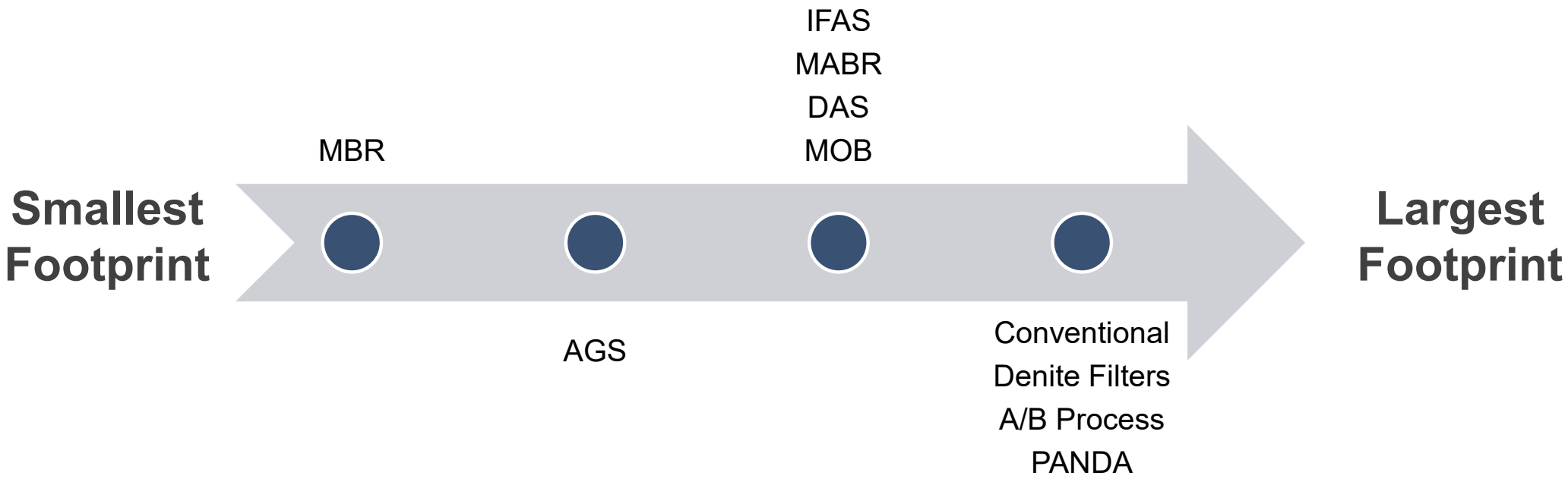
- MABR
- PANDA
- Perlemax/Moleaer
- A/B Process
- NUVODA's MOB

Resource Recovery & Sidestream Treatment

- Sidestream Deammonification
- Sidestream Struvite Recovery
- Chemical Sludge Recycling
- Reuse Treatment Alternatives

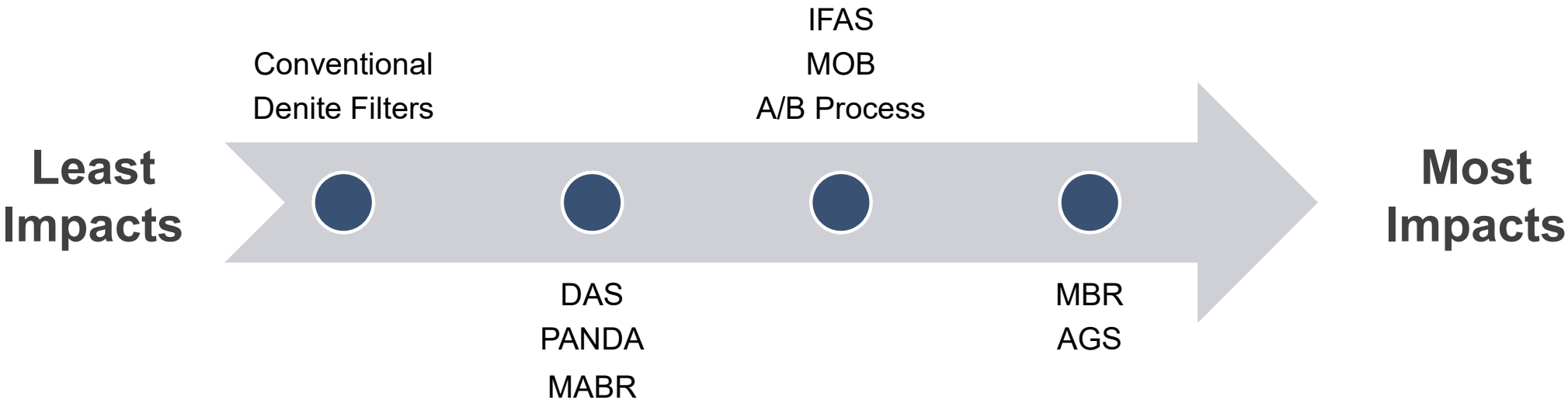
Site Footprint

Slide from Tier 1 Evaluation Workshop



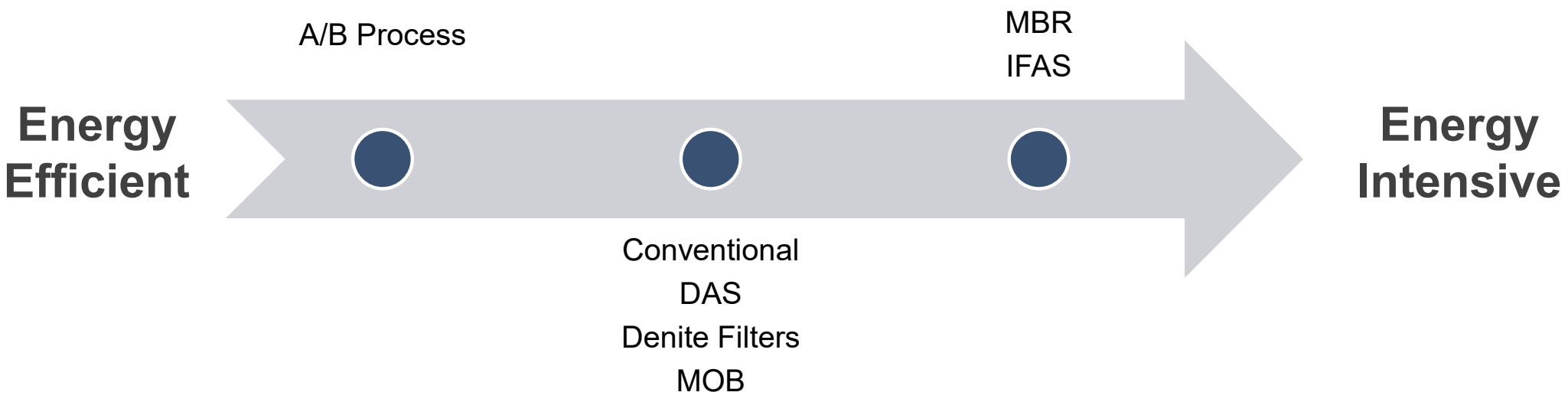
Constructability & Impacts on Operations

Slide from Tier 1 Evaluation Workshop

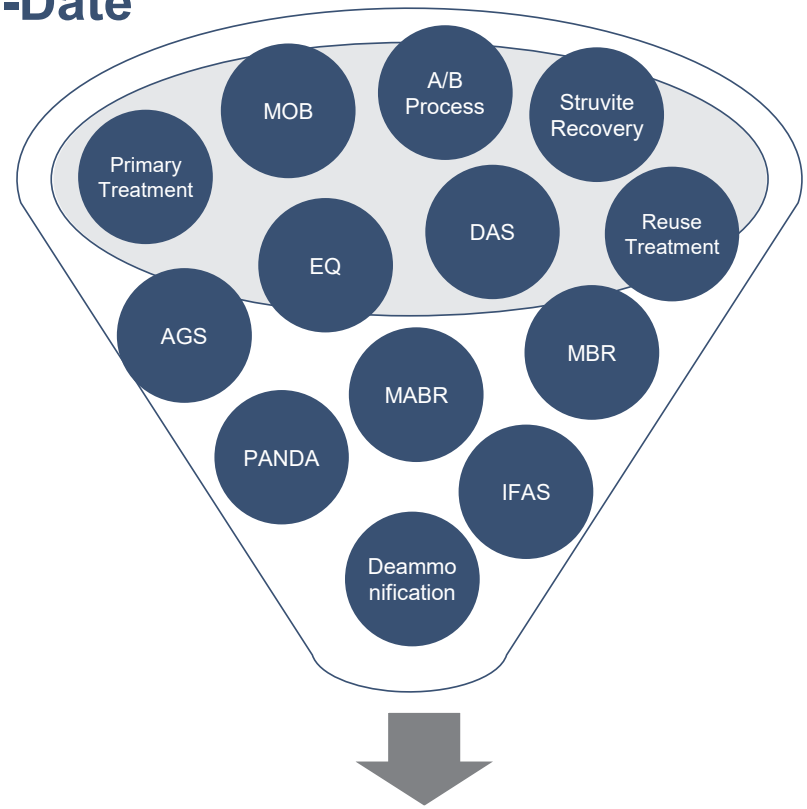


Energy Consumption

Slide from Tier 1 Evaluation Workshop



Task 3 Decision Made To-Date

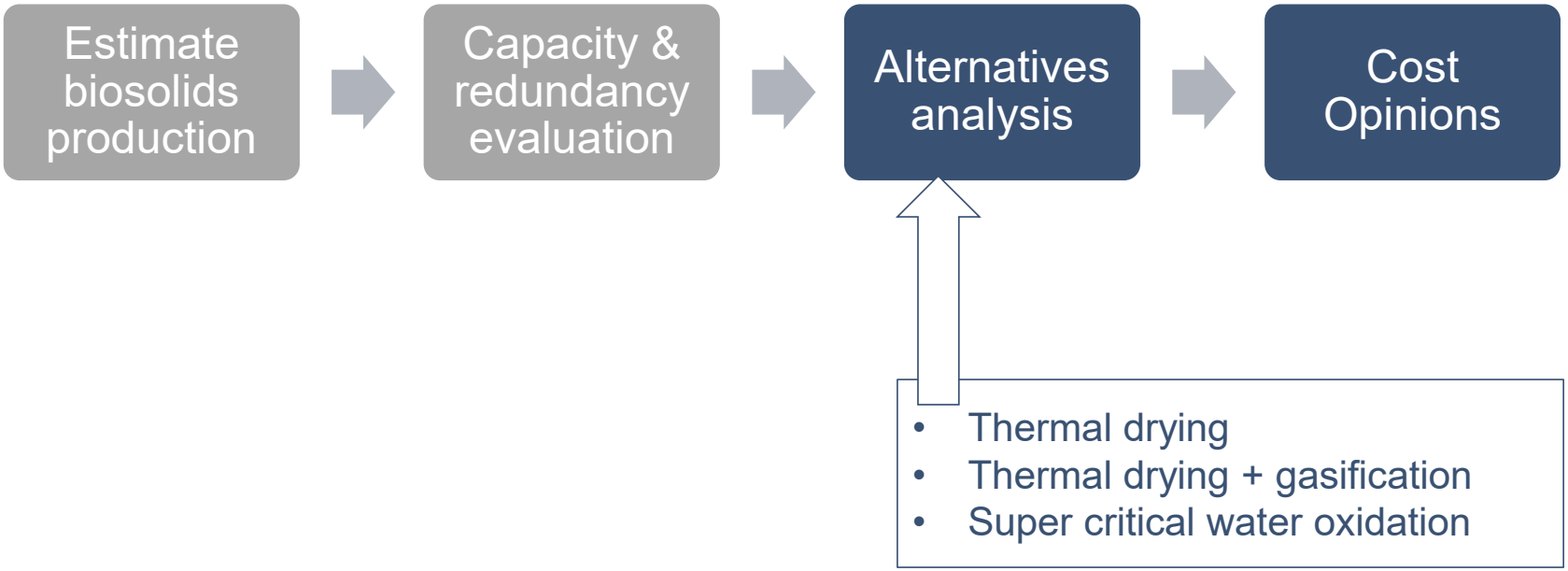


1. Conventional with ABAC & NRCY

2. DAS (Hydrocyclones)

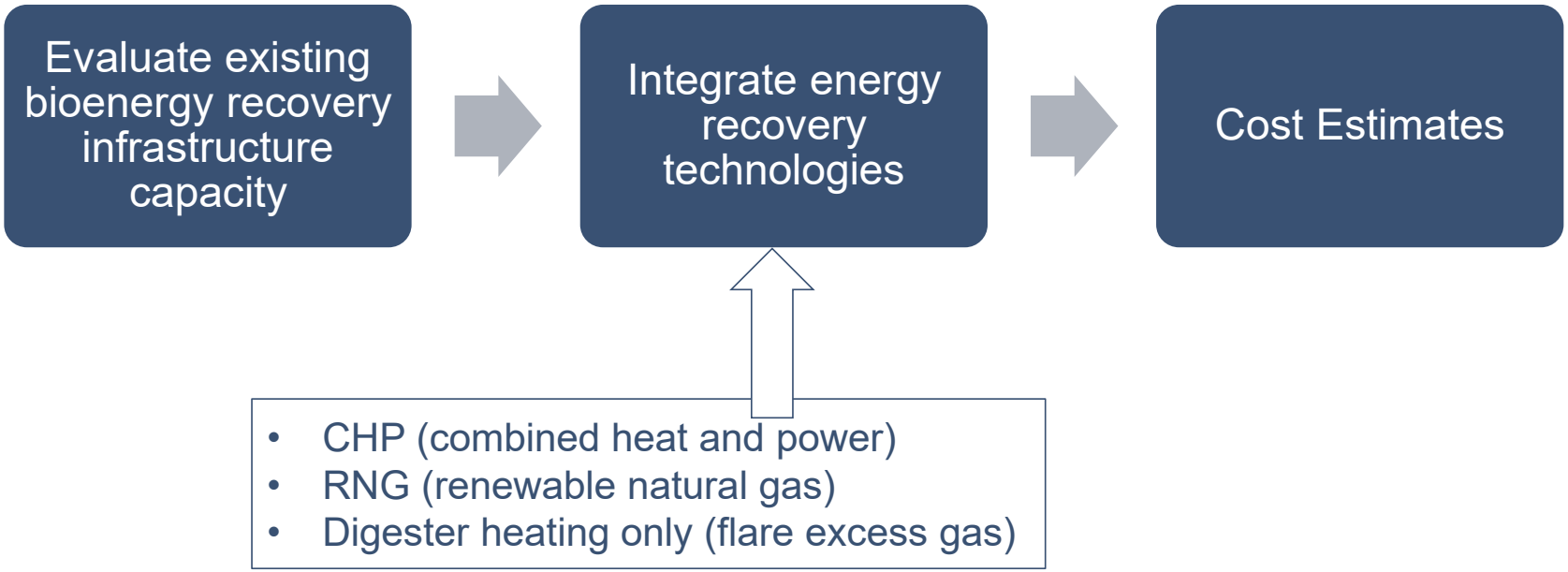
Task 4 – Biosolids Management

Status = Ongoing



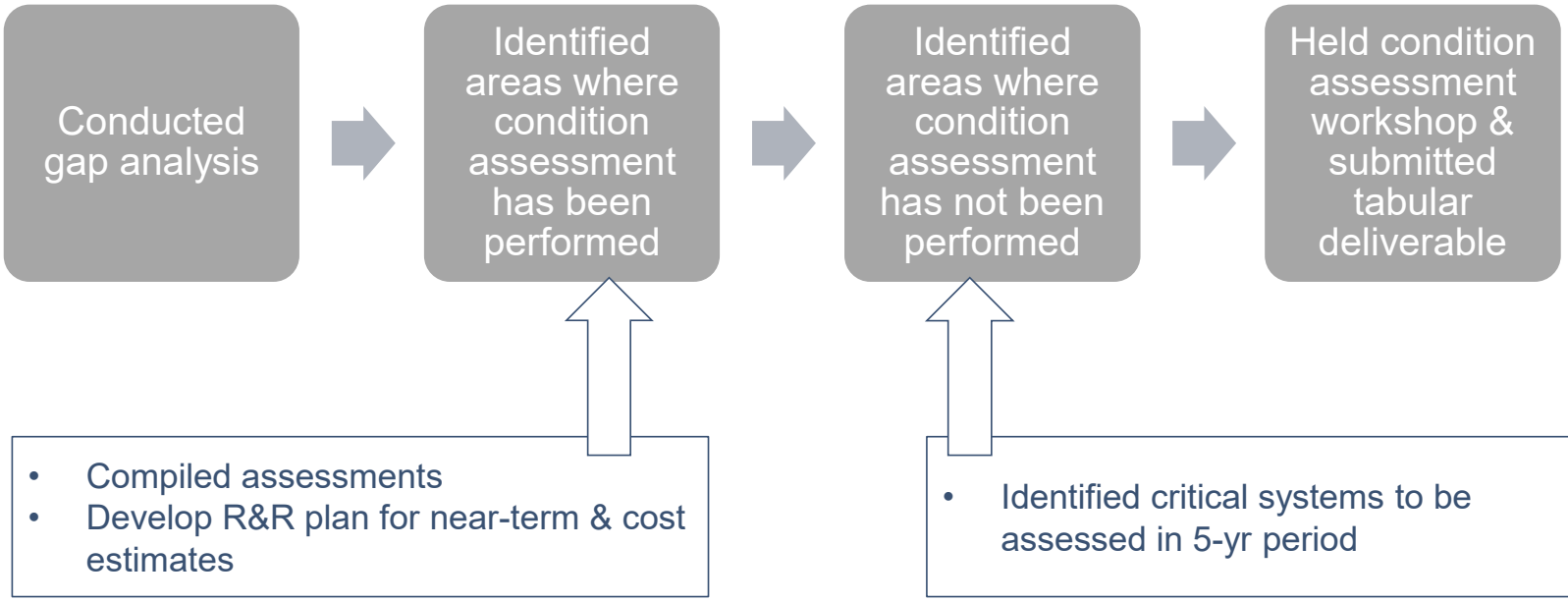
Task 5 – Energy Recovery & Resiliency

Status = Ongoing



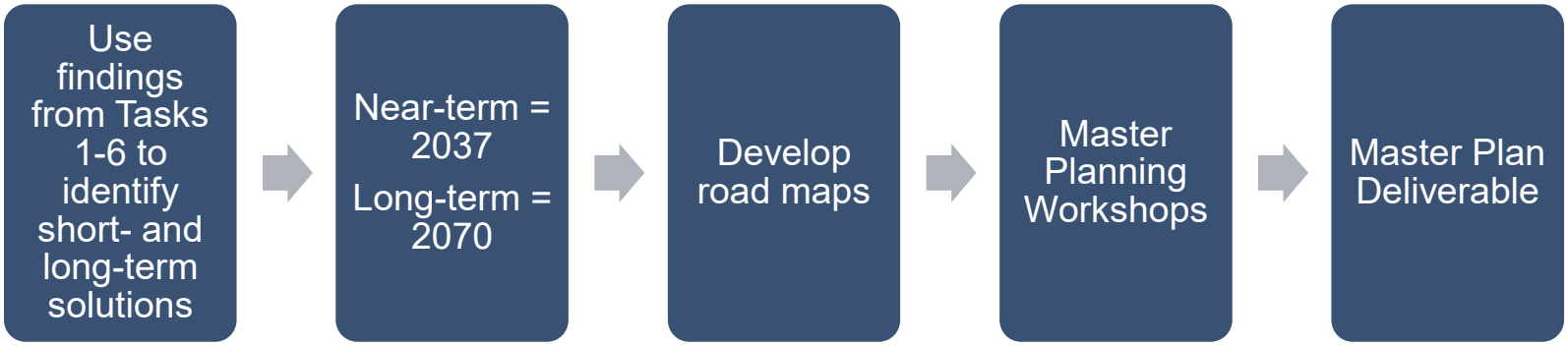
Task 6 – Condition Assessment

Status = Complete

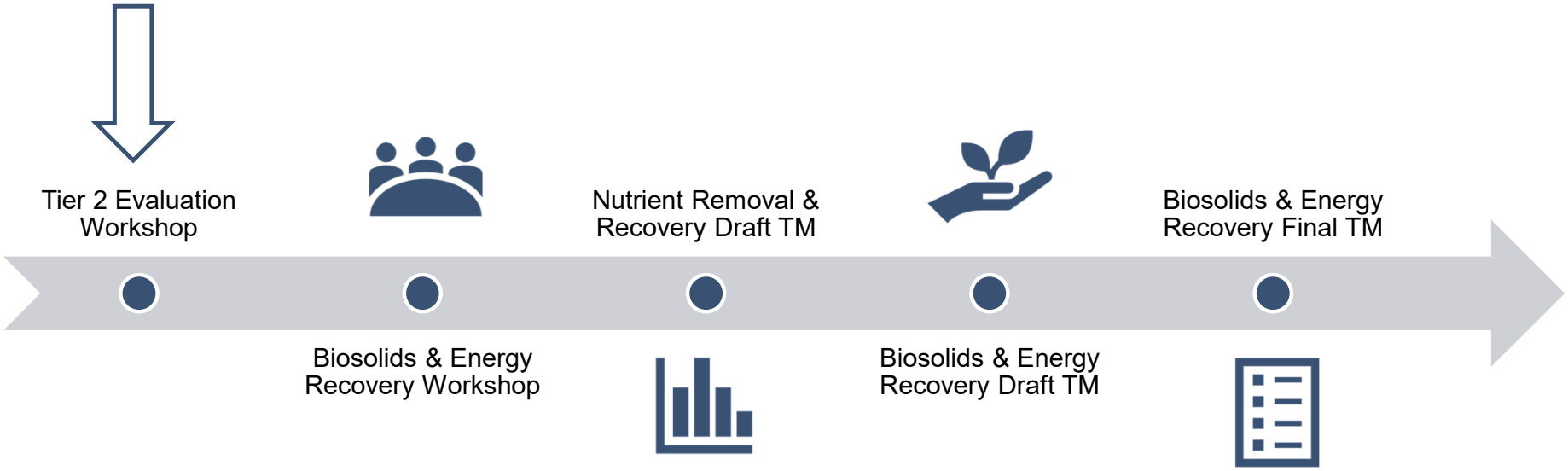


Task 7 – Master Plan Development

Status = Ongoing



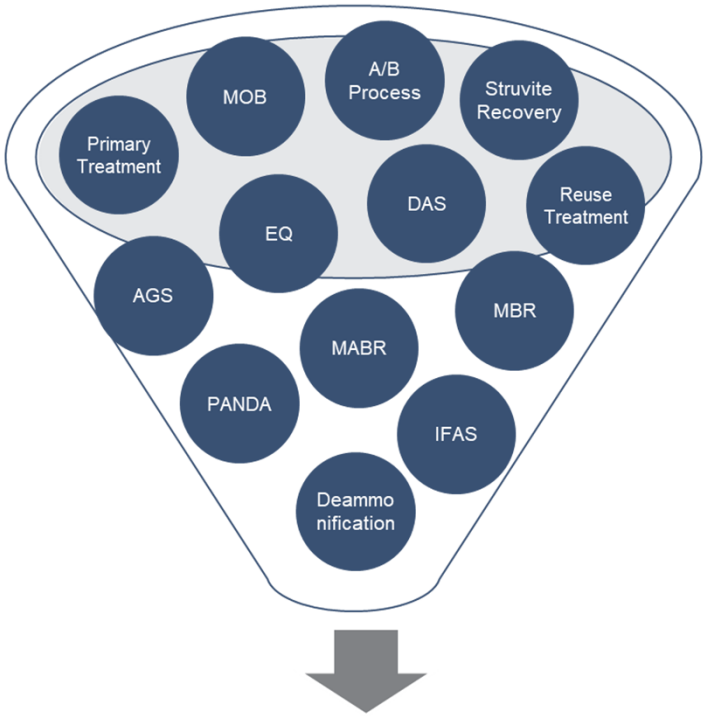
Project Schedule – Next 90 Days



Tier 2 Alternatives Evaluation

Selected Secondary Treatment Alternatives

- Alternative 1: Conventional Treatment with NRCY
- Alternative 2: Densified Activated Sludge (DAS) with Hydrocyclones
- Both alternatives include:
  - **Ammonia Based Aeration Control (ABAC)**
  - **Existing acetic acid addition to NSL Cells**
  - **Existing tertiary filters in denitrification mode**
  - **Existing primary sludge fermentation**



1. Conventional with ABAC & NRCY
2. DAS (Hydrocyclones)

NPDES Nutrient Limits

Near Term

Parameter	Allocation (ppy)	9.5 MGD (mg/L)	11.9 MGD (mg/L)	14.5 MGD (mg/L)
TN	134,375	4.63	3.71	3.04
TP	10,188	0.35	0.28	0.23

Long Term

Parameter	Allocation (ppy)	13.5 MGD (mg/L)	16.9 MGD (mg/L)	18.5 MGD (mg/L)
TN	134,375	3.27	2.62	2.39
TP	10,188	0.25	0.20	0.18

General Steady State Modeling Assumptions

- Modeled Flows:

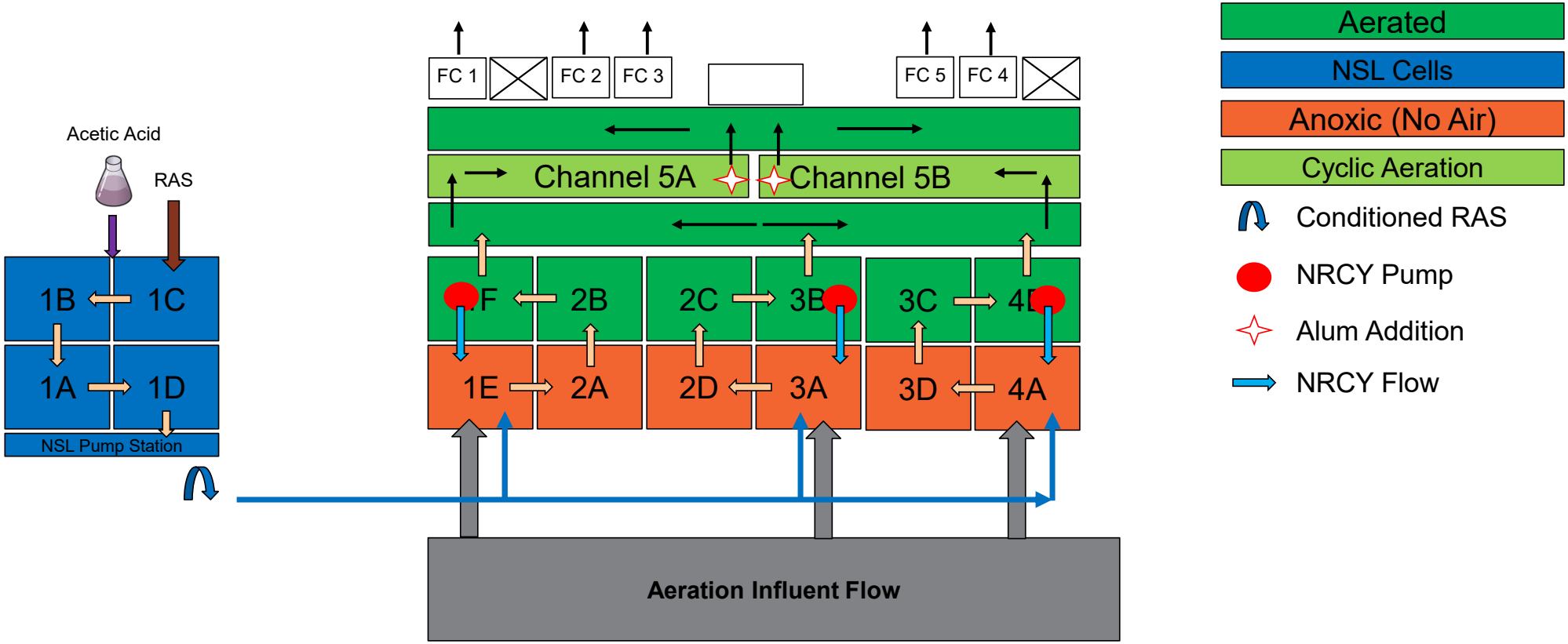
Parameter	Near Term	Current Capacity	Future Buildout
Annual Average Flow (mgd)	9.5	11.6	14.8
Maximum Month Flow (mgd)	11.9	14.5	18.5

- Temperature:
  - **Annual Average = 20ºC**
  - **Min Week Temp for Max Month Conditions = 13ºC**
- Aerobic Solids Retention Time (aSRT):
  - **Annual Average = 6 days**
  - **Maximum Month = 7 days**
- All trains in service
- Conservative AOB growth rate to 0.8/day
- 60% primary clarifier TSS removal
- RAS flow = 1Q
- **Modeled output values do not include denite filter performance**

Alternative 1: Conventional with NRCY

Alternative Configuration – MLE NRCY

Return portion of nitrified flow back to anoxic zone to promote denitrification. No step feed.



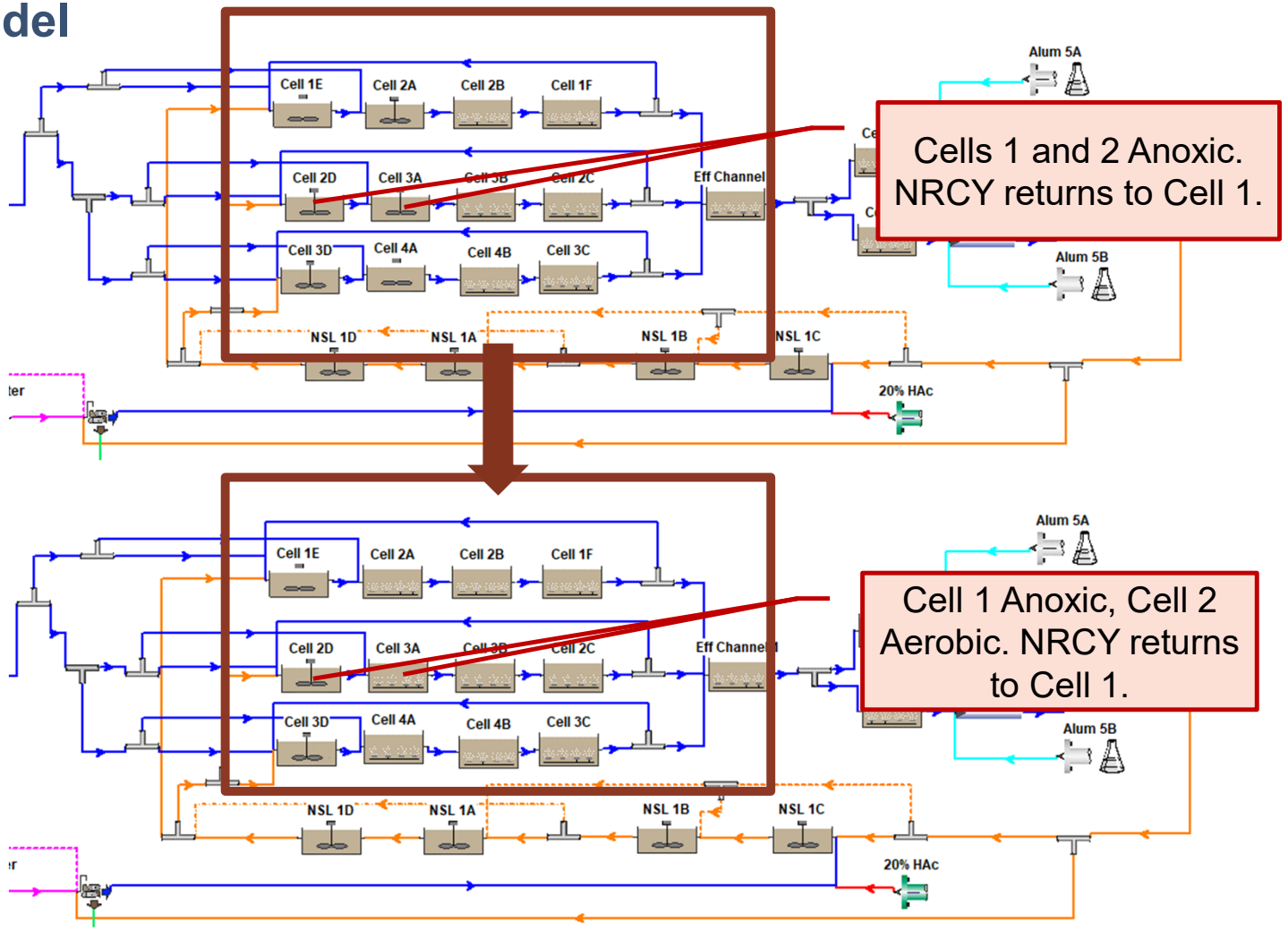
MLE Layout in Model

Annual Average

- NRCY = 3Q

Max Month

- NRCY = 1.5Q



Alternative 2: Densification

What Is Densified Activated Sludge?

Flocculant AS

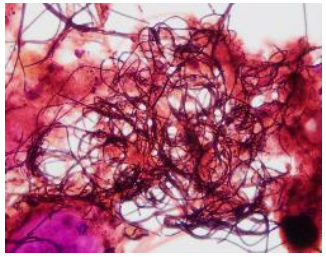
Densified AS

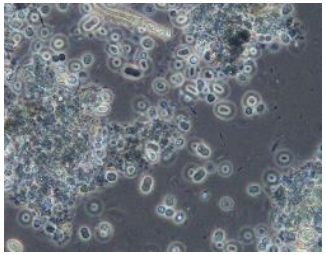
bulking

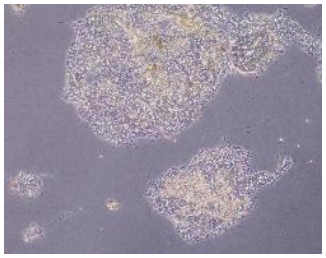
dispersed/non-bulking

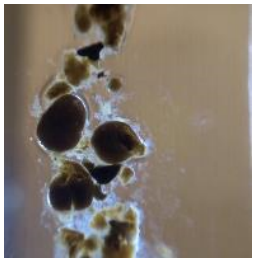
compact

granular









SVI_{30} > 150 mL/g

SVI_{30} ~ 120 to 150 mL/g

SVI_{30} 80 to 120 mL/g

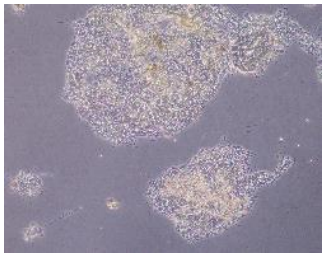
SVI_{30} < 50 mL/g

Continuum of Densification

How Does DAS Compare with Conventional and Granular Sludge?

non-patented AS

Compact AS (non-granular)



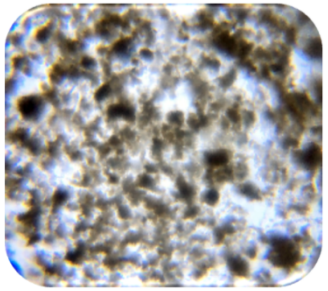
SVI_{30} 80 - 120 mL/g

$SVI_{10} > SVI_{30}$

Operating MLSS ~ 3,000 mg/L

non-patented AS

Densified AS (non-granular)



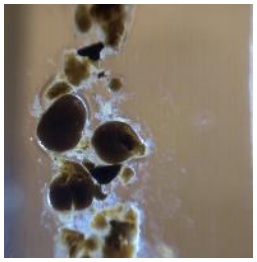
$SVI_{30} < 80$ mL/g

$SVI_{10} \sim SVI_{30}$

Operating MLSS ~ 5,000 – 6,000 mg/L

AquaNereda®

Densified AS (granular)

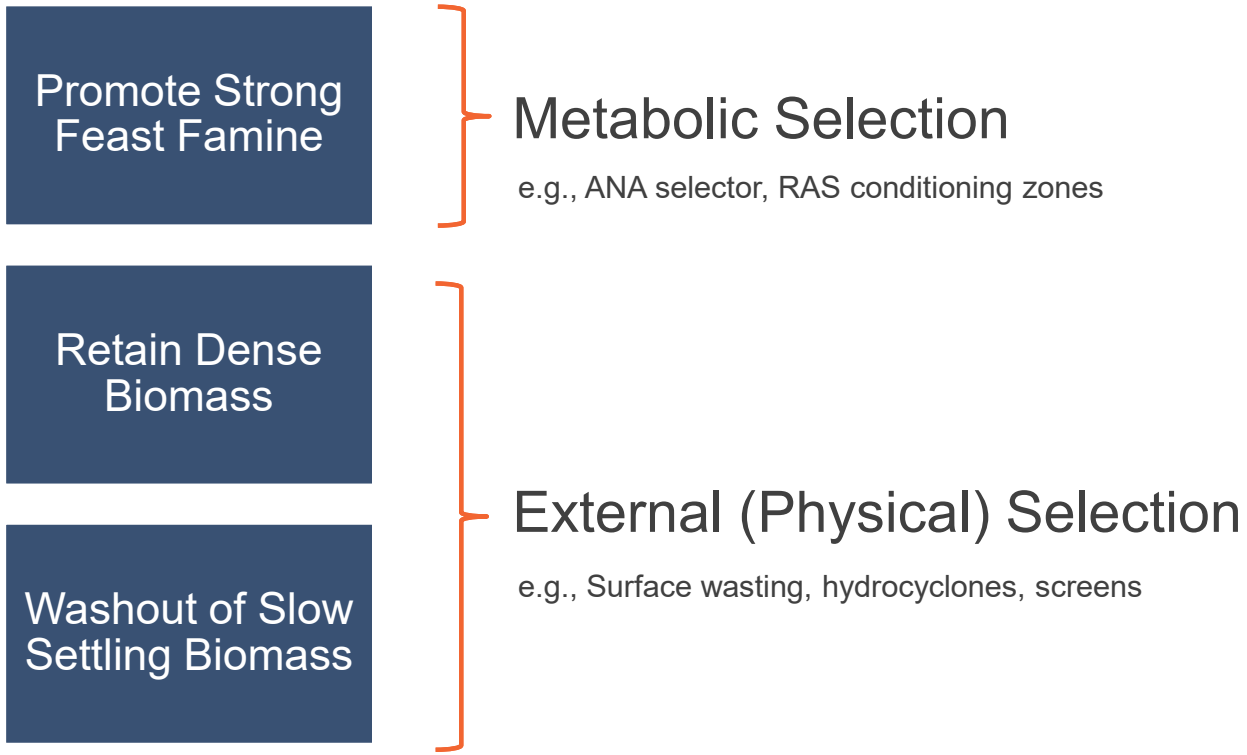


$SVI_{30} < 50$ mL/g

$SVI_5 \sim SVI_{30}$

Operating MLSS ~ 8,000 mg/L

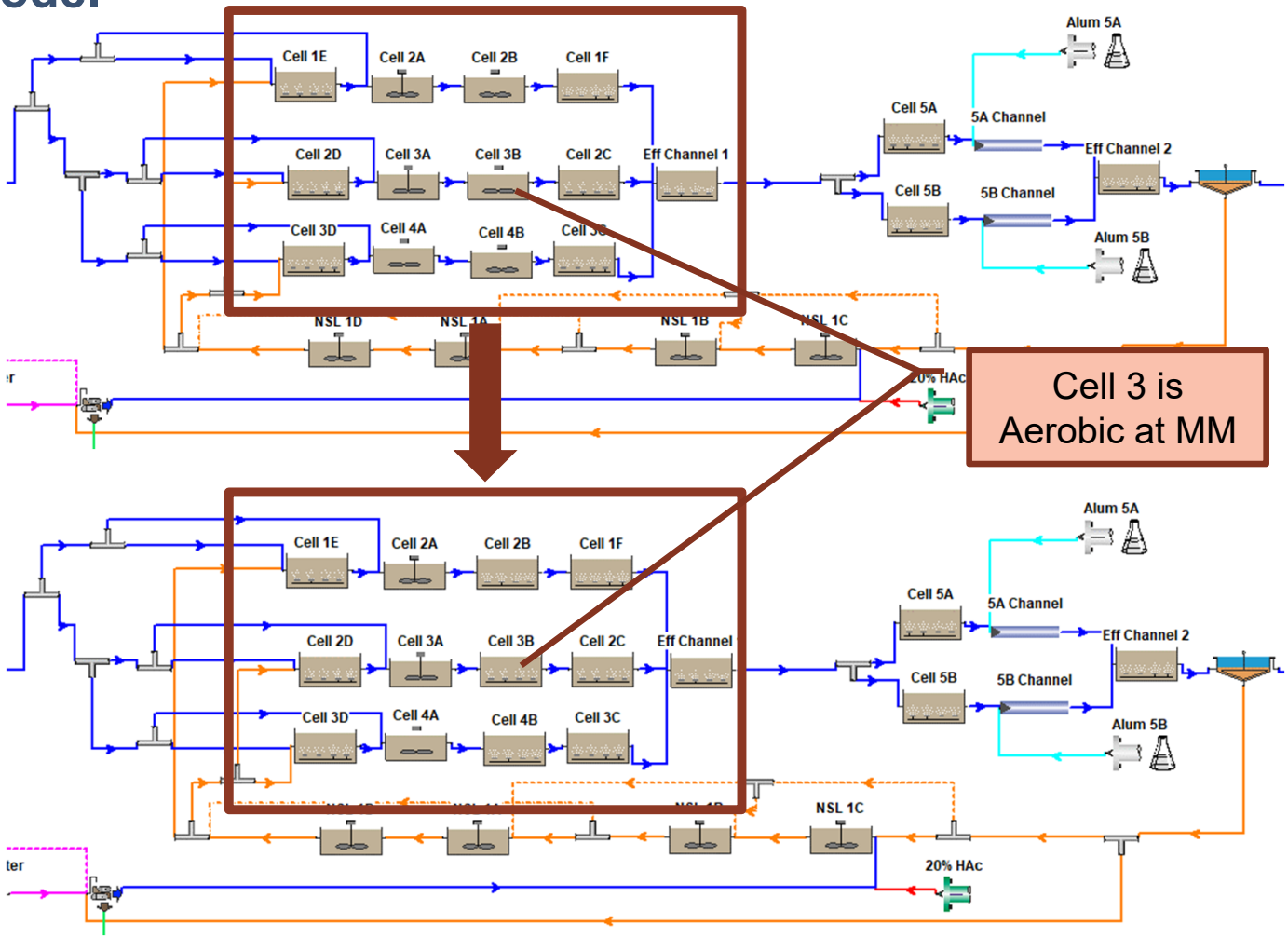
What are the Ingredients to Achieve Densified Activated Sludge (DAS)?



Basin Layout in Model

Annual Average

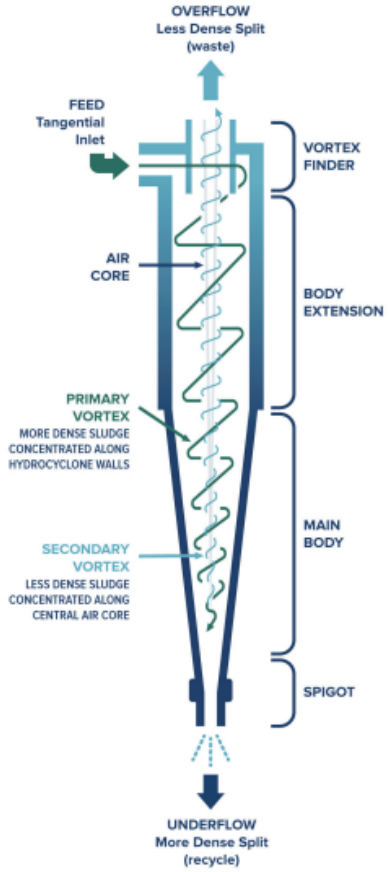
Max Month



Hydrocyclones for Densification

inDENSE Technology by WorldWaterWorks

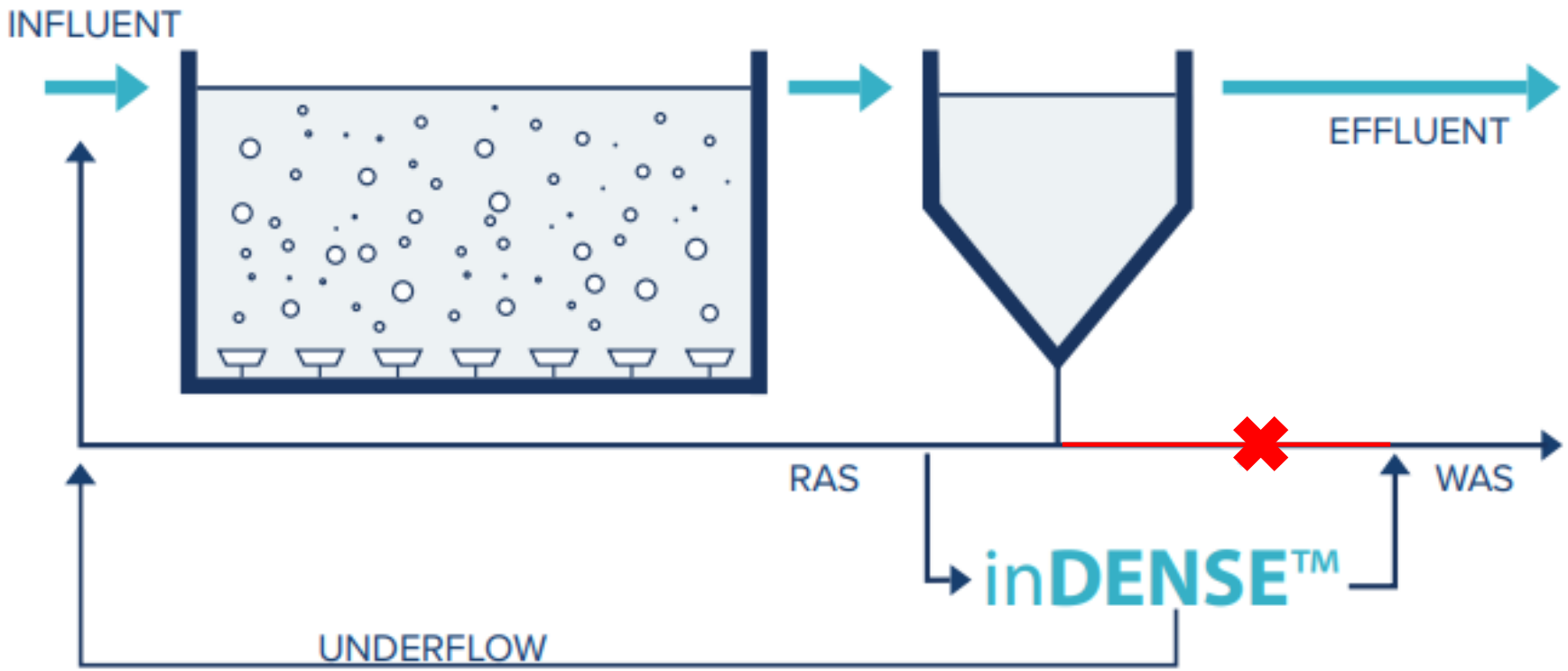
- Gravimetric selection technology for retaining denser biomass while wasting the light fraction of mixed liquor
- Increased density of sludge improves settling characteristics
  - **This allows for prevention of biomass loss & treatment disruption, especially in wet weather scenarios**
- Low capital cost investment to improve settleability





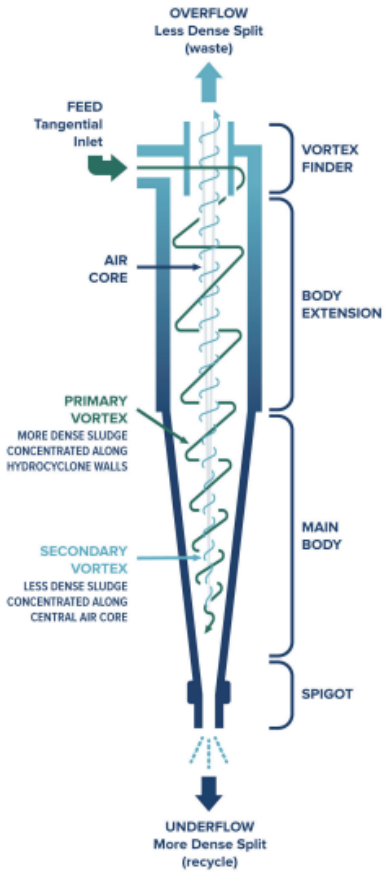
Hydrocyclones for Densification

inDENSE Technology by WorldWaterWorks



Hydrocyclone Design Considerations

- Pair hydrocyclones with biological selective pressures to produce better settling sludge
- Hydrocyclones require 35 psi of inlet pressure in order to operate properly
  - **Max and min bounds of 40 psi and 30 psi, respectively**
  - **Overpressure alarm at 37 psi**
  - **Will increase size of WAS pumps required to meet pressure rating.**
- Hydraulic break required for the overflow and underflow before being pumped
- Prefer to have underflow flow by gravity over being pumped
- Would waste all mass through hydrocyclones (24-hour wasting)



Hydrocyclone Design Criteria

- Hydrocyclone capacity of 10 m^3/hr (44 gpm)
- Flow split of 80% overflow, 20% underflow
- Conservative mass split design of 50% overflow to 50% underflow due to observed variability
  - **World Water Works designs based off 65% overflow, 35% underflow**
- Required mass wasting will all be through hydrocyclone overflow
- Want constant flow to hydrocyclones

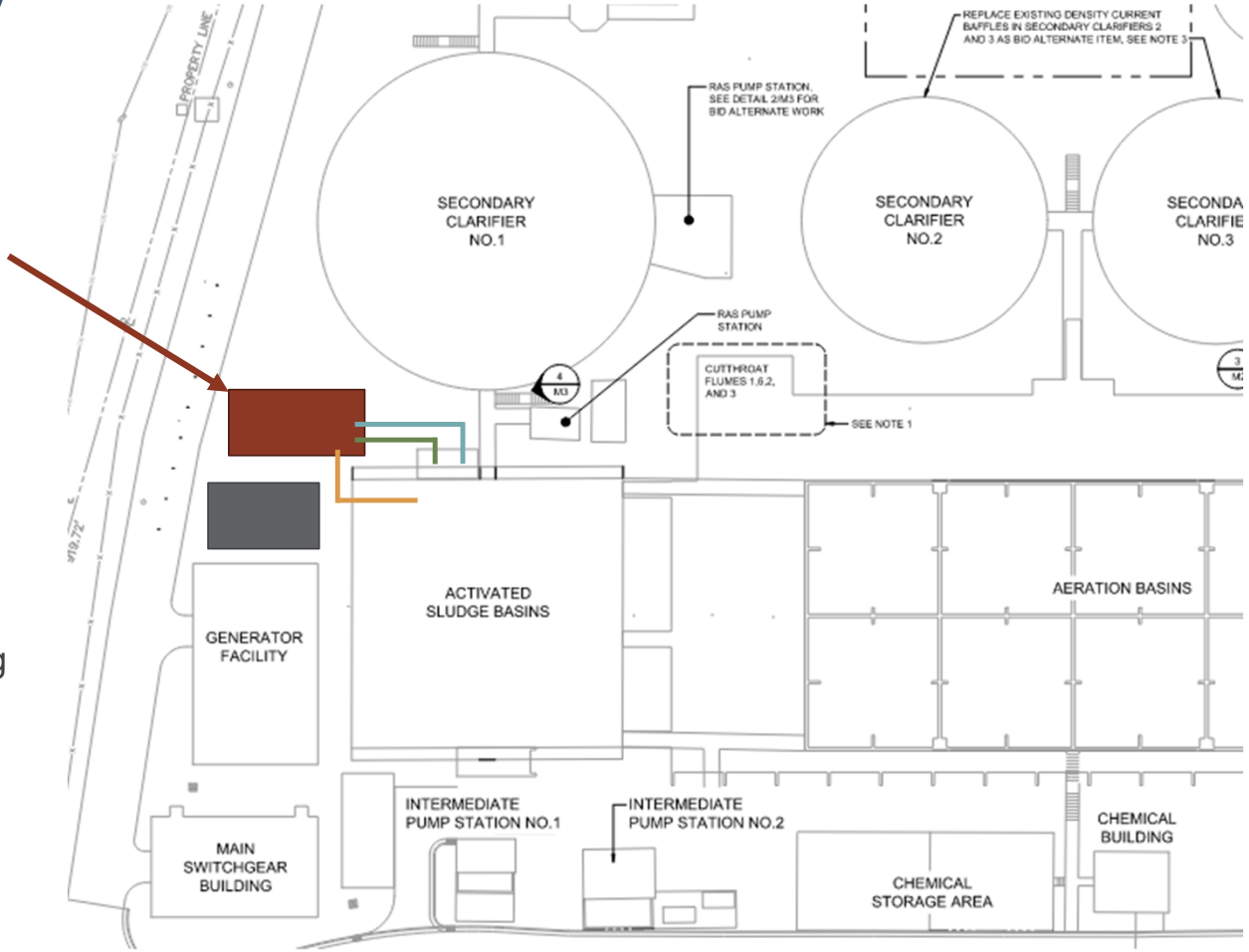
Parameter	Near Term		Current Capacity		Buildout Capacity	
	AA	MM	AA	MM	AA	MM
WAS Flow, mgd	0.19	0.21	0.19	0.21	0.19	0.21
WAS TSS, mg/L	6,620	7,850	8,180	9,780	11,060	13,100
WAS TSS Load, ppd	10,430	13,820	12,890	17,210	17,160	22,500

Hydrocyclone Design

Parameter	Near Term		Current Capacity		Buildout Capacity	
	AA	MM	AA	MM	AA	MM
WAS Flow, gpm	131	147	131	147	129	143
WAS TSS, mg/L	6,620	7,850	8,180	9,780	11,060	13,100
WAS TSS Load, ppd	10,430	13,820	12,890	17,210	17,160	22,500
No. of Duty Hydrocyclones	**6**	**7**	**6**	**7**	**6**	**7**
Hydrocyclone Feed Flow, gpm	263	293	263	293	258	286
Hydrocyclone Overflow Flow, gpm	210	234	210	234	207	229

Hydrocyclone Facility

- Proposed Hydrocyclone Facility would be located next to the NSL basins
- Two-story building
  - **Top floor houses the hydrocyclones and electrical room**
  - **Bottom floor houses new hydrocyclone feed pumps, overflow wet well, and WAS pumps**
- Underflow would flow back to NSLs by gravity
- Overflow would be pumped into existing WAS system



Alternatives Comparison

NRCY vs Step-Feed Performance

Excludes denitrification via the filters

	MLSS[1] (mg/L)		NH3-N (mg/L)		NOx-N (mg/L)	
Scenario	**NRCY**	**Step-Feed**	**NRCY**	**Step-Feed**	**NRCY**	**Step-Feed**
Near Term AA	3,660	3,280	0.08	0.12	7.5	10.0
Near Term MM	4,250	3,900	0.23	0.23	11.4	13.2
Current Capacity AA	4,570	4,060	0.08	0.13	7.6	10.3
Current Capacity MM	5,270	4,860	0.26	0.28	11.6	13.6
Future Buildout AA	6,140	5,500	0.08	0.14	7.9	10.5
Future Buildout MM	7,090	6,520	0.29	0.37	11.7	14.4

[1]Model runs completed at same aSRT.

NRCY vs Step-Feed Performance

Excludes denitrification via the filters

	TN (mg/L)		TP (mg/L)		SLR[1] (lb/ft^2-d)	
Scenario	**NRCY**	**Step-Feed**	**NRCY**	**Step-Feed**	**NRCY**	**Step-Feed**
Near Term AA	8.8	11.4	0.26	0.32	12.1	10.8
Near Term MM	12.8	14.6	0.26	0.27	17.6	16.1
Current Capacity AA	8.9	11.6	0.29	0.29	18.4	16.3
Current Capacity MM	13.1	15.1	0.22	0.22	26.5	24.5
Future Buildout AA	9.2	11.8	0.24*	0.21	31.5	28.2
Future Buildout MM	13.3	16.0	0.24*	0.21*	45.5	41.9

[1]SLR assumes existing 5 clarifiers online

NRCY vs Step-Feed Performance

Comparing Alum Usage

- Caustic held constant at 3,000 gpd
- Acetic Acid to NSLs held constant at 1,800 gpd

Scenario	Flow (mgd)	NRCY Total Alum (gpd)	Densification Total Alum (gpd)
Near Term AA	9.5	1,000	1,000
Near Term MM	11.9	1,600	1,500
Current Capacity AA	11.6	1,600	1,500
Current Capacity MM	14.5	2,300	2,200
Future Buildout AA	14.8	2,600*	2,600
Future Buildout MM	18.5	3,400*	3,400*

What is the Maximum MLSS passable based on flow and SVI?

Assumptions for State Point Analysis

- All clarifiers online at MM flow and peak flow
  - **Peak Flow Peaking Factor = 3.0**
- RAS at 100% of forward flow at maximum month conditions
- RAS at 100% of pump capacity at peak flows
- Clarifier 6 would be same diameter as Clarifier 1 (120 ft)
- Flow Splits With and Without Clarifier 6 Online:

1	2 & 3	4	5
23.5%	23.6%	19.8%	33.1%

1	2 & 3	4	5	6
19.0%	19.1%	16.0%	26.8%	19.0%

Parameter	2020 SVI30
Average	86.5
50^{th}	84.0
80^{th}	98.3
90^{th}	102
95^{th}	110
50^{th}:90^{th}	0.82

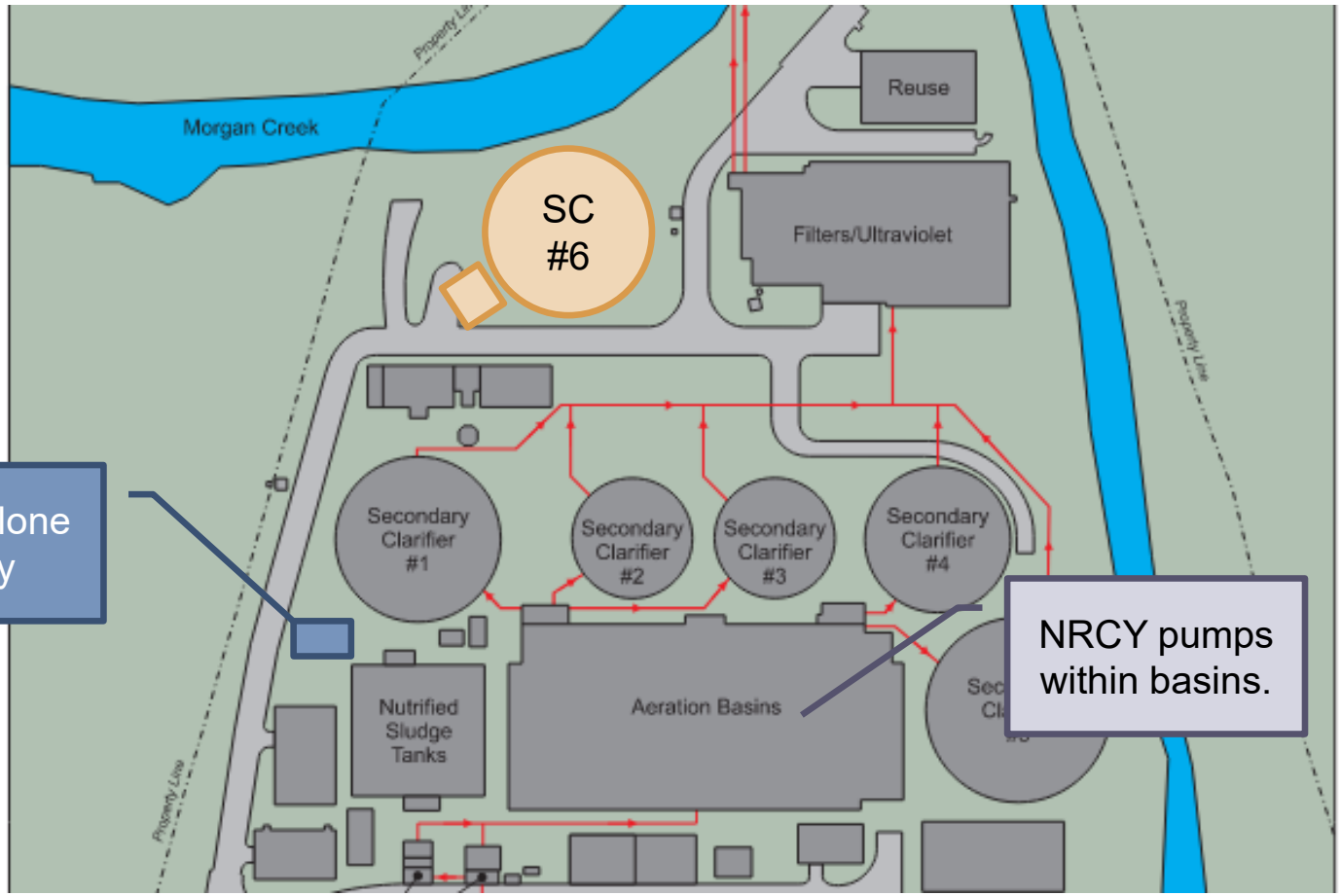
What is the Maximum MLSS Passable Based on Flow and SVI?

1. Reducing SVI_{30} to 80 mL/g from 110 mL/g increases the acceptable MLSS concentration by approximately *28%* based on state point analysis (SPA).
2. Wet weather (3Q peak) significantly reduces the limiting MLSS concentration.
3. The sixth clarifier provides an approximate 5% to 15% capacity increase, with the larger impact during wet weather.

Total Flow (mgd)	Clarifiers	SVI_{30} = 110 mL/g	SVI_{30} = 80 mL/g
14.5	5	5,900	7,600
43.5	5	3,200	4,100
14.5	6	6,300	8,000
43.5	6	3,700	4,700
18.5	6	5,900	7,500
55.5	6	3,100	4,000

Note: MLSS based on SPA, would not necessarily push values this high in application.

Alternatives Site Plan



Hydrocyclone Facility

NRCY pumps within basins.

Capital Cost Opinion – What is Included in Each Alternative

Alternative 1: NRCY

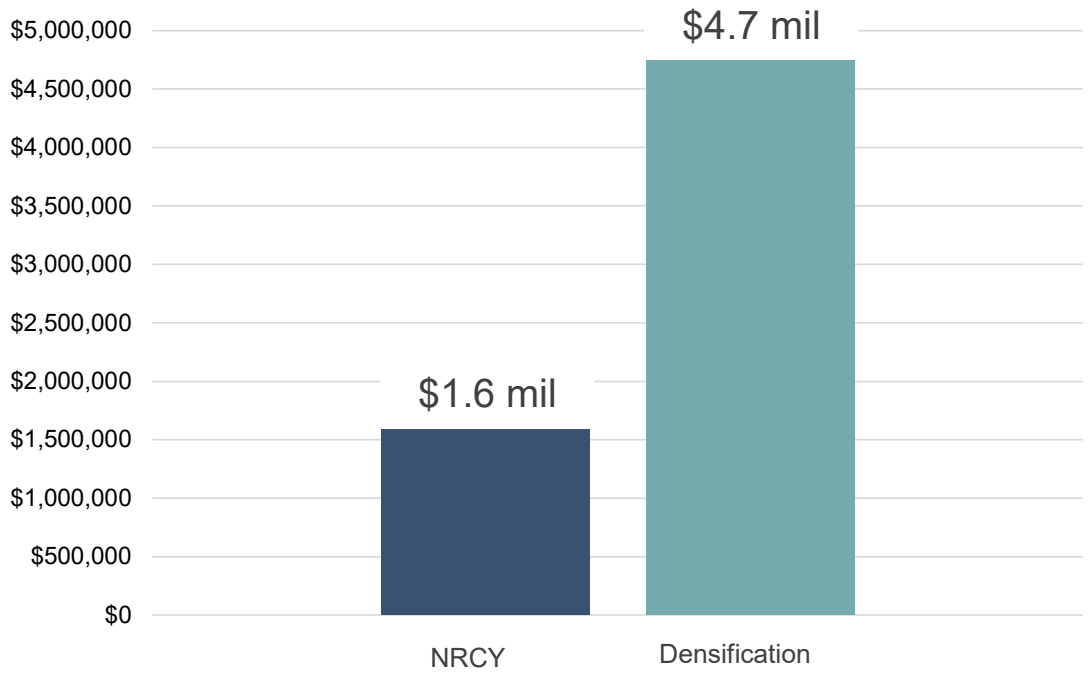
- NRCY Pumps
- Coring of wall between last cell and first cell in AB trains
- Pipe between cells for NRCY conveyance
- Additional wall penetrations with isolation gates between cells to accommodate additional headloss due to increased flow from NRCY

Alternative 2: Densification

- Demo and sitework for new structure
- New building for hydrocyclones and pumps
- Hydrocyclones & feed pumps
- New wet well and pumps for cyclone overflow
- Piping to and from cyclones
- Instrumentation for pump control

- Since both alternatives include ABAC, the following items were not included in cost opinions:
  - **Ammonia wet chemistry analyzer & appurtenances**
  - **Ammonia ISE probes**
  - **DO probes**
  - **Controllers for instrumentation**

Capital Cost Opinion



- Both alternatives include:
  - 15% Electrical I/C
  - 5% General Conditions
  - 15% Contractor OH&P
  - 2% Bonds and Insurance
  - 40% Contingencies
  - 1% Preliminary Engineering
  - 9% Design and Bidding
  - 10% Construction Management

Multi-Criteria Decision Analysis



Core Objectives

- Meeting NPDES permit requirements
- Future regulations of emerging contaminants
- Meeting reclaimed water requirements
- Operate within existing property boundary for the next 50 years
- Preparation for more frequent and larger storms
- Energy savings

Potential Criteria

- Technology reliability
- Ease of operation
- Ease of expansion (constructability)
- Resiliency to wet weather (climate change)
- Site footprint
- Leveraging existing assents
- Lifecycle cost

Hazen Converge Qualifying Points for Each Criteria

- Technology Reliability
  - **Will it provide COMPLETE treatment?**
  - **Will it provide CONSISTENT/REPEATABLE effluent quality?**
  - **Reliability in long term**
- Ease of Operation
  - **Does alternative increase treatment complexity? If so, how much?**
  - **Does alternative increase typical maintenance requirements? If so, how much?**
- Ease of Construction
  - **Will alternative have complex MOPO associated with expansion?**
  - **Will alternative have complicated design & constructability issues?**
- Resiliency to Wet Weather
  - **Does alternative provide increase in treatability and a reduction in risk during high flow events?**
- Site Footprint
  - **Does the alternative require a large footprint?**
  - **Does the alternative leave available space for advanced treatment?**
- Leveraging Existing Assets
  - **Does alternative utilize existing infrastructure to minimize impact to site footprint?**
  - **Does alternative utilize existing infrastructure to minimize capital costs?**
- Life Cycle Cost
  - **Capital & O&M Costs**

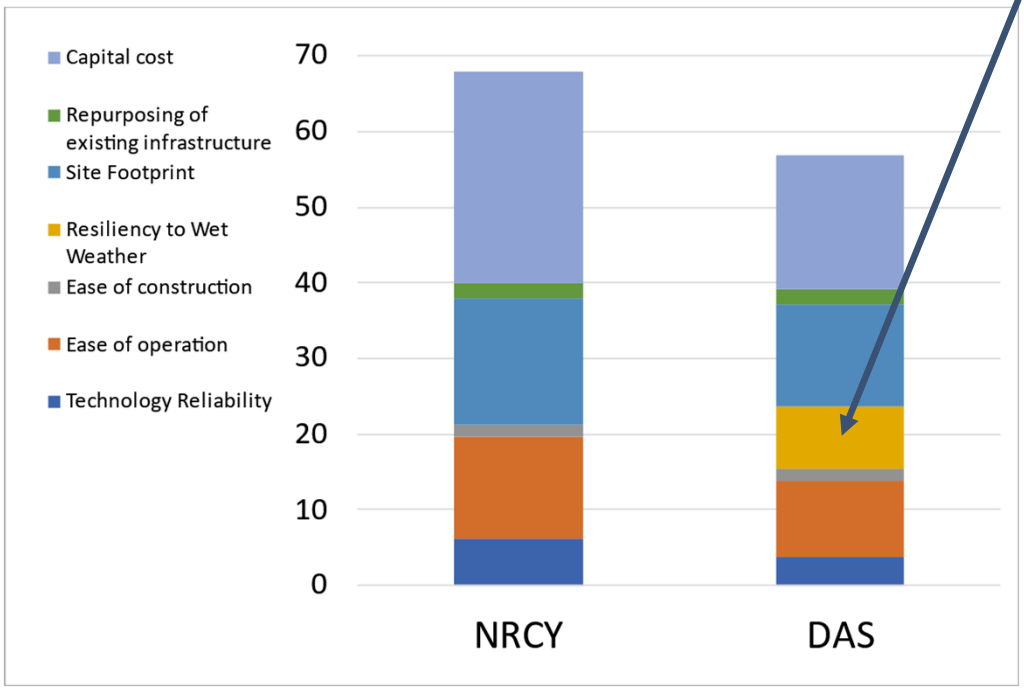
Criteria for Tier 2 Evaluation

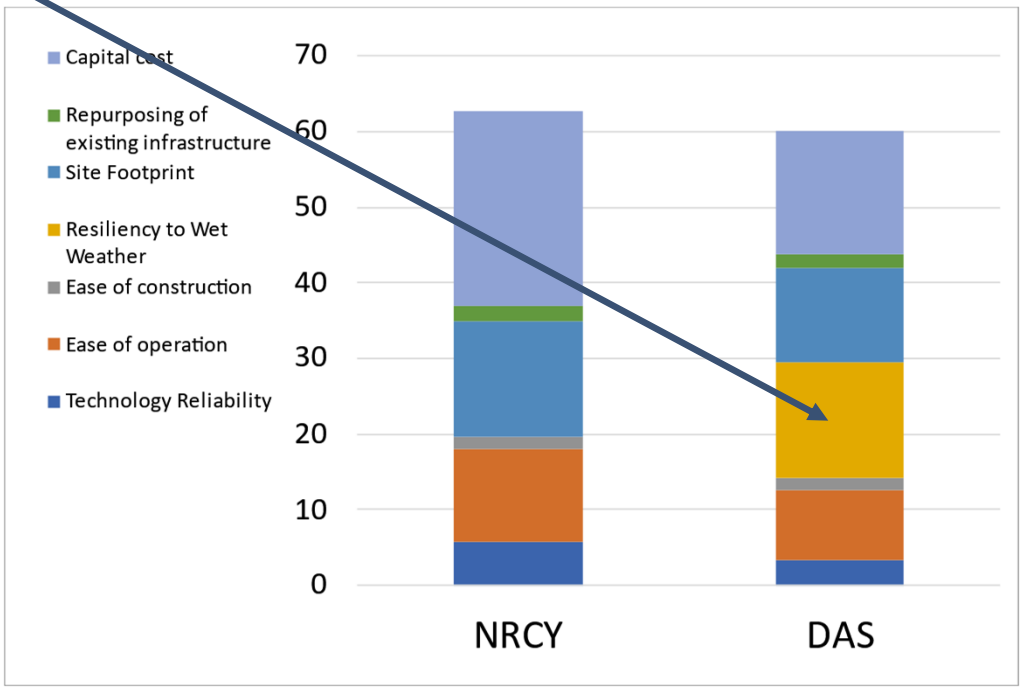


Criteria	User-Assigned Weighting
Technology Reliability	20
Ease of Operation	20
Ease of Constructability	5
Resiliency to Wet Weather (Ability to Accommodate Peak Flows)	10
Site Footprint	20
Leverage Existing Assets	5
Life Cycle Cost (Include Relevant Capital Cost, Energy Use, & Chemical Use)	40

Results Vary Based on Criteria Weighting

Changing the relative criteria weight of resiliency to wet weather equalizes the alternatives

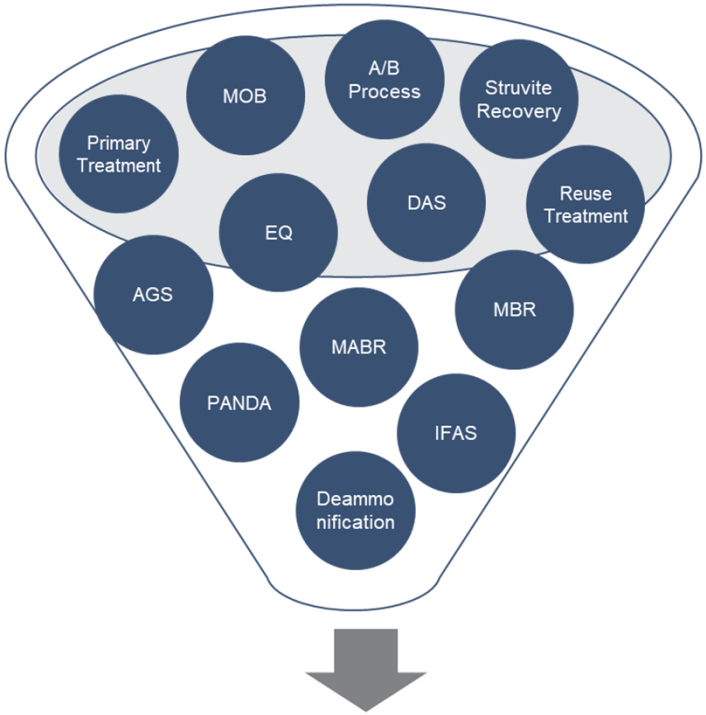




What Alternative Should OWASA Implement?

- Short answer: **Both.**

- NRCY is an optimization strategy; it *does not* increase plant capacity.
- Densification is intensification strategy; it *can* increase plant capacity.
- Combination of both alternatives will provide a reduction in chemical to denite filters (NRCY), while providing resiliency in settling and reduced risk at higher flows in a smaller footprint than equalization (DAS)
- Additionally, moving forward with both alternatives provides additional flexibility in treatment configurations
- Clarifier 6 provides additional capacity for both alternatives.
  - **Will determine timing within the trigger-based roadmap as part of Task 7.**



1. Conventional with ABAC & NRCY
2. DAS (Hydrocyclones)

Additional Items & Considerations

Ammonia Based Aeration Control (ABAC)

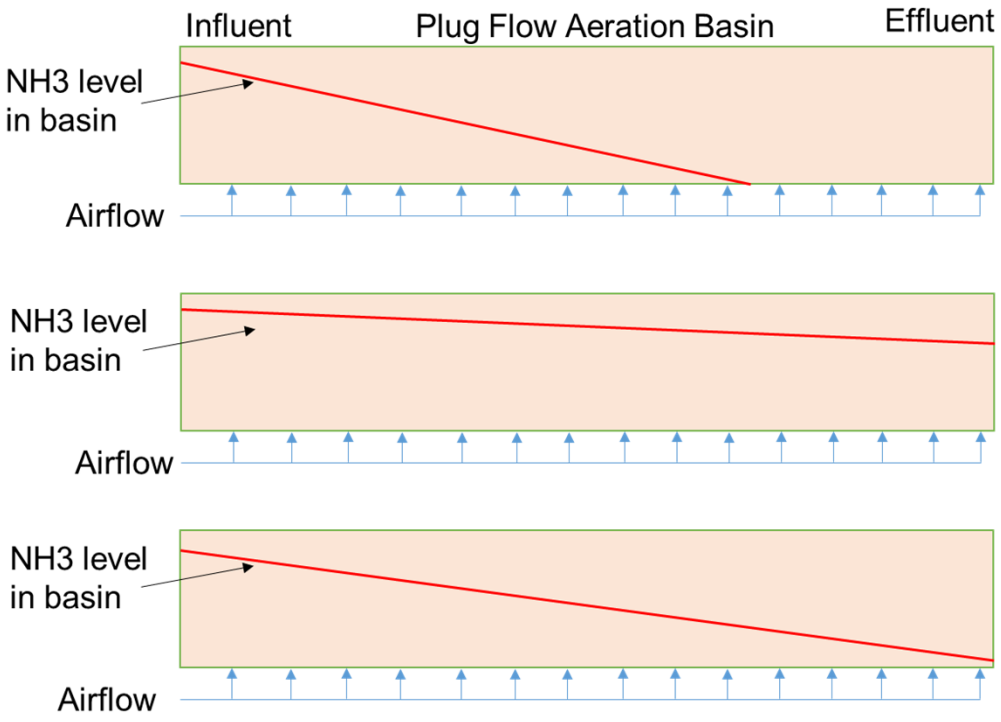
Included in Master Plan

Concept

- Input NH3-N conc. setpoint
- Program changes DO setpoint if the measured NH3 is above (or below) setpoint

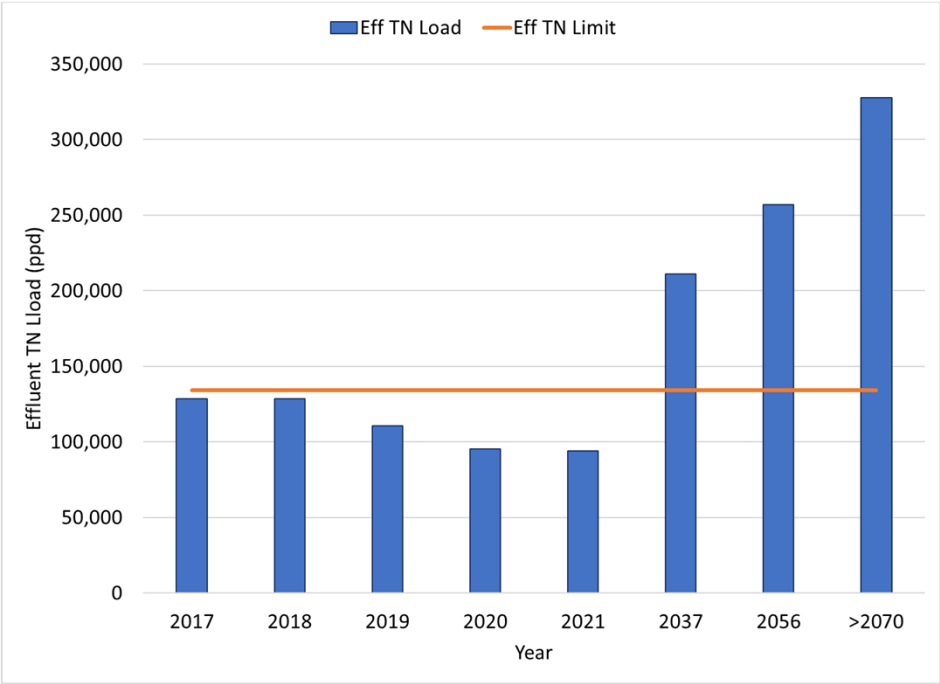
Benefits

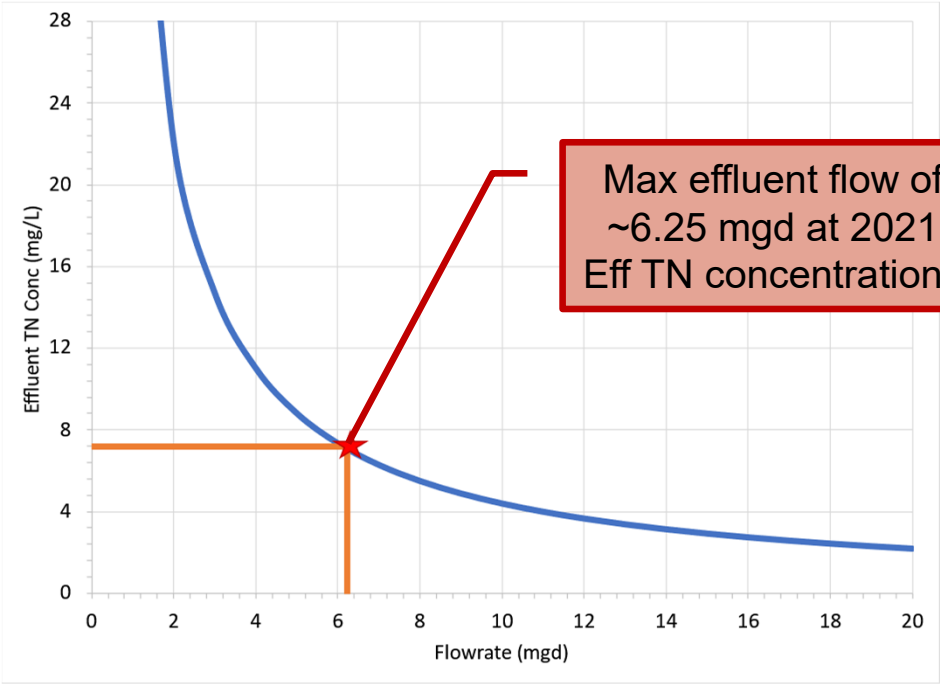
- Optimize nitrogen removal efficiency
- Minimizes airflow and energy use
- Reduces carbon usage due to less DO entering anoxic zones
- Maximize simultaneous nitrification and denitrification (SND) at low DO



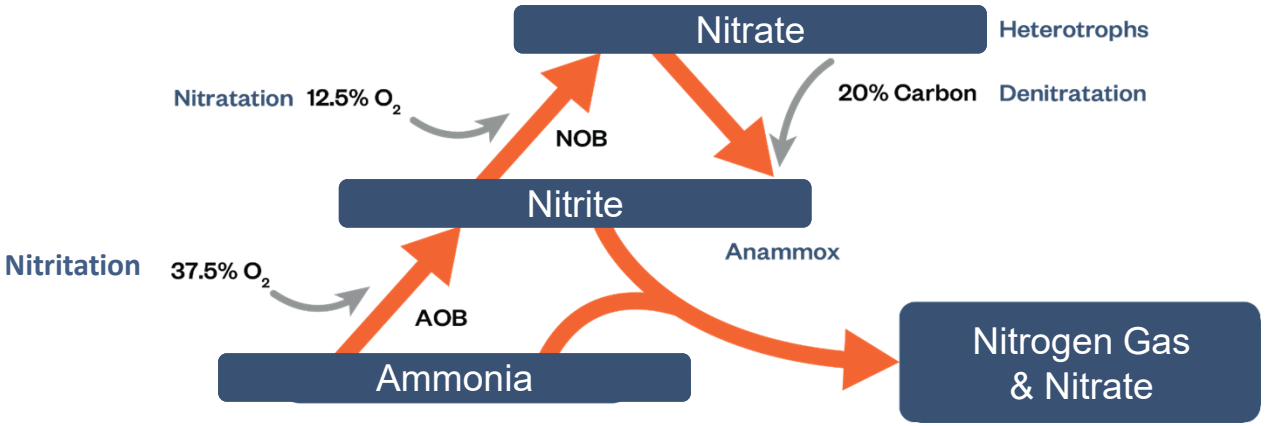
When will filters be required to operate in denitrification mode?

- Historically, there is around a 2.8 mgd difference in influent and effluent flow.
- Assuming 2021 effluent TN, would need to begin operating in denite mode when effluent flow is greater than ~6.25 mgd.
- Assuming flow difference, influent flow would be 9.03 mgd, which corresponds to approximately 2032.





Partial Nitrification-Denitratation-Anammox (PANDA or PdNA) Process can Reduce Operating Costs Vs. Conventional Nite/Denite



PANDA, PdNA, etc.

2.29 g O2/g NH4-N
1.2 to 2.4 g COD/g N vs
3.57 g Alkalinity/g N

40 to 60% less oxygen
40 to 80 % less carbon
NOB repression unnecessary

Deammonification

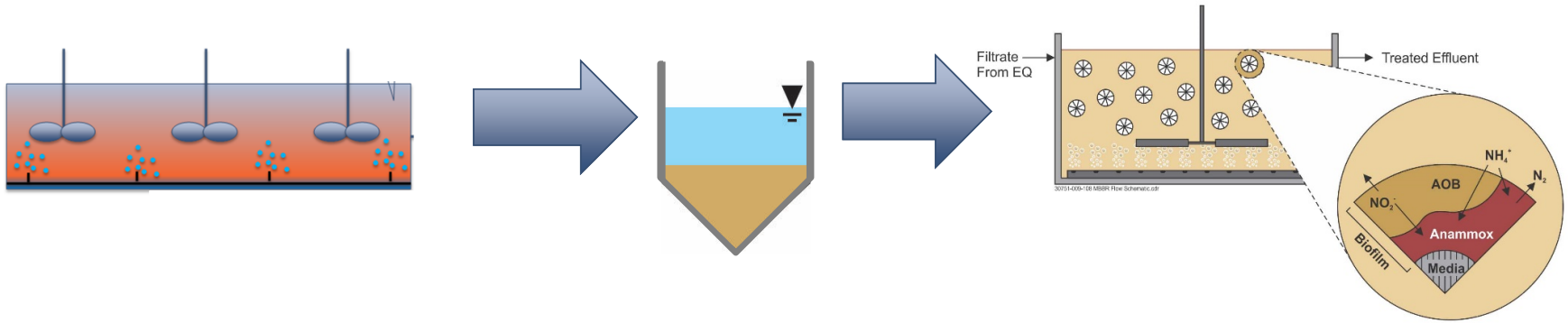
1.71 g O2/g NH4-N
No external COD
3.57 g Alkalinity/g N

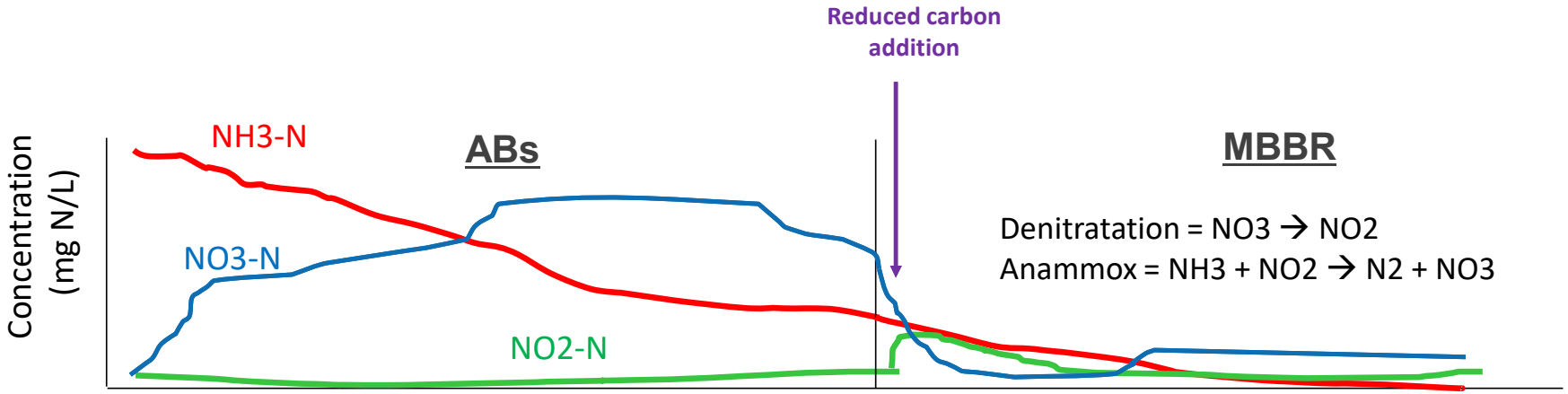
60% less oxygen
80 to 100% less carbon

Nitrification/Denitrification

4.57 g O_2/g NH4-N
4 to 6 g COD/g N
7.14 g Alkalinity/g N

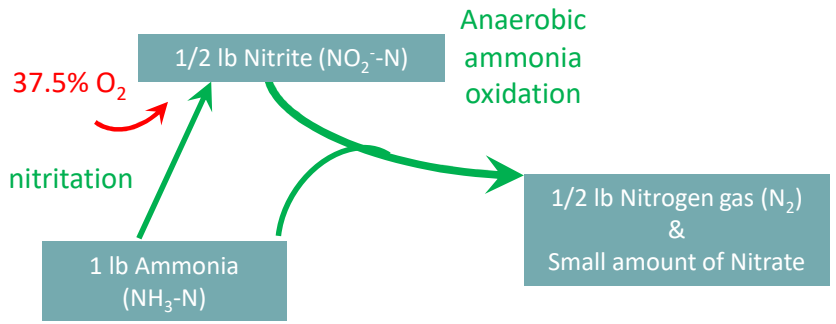
Translation of PANDA to Tertiary MBBR Application

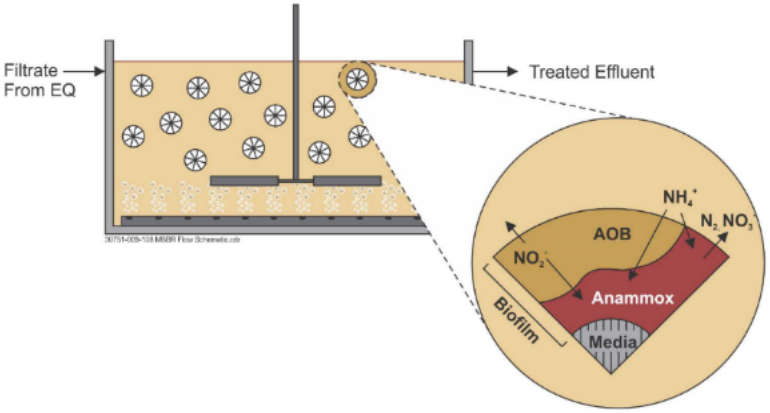




Sidestream Deammonification

- Utilize deammonification to intercept and treat sidestream TKN load
  - **Reduces sidestream TKN load by 75 to 85%**
- While not yet discussed, the potential Biosolids options will all require 24-hr dewatering.
  - **Sidestream deammonification will provide reliable reduction in recycled TKN load, increasing capacity of secondary treatment processes and reducing chemical requirements**



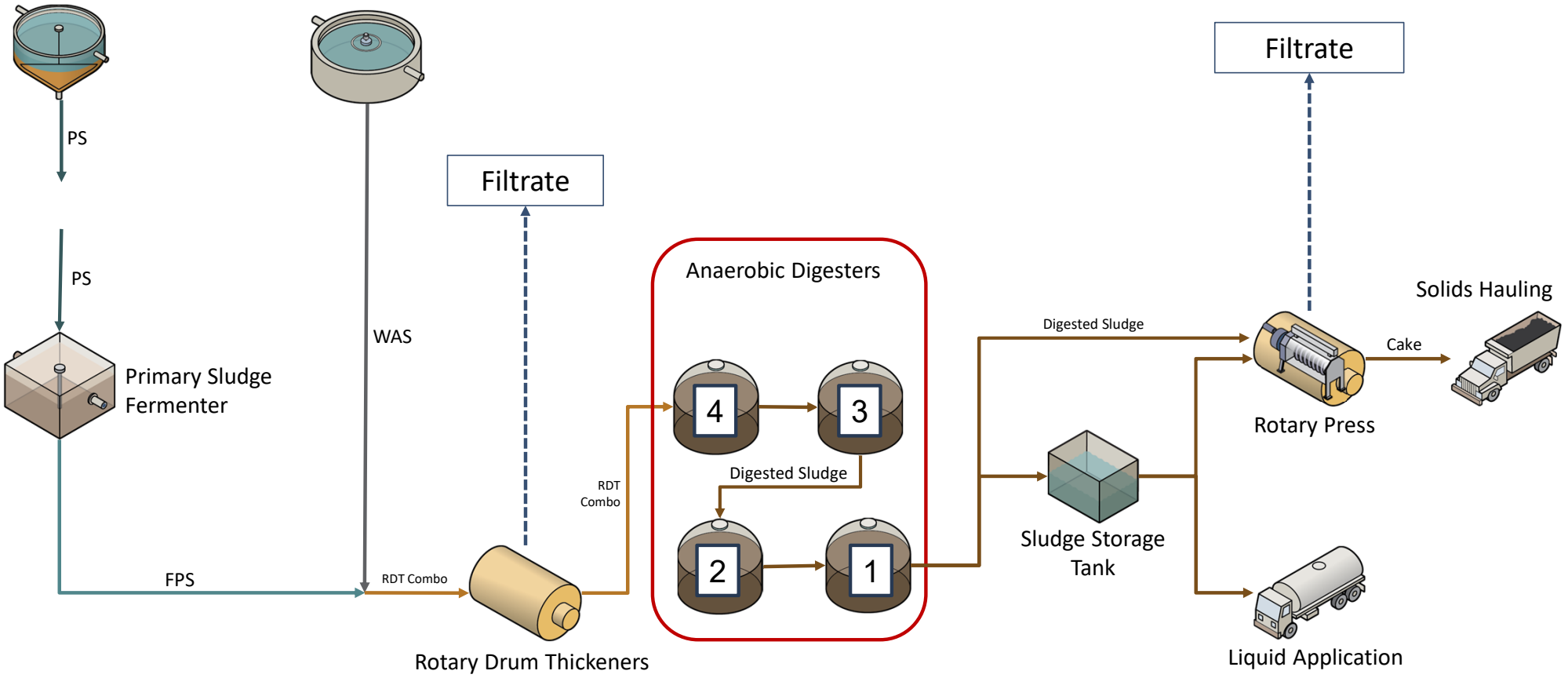


	ANITA™ Mox MBBR
Reactor configuration	MBBR
Biomass characteristic	Biofilm
Proprietary retention strategy	Plastic carrier and screen

Biosolids Alternatives Technology Overview

Temperature Phase Anaerobic Digestion

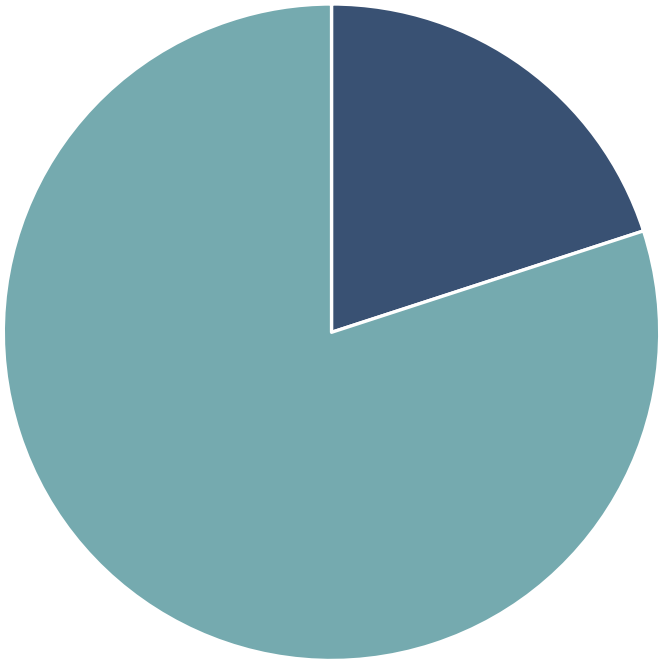
Temperature Phase Anaerobic Digestion

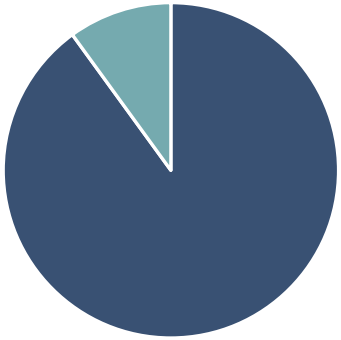


Thermal Drying

Thermal Drying Offers Opportunities for Volume AND Mass Reduction

20% Cake
2,000 lbs (cake)
1,600 lb(water)
400 lb(solids)
Bulk Density = 50 lb/cf
Volume = 40 cf





90% Product
440 lbs (product)
40 lb (water)
400 lb(solids)
Bulk Density = 45 lb/cf
Volume = 9.8 cf

22% of product mass and 25% of product volume

Dried Products Are Considered “High-End” Products

Revenue Potential / End Use Alternatives

- Heat Dried Products (Revenue = $5-$20 per dt)
- Bio-Fuel Products
  - **E-fuel (co-combust)**
  - **Syngas (electricity/heat)**





Advantages and Disadvantages

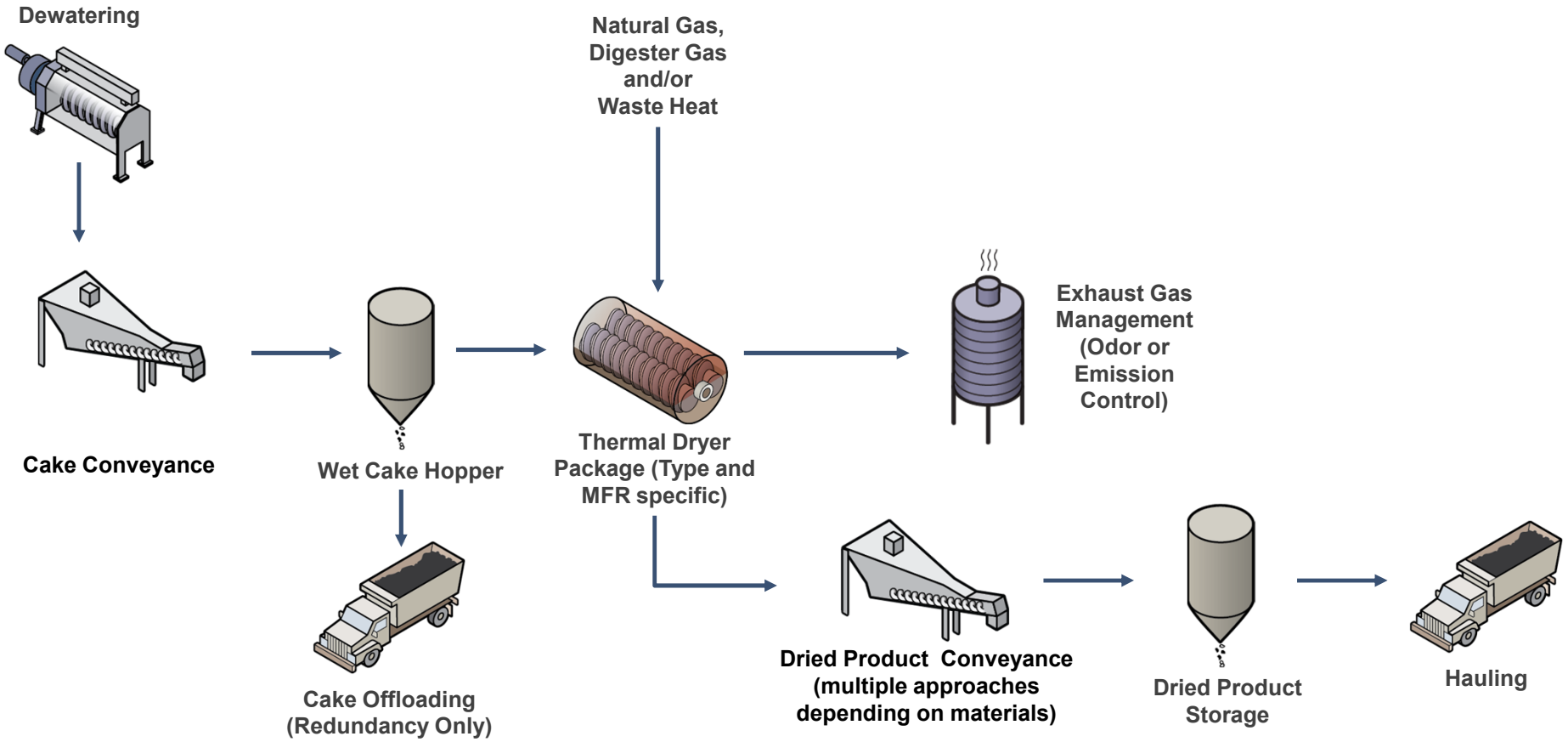
Advantages:

- Flexibility of outlets for solid products
- Advancement of agency’s public relations
- Revenue from sale can help to offset costs

Disadvantages:

- Market/customer development
- Equipment and ongoing operational/maintenance costs

Dryer General Process Flow Diagram



Many Types of Thermal Dryers Available

Major Dryer Types

Direct Dryers

(Hot Gas Contact)

- Belt Dryer
- Drum Dryer

Indirect Dryers

(Heated Surface Contact)

- Paddle Dryer
- Screw Dryer

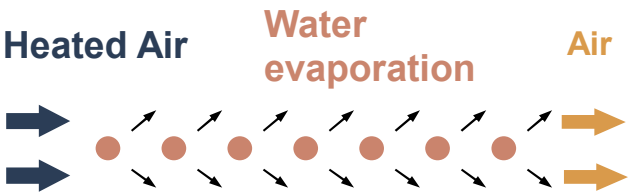
Selecting of the proper technology and size is critical and plant specific

Direct and Indirect Dryer Heat Transfer

Direct (Convection)

Heat is transferred to the particles directly by the hot gas

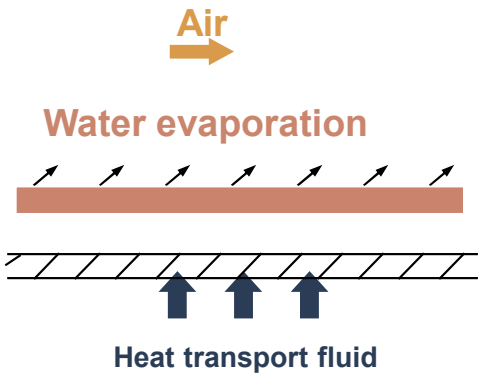




Indirect (Conduction)

Heat is conducted through metal to the solids touching the surface





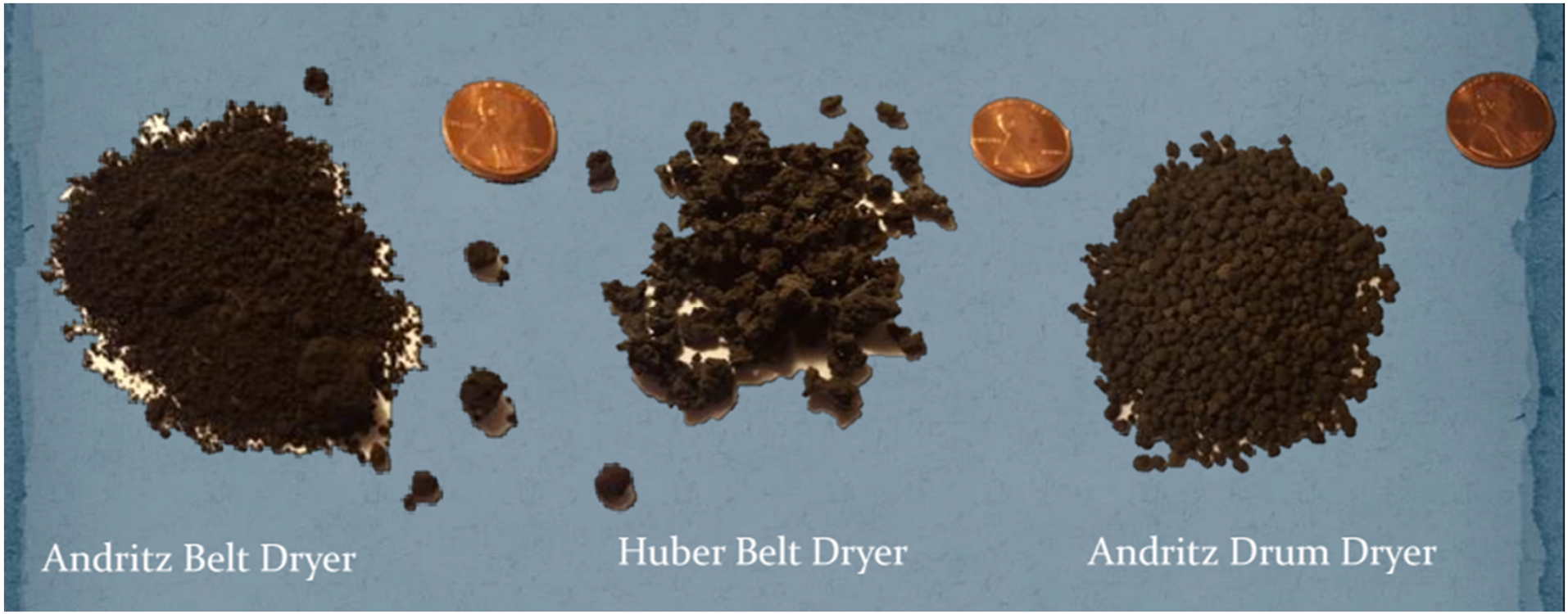
Heat transfer at surface

The Type of Dryer System Selected Can Impact the Quality and Characteristics of the Final Dried Product Solids

- Pelletized
  - Drum Dryer
  - Fluid Bed Dryer
- Granular
  - Paddle Dryer
  - Belt (with post handling)
- Irregular / Non-Granular
  - Belt Dryer



Not All Dried Products Are Created Equal



Lisa Challenger, Materials Matters, Inc
2016 MABA Annual Meeting and Fall Symposium

Dryer Technology Summary

Most Common Thermal Dryers

Attribute	Drum Dryer	Belt Dryer	Paddle Dryer
Dryer Type	Direct	Direct	Indirect
Operating Temp	~900°F	~300°F	~400°F
Footprint	🟨🟨	🟥🟥🟥	🟩
Product Uniformity	🟩🟩🟩	🟥	🟨🟨
System Complexity	🟥🟥🟥	🟩	🟨🟨
Evaporative Capacity/ Dryer Train	6,500-33,000 lbs/hr	750-13,000 lbs/hr	500-11,000 lbs/hr
Equivalent Plant Flowrate/ Dryer Train*	15-100 mgd	2-32 mgd	1-28 mgd

*** Assumes 24/7 dryer operation. Dependent on influent loading and treatment processes.**

Paddle and Screw Dryers

Paddle and Screw Dryer Basics

Indirect Drying

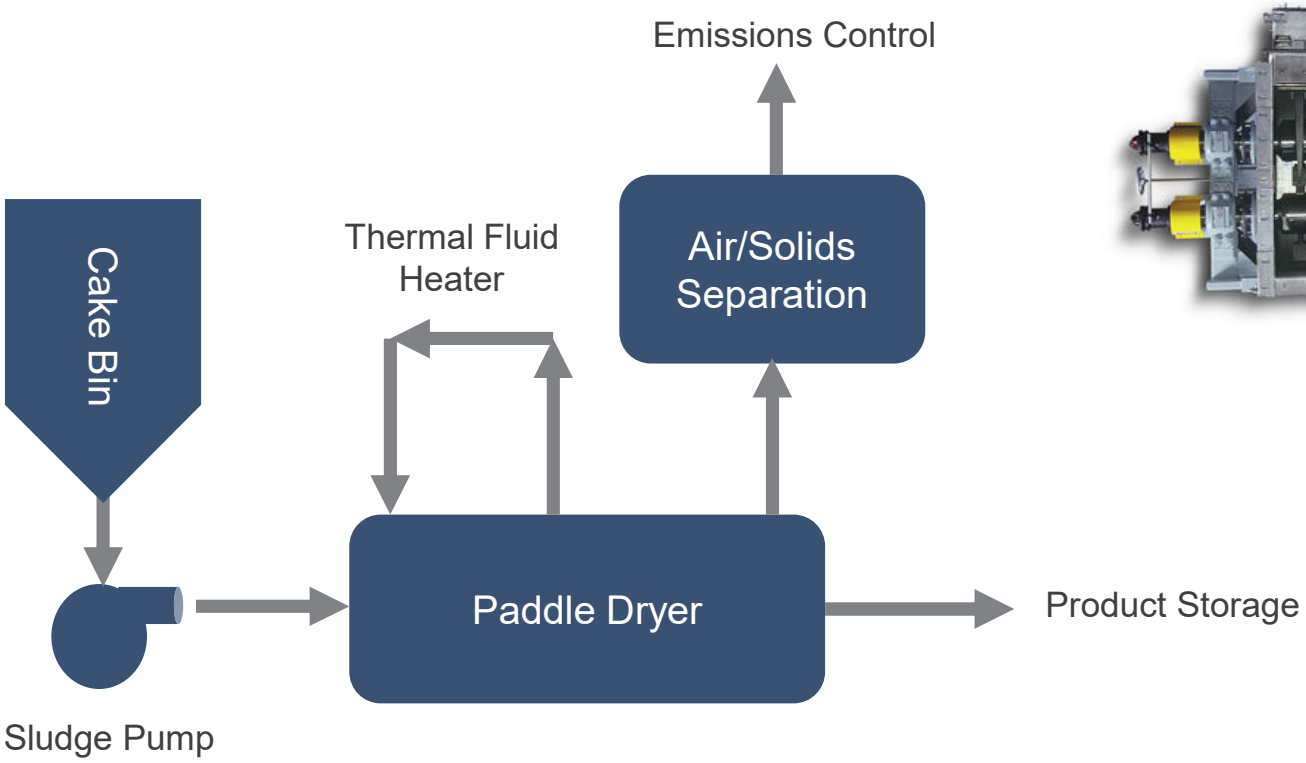
- Heat indirectly transferred to sludge from thermal oil or steam through walls/augers
- Dryer thermal oil/steam heated to about 350°F-450°F
- Sludge temps <200°F for most of dryer bed by control of thermal oil temperature
- Irregular product, 92 – 95% solids
  - **Screening can be added to improve quality**
- Typically applied for small- to medium-sized facilities (<25 dtpd)

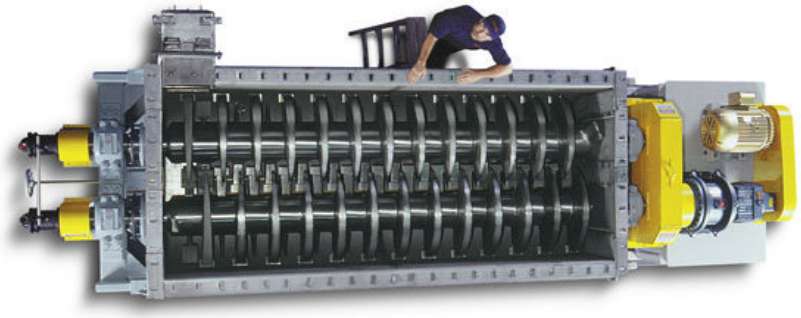




Rahway, NJ – Komline-Sanderson 15W-3000

Paddle & Screw Dryer Process Flow Diagram





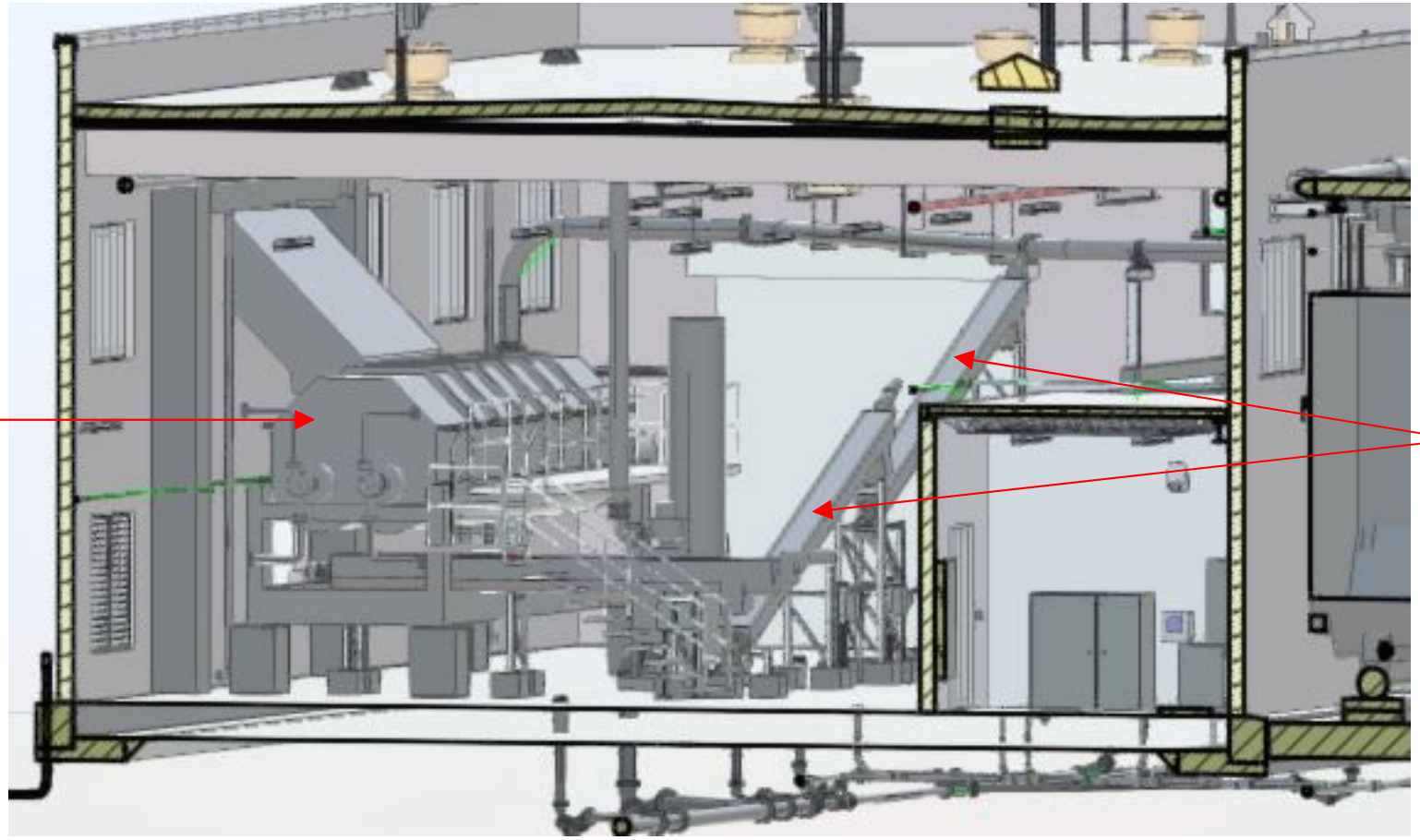
Courtesy of Komline Sanderson

Considerations for Paddle and Screw Dryers

Advantages	Disadvantages
• Compact footprint for evaporation rate • Indirect style dryer results in a “clean” combustion for the thermal oil heater or steam boiler • Lower air volume to manage for downstream odor control and odor management.	• Irregular product with wide product size gradation • Product can be dusty and susceptible to dust formation with handling. • Limited evaporative capacity per train/per dryer • Potential for surface fouling leading to reduced capacity • Back mix (dry recycle material) may be required • Evaporation rate dependent on particular type of sludge and can vary widely for same surface area dryer.

Example 3D Paddle Dryer Model

ATHENS CLARK COUNTY, GA



Thermal Drying
+ Gasification (or Pyrolysis)

EPA PFAS Roadmap for Biosolids

Winter 2024:
Completion of the risk assessment for PFOA and PFOS.

2025 – 2026:
Anticipated that EPA would issue a Final Rule

2026 – 2031:
Assuming a 5-year compliance schedule

EPA United States Environmental Protection Agency

PFAS Strategic Roadmap: EPA's Commitments to Action 2021–2024



The risk assessment will serve as the basis for determining whether regulation of PFOA and PFOS in biosolids is appropriate.

EPA's PITT Shortlisted Technologies



Summary of PITT Findings

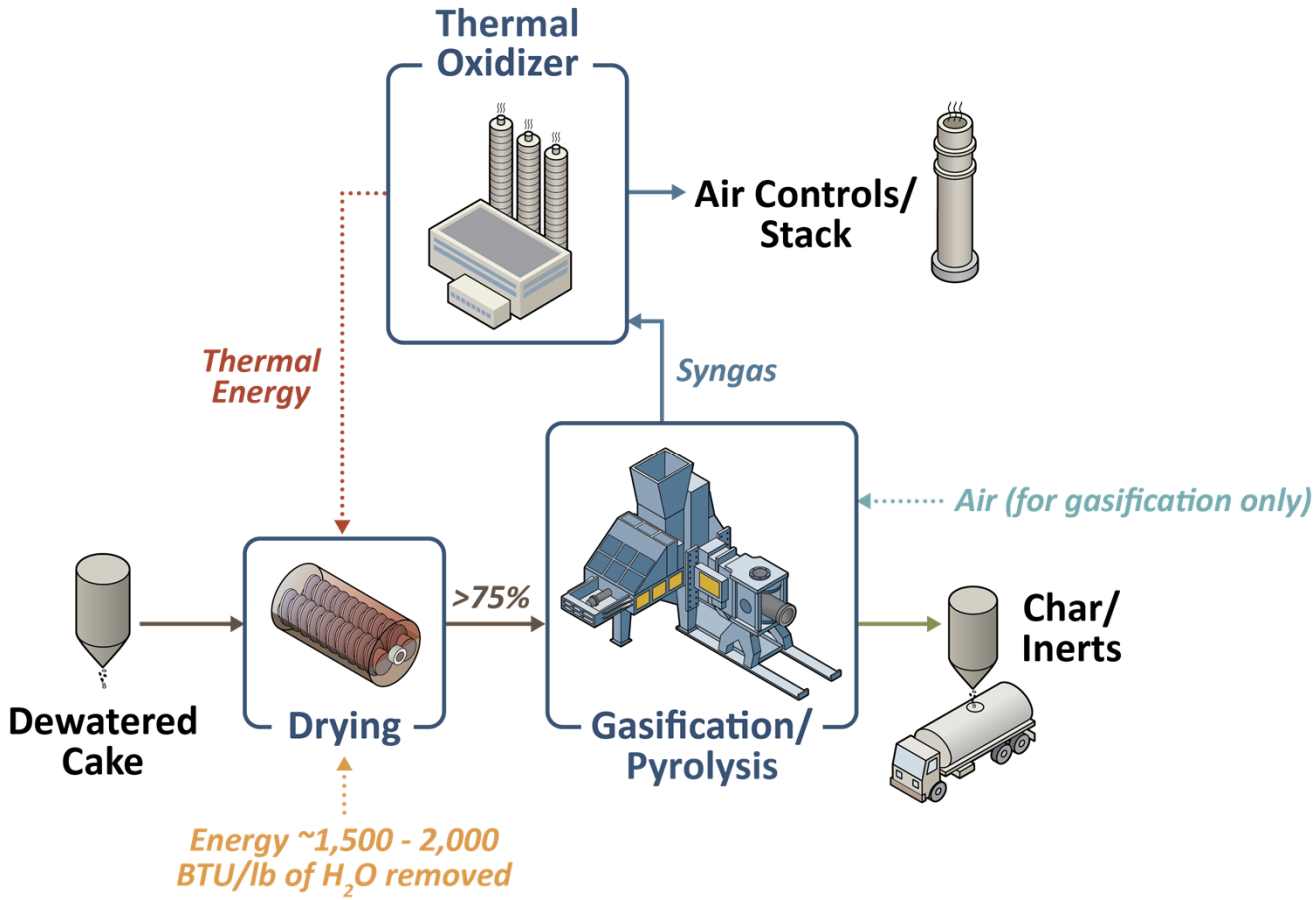
- Preliminary results in laboratory and pilot-scale treatment systems demonstrate up to 99% loss of the initial PFAS compounds in the contaminated waste
  - Thermal incineration/combustion
  - Supercritical water oxidation
  - Pyrolysis/gasification
  - Electrochemical oxidation, and
  - Mechanochemical treatment.

→ **Sludge/biosolids technologies**

- Still unknown, however, is what PFAS byproducts, if any, are formed from each of these technologies.

Major Components of Gasification/Pyrolysis

- ***Drying:*** Feed must have > 75% TS
- ***Gasification/ Pyrolysis:*** Chamber in which process occurs
- ***Thermal Oxidizer:*** Treatment of process gas (pyro/ syngas) at high temperature (1,800-2,000F)
- ***Air Controls/ Exhaust:*** treatment and release of treated air

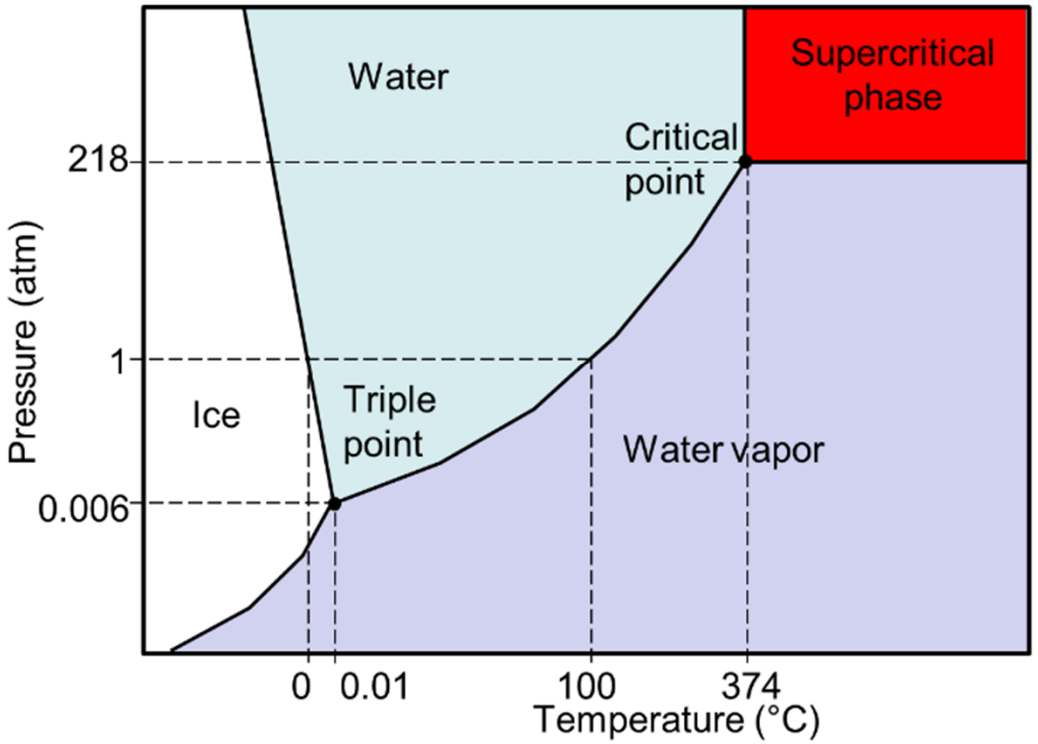


Supercritical Water Oxidation

Technology Review

What is Supercritical Water Oxidation (SCWO)?

- A special phase of water with both liquid-like and gas-like properties
- In the presence of an oxidizing agent, such as oxygen, organics are fully oxidized
- Above the critical point of water, most organic compounds are soluble, oxygen is fully miscible, and salts are insoluble
- It is not a combustion technology !!



SCWO and PFAS Removal

Recent Studies showed promising results

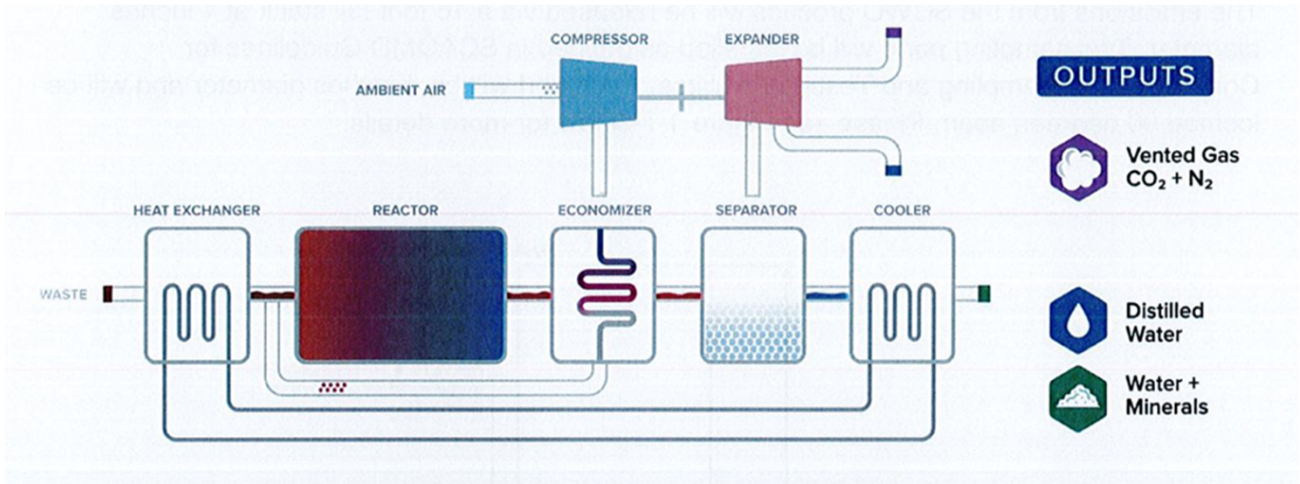
- Achieved greater than 99% destruction efficiency of ΣPFAS (also PFOS and PFOA) in the liquid phase
- The targeted analyses of the liquid-phase, showed positive results
- More rigorous examinations of the influent and effluent composition, including gas-phase products, are needed

SUBSTANCE	RESIDUAL ng/L (ppt)	REMOVAL %
PFBA	10.20	99.86%
PFPeA	5.10	ND in feed <5600 ng/L
PFHxA	5.15	99.89%
PFHpA	2.35	ND in feed <2100 ng/L
PFOA	3.15	ND in feed <6200 ng/L
PFNA	1.07	99.90%
PFDA	0.80	99.97%
PFUnA	ND <1.10 ng/L	>99.89%
PFTeA	0.30	ND in feed <3900 ng/L
PFBS	ND <0.19 ng/L	>99.98%
PFPeS	ND <0.29 ng/L	>99.98%
PFHxS	0.28	99.994%
PFOS	0.65	99.998%
Total PFAS	**29.1 ppt**	**99.95%**

Kraus et al,
J. Environ. Eng., 2022, 148(2)

374Water's Air SCWO

- Prototype unit installed at Duke University which has a capacity of one (1) wet tons per day "Nix 1".
- This first unit was funded by Bill and Melinda Gates Foundation.
- Modular unit

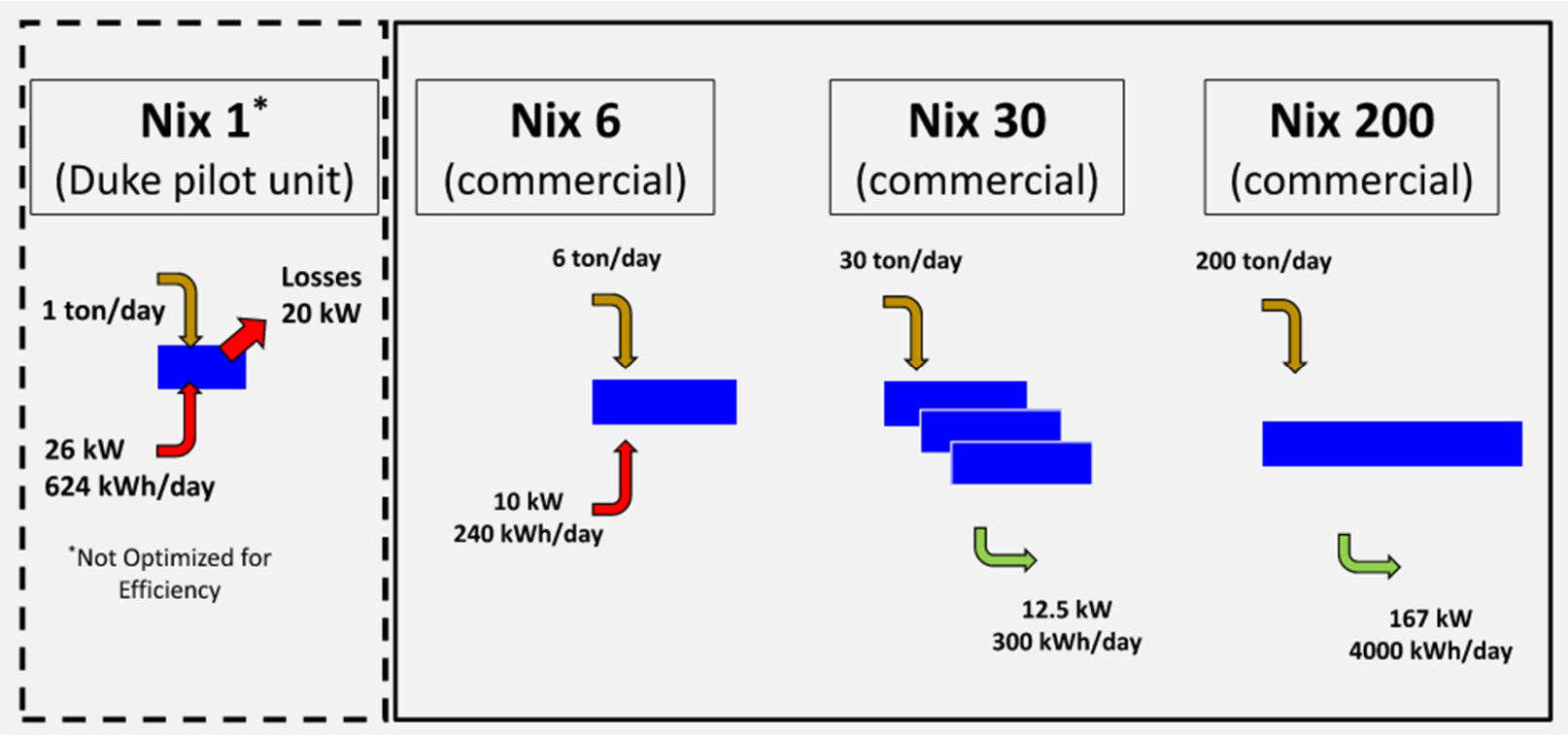






374Water's AirSCWO

Wet metric ton @ 15% solids



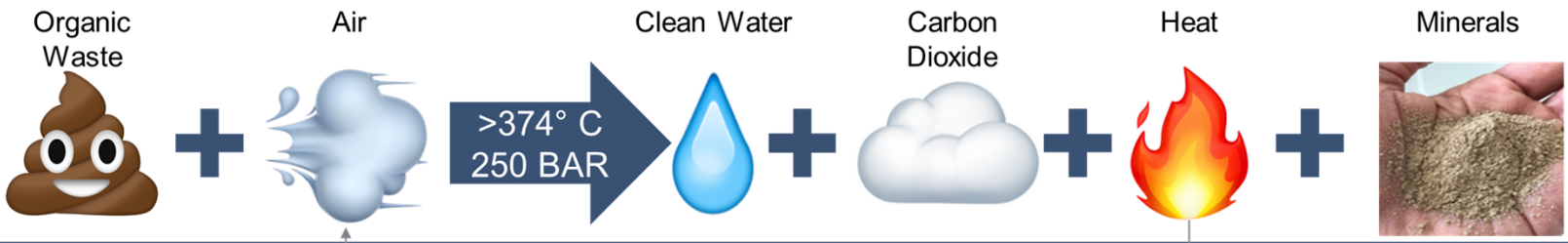
374Water AirSCWO-6 Demonstration at Orange County Sanitation District

OC San's Motivation:

- Plan for PFAS issues in the residuals
- Plan for future land application restrictions

Specific Goals:

- Design/construct first AirSCWO-6 (6 wtpd system)
- Demonstrate continuously and cost competitively processing biosolids
- Recover resources in the form of energy, mineral nutrients, heat and reusable water
- Eliminate pharmaceuticals, PFAS, microplastics and antibiotic resistant bacteria
- Move to AirSCWO-30 (30 wet tons per day), if successful



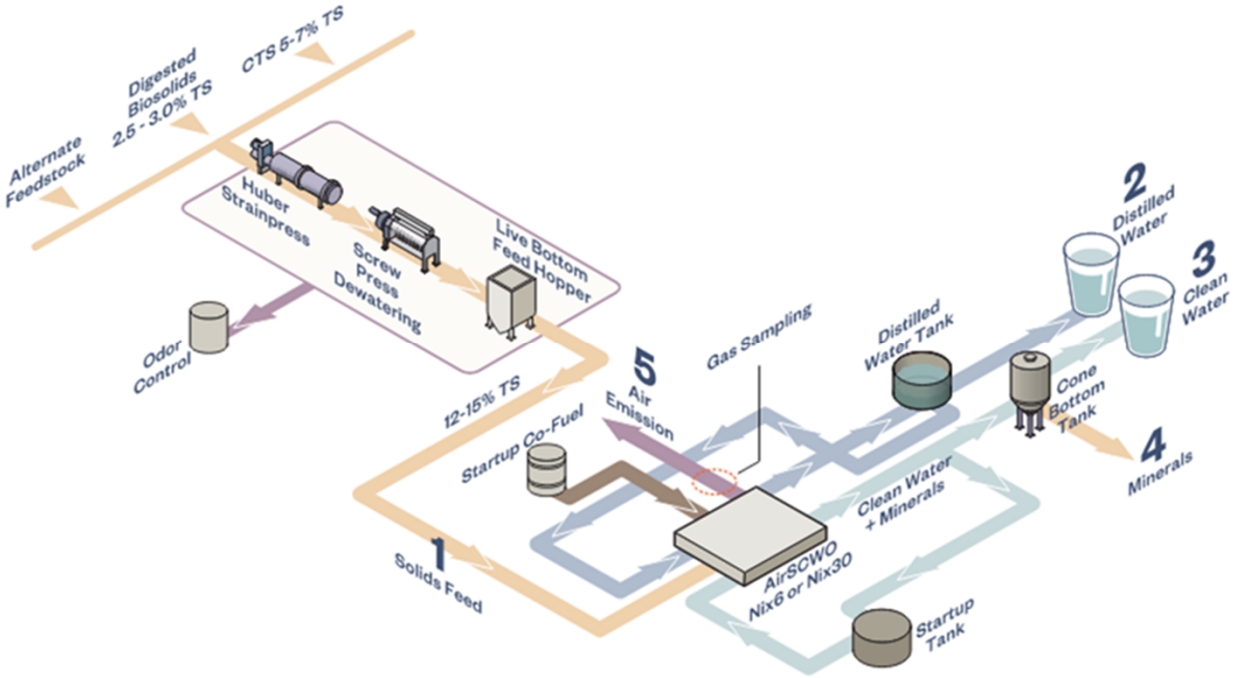
Project Team

- 374Water: process design, operate, service
- Merrel Brothers: fabricate Nix6, design and fabricate screening and dewatering skid
- Hazen: site engineering design, permitting, sampling and analysis and final report



AirSCWO-6 Demonstration Project Status

- Started January 2022
- Completed the design of the auxiliary units and the process
- Contractor is selected
- AQMD Permit submitted:
  - Air testing and sampling conducted at Duke in August
- Fabrication of dewatering and AirSCWO-6 skids were completed in December 2022
- The unit is expected to be on-site in 2023



Thank you!

Appendix C: Compiled BioWin™ Modeling Results

Model 1 - Near Term Annual Average Existing System - DAS / Step Feed

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	9.52	247.5	19,663.47	210.5	16,723.89	170.45	13,542.08	49.18	3,907.61
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	9.44	100.1	7,886.85	85.09	6,704.57	98.25	7,741.52	49.34	3,887.70
AB Inf. Channel	9.69	105.31	8,520.39	87.46	7,075.62	97.08	7,854.30	47.99	3,882.84
Cell 1E	4.79	4,357.86	174,131.87	2,561.17	102,339.41	817.87	32,680.61	1.78	71.21
Cell 2A	6.39	3,297.82	175,798.24	1,945.17	103,691.92	627.89	33,471.43	1.7	90.44
Cell 1F	6.39	3,288.39	175,295.54	1,933.66	103,078.23	616.39	32,858.05	1.01	53.85
Cell 2B	6.39	3,295.31	175,664.73	1,942.23	103,535.54	623.88	33,257.43	0.55	29.47
Cell 2D	4.81	4,336.70	174,163.51	2,548.92	102,365.70	814.21	32,698.87	1.8	72.34
Cell 3A	6.44	3,274.10	175,858.38	1,931.46	103,742.60	623.82	33,506.34	1.73	92.76
Cell 3B	6.44	3,271.65	175,726.70	1,928.58	103,587.65	619.83	33,292.03	0.56	30.14
Cell 2C	6.44	3,264.81	175,359.60	1,920.08	103,131.22	612.41	32,893.83	1.02	54.63
Cell 3D	4.81	4,336.70	174,163.51	2,548.92	102,365.70	814.21	32,698.87	1.8	72.34
Cell 4A	6.44	3,274.10	175,858.38	1,931.46	103,742.60	623.82	33,506.34	1.73	92.76
Cell 4B	6.44	3,271.65	175,726.70	1,928.58	103,587.65	619.83	33,292.03	0.56	30.14
Cell 3C	6.44	3,264.81	175,359.60	1,920.08	103,131.22	612.41	32,893.83	1.02	54.63
Eff Channel 1	19.26	3,271.62	525,852.17	1,923.34	309,141.54	612.56	98,458.19	1	161.52
Cell 5A	9.63	3,267.74	262,613.89	1,918.95	154,217.65	608.36	48,891.39	0.92	73.84
Cell 5B	9.63	3,267.74	262,613.89	1,918.95	154,217.65	608.36	48,891.39	0.92	73.84
Eff Channel 2	19.26	3,274.87	526,401.23	1,917.29	308,184.08	606.86	97,546.35	0.91	145.63
Secondaries	9.74	9.71	789.6	5.69	462.28	2.7	219.75	0.91	73.65
Denitrification Filters	9.49	1.99	157.92	1.17	92.46	1.27	100.98	0.91	71.76
Plant Effluent	9.49	1.99	157.92	1.17	92.46	1.27	100.98	0.91	71.76
Secondaries (U)	9.52	6,615.77	525,611.63	3,873.24	307,721.81	1,225.03	97,326.60	0.91	71.98
NSL 1C	9.57	6,491.03	518,154.75	3,808.07	303,984.00	1,213.12	96,838.74	2.57	205.04
NSL 1B	9.57	6,490.27	518,094.24	3,807.91	303,971.61	1,211.25	96,689.97	1.5	119.97
NSL 1A	9.57	6,489.21	518,009.40	3,807.19	303,914.26	1,210.24	96,609.26	1.74	138.53
NSL 1D	9.57	6,488.10	517,921.34	3,806.22	303,836.79	1,209.32	96,535.81	2.26	180.23
Primary Clarifiers (U)	0.09	14,994.73	11,830.28	12,746.93	10,056.85	7,376.35	5,819.66	49.34	38.93
Denitrification Filters (U)	0.25	302.77	631.68	177.26	369.82	56.93	118.77	0.91	1.89
WAS Splitter	9.33	6,615.77	515,176.69	3,873.24	301,612.63	1,225.03	95,394.38	0.91	70.55
WAS Splitter (U)	0.19	6,615.77	10,434.94	3,873.24	6,109.18	1,225.03	1,932.22	0.91	1.43
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.23	1,115.27	2,163.99	801.07	1,554.33	583.99	1,133.12	212.92	413.13
RDT (U)	0.05	45,726.18	19,475.88	32,843.73	13,988.93	15,426.83	6,570.66	212.92	90.69
Sludge to Digesters	0.05	45,726.18	19,475.88	32,843.73	13,988.93	15,426.83	6,570.66	212.92	90.69

Model 1 - Near Term Annual Average Existing System - DAS / Step Feed

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	392	31,143.71	85.42	6,786.84	306.58	24,356.88	7.64	607.3	42.5	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	210.76	16,606.52	86.81	6,839.76	123.95	9,766.77	7.75	610.26	38.62	
AB Inf. Channel	212.34	17,179.68	84.79	6,860.22	127.55	10,319.46	7.5	606.49	38.09	
Cell 1E	3,829.34	153,013.24	15.77	630.29	3,813.57	152,382.95	0.09	3.56	195.2	
Cell 2A	2,911.35	155,196.83	15.9	847.84	2,895.45	154,348.99	0.13	6.84	151.82	
Cell 1F	2,893.93	154,268.03	14.54	775.2	2,879.39	153,492.83	0	0.12	149.66	
Cell 2B	2,905.55	154,887.26	14.22	758.17	2,891.32	154,129.09	0.06	3.21	149.76	
Cell 2D	3,811.11	153,055.58	15.8	634.62	3,795.31	152,420.95	0.09	3.63	194.4	
Cell 3A	2,890.96	155,278.94	15.95	856.68	2,875.01	154,422.26	0.13	7.02	150.94	
Cell 3B	2,885.18	154,968.96	14.23	764.55	2,870.95	154,204.41	0.06	3.18	148.89	
Cell 2C	2,873.68	154,351.00	14.55	781.54	2,859.13	153,569.46	0	0.12	148.79	
Cell 3D	3,811.11	153,055.58	15.8	634.62	3,795.31	152,420.95	0.09	3.63	194.4	
Cell 4A	2,890.96	155,278.94	15.95	856.68	2,875.01	154,422.26	0.13	7.02	150.94	
Cell 4B	2,885.18	154,968.96	14.23	764.55	2,870.95	154,204.41	0.06	3.18	148.89	
Cell 3C	2,873.68	154,351.00	14.55	781.54	2,859.13	153,569.46	0	0.12	148.79	
Eff Channel 1	2,878.64	462,687.22	14.51	2,332.49	2,864.12	460,354.73	0	0.12	149.07	
Cell 5A	2,872.37	230,840.40	14.38	1,155.87	2,857.99	229,684.54	0	0.03	149.02	
Cell 5B	2,872.37	230,840.40	14.38	1,155.87	2,857.99	229,684.54	0	0.03	149.02	
Eff Channel 2	2,870.02	461,326.71	14.36	2,308.81	2,855.66	459,017.90	0	0.05	149	
Secondaries	22.83	1,856.17	14.36	1,167.64	8.47	688.53	0	0.02	11.67	
Denitrification Filters	16.1	1,275.38	14.36	1,137.68	1.74	137.71	0	0.02	11.35	
Plant Effluent	16.1	1,275.38	14.36	1,137.68	1.74	137.71	0	0.02	11.35	
Secondaries (U)	5,783.27	459,470.54	14.36	1,141.17	5,768.90	458,329.37	0	0.02	289.51	
NSL 1C	5,688.30	454,076.23	17.51	1,397.95	5,670.79	452,678.28	2.98	237.95	274.64	
NSL 1B	5,686.27	453,913.68	15.76	1,258.12	5,670.51	452,655.56	1.98	157.84	274.35	
NSL 1A	5,685.47	453,850.18	16.05	1,280.98	5,669.42	452,569.20	2.31	184.29	274.35	
NSL 1D	5,684.73	453,790.83	16.74	1,336.15	5,667.99	452,454.68	3.02	240.97	274.35	
Primary Clarifiers (U)	18,655.68	14,718.64	86.81	68.49	18,568.87	14,650.15	7.75	6.11	569.51	
Denitrification Filters (U)	278.38	580.79	14.36	29.97	264.01	550.82	0	0	24	
WAS Splitter	5,783.27	450,348.70	14.36	1,118.51	5,768.90	449,230.19	0	0.02	289.51	
WAS Splitter (U)	5,783.27	9,121.84	14.36	22.66	5,768.90	9,099.19	0	0	289.51	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	1,511.43	2,932.66	332.36	644.89	1,179.07	2,287.77	289.69	562.08	72.36	
RDT (U)	48,674.25	20,731.53	332.36	141.56	48,341.89	20,589.97	289.69	123.38	1,797.40	
Sludge to Digesters	48,674.25	20,731.53	332.36	141.56	48,341.89	20,589.97	289.69	123.38	1,797.40	

Model 1 - Near Term Annual Average Existing System - DAS / Step Feed

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]
Influent	3,376.55	42.5	3,376.55	28.9	2,296.05	0	0	0	0
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0
Primary Clarifiers	3,043.08	38.62	3,043.08	30.23	2,382.26	0	0	0	0
AB Inf. Channel	3,081.57	37.83	3,060.46	29.32	2,372.11	0.26	20.69	0.01	0.42
Cell 1E	7,799.69	186.09	7,435.74	1.13	45.16	8.75	349.83	0.35	14.11
Cell 2A	8,092.91	148.81	7,932.76	8.79	468.76	2.78	148.37	0.22	11.79
Cell 1F	7,978.10	142.17	7,578.59	2.45	130.59	6.6	351.57	0.9	47.94
Cell 2B	7,983.30	148.8	7,932.04	9.19	489.64	0.86	45.97	0.1	5.29
Cell 2D	7,807.37	185.25	7,439.75	1.17	47.17	8.78	352.6	0.37	15.02
Cell 3A	8,107.22	147.91	7,944.42	8.88	476.81	2.8	150.49	0.23	12.3
Cell 3B	7,997.21	147.89	7,943.71	9.27	497.81	0.89	47.89	0.1	5.61
Cell 2C	7,992.01	141.3	7,589.35	2.56	137.47	6.56	352.42	0.94	50.23
Cell 3D	7,807.37	185.25	7,439.75	1.17	47.17	8.78	352.6	0.37	15.02
Cell 4A	8,107.22	147.91	7,944.42	8.88	476.81	2.8	150.49	0.23	12.3
Cell 4B	7,997.21	147.89	7,943.71	9.27	497.81	0.89	47.89	0.1	5.61
Cell 3C	7,992.01	141.3	7,589.35	2.56	137.47	6.56	352.42	0.94	50.23
Eff Channel 1	23,959.77	140.68	22,611.86	1.62	260.03	7.45	1,197.40	0.94	150.5
Cell 5A	11,976.09	139.23	11,189.05	0.31	25.24	9.63	773.76	0.17	13.28
Cell 5B	11,976.09	139.23	11,189.05	0.31	25.24	9.63	773.76	0.17	13.28
Eff Channel 2	23,949.67	138.96	22,336.11	0.12	19.9	10	1,607.18	0.04	6.37
Secondaries	948.8	1.63	132.77	0.12	10.06	10	812.81	0.04	3.22
Denitrification Filters	898.74	1.31	103.65	0.12	9.81	10	791.95	0.04	3.14
Plant Effluent	898.74	1.31	103.65	0.12	9.81	10	791.95	0.04	3.14
Secondaries (U)	23,000.87	279.47	22,203.34	0.12	9.84	10	794.38	0.04	3.15
NSL 1C	21,923.62	274.35	21,899.97	0.08	6.11	0.28	22.04	0.02	1.61
NSL 1B	21,900.21	274.35	21,900.04	0.32	25.15	0	0.15	0	0.02
NSL 1A	21,900.04	274.35	21,900.04	0.45	36.2	0	0	0	0
NSL 1D	21,900.04	274.35	21,900.04	0.57	45.18	0	0	0	0
Primary Clarifiers (U)	449.33	569.51	449.33	30.23	23.85	0	0	0	0
Denitrification Filters (U)	50.07	13.96	29.12	0.12	0.26	10	20.86	0.04	0.08
WAS Splitter	22,544.24	279.47	21,762.54	0.12	9.64	10	778.61	0.04	3.09
WAS Splitter (U)	456.63	279.47	440.8	0.12	0.2	10	15.77	0.04	0.06
20% HAc	0	0	0	0	0	0	0	0	0
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	140.41	65.67	127.42	21.5	41.72	6.66	12.93	0.03	0.05
RDT (U)	765.56	1,790.71	762.71	21.5	9.16	6.66	2.84	0.03	0.01
Sludge to Digesters	765.56	1,790.71	762.71	21.5	9.16	6.66	2.84	0.03	0.01

Model 1 - Near Term Annual Average Existing System - DAS / Step Feed

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6	476.69	4.2	333.68	7	7	3.5	126.13	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.13	403.84	4.4	346.3	7	7	3.58	127.86	0	
AB Inf. Channel	5.32	430.73	4.28	346.65	9.42	9.42	6.01	220.59	0.5	
Cell 1E	181.93	7,269.55	0.52	20.96	6.85	6.85	3.09	56.06	2	
Cell 2A	137.7	7,340.62	1.03	54.98	7.44	7.44	4.16	100.53	0	
Cell 1F	137.7	7,340.62	0.45	23.85	6.9	6.9	3.39	81.97	2	
Cell 2B	137.7	7,340.62	0.87	46.3	7.51	7.51	4.34	104.92	0	
Cell 2D	181.04	7,270.63	0.53	21.29	6.85	6.85	3.1	56.38	2	
Cell 3A	136.71	7,342.77	1.04	56.05	7.45	7.45	4.16	101.44	0	
Cell 3B	136.71	7,342.77	0.88	47.27	7.51	7.51	4.34	105.85	0	
Cell 2C	136.71	7,342.77	0.45	24.4	6.9	6.9	3.4	82.84	2	
Cell 3D	181.04	7,270.63	0.53	21.29	6.85	6.85	3.1	56.38	2	
Cell 4A	136.71	7,342.77	1.04	56.05	7.45	7.45	4.16	101.44	0	
Cell 4B	136.71	7,342.77	0.88	47.27	7.51	7.51	4.34	105.85	0	
Cell 3C	136.71	7,342.77	0.45	24.4	6.9	6.9	3.4	82.84	2	
Eff Channel 1	137.04	22,026.17	0.4	63.62	6.87	6.87	3.27	238.22	2	
Cell 5A	137.04	11,013.09	0.29	23.06	6.82	6.82	3.07	111.77	2	
Cell 5B	137.04	11,013.09	0.29	23.06	6.82	6.82	3.07	111.77	2	
Eff Channel 2	137.03	22,026.17	0.24	38.54	6.71	6.71	2.7	196.94	2	
Secondaries	0.65	52.47	0.24	19.49	6.71	6.71	2.7	99.6	2	
Denitrification Filters	0.32	25.59	0.24	18.99	6.71	6.71	2.7	97.04	2	
Plant Effluent	0.32	25.59	0.24	18.99	6.71	6.71	2.7	97.04	2	
Secondaries (U)	276.58	21,973.70	0.24	19.05	6.71	6.71	2.7	97.34	2	
NSL 1C	270.53	21,595.44	0.45	35.89	6.74	6.74	3.4	123.07	0	
NSL 1B	270.53	21,595.44	0.6	47.62	6.8	6.8	3.49	126.43	0	
NSL 1A	270.53	21,595.44	0.64	51.39	6.84	6.84	3.54	128.07	0	
NSL 1D	270.53	21,595.44	0.6	48.29	6.87	6.87	3.58	129.46	0	
Primary Clarifiers (U)	113.79	89.78	4.4	3.47	7	7	3.58	1.28	0	
Denitrification Filters (U)	12.89	26.89	0.24	0.5	6.71	6.71	2.7	2.56	2	
WAS Splitter	276.58	21,537.46	0.24	18.67	6.71	6.71	2.7	95.41	2	
WAS Splitter (U)	276.58	436.24	0.24	0.38	6.71	6.71	2.7	1.93	2	
20% HAc	0	0	0	0	2.11	2.11	-966.41	-6.58	0	
25% NaOH	0	0	0	0	14.91	14.91	7,970.05	90.51	0	
RDT	29.88	57.98	3.16	6.13	5.52	5.52	2.65	2.34	1.33	
RDT (U)	1,098.88	468.04	3.16	1.35	5.52	5.52	2.65	0.51	1.33	
Sludge to Digesters	1,098.88	468.04	3.16	1.35	5.52	5.52	2.65	0.51	1.33	

Model 2 - Near Term Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	11.9	258.09	25,631.22	219.09	21,758.12	177.41	17,618.52	51.19	5,083.88
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	11.82	104.14	10,273.95	88.37	8,718.26	102.14	10,076.31	51.31	5,062.41
AB Inf. Channel	12.07	111.28	11,213.68	91.84	9,254.78	101.74	10,251.72	50.18	5,056.89
Cell 1E	5.97	5,181.86	258,289.82	2,966.46	147,863.16	1,004.24	50,056.18	1.84	91.9
Cell 2A	7.97	3,920.44	260,597.87	2,252.04	149,696.57	769.71	51,163.66	1.96	130.51
Cell 1F	7.97	3,909.81	259,891.35	2,239.38	148,854.94	756.76	50,303.02	0.95	63.26
Cell 2B	7.97	3,915.49	260,268.70	2,245.73	149,277.14	762.97	50,715.56	1.18	78.27
Cell 2D	6	5,156.61	258,330.56	2,952.21	147,896.47	999.65	50,079.20	1.87	93.47
Cell 3A	8.03	3,892.12	260,676.64	2,236.06	149,761.38	764.59	51,208.46	2	134
Cell 3B	8.03	3,887.27	260,351.83	2,229.85	149,344.94	757.91	50,761.06	1.19	79.66
Cell 2C	8.03	3,881.68	259,976.89	2,223.57	148,924.36	751.77	50,349.79	0.96	64.24
Cell 3D	6	5,156.61	258,330.56	2,952.21	147,896.47	999.65	50,079.20	1.87	93.47
Cell 4A	8.03	3,892.12	260,676.64	2,236.06	149,761.38	764.59	51,208.46	2	134
Cell 4B	8.03	3,887.27	260,351.83	2,229.85	149,344.94	757.91	50,761.06	1.19	79.66
Cell 3C	8.03	3,881.68	259,976.89	2,223.57	148,924.36	751.77	50,349.79	0.96	64.24
Eff Channel 1	24.02	3,890.13	779,669.34	2,227.84	446,509.74	752.48	150,814.51	0.93	186.21
Cell 5A	12.01	3,886.84	389,504.58	2,224.33	222,903.11	749.11	75,069.56	0.87	86.76
Cell 5B	12.01	3,886.84	389,504.58	2,224.33	222,903.11	749.11	75,069.56	0.87	86.76
Eff Channel 2	24.02	3,895.91	780,876.95	2,222.96	445,558.16	747.89	149,903.45	0.85	170.87
Secondaries	12.12	11.58	1,171.32	6.61	668.34	3.07	310.81	0.85	86.21
Denitrification Filters	11.87	2.37	234.26	1.35	133.67	1.31	129.35	0.85	84.43
Plant Effluent	11.87	2.37	234.26	1.35	133.67	1.31	129.35	0.85	84.43
Secondaries (U)	11.9	7,851.21	779,705.64	4,479.79	444,889.82	1,506.32	149,592.64	0.85	84.66
NSL 1C	11.94	7,721.58	769,496.36	4,412.24	439,702.78	1,491.95	148,680.82	3.92	391.11
NSL 1B	11.94	7,719.44	769,283.33	4,410.22	439,502.13	1,486.38	148,125.81	0.54	53.35
NSL 1A	11.94	7,715.99	768,939.67	4,407.04	439,184.65	1,483.07	147,795.83	0.33	33.1
NSL 1D	11.94	7,713.70	768,711.58	4,405.02	438,983.70	1,480.81	147,570.54	0.24	24.14
Primary Clarifiers (U)	0.09	19,533.15	15,410.93	16,575.42	13,077.39	9,583.88	7,561.32	51.31	40.48
Denitrification Filters (U)	0.25	449.13	937.05	256.27	534.67	86.97	181.46	0.85	1.78
WAS Splitter	11.69	7,851.21	765,880.60	4,479.79	437,001.44	1,506.32	146,940.20	0.85	83.16
WAS Splitter (U)	0.21	7,851.21	13,825.03	4,479.79	7,888.38	1,506.32	2,652.44	0.85	1.5
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.25	1,365.98	2,856.08	970.58	2,029.36	678.29	1,418.22	218.21	456.24
RDT (U)	0.05	56,005.04	25,704.73	39,793.86	18,264.26	19,081.67	8,757.95	218.21	100.15
Sludge to Digesters	0.05	56,005.04	25,704.73	39,793.86	18,264.26	19,081.67	8,757.95	218.21	100.15

Model 2 - Near Term Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	408	40,518.61	88.91	8,829.81	319.09	31,688.79	7.96	790.11	44.2	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	218.74	21,579.74	90.01	8,880.20	128.73	12,699.53	8.04	792.84	39.83	
AB Inf. Channel	222.28	22,398.57	88.32	8,899.83	133.96	13,498.75	7.83	789.26	39.6	
Cell 1E	4,434.16	221,020.56	16.03	799.2	4,418.12	220,221.36	0.06	3.19	224.65	
Cell 2A	3,369.63	223,984.38	16.57	1,101.47	3,353.05	222,882.91	0.17	11.22	174.81	
Cell 1F	3,349.94	222,675.76	14.5	963.96	3,335.44	221,711.80	0	0.03	174.65	
Cell 2B	3,359.20	223,291.34	14.91	991.04	3,344.29	222,300.29	0.01	0.45	174.73	
Cell 2D	4,412.93	221,074.46	16.07	804.95	4,396.87	220,269.51	0.07	3.28	223.72	
Cell 3A	3,345.86	224,090.44	16.63	1,113.81	3,329.23	222,976.63	0.17	11.61	173.77	
Cell 3B	3,335.52	223,398.13	14.93	999.84	3,320.60	222,398.29	0.01	0.48	173.69	
Cell 2C	3,326.36	222,784.17	14.51	972.01	3,311.84	221,812.17	0	0.03	173.62	
Cell 3D	4,412.93	221,074.46	16.07	804.95	4,396.87	220,269.51	0.07	3.28	223.72	
Cell 4A	3,345.86	224,090.44	16.63	1,113.81	3,329.23	222,976.63	0.17	11.61	173.77	
Cell 4B	3,335.52	223,398.13	14.93	999.84	3,320.60	222,398.29	0.01	0.48	173.69	
Cell 3C	3,326.36	222,784.17	14.51	972.01	3,311.84	221,812.17	0	0.03	173.62	
Eff Channel 1	3,332.78	667,964.18	14.46	2,898.50	3,318.32	665,065.68	0	0.04	173.95	
Cell 5A	3,327.78	333,480.67	14.36	1,439.48	3,313.41	332,041.19	0	0.01	173.91	
Cell 5B	3,327.78	333,480.67	14.36	1,439.48	3,313.41	332,041.19	0	0.01	173.91	
Eff Channel 2	3,325.82	666,610.22	14.34	2,874.87	3,311.47	663,735.34	0	0.03	173.89	
Secondaries	24.19	2,446.05	14.34	1,450.45	9.85	995.6	0	0.01	14.96	
Denitrification Filters	16.35	1,619.64	14.34	1,420.52	2.01	199.12	0	0.01	14.58	
Plant Effluent	16.35	1,619.64	14.34	1,420.52	2.01	199.12	0	0.01	14.58	
Secondaries (U)	6,687.77	664,164.16	14.34	1,424.43	6,673.42	662,739.74	0	0.01	335.72	
NSL 1C	6,591.29	656,856.86	19.31	1,924.44	6,571.98	654,932.42	3.84	382.72	322.46	
NSL 1B	6,583.96	656,126.68	14.82	1,477.08	6,569.14	654,649.60	0.18	18.2	319.95	
NSL 1A	6,579.43	655,675.68	14.81	1,475.40	6,564.63	654,200.27	0.05	5.08	318.4	
NSL 1D	6,576.87	655,420.11	15.12	1,506.67	6,561.75	653,913.44	0.15	14.61	317.53	
Primary Clarifiers (U)	24,234.75	19,120.32	90.01	71.02	24,144.74	19,049.30	8.04	6.34	730.35	
Denitrification Filters (U)	396.1	826.41	14.34	29.92	381.76	796.48	0	0	32.86	
WAS Splitter	6,687.77	652,387.81	14.34	1,399.17	6,673.42	650,988.64	0	0.01	335.72	
WAS Splitter (U)	6,687.77	11,776.36	14.34	25.26	6,673.42	11,751.10	0	0	335.72	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	1,770.31	3,701.50	342.22	715.53	1,428.10	2,985.97	297.39	621.81	83.25	
RDT (U)	58,894.22	27,030.79	342.22	157.07	58,552.01	26,873.72	297.39	136.49	2,164.20	
Sludge to Digesters	58,894.22	27,030.79	342.22	157.07	58,552.01	26,873.72	297.39	136.49	2,164.20	

Model 2 - Near Term Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent		4,389.52	44.2	4,389.52	30.06	2,984.87	0	0	0	0
Rotary Press Filtrate (50%)		115.86	862	115.86	818.9	110.06	0	0	0	0
Primary Clarifiers		3,929.16	39.83	3,929.16	31.12	3,070.38	0	0	0	0
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AB Inf. Channel		3,990.23	39.32	3,962.66	30.41	3,064.50	0.27	27.04	0.01	0.54
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Cell 1E		11,197.55	216.77	10,804.75	3.11	155.18	7.08	352.8	0.8	40.01
Cell 2A		11,619.91	172.27	11,450.78	10.53	700.05	2.17	143.93	0.38	25.21
Cell 1F		11,609.43	163.39	10,861.07	1.88	124.85	10.26	681.97	1	66.38
Cell 2B		11,614.35	167.36	11,124.51	5.67	376.68	6.25	415.15	1.12	74.69
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Cell 2D		11,207.51	215.86	10,813.87	3.23	161.84	7.03	352.27	0.83	41.37
Cell 3A		11,638.46	171.25	11,469.83	10.67	714.54	2.13	142.8	0.39	25.84
Cell 3B		11,632.90	166.4	11,144.68	5.86	392.14	6.15	412.23	1.13	75.99
Cell 2C		11,627.98	162.41	10,877.55	2.03	136.22	10.14	678.81	1.07	71.62
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Cell 3D		11,207.51	215.86	10,813.87	3.23	161.84	7.03	352.27	0.83	41.37
Cell 4A		11,638.46	171.25	11,469.83	10.67	714.54	2.13	142.8	0.39	25.84
Cell 4B		11,632.90	166.4	11,144.68	5.86	392.14	6.15	412.23	1.13	75.99
Cell 3C		11,627.98	162.41	10,877.55	2.03	136.22	10.14	678.81	1.07	71.62
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Eff Channel 1		34,863.15	162.18	32,504.19	1.45	291.22	10.79	2,161.89	0.98	197.07
Cell 5A		17,427.78	161.01	16,135.49	0.44	44.28	12.6	1,262.82	0.29	29.46
Cell 5B		17,427.78	161.01	16,135.49	0.44	44.28	12.6	1,262.82	0.29	29.46
Eff Channel 2		34,852.94	160.74	32,217.49	0.23	47.07	13.04	2,613.82	0.11	21.62
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Secondaries		1,512.42	1.81	182.77	0.23	23.75	13.04	1,318.74	0.11	10.91
Denitrification Filters		1,443.87	1.43	141.65	0.23	23.26	13.04	1,291.53	0.11	10.68
Plant Effluent		1,443.87	1.43	141.65	0.23	23.26	13.04	1,291.53	0.11	10.68
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Secondaries (U)		33,340.51	322.57	32,034.72	0.23	23.32	13.04	1,295.08	0.11	10.71
NSL 1C		32,134.71	317.36	31,626.27	0.2	20.26	4.97	494.81	0.14	13.63
NSL 1B		31,884.64	317.39	31,629.34	0.41	40.63	2.45	244.28	0.11	11.02
NSL 1A		31,730.29	317.41	31,631.21	0.66	66.14	0.93	92.33	0.07	6.75
NSL 1D		31,643.79	317.42	31,632.32	0.88	87.24	0.1	10.35	0.01	1.11
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Primary Clarifiers (U)		576.22	730.35	576.22	31.12	24.55	0	0	0	0
Denitrification Filters (U)		68.56	19.71	41.12	0.23	0.49	13.04	27.21	0.11	0.23
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WAS Splitter		32,749.35	322.57	31,466.71	0.23	22.91	13.04	1,272.12	0.11	10.52
WAS Splitter (U)		591.16	322.57	568.01	0.23	0.41	13.04	22.96	0.11	0.19
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20% HAc		0	0	0	0	0	0	0	0	0
25% NaOH		0	0	0	0	0	0	0	0	0
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RDT		174.07	74.17	155.09	21.1	44.12	9.01	18.83	0.07	0.16
RDT (U)		993.31	2,155.12	989.14	21.1	9.69	9.01	4.13	0.07	0.03
Sludge to Digesters		993.31	2,155.12	989.14	21.1	9.69	9.01	4.13	0.07	0.03

Model 2 - Near Term Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6.2	615.72	4.34	431.01	7	7	3.5	157.67	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.25	517.77	4.5	443.55	6.99	6.99	3.56	159.39	0	
AB Inf. Channel	5.52	556.35	4.4	443.69	9.27	9.27	5.5	251.38	0.5	
Cell 1E	211.29	10,531.86	0.48	23.68	6.74	6.74	2.61	59.07	2	
Cell 2A	159.82	10,623.66	0.75	49.66	7.18	7.18	3.65	110.03	0	
Cell 1F	159.82	10,623.66	0.26	17.01	6.69	6.69	2.43	73.21	2	
Cell 2B	159.82	10,623.66	0.39	26.24	6.82	6.82	2.97	89.62	2	
Cell 2D	210.26	10,533.25	0.48	24	6.74	6.74	2.63	59.66	2	
Cell 3A	158.66	10,626.44	0.76	50.6	7.18	7.18	3.66	111.31	0.01	
Cell 3B	158.66	10,626.44	0.4	26.73	6.82	6.82	2.99	90.97	2	
Cell 2C	158.66	10,626.44	0.26	17.25	6.69	6.69	2.45	74.31	2	
Cell 3D	210.26	10,533.25	0.48	24	6.74	6.74	2.63	59.66	2	
Cell 4A	158.66	10,626.44	0.76	50.6	7.18	7.18	3.66	111.31	0.01	
Cell 4B	158.66	10,626.44	0.4	26.73	6.82	6.82	2.99	90.97	2	
Cell 3C	158.66	10,626.44	0.26	17.25	6.69	6.69	2.45	74.31	2	
Eff Channel 1	159.05	31,876.54	0.24	48.03	6.68	6.68	2.36	214.87	2	
Cell 5A	159.05	15,938.27	0.21	20.99	6.65	6.65	2.21	100.42	2	
Cell 5B	159.05	15,938.27	0.21	20.99	6.65	6.65	2.21	100.42	2	
Eff Channel 2	159.04	31,876.54	0.18	35.74	6.49	6.49	1.78	161.51	2	
Secondaries	0.65	65.79	0.18	18.03	6.49	6.49	1.78	81.48	2	
Denitrification Filters	0.27	27.21	0.18	17.66	6.44	6.44	1.78	79.81	2	
Plant Effluent	0.27	27.21	0.18	17.66	6.49	6.49	1.78	79.8	2	
Secondaries (U)	320.32	31,810.74	0.18	17.71	6.49	6.49	1.78	80.02	2	
NSL 1C	314.29	31,320.18	0	0.19	6.54	6.54	2.32	104.83	0	
NSL 1B	314.29	31,320.18	0.02	1.53	6.61	6.61	2.53	114.58	0	
NSL 1A	314.29	31,320.18	0.06	6.16	6.65	6.65	2.67	120.57	0	
NSL 1D	314.29	31,320.18	0.09	8.54	6.67	6.67	2.75	124.17	0	
Primary Clarifiers (U)	145.62	114.89	4.5	3.55	6.99	6.99	3.56	1.27	0	
Denitrification Filters (U)	18.49	38.58	0.18	0.37	6.44	6.44	1.78	1.68	2	
WAS Splitter	320.32	31,246.70	0.18	17.4	6.49	6.49	1.78	78.6	2	
WAS Splitter (U)	320.32	564.04	0.18	0.31	6.49	6.49	1.78	1.42	2	
20% HAc	0	0	0	0	2.12	2.12	-960.07	-6.54	0	
25% NaOH	0	0	0	0	15.16	15.16	7,970.05	90.51	0	
RDT	35.14	73.48	3.04	6.36	5.23	5.23	1.95	1.85	1.38	
RDT (U)	1,319.13	605.45	3.04	1.4	5.23	5.23	1.95	0.41	1.38	
Sludge to Digesters	1,319.13	605.45	3.04	1.4	5.25	5.25	1.9	0.4	1.38	

Model 3 - Current Capacity Annual Average Existing System - DAS / Step Feed

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	11.6	247.5	23,959.69	210.5	20,377.84	170.45	16,500.86	49.18	4,761.38
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	11.52	99.9	9,605.34	84.93	8,166.15	98.15	9,437.31	49.31	4,741.49
AB Inf. Channel	11.77	107.47	10,559.99	88.55	8,700.82	97.67	9,597.14	48.18	4,734.74
Cell 1E	5.82	5,398.40	262,407.55	3,031.02	147,332.92	946.93	46,028.73	1.79	87.11
Cell 2A	7.77	4,080.91	264,532.12	2,298.81	149,013.22	725.28	47,014.33	1.72	111.59
Cell 1F	7.77	4,071.60	263,928.76	2,287.85	148,302.43	714.26	46,299.39	1.01	65.54
Cell 2B	7.77	4,078.76	264,393.13	2,296.10	148,837.56	721.46	46,766.08	0.56	36.21
Cell 2D	5.85	5,372.06	262,447.15	3,016.44	147,365.37	942.63	46,051.20	1.81	88.49
Cell 3A	7.83	4,051.37	264,607.69	2,282.47	149,075.58	720.48	47,057.17	1.75	114.46
Cell 3B	7.83	4,049.28	264,471.50	2,279.82	148,902.03	716.68	46,808.76	0.57	37.01
Cell 2C	7.83	4,042.21	264,009.59	2,271.64	148,368.33	709.56	46,343.78	1.02	66.45
Cell 3D	5.85	5,372.06	262,447.15	3,016.44	147,365.37	942.63	46,051.20	1.81	88.49
Cell 4A	7.83	4,051.37	264,607.69	2,282.47	149,075.58	720.48	47,057.17	1.75	114.46
Cell 4B	7.83	4,049.28	264,471.50	2,279.82	148,902.03	716.68	46,808.76	0.57	37.01
Cell 3C	7.83	4,042.21	264,009.59	2,271.64	148,368.33	709.56	46,343.78	1.02	66.45
Eff Channel 1	23.42	4,050.91	791,742.93	2,275.82	444,804.39	709.99	138,766.99	1.01	197.44
Cell 5A	11.71	4,046.93	395,482.52	2,271.48	221,978.33	705.87	68,980.92	0.94	91.97
Cell 5B	11.71	4,046.93	395,482.52	2,271.48	221,978.33	705.87	68,980.92	0.94	91.97
Eff Channel 2	23.42	4,055.99	792,786.44	2,269.78	443,653.14	704.38	137,678.55	0.93	182.72
Secondaries	11.82	12.05	1,189.18	6.75	665.48	3.03	298.47	0.93	92.22
Denitrification Filters	11.57	2.46	237.84	1.38	133.1	1.36	131.52	0.93	90.27
Plant Effluent	11.57	2.46	237.84	1.38	133.1	1.36	131.52	0.93	90.27
Secondaries (U)	11.6	8,177.09	791,597.26	4,576.00	442,987.66	1,419.12	137,380.08	0.93	90.5
NSL 1C	11.65	8,047.50	782,094.42	4,509.84	438,287.74	1,406.63	136,703.17	3.52	341.77
NSL 1B	11.65	8,046.47	781,994.51	4,509.07	438,212.65	1,402.36	136,287.69	0.52	50.23
NSL 1A	11.65	8,044.97	781,848.61	4,507.99	438,107.84	1,401.41	136,196.16	1.08	105.44
NSL 1D	11.65	8,043.40	781,695.81	4,506.82	437,994.61	1,400.62	136,119.36	1.87	181.9
Primary Clarifiers (U)	0.09	18,261.97	14,408.01	15,525.74	12,249.23	8,977.16	7,082.65	49.31	38.91
Denitrification Filters (U)	0.25	455.98	951.34	255.17	532.38	80.02	166.95	0.93	1.95
WAS Splitter	11.41	8,177.09	778,699.68	4,576.00	435,770.01	1,419.12	135,141.73	0.93	89.02
WAS Splitter (U)	0.19	8,177.09	12,897.58	4,576.00	7,217.64	1,419.12	2,238.35	0.93	1.47
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.23	1,367.94	2,654.24	964.11	1,870.69	702.44	1,362.96	256.31	497.32
RDT (U)	0.05	56,085.44	23,888.13	39,528.59	16,836.17	18,547.72	7,899.92	256.31	109.17
Sludge to Digesters	0.05	56,085.44	23,888.13	39,528.59	16,836.17	18,547.72	7,899.92	256.31	109.17

Model 3 - Current Capacity Annual Average Existing System - DAS / Step Feed

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	392	37,948.22	85.42	8,269.68	306.58	29,678.55	7.64	739.99	42.5	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	210.27	20,218.22	86.56	8,322.79	123.71	11,895.43	7.73	742.97	38.37	
AB Inf. Channel	214.04	21,032.48	84.87	8,339.76	129.17	12,692.72	7.52	738.78	38.07	
Cell 1E	4,534.40	220,409.88	15.4	748.73	4,519.00	219,661.15	0.09	4.16	226.78	
Cell 2A	3,441.95	223,113.41	15.59	1,010.43	3,426.36	222,102.99	0.13	8.56	175.69	
Cell 1F	3,425.22	222,029.09	14.16	917.92	3,411.06	221,111.17	0	0.13	173.64	
Cell 2B	3,436.42	222,755.23	13.88	899.42	3,422.55	221,855.81	0.05	3.45	173.73	
Cell 2D	4,512.66	220,461.99	15.43	753.97	4,497.23	219,708.02	0.09	4.25	225.83	
Cell 3A	3,417.60	223,214.30	15.63	1,021.16	3,401.96	222,193.14	0.13	8.8	174.64	
Cell 3B	3,412.11	222,855.96	13.89	907	3,398.23	221,948.97	0.05	3.43	172.68	
Cell 2C	3,401.03	222,131.90	14.17	925.49	3,386.86	221,206.41	0	0.14	172.59	
Cell 3D	4,512.66	220,461.99	15.43	753.97	4,497.23	219,708.02	0.09	4.25	225.83	
Cell 4A	3,417.60	223,214.30	15.63	1,021.16	3,401.96	222,193.14	0.13	8.8	174.64	
Cell 4B	3,412.11	222,855.96	13.89	907	3,398.23	221,948.97	0.05	3.43	172.68	
Cell 3C	3,401.03	222,131.90	14.17	925.49	3,386.86	221,206.41	0	0.14	172.59	
Eff Channel 1	3,407.35	665,960.04	14.13	2,762.52	3,393.21	663,197.52	0	0.11	172.92	
Cell 5A	3,401.18	332,377.52	14.02	1,370.06	3,387.16	331,007.45	0	0.02	172.88	
Cell 5B	3,401.18	332,377.52	14.02	1,370.06	3,387.16	331,007.45	0	0.02	172.88	
Eff Channel 2	3,398.78	664,328.60	14.01	2,737.76	3,384.78	661,590.84	0	0.04	172.85	
Secondaries	24.07	2,374.20	14.01	1,381.82	10.06	992.39	0	0.02	11.98	
Denitrification Filters	16.06	1,551.07	14.01	1,352.59	2.06	198.48	0	0.02	11.59	
Plant Effluent	16.06	1,551.07	14.01	1,352.59	2.06	198.48	0	0.02	11.59	
Secondaries (U)	6,837.90	661,954.40	14.01	1,355.94	6,823.89	660,598.46	0	0.02	336.79	
NSL 1C	6,742.82	655,299.39	18.38	1,786.69	6,724.44	653,512.70	3.47	337.47	323.04	
NSL 1B	6,737.30	654,762.33	13.98	1,358.89	6,723.31	653,403.44	0.51	50.05	321.6	
NSL 1A	6,736.40	654,675.03	14.67	1,425.35	6,721.73	653,249.68	1.42	137.91	321.55	
NSL 1D	6,735.74	654,611.22	15.71	1,527.23	6,720.03	653,083.98	2.49	242.35	321.55	
Primary Clarifiers (U)	22,702.52	17,911.44	86.56	68.29	22,615.96	17,843.15	7.73	6.1	685.58	
Denitrification Filters (U)	394.53	823.13	14.01	29.22	380.53	793.91	0	0	29.64	
WAS Splitter	6,837.90	651,169.11	14.01	1,333.85	6,823.89	649,835.26	0	0.02	336.79	
WAS Splitter (U)	6,837.90	10,785.29	14.01	22.09	6,823.89	10,763.20	0	0	336.79	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	1,812.06	3,515.97	392.57	761.7	1,419.49	2,754.27	349.35	677.85	82.92	
RDT (U)	58,591.73	24,955.62	392.57	167.2	58,199.16	24,788.42	349.35	148.8	2,139.41	
Sludge to Digesters	58,591.73	24,955.62	392.57	167.2	58,199.16	24,788.42	349.35	148.8	2,139.41	

Model 3 - Current Capacity Annual Average Existing System - DAS / Step Feed

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent	4,114.28	42.5	4,114.28	28.9	2,797.71	0	0	0	0	
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0	
Primary Clarifiers	3,689.24	38.37	3,689.24	30	2,884.11	0	0	0	0	
AB Inf. Channel	3,741.07	37.85	3,719.38	29.26	2,875.44	0.22	21.14	0.01	0.56	
Cell 1E	11,023.55	217.68	10,580.88	1.17	56.77	8.74	424.74	0.37	17.93	
Cell 2A	11,388.81	172.55	11,184.74	8.8	570.33	2.91	188.55	0.24	15.52	
Cell 1F	11,255.38	165.94	10,756.82	2.51	162.57	6.77	438.9	0.92	59.66	
Cell 2B	11,261.46	172.53	11,184.02	9.2	596.51	1.07	69.25	0.13	8.19	
Cell 2D	11,032.88	216.68	10,585.85	1.21	59.3	8.76	427.95	0.39	19.09	
Cell 3A	11,406.20	171.47	11,199.01	8.88	580.19	2.92	191	0.25	16.2	
Cell 3B	11,278.57	171.46	11,198.30	9.29	606.53	1.1	71.63	0.13	8.65	
Cell 2C	11,272.49	164.9	10,770.07	2.62	171.15	6.74	439.96	0.96	62.46	
Cell 3D	11,032.88	216.68	10,585.85	1.21	59.3	8.76	427.95	0.39	19.09	
Cell 4A	11,406.20	171.47	11,199.01	8.88	580.19	2.92	191	0.25	16.2	
Cell 4B	11,278.57	171.46	11,198.30	9.29	606.53	1.1	71.63	0.13	8.65	
Cell 3C	11,272.49	164.9	10,770.07	2.62	171.15	6.74	439.96	0.96	62.46	
Eff Channel 1	33,797.59	164.34	32,120.36	1.68	327.9	7.62	1,489.17	0.96	188.06	
Cell 5A	16,894.21	162.86	15,915.27	0.33	32.12	9.84	961.48	0.18	17.47	
Cell 5B	16,894.21	162.86	15,915.27	0.33	32.12	9.84	961.48	0.18	17.47	
Eff Channel 2	33,785.38	162.58	31,778.87	0.13	25.12	10.22	1,998.07	0.04	8.45	
Secondaries	1,181.40	1.71	168.66	0.13	12.68	10.22	1,008.48	0.04	4.26	
Denitrification Filters	1,119.57	1.33	128.25	0.13	12.41	10.22	987.15	0.04	4.17	
Plant Effluent	1,119.57	1.33	128.25	0.13	12.41	10.22	987.15	0.04	4.17	
Secondaries (U)	32,603.98	326.53	31,610.21	0.13	12.44	10.22	989.59	0.04	4.18	
NSL 1C	31,394.53	321.53	31,248.24	0.15	14.77	1.44	139.65	0.07	6.64	
NSL 1B	31,254.65	321.55	31,249.41	0.36	35.22	0.05	4.76	0	0.48	
NSL 1A	31,249.47	321.55	31,249.42	0.52	50.84	0	0.04	0	0.01	
NSL 1D	31,249.42	321.55	31,249.42	0.64	61.85	0	0	0	0	
Primary Clarifiers (U)	540.9	685.58	540.9	30	23.67	0	0	0	0	
Denitrification Filters (U)	61.83	19.37	40.41	0.13	0.27	10.22	21.33	0.04	0.09	
WAS Splitter	32,072.76	326.53	31,095.18	0.13	12.24	10.22	973.47	0.04	4.11	
WAS Splitter (U)	531.22	326.53	515.03	0.13	0.2	10.22	16.12	0.04	0.07	
20% HAc	0	0	0	0	0	0	0	0	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	160.89	76.08	147.61	23.63	45.84	6.81	13.22	0.03	0.06	
RDT (U)	911.23	2,132.57	908.31	23.63	10.06	6.81	2.9	0.03	0.01	
Sludge to Digesters	911.23	2,132.57	908.31	23.63	10.06	6.81	2.9	0.03	0.01	

Model 3 - Current Capacity Annual Average Existing System - DAS / Step Feed

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6	580.84	4.2	406.59	7	7	3.5	153.68	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.09	489.28	4.36	419.24	6.99	6.99	3.56	155.42	0	
AB Inf. Channel	5.38	528.8	4.27	419.36	9.22	9.22	5.56	247.61	0.5	
Cell 1E	221.97	10,789.51	0.43	20.89	6.75	6.75	2.53	55.86	2	
Cell 2A	167.79	10,876.76	0.73	47.58	7.26	7.26	3.62	106.5	0	
Cell 1F	167.79	10,876.76	0.31	20.07	6.81	6.81	2.86	84.07	2	
Cell 2B	167.79	10,876.76	0.53	34.44	7.33	7.33	3.8	111.73	0	
Cell 2D	220.88	10,790.83	0.43	21.14	6.75	6.75	2.54	56.21	2	
Cell 3A	166.57	10,879.41	0.74	48.47	7.27	7.27	3.63	107.52	0	
Cell 3B	166.57	10,879.41	0.54	35.13	7.33	7.33	3.81	112.76	0	
Cell 2C	166.57	10,879.41	0.31	20.4	6.82	6.82	2.87	85.03	2	
Cell 3D	220.88	10,790.83	0.43	21.14	6.75	6.75	2.54	56.21	2	
Cell 4A	166.57	10,879.41	0.74	48.47	7.27	7.27	3.63	107.52	0	
Cell 4B	166.57	10,879.41	0.54	35.13	7.33	7.33	3.81	112.76	0	
Cell 3C	166.57	10,879.41	0.31	20.4	6.82	6.82	2.87	85.03	2	
Eff Channel 1	166.98	32,635.57	0.28	55.17	6.79	6.79	2.74	242.72	2	
Cell 5A	166.98	16,317.79	0.23	22.7	6.74	6.74	2.53	112.27	2	
Cell 5B	166.98	16,317.79	0.23	22.7	6.74	6.74	2.53	112.27	2	
Eff Channel 2	166.97	32,635.57	0.19	37.79	6.58	6.58	2.09	185.28	2	
Secondaries	0.69	67.97	0.19	19.07	6.58	6.58	2.09	93.52	2	
Denitrification Filters	0.29	28.45	0.19	18.67	6.58	6.58	2.09	91.54	2	
Plant Effluent	0.29	28.45	0.19	18.67	6.58	6.58	2.09	91.54	2	
Secondaries (U)	336.42	32,567.61	0.19	18.71	6.58	6.58	2.09	91.76	2	
NSL 1C	330.37	32,106.77	0	0.2	6.61	6.61	2.69	118.74	0	
NSL 1B	330.37	32,106.77	0.01	0.69	6.68	6.68	2.87	126.61	0	
NSL 1A	330.37	32,106.78	0.04	3.66	6.71	6.71	2.91	128.22	0	
NSL 1D	330.37	32,106.78	0.06	6.17	6.73	6.73	2.93	129.35	0	
Primary Clarifiers (U)	137.52	108.5	4.36	3.44	6.99	6.99	3.56	1.28	0	
Denitrification Filters (U)	18.94	39.52	0.19	0.4	6.58	6.58	2.09	1.98	2	
WAS Splitter	336.42	32,036.98	0.19	18.41	6.58	6.58	2.09	90.27	2	
WAS Splitter (U)	336.42	530.63	0.19	0.3	6.58	6.58	2.09	1.5	2	
20% HAc	0	0	0	0	2.11	2.11	-966.41	-6.58	0	
25% NaOH	0	0	0	0	14.91	14.91	7,970.05	90.51	0	
RDT	35.97	69.8	3.46	6.7	5.16	5.16	2.12	1.86	1.33	
RDT (U)	1,336.69	569.33	3.46	1.47	5.16	5.16	2.12	0.41	1.33	
Sludge to Digesters	1,336.69	569.33	3.46	1.47	5.16	5.16	2.12	0.41	1.33	

Model 4 - Current Capacity Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent		14.5	258.09	31,231.32	219.09	26,511.99	177.41	21,467.95	51.19	6,194.65
Rotary Press Filtrate (50%)		0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers		14.42	103.98	12,513.99	88.24	10,619.81	102.05	12,282.55	51.29	6,173.20
AB Inf. Channel		14.67	113.83	13,940.15	93.1	11,401.66	102.37	12,537.09	50.35	6,165.88
Cell 1E		7.27	6,467.23	392,288.31	3,553.10	215,523.58	1,191.89	72,297.71	1.86	113.08
Cell 2A		9.69	4,887.10	395,193.72	2,693.29	217,791.88	910.99	73,666.76	1.99	160.94
Cell 1F		9.69	4,876.46	394,333.57	2,681.02	216,800.02	898.39	72,648.12	0.97	78.13
Cell 2B		9.69	4,882.18	394,795.72	2,687.26	217,303.92	904.47	73,139.27	1.18	95.26
Cell 2D		7.31	6,435.58	392,339.12	3,535.93	215,564.67	1,186.37	72,326.01	1.89	115
Cell 3A		9.76	4,851.58	395,292.38	2,674.03	217,871.68	904.82	73,721.77	2.03	165.24
Cell 3B		9.76	4,846.76	394,899.68	2,668.09	217,387.71	898.36	73,195.30	1.19	96.92
Cell 2C		9.76	4,841.13	394,440.43	2,661.93	216,886.06	892.35	72,705.93	0.97	79.29
Cell 3D		7.31	6,435.58	392,339.12	3,535.93	215,564.67	1,186.37	72,326.01	1.89	115
Cell 4A		9.76	4,851.58	395,292.38	2,674.03	217,871.68	904.82	73,721.77	2.03	165.24
Cell 4B		9.76	4,846.76	394,899.68	2,668.09	217,387.71	898.36	73,195.30	1.19	96.92
Cell 3C		9.76	4,841.13	394,440.43	2,661.93	216,886.06	892.35	72,705.93	0.97	79.29
Eff Channel 1		29.22	4,851.96	1,182,999.13	2,667.31	650,340.04	893.43	217,835.67	0.95	230.61
Cell 5A		14.61	4,848.66	591,096.48	2,663.84	324,746.44	890.11	108,512.88	0.89	108.51
Cell 5B		14.61	4,848.66	591,096.48	2,663.84	324,746.44	890.11	108,512.88	0.89	108.51
Eff Channel 2		29.22	4,859.71	1,184,976.97	2,662.41	649,193.78	888.88	216,742.85	0.88	214.49
Secondaries		14.72	14.47	1,777.47	7.93	973.79	3.52	432.84	0.88	108.04
Denitrification Filters		14.47	2.94	355.49	1.61	194.76	1.42	171.17	0.88	106.21
Plant Effluent		14.47	2.94	355.49	1.61	194.76	1.42	171.17	0.88	106.21
Secondaries (U)		14.5	9,777.83	1,183,199.50	5,356.82	648,219.99	1,787.56	216,310.01	0.88	106.44
NSL 1C		14.54	9,642.26	1,170,120.21	5,288.63	641,793.38	1,773.07	215,167.93	4.81	584.19
NSL 1B		14.54	9,640.46	1,169,901.74	5,286.91	641,583.88	1,767.18	214,453.18	0.86	104.63
NSL 1A		14.54	9,637.08	1,169,492.68	5,283.76	641,201.99	1,763.63	214,022.23	0.38	45.53
NSL 1D		14.54	9,633.71	1,169,083.34	5,280.59	640,817.82	1,760.50	213,642.86	0.33	39.51
Primary Clarifiers (U)		0.09	23,791.98	18,770.99	20,190.71	15,929.72	11,666.59	9,204.50	51.29	40.47
Denitrification Filters (U)		0.25	681.56	1,421.97	373.39	779.03	125.42	261.67	0.88	1.84
WAS Splitter		14.29	9,777.83	1,165,981.91	5,356.82	638,787.27	1,787.56	213,162.33	0.88	104.89
WAS Splitter (U)		0.21	9,777.83	17,217.59	5,356.82	9,432.72	1,787.56	3,147.68	0.88	1.55
20% HAc		0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH		0	0	0	0	0	0	0	0	0
RDT		0.25	1,681.80	3,516.44	1,173.77	2,454.20	819.48	1,713.44	262.95	549.79
RDT (U)		0.05	68,953.99	31,647.94	48,124.43	22,087.76	23,080.85	10,593.46	262.95	120.69
Sludge to Digesters		0.05	68,953.99	31,647.94	48,124.43	22,087.76	23,080.85	10,593.46	262.95	120.69

Model 4 - Current Capacity Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	408	49,371.41	88.91	10,759.02	319.09	38,612.39	7.96	962.74	44.2	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	218.34	26,278.54	89.81	10,809.56	128.53	15,468.97	8.02	965.49	39.63	
AB Inf. Channel	224.23	27,460.68	88.4	10,826.34	135.83	16,634.34	7.85	961.38	39.6	
Cell 1E	5,311.39	322,177.56	15.88	963.07	5,295.51	321,214.49	0.06	3.89	265.85	
Cell 2A	4,029.37	325,833.61	16.4	1,326.20	4,012.97	324,507.41	0.16	13.26	205.83	
Cell 1F	4,010.26	324,288.63	14.36	1,161.29	3,995.90	323,127.34	0	0.03	205.68	
Cell 2B	4,019.33	325,021.88	14.74	1,192.30	4,004.59	323,829.58	0.01	0.55	205.75	
Cell 2D	5,285.80	322,243.91	15.91	970.03	5,269.89	321,273.88	0.07	4	264.71	
Cell 3A	4,000.69	325,963.99	16.46	1,341.16	3,984.23	324,622.82	0.17	13.72	204.56	
Cell 3B	3,990.74	325,153.51	14.76	1,202.85	3,975.98	323,950.66	0.01	0.57	204.48	
Cell 2C	3,981.77	324,422.61	14.37	1,170.93	3,967.40	323,251.68	0	0.04	204.41	
Cell 3D	5,285.80	322,243.91	15.91	970.03	5,269.89	321,273.88	0.07	4	264.71	
Cell 4A	4,000.69	325,963.99	16.46	1,341.16	3,984.23	324,622.82	0.17	13.72	204.56	
Cell 4B	3,990.74	325,153.51	14.76	1,202.85	3,975.98	323,950.66	0.01	0.57	204.48	
Cell 3C	3,981.77	324,422.61	14.37	1,170.93	3,967.40	323,251.68	0	0.04	204.41	
Eff Channel 1	3,989.85	972,799.72	14.32	3,492.59	3,975.53	969,307.13	0	0.05	204.82	
Cell 5A	3,984.91	485,797.62	14.24	1,735.72	3,970.67	484,061.91	0	0.02	204.78	
Cell 5B	3,984.91	485,797.62	14.24	1,735.72	3,970.67	484,061.91	0	0.02	204.78	
Eff Channel 2	3,982.88	971,173.09	14.22	3,467.45	3,968.66	967,705.64	0	0.03	204.75	
Secondaries	26.04	3,198.23	14.22	1,746.67	11.82	1,451.56	0	0.02	15.52	
Denitrification Filters	16.62	2,007.31	14.22	1,717.00	2.4	290.31	0	0.02	15.07	
Plant Effluent	16.62	2,007.31	14.22	1,717.00	2.4	290.31	0	0.02	15.07	
Secondaries (U)	7,999.24	967,974.87	14.22	1,720.78	7,985.02	966,254.08	0	0.02	396.83	
NSL 1C	7,902.97	959,051.79	20.26	2,458.15	7,882.71	956,593.64	4.45	540.33	384.99	
NSL 1B	7,895.23	958,112.28	14.94	1,813.25	7,880.28	956,299.02	0.3	36	382.32	
NSL 1A	7,890.25	957,508.12	14.41	1,748.78	7,875.84	955,759.34	0.03	3.86	380.61	
NSL 1D	7,885.96	956,987.44	14.6	1,771.75	7,871.36	955,215.69	0.05	5.5	379.12	
Primary Clarifiers (U)	29,499.89	23,274.32	89.81	70.86	29,410.08	23,203.46	8.02	6.33	881.36	
Denitrification Filters (U)	570.81	1,190.92	14.22	29.67	556.59	1,161.25	0	0	41.57	
WAS Splitter	7,999.24	953,889.16	14.22	1,695.74	7,985.02	952,193.42	0	0.02	396.83	
WAS Splitter (U)	7,999.24	14,085.70	14.22	25.04	7,985.02	14,060.66	0	0	396.83	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	2,131.95	4,457.64	404.65	846.06	1,727.31	3,611.58	358.96	750.53	96.27	
RDT (U)	71,224.30	32,689.95	404.65	185.72	70,819.66	32,504.22	358.96	164.75	2,598.95	
Sludge to Digesters	71,224.30	32,689.95	404.65	185.72	70,819.66	32,504.22	358.96	164.75	2,598.95	

Model 4 - Current Capacity Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent	5,348.57	44.2	5,348.57	30.06	3,637.03	0	0	0	0	
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0	
Primary Clarifiers	4,769.06	39.63	4,769.06	30.93	3,722.69	0	0	0	0	
AB Inf. Channel	4,850.01	39.37	4,821.45	30.36	3,718.54	0.23	27.8	0.01	0.76	
Cell 1E	16,125.70	257.49	15,618.71	3.26	197.83	7.51	455.72	0.85	51.28	
Cell 2A	16,644.30	202.87	16,404.65	10.62	858.92	2.53	204.96	0.43	34.68	
Cell 1F	16,631.90	194.07	15,693.32	2.03	164.52	10.53	851.12	1.08	87.47	
Cell 2B	16,637.77	198.02	16,012.80	5.83	471.19	6.57	531.36	1.16	93.62	
Cell 2D	16,137.80	256.38	15,629.95	3.38	206.1	7.46	454.98	0.87	52.88	
Cell 3A	16,666.90	201.63	16,427.97	10.76	876.67	2.5	203.44	0.44	35.49	
Cell 3B	16,660.38	196.83	16,037.45	6.02	490.16	6.48	527.73	1.17	95.19	
Cell 2C	16,654.52	192.86	15,714.01	2.2	179.09	10.39	846.93	1.15	93.57	
Cell 3D	16,137.80	256.38	15,629.95	3.38	206.1	7.46	454.98	0.87	52.88	
Cell 4A	16,666.90	201.63	16,427.97	10.76	876.67	2.5	203.44	0.44	35.49	
Cell 4B	16,660.38	196.83	16,037.45	6.02	490.16	6.48	527.73	1.17	95.19	
Cell 3C	16,654.52	192.86	15,714.01	2.2	179.09	10.39	846.93	1.15	93.57	
Eff Channel 1	49,938.27	192.7	46,984.22	1.61	392.04	11.04	2,691.53	1.08	262.51	
Cell 5A	24,964.53	191.47	23,341.71	0.51	62.07	12.92	1,575.63	0.39	47.19	
Cell 5B	24,964.53	191.47	23,341.71	0.51	62.07	12.92	1,575.63	0.39	47.19	
Eff Channel 2	49,925.85	191.17	46,614.06	0.28	67.73	13.42	3,271.31	0.17	40.47	
Secondaries	1,906.51	1.94	238.25	0.28	34.12	13.42	1,647.86	0.17	20.39	
Denitrification Filters	1,819.77	1.49	179.85	0.28	33.54	13.42	1,619.87	0.17	20.04	
Plant Effluent	1,819.77	1.49	179.85	0.28	33.54	13.42	1,619.87	0.17	20.04	
Secondaries (U)	48,019.34	383.24	46,375.81	0.28	33.61	13.42	1,623.44	0.17	20.09	
NSL 1C	46,720.28	378.1	45,883.74	0.37	44.67	6.71	814.79	0.18	21.75	
NSL 1B	46,396.09	378.12	45,886.52	0.53	64.39	4.04	490.6	0.16	18.97	
NSL 1A	46,187.76	378.14	45,888.45	0.76	92.21	2.34	284.04	0.13	15.27	
NSL 1D	46,007.59	378.15	45,889.91	0.99	120.31	0.9	108.72	0.07	8.97	
Primary Clarifiers (U)	695.36	881.36	695.36	30.93	24.4	0	0	0	0	
Denitrification Filters (U)	86.74	27.99	58.4	0.28	0.58	13.42	27.99	0.17	0.35	
WAS Splitter	47,320.58	383.24	45,700.96	0.28	33.12	13.42	1,599.82	0.17	19.79	
WAS Splitter (U)	698.76	383.24	674.85	0.28	0.49	13.42	23.62	0.17	0.29	
20% HAc	0	0	0	0	0	0	0	0	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	201.28	86.89	181.67	23.28	48.67	9.26	19.37	0.11	0.24	
RDT (U)	1,192.85	2,589.57	1,188.54	23.28	10.68	9.26	4.25	0.11	0.05	
Sludge to Digesters	1,192.85	2,589.57	1,188.54	23.28	10.68	9.26	4.25	0.11	0.05	

Model 4 - Current Capacity Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6.2	750.25	4.34	525.18	7	7	3.5	192.11	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.22	628.11	4.47	537.74	6.99	6.99	3.55	193.84	0	
AB Inf. Channel	5.6	685.38	4.39	537.55	9.05	9.05	5.14	285.36	0.5	
Cell 1E	259.57	15,744.99	0.34	20.7	6.64	6.64	2.13	58.56	2	
Cell 2A	196.11	15,858.08	0.51	41.08	7.06	7.06	3.19	117.16	0.01	
Cell 1F	196.11	15,858.08	0.14	11.12	6.6	6.6	1.98	72.58	2	
Cell 2B	196.11	15,858.08	0.23	18.54	6.74	6.74	2.52	92.58	2	
Cell 2D	258.29	15,746.70	0.34	20.98	6.65	6.65	2.14	59.23	2	
Cell 3A	194.67	15,861.50	0.51	41.87	7.06	7.06	3.21	118.62	0.01	
Cell 3B	194.67	15,861.50	0.23	18.87	6.74	6.74	2.55	94.12	2	
Cell 2C	194.67	15,861.50	0.14	11.25	6.6	6.6	2	73.86	2	
Cell 3D	258.29	15,746.70	0.34	20.98	6.65	6.65	2.14	59.23	2	
Cell 4A	194.67	15,861.50	0.51	41.87	7.06	7.06	3.21	118.62	0.01	
Cell 4B	194.67	15,861.50	0.23	18.87	6.74	6.74	2.55	94.12	2	
Cell 3C	194.67	15,861.50	0.14	11.25	6.6	6.6	2	73.86	2	
Eff Channel 1	195.15	47,581.08	0.13	30.95	6.59	6.59	1.91	211.73	2	
Cell 5A	195.15	23,790.54	0.11	13.6	6.55	6.55	1.75	96.69	2	
Cell 5B	195.15	23,790.54	0.11	13.6	6.55	6.55	1.75	96.69	2	
Eff Channel 2	195.13	47,581.08	0.1	23.79	6.31	6.31	1.23	136	2	
Secondaries	0.68	83.32	0.1	11.99	6.31	6.31	1.23	68.51	2	
Denitrification Filters	0.22	26.05	0.1	11.78	6.26	6.26	1.23	67.35	2	
Plant Effluent	0.22	26.05	0.1	11.78	6.31	6.31	1.23	67.35	2	
Secondaries (U)	392.52	47,497.76	0.1	11.81	6.31	6.31	1.23	67.49	2	
NSL 1C	386.44	46,895.70	0	0.13	6.38	6.38	1.68	92.68	0	
NSL 1B	386.44	46,895.70	0	0.25	6.47	6.47	1.91	105.19	0	
NSL 1A	386.44	46,895.70	0.04	5.1	6.51	6.51	2.05	113.06	0	
NSL 1D	386.44	46,895.70	0.07	8.78	6.55	6.55	2.18	119.96	0	
Primary Clarifiers (U)	176.28	139.08	4.47	3.53	6.99	6.99	3.55	1.27	0	
Denitrification Filters (U)	27.45	57.27	0.1	0.2	6.26	6.26	1.23	1.16	2	
WAS Splitter	392.52	46,806.59	0.1	11.64	6.31	6.31	1.23	66.51	2	
WAS Splitter (U)	392.52	691.17	0.1	0.17	6.31	6.31	1.23	0.98	2	
20% HAc	0	0	0	0	2.12	2.12	-960.07	-6.54	0	
25% NaOH	0	0	0	0	15.16	15.16	7,970.05	90.51	0	
RDT	42.62	89.12	3.32	6.94	4.94	4.94	1.43	1.36	1.38	
RDT (U)	1,614.78	741.14	3.32	1.52	4.94	4.94	1.43	0.3	1.38	
Sludge to Digesters	1,614.78	741.14	3.32	1.52	4.94	4.94	1.38	0.29	1.38	

Model 5 - Buildout Annual Average Existing System - DAS / Step Feed

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	14.8	247.5	30,569.26	210.5	25,999.32	170.45	21,052.82	49.18	6,074.86
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	14.72	99.7	12,249.17	84.77	10,414.74	98.05	12,046.21	49.28	6,054.99
AB Inf. Channel	14.97	111.2	13,897.00	90.18	11,269.90	98.41	12,297.97	48.38	6,045.97
Cell 1E	7.42	7,320.96	453,299.45	3,807.66	235,762.88	1,161.36	71,908.94	1.79	111.14
Cell 2A	9.89	5,526.55	456,150.08	2,882.98	237,954.70	886.8	73,194.43	1.75	144.64
Cell 1F	9.89	5,517.29	455,385.46	2,872.52	237,091.78	876.21	72,320.46	1.02	84.04
Cell 2B	9.89	5,524.52	455,981.97	2,880.46	237,746.74	883.11	72,890.35	0.56	46.61
Cell 2D	7.46	7,285.04	453,351.59	3,789.22	235,804.90	1,155.99	71,937.87	1.81	112.89
Cell 3A	9.97	5,486.24	456,250.38	2,862.28	238,035.34	880.8	73,249.57	1.78	148.37
Cell 3B	9.97	5,484.26	456,086.18	2,859.82	237,830.38	877.14	72,945.44	0.57	47.62
Cell 2C	9.97	5,477.12	455,492.50	2,851.97	237,177.65	870.32	72,378.02	1.02	85.16
Cell 3D	7.46	7,285.04	453,351.59	3,789.22	235,804.90	1,155.99	71,937.87	1.81	112.89
Cell 4A	9.97	5,486.24	456,250.38	2,862.28	238,035.34	880.8	73,249.57	1.78	148.37
Cell 4B	9.97	5,484.26	456,086.18	2,859.82	237,830.38	877.14	72,945.44	0.57	47.62
Cell 3C	9.97	5,477.12	455,492.50	2,851.97	237,177.65	870.32	72,378.02	1.02	85.16
Eff Channel 1	29.82	5,489.38	1,366,106.26	2,857.63	711,158.27	871.19	216,807.14	1.02	254.37
Cell 5A	14.91	5,485.38	682,554.56	2,853.38	355,050.47	867.18	107,904.29	0.97	120.57
Cell 5B	14.91	5,485.38	682,554.56	2,853.38	355,050.47	867.18	107,904.29	0.97	120.57
Eff Channel 2	29.82	5,498.01	1,368,372.68	2,851.60	709,720.30	865.68	215,455.78	0.97	241.12
Secondaries	15.02	16.37	2,052.56	8.49	1,064.58	3.54	444.28	0.97	121.46
Denitrification Filters	14.77	3.33	410.51	1.73	212.92	1.49	184.01	0.97	119.44
Plant Effluent	14.77	3.33	410.51	1.73	212.92	1.49	184.01	0.97	119.44
Secondaries (U)	14.8	11,062.25	1,366,320.12	5,737.55	708,655.72	1,740.81	215,011.50	0.97	119.66
NSL 1C	14.85	10,921.46	1,353,109.50	5,670.48	702,542.06	1,729.01	214,215.40	5.46	676.85
NSL 1B	14.85	10,919.59	1,352,877.63	5,668.70	702,321.39	1,722.39	213,395.11	0.91	112.33
NSL 1A	14.85	10,918.00	1,352,680.46	5,667.45	702,166.05	1,720.14	213,116.15	0.28	35.3
NSL 1D	14.85	10,916.55	1,352,500.97	5,666.37	702,032.30	1,719.30	213,012.25	0.93	115.52
Primary Clarifiers (U)	0.09	23,288.49	18,373.76	19,800.82	15,622.11	11,439.97	9,025.71	49.28	38.88
Denitrification Filters (U)	0.25	787.04	1,642.05	408.21	851.66	124.75	260.28	0.97	2.02
WAS Splitter	14.61	11,062.25	1,349,148.80	5,737.55	699,749.64	1,740.81	212,309.33	0.97	118.16
WAS Splitter (U)	0.19	11,062.25	17,171.32	5,737.55	8,906.08	1,740.81	2,702.17	0.97	1.5
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.23	1,800.69	3,456.95	1,227.05	2,355.69	893.84	1,715.98	326.6	627.01
RDT (U)	0.05	73,828.44	31,112.59	50,309.18	21,201.17	23,583.34	9,938.43	326.6	137.64
Sludge to Digesters	0.05	73,828.44	31,112.59	50,309.18	21,201.17	23,583.34	9,938.43	326.6	137.64

Model 5 - Buildout Annual Average Existing System - DAS / Step Feed

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	392	48,416.70	85.42	10,550.97	306.58	37,865.73	7.64	944.13	42.5	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	209.79	25,774.58	86.31	10,604.27	123.48	15,170.31	7.71	947.12	38.12	
AB Inf. Channel	216.57	27,064.70	84.96	10,617.65	131.61	16,447.06	7.54	942.28	38.09	
Cell 1E	5,699.67	352,912.49	15.21	941.57	5,684.46	351,970.92	0.07	4.38	279.11	
Cell 2A	4,318.37	356,429.55	15.43	1,273.41	4,302.95	355,156.14	0.13	11.06	215.14	
Cell 1F	4,302.33	355,105.07	13.97	1,153.05	4,288.36	353,952.02	0	0.16	213.16	
Cell 2B	4,313.07	355,992.09	13.67	1,128.68	4,299.40	354,863.40	0.05	3.88	213.25	
Cell 2D	5,672.14	352,979.80	15.24	948.16	5,656.90	352,031.63	0.07	4.48	277.9	
Cell 3A	4,287.49	356,559.81	15.48	1,287.07	4,272.02	355,272.74	0.14	11.37	213.79	
Cell 3B	4,282.24	356,122.44	13.69	1,138.18	4,268.55	354,984.26	0.05	3.89	211.91	
Cell 2C	4,271.61	355,238.58	13.98	1,162.49	4,257.63	354,076.09	0	0.16	211.82	
Cell 3D	5,672.14	352,979.80	15.24	948.16	5,656.90	352,031.63	0.07	4.48	277.9	
Cell 4A	4,287.49	356,559.81	15.48	1,287.07	4,272.02	355,272.74	0.14	11.37	213.79	
Cell 4B	4,282.24	356,122.44	13.69	1,138.18	4,268.55	354,984.26	0.05	3.89	211.91	
Cell 3C	4,271.61	355,238.58	13.98	1,162.49	4,257.63	354,076.09	0	0.16	211.82	
Eff Channel 1	4,280.16	1,065,174.26	13.95	3,471.80	4,266.21	1,061,702.46	0	0.14	212.25	
Cell 5A	4,274.14	531,838.47	13.86	1,724.40	4,260.28	530,114.07	0	0.03	212.21	
Cell 5B	4,274.14	531,838.47	13.86	1,724.40	4,260.28	530,114.07	0	0.03	212.21	
Eff Channel 2	4,271.63	1,063,144.62	13.85	3,447.98	4,257.78	1,059,696.65	0	0.05	212.17	
Secondaries	26.53	3,326.43	13.85	1,736.88	12.68	1,589.54	0	0.02	12.29	
Denitrification Filters	16.43	2,025.89	13.85	1,707.98	2.58	317.91	0	0.02	11.82	
Plant Effluent	16.43	2,025.89	13.85	1,707.98	2.58	317.91	0	0.02	11.82	
Secondaries (U)	8,580.69	1,059,818.20	13.85	1,711.10	8,566.84	1,058,107.10	0	0.02	415.06	
NSL 1C	8,486.80	1,051,468.27	20.68	2,562.73	8,466.12	1,048,905.54	4.87	603.85	403.27	
NSL 1B	8,478.22	1,050,405.61	14.61	1,810.67	8,463.61	1,048,594.94	0.44	54.15	400.39	
NSL 1A	8,475.13	1,050,023.01	13.34	1,652.94	8,461.79	1,048,370.07	0.26	32.57	399.78	
NSL 1D	8,474.38	1,049,929.33	14.17	1,755.24	8,460.21	1,048,174.10	1.21	150.21	399.75	
Primary Clarifiers (U)	28,928.56	22,823.56	86.31	68.1	28,842.25	22,755.46	7.71	6.08	864.28	
Denitrification Filters (U)	623.36	1,300.54	13.85	28.9	609.5	1,271.64	0	0	40.4	
WAS Splitter	8,580.69	1,046,498.86	13.85	1,689.59	8,566.84	1,044,809.27	0	0.02	415.06	
WAS Splitter (U)	8,580.69	13,319.34	13.85	21.5	8,566.84	13,297.83	0	0	415.06	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	2,297.53	4,410.78	490.36	941.4	1,807.17	3,469.39	445.9	856.04	99.98	
RDT (U)	74,584.28	31,431.12	490.36	206.65	74,093.92	31,224.47	445.9	187.91	2,691.44	
Sludge to Digesters	74,584.28	31,431.12	490.36	206.65	74,093.92	31,224.47	445.9	187.91	2,691.44	

Model 5 - Buildout Annual Average Existing System - DAS / Step Feed

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent		5,249.26	42.5	5,249.26	28.9	3,569.50	0	0	0	0
Rotary Press Filtrate (50%)		115.86	862	115.86	818.9	110.06	0	0	0	0
Primary Clarifiers		4,683.23	38.12	4,683.23	29.76	3,656.08	0	0	0	0
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AB Inf. Channel		4,759.77	37.91	4,737.49	29.2	3,649.57	0.17	21.51	0.01	0.77
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Cell 1E		17,281.86	269.96	16,715.69	1.24	76.77	8.74	541.32	0.4	24.86
Cell 2A		17,756.83	211.84	17,484.64	8.82	727.93	3.04	250.7	0.26	21.48
Cell 1F		17,593.67	205.3	16,945.28	2.59	213.38	6.91	570.33	0.95	78.06
Cell 2B		17,601.07	211.83	17,483.86	9.22	761.38	1.27	104.76	0.15	12.45
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Cell 2D		17,293.74	268.71	16,722.21	1.29	80.24	8.76	545.06	0.43	26.47
Cell 3A		17,779.00	210.47	17,503.02	8.91	740.69	3.05	253.53	0.27	22.44
Cell 3B		17,623.02	210.46	17,502.23	9.31	774.37	1.29	107.67	0.16	13.12
Cell 2C		17,615.63	203.97	16,962.44	2.7	224.68	6.87	571.56	0.98	81.62
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Cell 3D		17,293.74	268.71	16,722.21	1.29	80.24	8.76	545.06	0.43	26.47
Cell 4A		17,779.00	210.47	17,503.02	8.91	740.69	3.05	253.53	0.27	22.44
Cell 4B		17,623.02	210.46	17,502.23	9.31	774.37	1.29	107.67	0.16	13.12
Cell 3C		17,615.63	203.97	16,962.44	2.7	224.68	6.87	571.56	0.98	81.62
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Eff Channel 1		52,821.53	203.51	50,646.47	1.76	437.78	7.75	1,927.52	0.99	247.55
Cell 5A		26,405.05	201.99	25,134.38	0.35	43.68	10.01	1,245.65	0.2	25.02
Cell 5B		26,405.05	201.99	25,134.38	0.35	43.68	10.01	1,245.65	0.2	25.02
Eff Channel 2		52,806.24	201.71	50,202.43	0.14	34.66	10.41	2,591.13	0.05	12.68
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Secondaries		1,541.37	1.83	229.72	0.14	17.46	10.41	1,305.25	0.05	6.39
Denitrification Filters		1,457.09	1.36	167.27	0.14	17.17	10.41	1,283.53	0.05	6.28
Plant Effluent		1,457.09	1.36	167.27	0.14	17.17	10.41	1,283.53	0.05	6.28
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Secondaries (U)		51,264.88	404.6	49,972.71	0.14	17.2	10.41	1,285.88	0.05	6.29
NSL 1C		49,962.82	399.73	49,523.80	0.33	41.38	3.43	425.21	0.11	13.82
NSL 1B		49,606.61	399.74	49,526.00	0.5	62.56	0.6	74.8	0.05	5.81
NSL 1A		49,530.03	399.75	49,526.36	0.7	86.57	0.03	3.3	0	0.37
NSL 1D		49,526.40	399.75	49,526.36	0.83	103.07	0	0.03	0	0
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Primary Clarifiers (U)		681.88	864.28	681.88	29.76	23.48	0	0	0	0
Denitrification Filters (U)		84.28	29.93	62.45	0.14	0.29	10.41	21.72	0.05	0.11
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WAS Splitter		50,620.60	404.6	49,344.67	0.14	16.99	10.41	1,269.72	0.05	6.22
WAS Splitter (U)		644.27	404.6	628.04	0.14	0.22	10.41	16.16	0.05	0.08
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20% HAc		0	0	0	0	0	0	0	0	0
25% NaOH		0	0	0	0	0	0	0	0	0
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RDT		191.94	93.04	178.62	27.23	52.27	6.9	13.25	0.03	0.06
RDT (U)		1,134.22	2,684.50	1,131.30	27.23	11.47	6.9	2.91	0.03	0.01
Sludge to Digesters		1,134.22	2,684.50	1,131.30	27.23	11.47	6.9	2.91	0.03	0.01

Model 5 - Buildout Annual Average Existing System - DAS / Step Feed

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6	741.07	4.2	518.75	7	7	3.5	196.08	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.05	620.69	4.33	531.43	6.99	6.99	3.55	197.81	0	
AB Inf. Channel	5.49	686.21	4.25	530.91	8.96	8.96	5.1	289.36	0.5	
Cell 1E	291.42	18,044.17	0.26	15.94	6.61	6.61	1.9	53.4	2	
Cell 2A	219.99	18,157.39	0.4	33.31	7.09	7.09	3.03	113.5	0	
Cell 1F	219.99	18,157.39	0.12	9.74	6.71	6.71	2.27	84.94	2	
Cell 2B	219.99	18,157.39	0.23	18.74	7.14	7.14	3.2	119.93	0	
Cell 2D	289.98	18,045.88	0.26	16.14	6.61	6.61	1.91	53.79	2	
Cell 3A	218.38	18,160.82	0.41	33.93	7.09	7.09	3.04	114.68	0	
Cell 3B	218.38	18,160.82	0.23	19.1	7.15	7.15	3.21	121.12	0	
Cell 2C	218.38	18,160.82	0.12	9.86	6.71	6.71	2.28	86.05	2	
Cell 3D	289.98	18,045.88	0.26	16.14	6.61	6.61	1.91	53.79	2	
Cell 4A	218.38	18,160.82	0.41	33.93	7.09	7.09	3.04	114.68	0	
Cell 4B	218.38	18,160.82	0.23	19.1	7.15	7.15	3.21	121.12	0	
Cell 3C	218.38	18,160.82	0.12	9.86	6.71	6.71	2.28	86.05	2	
Eff Channel 1	218.91	54,479.03	0.1	26.08	6.67	6.67	2.15	242.54	2	
Cell 5A	218.91	27,239.51	0.09	11.05	6.62	6.62	1.94	109.29	2	
Cell 5B	218.91	27,239.51	0.09	11.05	6.62	6.62	1.94	109.29	2	
Eff Channel 2	218.89	54,479.03	0.08	19.26	6.34	6.34	1.34	151.65	2	
Secondaries	0.73	91.39	0.08	9.7	6.34	6.34	1.34	76.39	2	
Denitrification Filters	0.21	25.88	0.08	9.54	6.34	6.34	1.34	75.12	2	
Plant Effluent	0.21	25.88	0.08	9.54	6.34	6.34	1.34	75.12	2	
Secondaries (U)	440.34	54,387.64	0.08	9.56	6.34	6.34	1.34	75.26	2	
NSL 1C	434.18	53,792.82	0	0.1	6.4	6.4	1.82	102.36	0	
NSL 1B	434.18	53,792.82	0	0.22	6.5	6.5	2.07	116.55	0	
NSL 1A	434.18	53,792.82	0.02	2.79	6.54	6.54	2.18	122.34	0	
NSL 1D	434.18	53,792.82	0.04	4.78	6.56	6.56	2.21	124.05	0	
Primary Clarifiers (U)	174.04	137.31	4.33	3.41	6.99	6.99	3.55	1.27	0	
Denitrification Filters (U)	31.4	65.51	0.08	0.16	6.34	6.34	1.34	1.27	2	
WAS Splitter	440.34	53,704.12	0.08	9.44	6.34	6.34	1.34	74.31	2	
WAS Splitter (U)	440.34	683.52	0.08	0.12	6.34	6.34	1.34	0.95	2	
20% HAc	0	0	0	0	2.11	2.11	-966.41	-6.58	0	
25% NaOH	0	0	0	0	14.91	14.91	7,970.05	90.51	0	
RDT	46.21	88.71	3.93	7.54	4.83	4.83	1.41	1.23	1.33	
RDT (U)	1,737.30	732.13	3.93	1.66	4.83	4.83	1.41	0.27	1.33	
Sludge to Digesters	1,737.30	732.13	3.93	1.66	4.83	4.83	1.41	0.27	1.33	

Model 6 - Buildout Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	18.5	258.09	39,846.85	219.09	33,825.64	177.41	27,390.14	51.19	7,903.52
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	18.42	103.82	15,960.21	88.11	13,545.27	101.97	15,676.77	51.27	7,882.08
AB Inf. Channel	18.67	118.45	18,460.37	95.46	14,877.21	103.42	16,117.71	50.51	7,871.70
Cell 1E	9.26	8,897.92	687,804.47	4,757.73	367,769.81	1,614.03	124,763.45	1.83	141.59
Cell 2A	12.34	6,714.06	691,643.54	3,598.66	370,712.61	1,228.11	126,512.47	1.87	193.14
Cell 1F	12.34	6,702.13	690,414.88	3,585.37	369,344.40	1,214.70	125,131.36	0.97	99.66
Cell 2B	12.34	6,708.46	691,066.38	3,592.13	370,040.66	1,221.22	125,802.76	1.14	117.82
Cell 2D	9.31	8,854.17	687,872.17	4,734.57	367,824.01	1,606.41	124,800.51	1.85	143.88
Cell 3A	12.44	6,664.92	691,775.15	3,572.65	370,817.50	1,219.58	126,584.05	1.91	198.23
Cell 3B	12.44	6,659.43	691,204.92	3,566.23	370,151.30	1,212.76	125,876.41	1.15	119.72
Cell 2C	12.44	6,653.19	690,557.44	3,559.56	369,458.58	1,206.32	125,207.96	0.97	101.02
Cell 3D	9.31	8,854.17	687,872.17	4,734.57	367,824.01	1,606.41	124,800.51	1.85	143.88
Cell 4A	12.44	6,664.92	691,775.15	3,572.65	370,817.50	1,219.58	126,584.05	1.91	198.23
Cell 4B	12.44	6,659.43	691,204.92	3,566.23	370,151.30	1,212.76	125,876.41	1.15	119.72
Cell 3C	12.44	6,653.19	690,557.44	3,559.56	369,458.58	1,206.32	125,207.96	0.97	101.02
Eff Channel 1	37.22	6,668.45	2,071,227.20	3,567.09	1,107,940.78	1,208.11	375,240.25	0.95	295.47
Cell 5A	18.61	6,664.83	1,035,052.10	3,563.32	553,384.73	1,204.53	187,064.05	0.91	140.78
Cell 5B	18.61	6,664.83	1,035,052.10	3,563.32	553,384.73	1,204.53	187,064.05	0.91	140.78
Eff Channel 2	37.22	6,678.20	2,074,444.62	3,561.66	1,106,355.99	1,203.17	373,739.74	0.9	279.86
Secondaries	18.72	19.92	3,111.67	10.62	1,659.53	4.49	700.95	0.9	140.76
Denitrification Filters	18.47	4.04	622.33	2.15	331.91	1.63	250.92	0.9	138.88
Plant Effluent	18.47	4.04	622.33	2.15	331.91	1.63	250.92	0.9	138.88
Secondaries (U)	18.5	13,416.24	2,071,332.95	7,155.23	1,104,696.46	2,416.21	373,038.79	0.9	139.1
NSL 1C	18.54	13,269.50	2,053,510.34	7,083.05	1,096,131.68	2,407.93	372,636.98	13.14	2,034.24
NSL 1B	18.54	13,270.01	2,053,589.72	7,083.60	1,096,216.55	2,398.02	371,103.70	3.41	527.18
NSL 1A	18.54	13,268.85	2,053,410.25	7,082.63	1,096,067.00	2,393.93	370,470.50	0.68	104.75
NSL 1D	18.54	13,267.63	2,053,221.35	7,081.77	1,095,933.14	2,393.15	370,349.91	1.17	181
Primary Clarifiers (U)	0.09	30,344.03	23,940.31	25,752.68	20,317.91	14,870.76	11,732.48	51.27	40.45
Denitrification Filters (U)	0.25	1,193.15	2,489.33	636.34	1,327.63	215.7	450.03	0.9	1.88
WAS Splitter	18.29	13,416.24	2,048,268.38	7,155.23	1,092,395.52	2,416.21	368,884.95	0.9	137.55
WAS Splitter (U)	0.21	13,416.24	23,064.57	7,155.23	12,300.94	2,416.21	4,153.84	0.9	1.55
20% HAc	0	0	0	0	0	158,852.18	4,242.19	158,852.18	4,242.19
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.25	2,234.27	4,595.11	1,535.02	3,157.00	1,065.88	2,192.15	337.37	693.85
RDT (U)	0.05	91,604.91	41,356.03	62,935.62	28,412.97	30,206.57	13,637.08	337.37	152.31
Sludge to Digesters	0.05	91,604.91	41,356.03	62,935.62	28,412.97	30,206.57	13,637.08	337.37	152.31

Model 6 - Buildout Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	408	62,991.11	88.91	13,727.02	319.09	49,264.09	7.96	1,228.33	44.2	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	217.95	33,507.37	89.62	13,777.72	128.34	19,729.65	8.01	1,231.08	39.43	
AB Inf. Channel	227.8	35,502.01	88.48	13,789.88	139.32	21,712.13	7.87	1,226.09	39.67	
Cell 1E	7,096.66	548,568.07	15.69	1,213.07	7,080.97	547,354.99	0.08	6.47	354.49	
Cell 2A	5,371.05	553,294.04	16.17	1,665.44	5,354.88	551,628.60	0.17	17.74	272.34	
Cell 1F	5,350.59	551,187.14	14.2	1,463.20	5,336.39	549,723.94	0	0.04	272.18	
Cell 2B	5,360.36	552,192.79	14.55	1,498.37	5,345.81	550,694.43	0.01	0.69	272.26	
Cell 2D	7,062.19	548,654.96	15.72	1,221.65	7,046.47	547,433.31	0.09	6.61	352.91	
Cell 3A	5,332.36	553,464.15	16.22	1,683.88	5,316.14	551,780.27	0.18	18.36	270.58	
Cell 3B	5,321.78	552,365.61	14.56	1,511.37	5,307.22	550,854.24	0.01	0.73	270.49	
Cell 2C	5,312.13	551,364.01	14.21	1,475.18	5,297.92	549,888.83	0	0.05	270.42	
Cell 3D	7,062.19	548,654.96	15.72	1,221.65	7,046.47	547,433.31	0.09	6.61	352.91	
Cell 4A	5,332.36	553,464.15	16.22	1,683.88	5,316.14	551,780.27	0.18	18.36	270.58	
Cell 4B	5,321.78	552,365.61	14.56	1,511.37	5,307.22	550,854.24	0.01	0.73	270.49	
Cell 3C	5,312.13	551,364.01	14.21	1,475.18	5,297.92	549,888.83	0	0.05	270.42	
Eff Channel 1	5,323.41	1,653,456.43	14.17	4,402.10	5,309.24	1,649,054.33	0	0.07	270.99	
Cell 5A	5,318.07	825,899.33	14.1	2,189.96	5,303.97	823,709.37	0	0.02	270.95	
Cell 5B	5,318.07	825,899.33	14.1	2,189.96	5,303.97	823,709.37	0	0.02	270.95	
Eff Channel 2	5,315.72	1,651,217.92	14.09	4,376.99	5,301.63	1,646,840.92	0	0.04	270.91	
Secondaries	29.9	4,671.79	14.09	2,201.53	15.81	2,470.26	0	0.02	14.99	
Denitrification Filters	17.3	2,666.18	14.09	2,172.13	3.2	494.05	0	0.02	14.38	
Plant Effluent	17.3	2,666.18	14.09	2,172.13	3.2	494.05	0	0.02	14.38	
Secondaries (U)	10,664.85	1,646,546.13	14.09	2,175.47	10,650.76	1,644,370.66	0	0.02	529.89	
NSL 1C	10,574.23	1,636,405.93	31.49	4,872.55	10,542.74	1,631,533.38	13.09	2,026.03	517.65	
NSL 1B	10,562.01	1,634,515.56	18.47	2,858.12	10,543.54	1,631,657.44	2.16	334.22	513.38	
NSL 1A	10,557.50	1,633,817.29	15.34	2,374.38	10,542.16	1,631,442.91	0.52	79.89	511.81	
NSL 1D	10,557.12	1,633,758.45	16.24	2,512.71	10,540.88	1,631,245.74	1.54	238.45	511.7	
Primary Clarifiers (U)	37,600.23	29,665.18	89.62	70.71	37,510.61	29,594.48	8.01	6.32	1,113.81	
Denitrification Filters (U)	961.3	2,005.61	14.09	29.4	947.21	1,976.21	0	0	60.09	
WAS Splitter	10,664.85	1,628,211.62	14.09	2,151.24	10,650.76	1,626,060.37	0	0.02	529.89	
WAS Splitter (U)	10,664.85	18,334.51	14.09	24.22	10,650.76	18,310.29	0	0	529.89	
20% HAc	216,000.00	5,768.34	216,000.00	5,768.34	0	0	216,000.00	5,768.34	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	2,766.50	5,689.73	508.62	1,046.06	2,257.88	4,643.68	461.26	948.65	119.42	
RDT (U)	93,081.64	42,022.72	508.62	229.62	92,573.02	41,793.10	461.26	208.24	3,420.27	
Sludge to Digesters	93,081.64	42,022.72	508.62	229.62	92,573.02	41,793.10	461.26	208.24	3,420.27	

Model 6 - Buildout Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent	6,824.04	44.2	6,824.04	30.06	4,640.35	0	0	0	0	0
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0	0
Primary Clarifiers	6,061.14	39.43	6,061.14	30.74	4,726.15	0	0	0	0	0
AB Inf. Channel	6,182.97	39.5	6,155.98	30.31	4,724.48	0.17	25.74	0.01	1.25	
Cell 1E	27,401.86	347.03	26,825.34	3.22	249.16	6.61	510.86	0.85	65.66	
Cell 2A	28,055.20	270.15	27,829.21	10.61	1,093.19	1.82	187.98	0.37	38.02	
Cell 1F	28,038.56	261.49	26,937.23	2.21	227.68	9.51	980.1	1.18	121.23	
Cell 2B	28,046.53	265.39	27,339.34	5.93	611.21	5.72	588.88	1.15	118.31	
Cell 2D	27,417.30	345.47	26,839.54	3.34	259.55	6.57	510.08	0.87	67.68	
Cell 3A	28,084.07	268.41	27,858.83	10.75	1,115.66	1.8	186.39	0.37	38.85	
Cell 3B	28,075.42	263.7	27,370.59	6.12	635.17	5.63	584.77	1.16	120.06	
Cell 2C	28,067.47	259.79	26,964.19	2.38	246.81	9.39	975.01	1.24	128.27	
Cell 3D	27,417.30	345.47	26,839.54	3.34	259.55	6.57	510.08	0.87	67.68	
Cell 4A	28,084.07	268.41	27,858.83	10.75	1,115.66	1.8	186.39	0.37	38.85	
Cell 4B	28,075.42	263.7	27,370.59	6.12	635.17	5.63	584.77	1.16	120.06	
Cell 3C	28,067.47	259.79	26,964.19	2.38	246.81	9.39	975.01	1.24	128.27	
Eff Channel 1	84,169.88	259.79	80,691.45	1.79	556.32	10.01	3,109.34	1.19	369.09	
Cell 5A	42,078.58	258.47	40,140.99	0.61	95.38	11.92	1,851.08	0.56	86.52	
Cell 5B	42,078.58	258.47	40,140.99	0.61	95.38	11.92	1,851.08	0.56	86.52	
Eff Channel 2	84,152.69	258.15	80,187.98	0.37	113.87	12.44	3,863.86	0.32	100.86	
Secondaries	2,342.44	2.23	348.28	0.37	57.27	12.44	1,943.43	0.32	50.73	
Denitrification Filters	2,217.07	1.62	249.55	0.37	56.51	12.44	1,917.48	0.32	50.05	
Plant Effluent	2,217.07	1.62	249.55	0.37	56.51	12.44	1,917.48	0.32	50.05	
Secondaries (U)	81,810.26	517.13	79,839.70	0.37	56.6	12.44	1,920.43	0.32	50.13	
NSL 1C	80,107.80	511.65	79,179.66	0.49	75.72	5.76	890.66	0.24	37.48	
NSL 1B	79,447.57	511.68	79,184.38	0.43	66.85	1.59	245.33	0.12	17.87	
NSL 1A	79,204.55	511.7	79,187.20	0.56	86.13	0.1	15.65	0.01	1.7	
NSL 1D	79,187.45	511.7	79,187.27	0.7	107.61	0	0.16	0	0.02	
Primary Clarifiers (U)	878.75	1,113.81	878.75	30.74	24.25	0	0	0	0	
Denitrification Filters (U)	125.36	47.32	98.73	0.37	0.76	12.44	25.95	0.32	0.68	
WAS Splitter	80,899.29	517.13	78,950.68	0.37	55.97	12.44	1,899.04	0.32	49.57	
WAS Splitter (U)	910.97	517.13	889.03	0.37	0.63	12.44	21.38	0.32	0.56	
20% HAc	0	0	0	0	0	0	0	0	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	245.6	110.67	227.61	27.11	55.76	8.53	17.54	0.22	0.46	
RDT (U)	1,544.12	3,411.52	1,540.17	27.11	12.24	8.53	3.85	0.22	0.1	
Sludge to Digesters	1,544.12	3,411.52	1,540.17	27.11	12.24	8.53	3.85	0.22	0.1	

Model 6 - Buildout Max Month Min Week Temp Existing System - DAS / Step Feed

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6.2	957.22	4.34	670.05	7	7	3.5	245.11	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.19	797.84	4.44	682.64	6.99	6.99	3.54	246.83	0	
AB Inf. Channel	5.73	892.62	4.37	680.74	8.7	8.7	4.78	337.97	0.5	
Cell 1E	338.27	26,147.93	0.24	18.79	6.53	6.53	1.7	59.51	2	
Cell 2A	255.26	26,295.21	0.35	35.55	6.94	6.94	2.79	130.48	0.01	
Cell 1F	255.26	26,295.21	0.08	8.28	6.5	6.5	1.6	74.67	2	
Cell 2B	255.26	26,295.21	0.14	14.13	6.65	6.65	2.14	99.77	2	
Cell 2D	336.6	26,150.16	0.25	19.05	6.54	6.54	1.71	60.3	2	
Cell 3A	253.38	26,299.67	0.35	36.22	6.94	6.94	2.81	132.2	0.01	
Cell 3B	253.38	26,299.67	0.14	14.36	6.66	6.66	2.16	101.6	2	
Cell 2C	253.38	26,299.67	0.08	8.34	6.51	6.51	1.62	76.21	2	
Cell 3D	336.6	26,150.16	0.25	19.05	6.54	6.54	1.71	60.3	2	
Cell 4A	253.38	26,299.67	0.35	36.22	6.94	6.94	2.81	132.2	0.01	
Cell 4B	253.38	26,299.67	0.14	14.36	6.66	6.66	2.16	101.6	2	
Cell 3C	253.38	26,299.67	0.08	8.34	6.51	6.51	1.62	76.21	2	
Eff Channel 1	254.01	78,894.56	0.07	22.99	6.49	6.49	1.53	216.23	2	
Cell 5A	254.01	39,447.28	0.07	10.53	6.43	6.43	1.36	95.63	2	
Cell 5B	254.01	39,447.28	0.07	10.53	6.43	6.43	1.36	95.63	2	
Eff Channel 2	253.98	78,894.56	0.06	18.99	6.06	6.06	0.73	103.3	2	
Secondaries	0.82	127.86	0.06	9.55	6.06	6.06	0.73	51.96	2	
Denitrification Filters	0.21	33.09	0.06	9.42	6.01	6.01	0.73	51.27	2	
Plant Effluent	0.21	33.09	0.06	9.42	6.06	6.06	0.73	51.26	2	
Secondaries (U)	510.18	78,766.70	0.06	9.44	6.06	6.06	0.73	51.34	2	
NSL 1C	504.04	78,001.93	0	0.08	6.13	6.13	1.15	80.56	0	
NSL 1B	504.04	78,001.93	0	0.09	6.32	6.32	1.51	106.01	0	
NSL 1A	504.04	78,001.94	0	0.3	6.37	6.37	1.64	115.34	0	
NSL 1D	504.04	78,001.94	0.02	3.14	6.38	6.38	1.66	116.49	0	
Primary Clarifiers (U)	223.47	176.31	4.44	3.5	6.99	6.99	3.54	1.27	0	
Denitrification Filters (U)	45.43	94.78	0.06	0.13	6.01	6.01	0.73	0.69	2	
WAS Splitter	510.18	77,889.62	0.06	9.33	6.06	6.06	0.73	50.77	2	
WAS Splitter (U)	510.18	877.08	0.06	0.11	6.06	6.06	0.73	0.57	2	
20% HAc	0	0	0	0	2.12	2.12	-960.07	-11.63	0	
25% NaOH	0	0	0	0	15.16	15.16	7,970.05	90.51	0	
RDT	54.61	112.32	3.87	7.95	4.7	4.7	0.89	0.83	1.37	
RDT (U)	2,084.49	941.07	3.87	1.75	4.7	4.7	0.89	0.18	1.37	
Sludge to Digesters	2,084.49	941.07	3.87	1.75	4.71	4.71	0.82	0.17	1.37	

Model 7 - Near Term Annual Average MLE / NRCY

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	9.50	247.50	19,622.16	210.5	16,688.75	170.45	13,513.63	49.18	3,899.40
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	9.42	100.10	7,870.33	85.09	6,690.52	98.25	7,725.22	49.34	3,879.49
AB Inf. Channel	9.67	106.22	8,575.77	87.96	7,101.89	97.22	7,849.26	47.99	3,874.65
Cell 1E	15.88	3,676.27	487,062.34	2,156.23	285,675.75	685.91	90,875.11	2.67	353.55
Cell 2A	15.88	3,676.65	487,112.75	2,156.42	285,700.44	683.91	90,609.90	0.74	98.51
Cell 1F	15.88	3,670.89	486,350.50	2,148.66	284,672.18	677.12	89,710.97	1.11	146.53
Cell 2B	15.88	3,673.69	486,721.12	2,152.33	285,158.22	680.59	90,170.46	1.17	155.02
Cell 2D	15.92	3,649.74	485,020.86	2,140.98	284,519.15	681.47	90,561.81	2.72	362.05
Cell 3A	15.92	3,650.17	485,078.00	2,141.22	284,550.74	679.47	90,296.21	0.76	100.88
Cell 3B	15.92	3,647.24	484,689.77	2,137.15	284,010.41	676.17	89,858.05	1.18	156.77
Cell 2C	15.92	3,644.48	484,322.58	2,133.51	283,526.23	672.73	89,400.25	1.11	148.08
Cell 3D	15.92	3,649.74	485,020.86	2,140.98	284,519.15	681.47	90,561.81	2.72	362.05
Cell 4A	15.92	3,650.17	485,078.00	2,141.22	284,550.74	679.47	90,296.21	0.76	100.88
Cell 4B	15.92	3,647.24	484,689.77	2,137.15	284,010.41	676.17	89,858.05	1.18	156.77
Cell 3C	15.92	3,644.48	484,322.58	2,133.51	283,526.23	672.73	89,400.25	1.11	148.08
Eff Channel 1	19.22	3,652.15	585,908.07	2,137.15	342,859.47	672.87	107,946.94	1.08	172.68
Cell 5A	9.61	3,647.74	292,600.35	2,132.12	171,026.06	668.11	53,591.86	0.99	79.34
Cell 5B	9.61	3,647.74	292,600.35	2,132.12	171,026.06	668.11	53,591.86	0.99	79.34
Eff Channel 2	19.22	3,654.62	586,335.99	2,130.22	341,765.41	666.42	106,917.75	0.98	157.81
Secondaries	9.72	10.84	879.5	6.32	512.65	2.96	239.97	0.98	79.83
Denitrification Filters	9.47	2.22	175.9	1.3	102.53	1.39	109.8	0.98	77.77
Plant Effluent	9.47	2.22	175.9	1.3	102.53	1.39	109.8	0.98	77.77
Secondaries (U)	9.50	7,384.54	585,456.48	4,304.33	341,252.76	1,345.56	106,677.78	0.98	77.98
NSL 1C	9.55	7,253.17	578,006.29	4,236.75	337,627.75	1,337.23	106,563.86	6.28	500.23
NSL 1B	9.55	7,252.29	577,936.50	4,236.22	337,584.87	1,335.92	106,459.90	6.12	487.78
NSL 1A	9.55	7,251.25	577,853.89	4,235.02	337,489.88	1,334.96	106,383.44	6.83	544.28
NSL 1D	9.55	7,249.96	577,750.61	4,233.66	337,381.59	1,334.06	106,311.38	7.73	615.61
Primary Clarifiers (U)	0.09	14,963.31	11,805.50	12,720.21	10,035.77	7,360.95	5,807.52	49.34	38.93
Denitrification Filters (U)	0.25	337.24	703.6	196.57	410.12	62.39	130.16	0.98	2.05
WAS Splitter	9.33	7,384.54	575,072.33	4,304.33	335,200.01	1,345.56	104,785.66	0.98	76.6
WAS Splitter (U)	0.17	7,384.54	10,384.15	4,304.33	6,052.75	1,345.56	1,892.13	0.98	1.38
20% HAc	0.00	0	0.00	0.00	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.22	1,198.07	2,156.56	859.26	1,546.71	626.19	1,127.17	229.04	412.28
RDT (U)	0.05	49,120.75	19,409.05	35,229.86	13,920.35	16,512.25	6,524.48	229.04	90.5
Sludge to Digesters	0.05	49,120.75	19,409.05	35,229.86	13,920.35	16,512.25	6,524.48	229.04	90.5

Model 7 - Near Term Annual Average MLE / NRCY

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	392	31,078.29	85.42	6,772.58	306.58	24,305.71	7.64	606.03	42.5	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	210.77	16,571.79	86.81	6,825.50	123.96	9,746.30	7.75	608.99	38.62	
AB Inf. Channel	213.1	17,205.35	84.79	6,846.16	128.31	10,359.19	7.49	605.08	38.06	
Cell 1E	3,228.33	427,716.45	17.53	2,322.00	3,210.81	425,394.45	0.59	78.47	163.07	
Cell 2A	3,225.51	427,342.61	14.45	1,914.27	3,211.06	425,428.34	0.27	35.86	162.2	
Cell 1F	3,215.01	425,951.79	14.73	1,951.32	3,200.29	424,000.46	0	0.27	162.11	
Cell 2B	3,220.24	426,644.69	14.86	1,969.37	3,205.38	424,675.32	0.02	2.72	162.15	
Cell 2D	3,205.66	426,006.91	17.61	2,340.66	3,188.05	423,666.25	0.61	80.72	162.1	
Cell 3A	3,202.85	425,632.95	14.47	1,923.12	3,188.38	423,709.83	0.28	37.56	161.24	
Cell 3B	3,197.61	424,936.52	14.88	1,977.00	3,182.73	422,959.52	0.02	2.87	161.19	
Cell 2C	3,192.41	424,245.88	14.74	1,958.52	3,177.67	422,287.36	0	0.29	161.15	
Cell 3D	3,205.66	426,006.91	17.61	2,340.66	3,188.05	423,666.25	0.61	80.72	162.1	
Cell 4A	3,202.85	425,632.95	14.47	1,923.12	3,188.38	423,709.83	0.28	37.56	161.24	
Cell 4B	3,197.61	424,936.52	14.88	1,977.00	3,182.73	422,959.52	0.02	2.87	161.19	
Cell 3C	3,192.41	424,245.88	14.74	1,958.52	3,177.67	422,287.36	0	0.29	161.15	
Eff Channel 1	3,197.93	513,038.25	14.68	2,354.56	3,183.25	510,683.69	0	0.13	161.45	
Cell 5A	3,190.79	255,946.50	14.56	1,167.69	3,176.23	254,778.81	0	0.04	161.4	
Cell 5B	3,190.79	255,946.50	14.56	1,167.69	3,176.23	254,778.81	0	0.04	161.4	
Eff Channel 2	3,188.12	511,491.64	14.55	2,334.56	3,173.57	509,157.08	0	0.07	161.37	
Secondaries	23.96	1,944.65	14.55	1,180.91	9.41	763.74	0	0.04	9.17	
Denitrification Filters	16.48	1,303.30	14.55	1,150.55	1.93	152.75	0	0.04	8.81	
Plant Effluent	16.48	1,303.30	14.55	1,150.55	1.93	152.75	0	0.04	8.81	
Secondaries (U)	6,427.07	509,546.99	14.55	1,153.64	6,412.52	508,393.35	0	0.04	317.17	
NSL 1C	6,333.05	504,681.59	22.37	1,782.74	6,310.67	502,898.85	8.32	663.39	304.26	
NSL 1B	6,331.95	504,594.69	22.11	1,762.28	6,309.84	502,832.41	8.27	659.11	304.23	
NSL 1A	6,331.15	504,530.71	23.06	1,837.78	6,308.09	502,692.93	9.24	736.22	304.23	
NSL 1D	6,330.37	504,468.55	24.27	1,933.71	6,306.11	502,534.84	10.46	833.17	304.23	
Primary Clarifiers (U)	18,616.77	14,687.94	86.81	68.49	18,529.96	14,619.45	7.75	6.11	568.4	
Denitrification Filters (U)	307.4	641.35	14.55	30.36	292.85	610.99	0	0	22.8	
WAS Splitter	6,427.07	500,509.24	14.55	1,133.18	6,412.52	499,376.05	0	0.04	317.17	
WAS Splitter (U)	6,427.07	9,037.75	14.55	20.46	6,412.52	9,017.29	0	0	317.17	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	1,621.45	2,918.66	356.64	641.96	1,264.81	2,276.70	311.64	560.97	75.14	
RDT (U)	52,213.81	20,631.21	356.64	140.92	51,857.17	20,490.29	311.64	123.14	1,921.40	
Sludge to Digesters	52,213.81	20,631.21	356.64	140.92	51,857.17	20,490.29	311.64	123.14	1,921.40	

Model 7 - Near Term Annual Average MLE / NRCY

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent		3,369.46	42.5	3,369.46	28.9	2,291.23	0	0	0	0
Rotary Press Filtrate (50%)		115.86	862	115.86	818.9	110.06	0	0	0	0
Primary Clarifiers		3,036.87	38.62	3,036.87	30.24	2,377.44	0	0	0	0
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AB Inf. Channel		3,072.82	37.86	3,056.96	29.32	2,367.17	0.19	15.46	0.01	0.4
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Cell 1E		21,605.41	162.09	21,475.11	7.13	945.22	0.7	93.16	0.28	37.14
Cell 2A		21,490.13	162.08	21,473.70	7.43	984.31	0.09	11.78	0.04	4.64
Cell 1F		21,477.65	156.37	20,716.77	1.56	206.83	4.62	611.63	1.13	149.25
Cell 2B		21,483.61	158.91	21,053.67	4.12	545.74	2.33	308.44	0.92	121.5
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Cell 2D		21,542.30	161.13	21,413.34	7.27	966.65	0.68	90.55	0.29	38.4
Cell 3A		21,427.59	161.12	21,411.98	7.57	1,006.05	0.08	11.05	0.03	4.57
Cell 3B		21,421.06	157.97	20,992.67	4.27	567.95	2.3	305.57	0.92	122.82
Cell 2C		21,415.09	155.39	20,650.61	1.68	223.35	4.57	607.62	1.18	156.86
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Cell 3D		21,542.30	161.13	21,413.34	7.27	966.65	0.68	90.55	0.29	38.4
Cell 4A		21,427.59	161.12	21,411.98	7.57	1,006.05	0.08	11.05	0.03	4.57
Cell 4B		21,421.06	157.97	20,992.67	4.27	567.95	2.3	305.57	0.92	122.82
Cell 3C		21,415.09	155.39	20,650.61	1.68	223.35	4.57	607.62	1.18	156.86
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Eff Channel 1		25,901.07	154.94	24,856.89	0.88	140.66	5.45	874.33	1.06	169.86
Cell 5A		12,946.36	154.03	12,355.61	0.16	12.7	7.25	581.35	0.12	9.39
Cell 5B		12,946.36	154.03	12,355.61	0.16	12.7	7.25	581.35	0.12	9.39
Eff Channel 2		25,890.08	153.86	24,684.66	0.08	12.31	7.49	1,201.57	0.02	3.85
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Secondaries		744.07	1.66	134.32	0.08	6.23	7.49	607.8	0.02	1.95
Denitrification Filters		696.5	1.3	102.42	0.08	6.07	7.49	592.18	0.02	1.9
Plant Effluent		696.5	1.3	102.42	0.08	6.07	7.49	592.18	0.02	1.9
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Secondaries (U)		25,146.01	309.66	24,550.34	0.08	6.08	7.49	593.77	0.02	1.9
NSL 1C		24,246.89	304.23	24,243.80	0.11	8.43	0.04	2.84	0	0.25
NSL 1B		24,243.81	304.23	24,243.80	0.34	27.01	0	0.01	0	0
NSL 1A		24,243.80	304.23	24,243.80	0.48	38.15	0	0	0	0
NSL 1D		24,243.80	304.23	24,243.80	0.6	48	0	0	0	0
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Primary Clarifiers (U)		448.45	568.4	448.45	30.24	23.86	0	0	0	0
Denitrification Filters (U)		47.57	15.29	31.9	0.08	0.16	7.49	15.63	0.02	0.05
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WAS Splitter		24,699.99	309.66	24,114.89	0.08	5.98	7.49	583.24	0.02	1.87
WAS Splitter (U)		446.01	309.66	435.45	0.08	0.11	7.49	10.53	0.02	0.03
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20% HAc		0	0	0	0	0	0	0	0	0
25% NaOH		0	0	0	0	0	0	0	0	0
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RDT		135.25	70.33	126.59	23.12	41.61	4.8	8.64	0.02	0.03
RDT (U)		759.2	1,916.59	757.3	23.12	9.13	4.8	1.9	0.02	0.01
Sludge to Digesters		759.2	1,916.59	757.3	23.12	9.13	4.8	1.9	0.02	0.01

Model 7 - Near Term Annual Average MLE / NRCY

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6	475.69	4.2	332.98	7	7	3.5	125.86	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.13	403.02	4.4	345.6	7	7	3.58	127.6	0	
AB Inf. Channel	5.37	433.24	4.28	345.8	9.42	9.42	6.02	220.49	0.5	
Cell 1E	156.11	20,682.45	1.03	136.32	7.28	7.28	4.21	253.11	0.01	
Cell 2A	156.11	20,682.45	0.95	126.18	7.34	7.34	4.32	259.48	0	
Cell 1F	156.11	20,682.45	0.41	53.66	6.87	6.87	3.47	208.6	2	
Cell 2B	156.11	20,682.45	0.63	84.12	6.98	6.98	3.85	231.09	2	
Cell 2D	154.97	20,594.63	1.04	138.62	7.29	7.29	4.23	254.68	0.01	
Cell 3A	154.97	20,594.63	0.97	128.53	7.34	7.34	4.33	261.09	0	
Cell 3B	154.97	20,594.63	0.65	85.95	6.98	6.98	3.86	232.75	2	
Cell 2C	154.97	20,594.63	0.41	54.97	6.88	6.88	3.48	209.91	2	
Cell 3D	154.97	20,594.63	1.04	138.62	7.29	7.29	4.23	254.68	0.01	
Cell 4A	154.97	20,594.63	0.97	128.53	7.34	7.34	4.33	261.09	0	
Cell 4B	154.97	20,594.63	0.65	85.95	6.98	6.98	3.86	232.75	2	
Cell 3C	154.97	20,594.63	0.41	54.97	6.88	6.88	3.48	209.91	2	
Eff Channel 1	155.35	24,922.40	0.34	54.04	6.86	6.86	3.36	244.82	2	
Cell 5A	155.35	12,461.20	0.2	16.05	6.84	6.84	3.24	117.73	2	
Cell 5B	155.35	12,461.20	0.2	16.05	6.84	6.84	3.24	117.73	2	
Eff Channel 2	155.34	24,922.40	0.16	25.86	6.74	6.74	2.88	209.77	2	
Secondaries	0.62	50.43	0.16	13.08	6.74	6.74	2.88	106.11	2	
Denitrification Filters	0.26	20.21	0.16	12.75	6.74	6.74	2.88	103.38	2	
Plant Effluent	0.26	20.21	0.16	12.75	6.74	6.74	2.88	103.38	2	
Secondaries (U)	313.72	24,871.97	0.16	12.78	6.74	6.74	2.88	103.66	2	
NSL 1C	307.3	24,489.16	0.81	64.24	6.73	6.73	3.44	124.31	0	
NSL 1B	307.3	24,489.16	0.87	69.04	6.78	6.78	3.51	126.75	0	
NSL 1A	307.3	24,489.16	0.72	57.4	6.82	6.82	3.55	128.28	0	
NSL 1D	307.3	24,489.16	0.59	47.2	6.85	6.85	3.58	129.56	0	
Primary Clarifiers (U)	113.57	89.6	4.4	3.47	7	7	3.58	1.28	0	
Denitrification Filters (U)	14.48	30.21	0.16	0.34	6.74	6.74	2.88	2.73	2	
WAS Splitter	313.72	24,430.82	0.16	12.55	6.74	6.74	2.88	101.82	2	
WAS Splitter (U)	313.72	441.15	0.16	0.23	6.74	6.74	2.88	1.84	2	
20% HAc	0	0	0	0	2.11	2.11	-966.41	-6.58	0	
25% NaOH	0	0	0	0	14.91	14.91	7,970.05	90.51	0	
RDT	32.41	58.34	3.33	6	5.49	5.49	2.78	2.27	1.28	
RDT (U)	1,195.58	472.41	3.33	1.32	5.49	5.49	2.78	0.5	1.28	
Sludge to Digesters	1,195.58	472.41	3.33	1.32	5.49	5.49	2.78	0.5	1.28	

Model 8 - Near Term Max Month Min Week Temp MLE / NRCY

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	11.9	258.09	25,631.22	219.09	21,758.12	177.41	17,618.52	51.19	5,083.88
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	11.82	104.14	10,273.95	88.37	8,718.26	102.14	10,076.31	51.31	5,062.41
AB Inf. Channel	12.07	112.14	11,299.94	92.26	9,296.91	101.87	10,264.91	50.18	5,056.71
Cell 1E	13.92	4,277.74	496,793.78	2,426.29	281,776.44	825.17	95,831.17	2.97	344.36
Cell 2A	13.92	4,275.84	496,574.00	2,423.20	281,418.01	820.64	95,304.46	1.46	168.98
Cell 1F	13.92	4,269.02	495,781.81	2,415.32	280,502.60	812.75	94,389.02	0.98	113.56
Cell 2B	13.92	4,272.57	496,193.73	2,419.27	280,961.79	816.6	94,835.40	1.11	128.91
Cell 2D	13.98	4,246.74	495,334.03	2,409.02	280,984.67	819.69	95,607.07	3.03	353.31
Cell 3A	13.98	4,244.93	495,122.78	2,406.00	280,632.52	815.17	95,079.81	1.47	171.93
Cell 3B	13.98	4,241.70	494,746.06	2,402.11	280,178.73	811.15	94,611.88	1.12	130.62
Cell 2C	13.98	4,238.19	494,336.76	2,398.19	279,721.43	807.34	94,167.04	0.98	114.88
Cell 3D	13.98	4,246.74	495,334.03	2,409.02	280,984.67	819.69	95,607.07	3.03	353.31
Cell 4A	13.98	4,244.93	495,122.78	2,406.00	280,632.52	815.17	95,079.81	1.47	171.93
Cell 4B	13.98	4,241.70	494,746.06	2,402.11	280,178.73	811.15	94,611.88	1.12	130.62
Cell 3C	13.98	4,238.19	494,336.76	2,398.19	279,721.43	807.34	94,167.04	0.98	114.88
Eff Channel 1	24.02	4,247.46	851,388.48	2,402.82	481,636.62	808.12	161,985.01	0.95	191.38
Cell 5A	12.01	4,243.88	425,335.71	2,399.01	240,436.66	804.48	80,627.55	0.89	89.25
Cell 5B	12.01	4,243.88	425,335.71	2,399.01	240,436.66	804.48	80,627.55	0.89	89.25
Eff Channel 2	24.02	4,253.50	852,656.72	2,397.51	480,604.26	803.16	161,000.44	0.88	175.94
Secondaries	12.12	12.64	1,278.99	7.13	720.91	3.26	330.01	0.88	88.78
Denitrification Filters	11.87	2.58	255.8	1.46	144.18	1.36	135.19	0.88	86.95
Plant Effluent	11.87	2.58	255.8	1.46	144.18	1.36	135.19	0.88	86.95
Secondaries (U)	11.9	8,572.90	851,377.74	4,832.16	479,883.35	1,617.86	160,670.43	0.88	87.16
NSL 1C	11.94	8,437.16	841,010.85	4,762.09	474,682.19	1,602.72	159,758.44	4.1	408.71
NSL 1B	11.94	8,435.09	840,803.82	4,760.16	474,489.57	1,596.98	159,186.27	0.51	50.99
NSL 1A	11.94	8,433.16	840,612.20	4,758.57	474,331.05	1,594.83	158,971.49	0.22	22.34
NSL 1D	11.94	8,431.85	840,481.09	4,757.61	474,235.79	1,593.98	158,887.22	0.74	73.33
Primary Clarifiers (U)	0.09	19,533.15	15,410.93	16,575.42	13,077.39	9,583.88	7,561.32	51.31	40.48
Denitrification Filters (U)	0.25	490.42	1,023.19	276.43	576.73	93.38	194.82	0.88	1.83
WAS Splitter	11.71	8,572.90	837,426.59	4,832.16	472,019.71	1,617.86	158,037.59	0.88	85.73
WAS Splitter (U)	0.2	8,572.90	13,951.15	4,832.16	7,863.63	1,617.86	2,632.83	0.88	1.43
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.24	1,447.83	2,868.69	1,022.97	2,026.89	714.76	1,416.21	230.24	456.19
RDT (U)	0.05	59,360.86	25,818.24	41,941.67	18,241.98	20,095.68	8,740.36	230.24	100.14
Sludge to Digesters	0.05	59,360.86	25,818.24	41,941.67	18,241.98	20,095.68	8,740.36	230.24	100.14

Model 8 - Near Term Max Month Min Week Temp MLE / NRCY

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	408	40,518.61	88.91	8,829.81	319.09	31,688.79	7.96	790.11	44.2	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	218.74	21,579.74	90.01	8,880.20	128.73	12,699.53	8.04	792.84	39.83	
AB Inf. Channel	222.9	22,461.14	88.32	8,899.57	134.58	13,561.57	7.83	789.16	39.59	
Cell 1E	3,631.26	421,715.69	18.29	2,124.32	3,612.97	419,591.37	0.43	50.37	185.52	
Cell 2A	3,624.14	420,888.95	15.44	1,792.70	3,608.71	419,096.25	0.03	3.27	185.47	
Cell 1F	3,612.28	419,511.04	14.54	1,688.51	3,597.74	417,822.52	0	0.04	185.37	
Cell 2B	3,618.02	420,177.86	14.77	1,715.71	3,603.25	418,462.14	0	0.24	185.42	
Cell 2D	3,605.62	420,553.96	18.4	2,146.65	3,587.21	418,407.31	0.45	52.99	184.39	
Cell 3A	3,598.51	419,725.49	15.47	1,804.39	3,583.04	417,921.10	0.03	3.48	184.33	
Cell 3B	3,592.43	419,015.50	14.79	1,725.02	3,577.64	417,290.48	0	0.25	184.28	
Cell 2C	3,586.73	418,350.68	14.55	1,697.08	3,572.18	416,653.60	0	0.04	184.23	
Cell 3D	3,605.62	420,553.96	18.4	2,146.65	3,587.21	418,407.31	0.45	52.99	184.39	
Cell 4A	3,598.51	419,725.49	15.47	1,804.39	3,583.04	417,921.10	0.03	3.48	184.33	
Cell 4B	3,592.43	419,015.50	14.79	1,725.02	3,577.64	417,290.48	0	0.25	184.28	
Cell 3C	3,586.73	418,350.68	14.55	1,697.08	3,572.18	416,653.60	0	0.04	184.23	
Eff Channel 1	3,593.69	720,342.05	14.5	2,906.32	3,579.19	717,435.72	0	0.05	184.6	
Cell 5A	3,588.27	359,628.06	14.4	1,443.26	3,573.87	358,184.80	0	0.02	184.56	
Cell 5B	3,588.27	359,628.06	14.4	1,443.26	3,573.87	358,184.80	0	0.02	184.56	
Eff Channel 2	3,586.13	718,875.97	14.38	2,882.55	3,571.75	715,993.42	0	0.03	184.53	
Secondaries	25	2,528.49	14.38	1,454.50	10.62	1,073.99	0	0.02	13.25	
Denitrification Filters	16.55	1,639.30	14.38	1,424.50	2.17	214.8	0	0.02	12.84	
Plant Effluent	16.55	1,639.30	14.38	1,424.50	2.17	214.8	0	0.02	12.84	
Secondaries (U)	7,213.22	716,347.49	14.38	1,428.05	7,198.84	714,919.43	0	0.02	358.98	
NSL 1C	7,113.28	709,046.84	19.6	1,953.60	7,093.68	707,093.25	3.98	397	345.46	
NSL 1B	7,105.75	708,296.20	14.8	1,474.90	7,090.95	706,821.30	0.23	23.38	342.95	
NSL 1A	7,102.76	707,998.25	14.09	1,404.85	7,088.66	706,593.40	0.17	17.14	342.3	
NSL 1D	7,101.95	707,917.97	14.69	1,464.55	7,087.26	706,453.41	0.95	94.43	342.25	
Primary Clarifiers (U)	24,234.75	19,120.32	90.01	71.02	24,144.74	19,049.30	8.04	6.34	730.35	
Denitrification Filters (U)	426.2	889.19	14.38	30	411.82	859.19	0	0	32.55	
WAS Splitter	7,213.22	704,609.02	14.38	1,404.65	7,198.84	703,204.37	0	0.02	358.98	
WAS Splitter (U)	7,213.22	11,738.47	14.38	23.4	7,198.84	11,715.07	0	0	358.98	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	1,865.56	3,696.38	360.36	714.01	1,505.20	2,982.37	313.83	621.81	85.77	
RDT (U)	62,073.41	26,998.02	360.36	156.73	61,713.05	26,841.29	313.83	136.49	2,277.27	
Sludge to Digesters	62,073.41	26,998.02	360.36	156.73	61,713.05	26,841.29	313.83	136.49	2,277.27	

Model 8 - Near Term Max Month Min Week Temp MLE / NRCY

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent	4,389.52	44.2	4,389.52	30.06	2,984.87	0	0	0	0	
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0	
Primary Clarifiers	3,929.16	39.83	3,929.16	31.12	3,070.38	0	0	0	0	
AB Inf. Channel	3,989.56	39.35	3,965.63	30.41	3,064.49	0.23	23.33	0.01	0.61	
Cell 1E	21,545.55	184.37	21,411.36	10.13	1,176.98	0.94	109.39	0.21	24.81	
Cell 2A	21,538.98	181.29	21,053.89	7.08	822.44	3.31	384.91	0.86	100.19	
Cell 1F	21,527.74	175.97	20,436.13	1.96	227.84	8.19	951.46	1.21	140.15	
Cell 2B	21,533.16	178.41	20,720.04	4.29	498.04	5.76	669.03	1.24	144.09	
Cell 2D	21,506.65	183.29	21,378.57	10.3	1,201.11	0.88	103.18	0.21	24.9	
Cell 3A	21,500.07	180.24	21,022.76	7.27	848.13	3.23	376.62	0.86	100.7	
Cell 3B	21,494.25	177.38	20,689.11	4.49	523.68	5.65	658.88	1.25	146.27	
Cell 2C	21,488.84	174.91	20,401.06	2.13	248.93	8.06	940.3	1.26	147.48	
Cell 3D	21,506.65	183.29	21,378.57	10.3	1,201.11	0.88	103.18	0.21	24.9	
Cell 4A	21,500.07	180.24	21,022.76	7.27	848.13	3.23	376.62	0.86	100.7	
Cell 4B	21,494.25	177.38	20,689.11	4.49	523.68	5.65	658.88	1.25	146.27	
Cell 3C	21,488.84	174.91	20,401.06	2.13	248.93	8.06	940.3	1.26	147.48	
Eff Channel 1	37,002.09	174.66	35,009.52	1.51	302.38	8.75	1,754.18	1.19	238.4	
Cell 5A	18,496.86	173.42	17,380.88	0.44	44.03	10.76	1,078.14	0.38	37.85	
Cell 5B	18,496.86	173.42	17,380.88	0.44	44.03	10.76	1,078.14	0.38	37.85	
Eff Channel 2	36,990.83	173.13	34,706.07	0.23	45.46	11.26	2,257.55	0.14	27.21	
Secondaries	1,340.09	1.85	187.23	0.23	22.94	11.26	1,139.13	0.14	13.73	
Denitrification Filters	1,272.19	1.44	143.11	0.23	22.46	11.26	1,115.63	0.14	13.45	
Plant Effluent	1,272.19	1.44	143.11	0.23	22.46	11.26	1,115.63	0.14	13.45	
Secondaries (U)	35,650.73	347.59	34,518.84	0.23	22.52	11.26	1,118.42	0.14	13.48	
NSL 1C	34,435.08	342.21	34,111.66	0.23	23.01	3.12	311.39	0.12	12.03	
NSL 1B	34,184.57	342.24	34,114.14	0.44	43.88	0.66	65.34	0.05	5.09	
NSL 1A	34,119.96	342.25	34,114.89	0.65	65.28	0.05	4.58	0.01	0.5	
NSL 1D	34,114.97	342.25	34,114.90	0.79	78.5	0	0.06	0	0.01	
Primary Clarifiers (U)	576.22	730.35	576.22	31.12	24.55	0	0	0	0	
Denitrification Filters (U)	67.9	21.15	44.12	0.23	0.47	11.26	23.5	0.14	0.28	
WAS Splitter	35,066.54	347.59	33,953.19	0.23	22.15	11.26	1,100.09	0.14	13.26	
WAS Splitter (U)	584.19	347.59	565.64	0.23	0.37	11.26	18.33	0.14	0.22	
20% HAc	0	0	0	0	0	0	0	0	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	169.94	78.09	154.73	22.25	44.09	7.58	15.03	0.09	0.18	
RDT (U)	990.47	2,269.59	987.13	22.25	9.68	7.58	3.3	0.09	0.04	
Sludge to Digesters	990.47	2,269.59	987.13	22.25	9.68	7.58	3.3	0.09	0.04	

Model 8 - Near Term Max Month Min Week Temp MLE / NRCY

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6.2	615.72	4.34	431.01	7	7	3.5	157.67	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.25	517.77	4.5	443.55	6.99	6.99	3.56	159.39	0	
AB Inf. Channel	5.55	559.58	4.4	443.63	9.27	9.27	5.5	251.46	0.5	
Cell 1E	173.47	20,146.09	0.77	89.23	7.17	7.17	3.72	196.01	0	
Cell 2A	173.47	20,146.09	0.45	52.03	6.88	6.88	3.3	173.67	2	
Cell 1F	173.47	20,146.09	0.22	25.59	6.7	6.7	2.56	134.79	2	
Cell 2B	173.47	20,146.09	0.3	34.38	6.77	6.77	2.9	152.65	2	
Cell 2D	172.21	20,086.17	0.78	90.84	7.18	7.18	3.74	197.85	0	
Cell 3A	172.21	20,086.17	0.45	52.91	6.89	6.89	3.32	175.62	2	
Cell 3B	172.21	20,086.17	0.3	34.88	6.78	6.78	2.92	154.62	2	
Cell 2C	172.21	20,086.17	0.22	25.86	6.71	6.71	2.58	136.49	2	
Cell 3D	172.21	20,086.17	0.78	90.84	7.18	7.18	3.74	197.85	0	
Cell 4A	172.21	20,086.17	0.45	52.91	6.89	6.89	3.32	175.62	2	
Cell 4B	172.21	20,086.17	0.3	34.88	6.78	6.78	2.92	154.62	2	
Cell 3C	172.21	20,086.17	0.22	25.86	6.71	6.71	2.58	136.49	2	
Eff Channel 1	172.63	34,602.58	0.21	41.12	6.7	6.7	2.49	226.34	2	
Cell 5A	172.63	17,301.29	0.18	17.99	6.67	6.67	2.32	105.56	2	
Cell 5B	172.63	17,301.29	0.18	17.99	6.67	6.67	2.32	105.56	2	
Eff Channel 2	172.62	34,602.58	0.15	30.57	6.51	6.51	1.86	169.14	2	
Secondaries	0.67	67.28	0.15	15.42	6.51	6.51	1.86	85.34	2	
Denitrification Filters	0.26	25.48	0.15	15.11	6.45	6.45	1.86	83.59	2	
Plant Effluent	0.26	25.48	0.15	15.11	6.51	6.51	1.86	83.58	2	
Secondaries (U)	347.75	34,535.30	0.15	15.14	6.51	6.51	1.86	83.79	2	
NSL 1C	341.53	34,043.00	0	0.16	6.55	6.55	2.41	109.05	0	
NSL 1B	341.53	34,043.00	0.01	1.49	6.62	6.62	2.64	119.2	0	
NSL 1A	341.53	34,043.01	0.04	4.18	6.66	6.66	2.74	123.72	0	
NSL 1D	341.53	34,043.01	0.06	6	6.69	6.69	2.77	125.17	0	
Primary Clarifiers (U)	145.62	114.89	4.5	3.55	6.99	6.99	3.56	1.27	0	
Denitrification Filters (U)	20.04	41.8	0.15	0.32	6.45	6.45	1.86	1.76	2	
WAS Splitter	347.75	33,969.39	0.15	14.9	6.51	6.51	1.86	82.42	2	
WAS Splitter (U)	347.75	565.91	0.15	0.25	6.51	6.51	1.86	1.37	2	
20% HAc	0	0	0	0	2.12	2.12	-960.07	-6.54	0	
25% NaOH	0	0	0	0	15.16	15.16	7,970.05	90.51	0	
RDT	37.16	73.62	3.18	6.31	5.22	5.22	2.03	1.82	1.35	
RDT (U)	1,396.02	607.18	3.18	1.38	5.22	5.22	2.03	0.4	1.35	
Sludge to Digesters	1,396.02	607.18	3.18	1.38	5.23	5.23	1.98	0.39	1.35	

Model 9 - Current Capacity Annual Average MLE / NRCY

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	11.6	247.5	23,959.69	210.5	20,377.84	170.45	16,500.86	49.18	4,761.38
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	11.52	99.9	9,605.34	84.93	8,166.15	98.15	9,437.31	49.31	4,741.49
AB Inf. Channel	11.77	108.7	10,681.15	89.14	8,759.18	97.82	9,612.42	48.18	4,734.66
Cell 1E	19.37	4,595.31	742,781.25	2,545.21	411,405.38	789.03	127,538.54	2.73	440.52
Cell 2A	19.37	4,595.90	742,876.39	2,545.38	411,431.80	787.01	127,211.64	0.79	127.29
Cell 1F	19.37	4,589.72	741,876.20	2,538.07	410,250.21	780.58	126,172.65	1.11	178.87
Cell 2B	19.37	4,592.73	742,362.87	2,541.56	410,815.37	783.89	126,706.49	1.16	187.91
Cell 2D	19.43	4,561.95	739,629.77	2,527.07	409,713.53	783.83	127,082.40	2.78	451.05
Cell 3A	19.43	4,562.59	739,734.12	2,527.28	409,748.26	781.81	126,754.75	0.8	130.19
Cell 3B	19.43	4,559.45	739,224.79	2,523.50	409,134.64	778.7	126,251.47	1.17	189.94
Cell 2C	19.43	4,556.47	738,741.93	2,520.03	408,572.24	775.43	125,720.05	1.11	180.63
Cell 3D	19.43	4,561.95	739,629.77	2,527.07	409,713.53	783.83	127,082.40	2.78	451.05
Cell 4A	19.43	4,562.59	739,734.12	2,527.28	409,748.26	781.81	126,754.75	0.8	130.19
Cell 4B	19.43	4,559.45	739,224.79	2,523.50	409,134.64	778.7	126,251.47	1.17	189.94
Cell 3C	19.43	4,556.47	738,741.93	2,520.03	408,572.24	775.43	125,720.05	1.11	180.63
Eff Channel 1	23.42	4,566.33	892,622.03	2,524.68	493,522.23	775.87	151,667.05	1.08	211.47
Cell 5A	11.71	4,561.76	445,864.34	2,519.74	246,277.91	771.23	75,379.68	1.01	98.99
Cell 5B	11.71	4,561.76	445,864.34	2,519.74	246,277.91	771.23	75,379.68	1.01	98.99
Eff Channel 2	23.43	4,571.26	893,646.50	2,517.79	492,209.42	769.55	150,441.10	1.02	198.71
Secondaries	11.83	13.58	1,340.47	7.48	738.31	3.3	325.67	1.02	100.31
Denitrification Filters	11.58	2.78	268.09	1.53	147.66	1.48	143.26	1.02	98.19
Plant Effluent	11.58	2.78	268.09	1.53	147.66	1.48	143.26	1.02	98.19
Secondaries (U)	11.6	9,217.40	892,306.03	5,076.83	491,471.11	1,550.67	150,115.43	1.02	98.4
NSL 1C	11.65	9,080.47	882,762.48	5,008.23	486,877.71	1,539.57	149,670.18	5.18	503.37
NSL 1B	11.65	9,078.97	882,617.09	5,007.17	486,774.36	1,538.31	149,547.20	5.46	530.37
NSL 1A	11.65	9,077.26	882,450.34	5,005.88	486,648.91	1,537.45	149,464.17	6.32	614.71
NSL 1D	11.65	9,075.54	882,283.85	5,004.57	486,521.53	1,536.60	149,381.55	7.21	700.79
Primary Clarifiers (U)	0.09	18,261.97	14,408.01	15,525.74	12,249.23	8,977.16	7,082.65	49.31	38.91
Denitrification Filters (U)	0.25	514	1,072.38	283.1	590.65	87.43	182.41	1.02	2.12
WAS Splitter	11.43	9,217.40	879,344.52	5,076.83	484,332.07	1,550.67	147,934.87	1.02	96.97
WAS Splitter (U)	0.17	9,217.40	12,961.51	5,076.83	7,139.04	1,550.67	2,180.56	1.02	1.43
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.22	1,478.10	2,660.63	1,034.88	1,862.83	753.96	1,357.15	276.27	497.29
RDT (U)	0.05	60,602.11	23,945.68	42,430.23	16,765.43	19,861.69	7,847.94	276.27	109.16
Sludge to Digesters	0.05	60,602.11	23,945.68	42,430.23	16,765.43	19,861.69	7,847.94	276.27	109.16

Model 9 - Current Capacity Annual Average MLE / NRCY

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	392	37,948.22	85.42	8,269.68	306.58	29,678.55	7.64	739.99	42.5	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	210.27	20,218.22	86.56	8,322.79	123.71	11,895.43	7.73	742.97	38.37	
AB Inf. Channel	214.93	21,119.74	84.87	8,339.65	130.06	12,780.09	7.52	738.69	38.06	
Cell 1E	3,812.69	616,278.19	17.14	2,770.23	3,795.55	613,507.96	0.59	95.55	189.01	
Cell 2A	3,809.84	615,817.80	14.07	2,273.51	3,795.77	613,544.29	0.25	40.93	188.1	
Cell 1F	3,799.89	614,209.93	14.27	2,307.02	3,785.62	611,902.92	0	0.3	188.01	
Cell 2B	3,804.88	615,016.47	14.41	2,328.63	3,790.47	612,687.85	0.02	3.21	188.05	
Cell 2D	3,785.67	613,770.60	17.23	2,793.32	3,768.44	610,977.28	0.61	98.34	187.85	
Cell 3A	3,782.82	613,309.71	14.09	2,284.41	3,768.73	611,025.30	0.27	43	186.94	
Cell 3B	3,777.90	612,510.84	14.42	2,337.98	3,763.48	610,172.86	0.02	3.4	186.89	
Cell 2C	3,772.94	611,707.72	14.28	2,315.83	3,758.66	609,391.90	0	0.32	186.85	
Cell 3D	3,785.67	613,770.60	17.23	2,793.32	3,768.44	610,977.28	0.61	98.34	187.85	
Cell 4A	3,782.82	613,309.71	14.09	2,284.41	3,768.73	611,025.30	0.27	43	186.94	
Cell 4B	3,777.90	612,510.84	14.42	2,337.98	3,763.48	610,172.86	0.02	3.4	186.89	
Cell 3C	3,772.94	611,707.72	14.28	2,315.83	3,758.66	609,391.90	0	0.32	186.85	
Eff Channel 1	3,779.98	738,906.81	14.23	2,780.90	3,765.75	736,125.91	0	0.12	187.22	
Cell 5A	3,772.98	368,769.18	14.12	1,379.93	3,758.86	367,389.24	0	0.03	187.17	
Cell 5B	3,772.98	368,769.18	14.12	1,379.93	3,758.86	367,389.24	0	0.03	187.17	
Eff Channel 2	3,770.25	737,055.27	14.12	2,760.45	3,756.13	734,294.82	0	0.06	187.14	
Secondaries	25.28	2,494.93	14.12	1,393.49	11.16	1,101.44	0	0.03	9.34	
Denitrification Filters	16.4	1,584.32	14.12	1,364.03	2.28	220.29	0	0.03	8.92	
Plant Effluent	16.4	1,584.32	14.12	1,364.03	2.28	220.29	0	0.03	8.92	
Secondaries (U)	7,587.91	734,560.34	14.12	1,366.96	7,573.79	733,193.38	0	0.03	368.39	
NSL 1C	7,490.94	728,235.58	20.36	1,979.25	7,470.58	726,256.33	6.42	624.18	355.7	
NSL 1B	7,489.64	728,109.85	20.63	2,005.51	7,469.02	726,104.34	7.36	715.08	355.58	
NSL 1A	7,488.92	728,039.06	21.79	2,118.05	7,467.13	725,921.01	8.55	831.37	355.58	
NSL 1D	7,488.19	727,968.28	22.97	2,233.28	7,465.22	725,735.00	9.76	948.45	355.58	
Primary Clarifiers (U)	22,702.52	17,911.44	86.56	68.29	22,615.96	17,843.15	7.73	6.1	685.58	
Denitrification Filters (U)	436.46	910.61	14.12	29.46	422.34	881.15	0	0	28.86	
WAS Splitter	7,587.91	723,890.21	14.12	1,347.10	7,573.79	722,543.11	0	0.03	368.39	
WAS Splitter (U)	7,587.91	10,670.12	14.12	19.86	7,573.79	10,650.27	0	0	368.39	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	1,945.99	3,502.84	422.14	759.87	1,523.85	2,742.98	376.58	677.85	86.35	
RDT (U)	62,899.84	24,853.58	422.14	166.8	62,477.70	24,686.78	376.58	148.8	2,286.56	
Sludge to Digesters	62,899.84	24,853.58	422.14	166.8	62,477.70	24,686.78	376.58	148.8	2,286.56	

Model 9 - Current Capacity Annual Average MLE / NRCY

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent		4,114.28	42.5	4,114.28	28.9	2,797.71	0	0	0	0
Rotary Press Filtrate (50%)		115.86	862	115.86	818.9	110.06	0	0	0	0
Primary Clarifiers		3,689.24	38.37	3,689.24	30	2,884.11	0	0	0	0
AB Inf. Channel		3,739.43	37.89	3,723.27	29.26	2,875.31	0.16	15.62	0.01	0.54
Cell 1E		30,551.83	187.93	30,377.43	7.16	1,157.18	0.76	123.56	0.31	50.84
Cell 2A		30,403.69	187.92	30,375.71	7.45	1,204.83	0.12	18.91	0.06	9.08
Cell 1F		30,389.27	182.23	29,455.09	1.63	263.43	4.62	747.09	1.16	187.09
Cell 2B		30,396.25	184.77	29,866.67	4.19	676.63	2.35	379.6	0.93	149.97
Cell 2D		30,456.04	186.79	30,283.74	7.3	1,183.69	0.74	119.95	0.32	52.35
Cell 3A		30,308.55	186.78	30,282.06	7.6	1,231.69	0.11	17.62	0.05	8.88
Cell 3B		30,301.10	183.64	29,773.93	4.34	704.14	2.32	375.74	0.93	151.42
Cell 2C		30,294.12	181.07	29,356.37	1.75	284.38	4.58	741.76	1.21	195.99
Cell 3D		30,456.04	186.79	30,283.74	7.3	1,183.69	0.74	119.95	0.32	52.35
Cell 4A		30,308.55	186.78	30,282.06	7.6	1,231.69	0.11	17.62	0.05	8.88
Cell 4B		30,301.10	183.64	29,773.93	4.34	704.14	2.32	375.74	0.93	151.42
Cell 3C		30,294.12	181.07	29,356.37	1.75	284.38	4.58	741.76	1.21	195.99
Eff Channel 1		36,597.25	180.66	35,315.75	0.94	182.78	5.45	1,065.33	1.11	216.18
Cell 5A		18,293.56	179.72	17,565.60	0.17	16.31	7.32	715.32	0.13	12.64
Cell 5B		18,293.56	179.72	17,565.60	0.17	16.31	7.32	715.32	0.13	12.64
Eff Channel 2		36,583.90	179.54	35,098.49	0.08	15.25	7.57	1,480.34	0.03	5.07
Secondaries		921.59	1.74	171.74	0.08	7.7	7.57	747.28	0.03	2.56
Denitrification Filters		861.37	1.32	127.38	0.08	7.54	7.57	731.48	0.03	2.5
Plant Effluent		861.37	1.32	127.38	0.08	7.54	7.57	731.48	0.03	2.5
Secondaries (U)		35,662.31	360.79	34,926.75	0.08	7.55	7.57	733.05	0.03	2.51
NSL 1C		34,579.48	355.58	34,567.84	0.18	17.61	0.11	10.73	0.01	0.91
NSL 1B		34,567.87	355.58	34,567.83	0.44	42.37	0	0.03	0	0
NSL 1A		34,567.83	355.58	34,567.83	0.58	56.18	0	0	0	0
NSL 1D		34,567.83	355.58	34,567.83	0.7	67.61	0	0	0	0
Primary Clarifiers (U)		540.9	685.58	540.9	30	23.67	0	0	0	0
Denitrification Filters (U)		60.21	21.26	44.36	0.08	0.16	7.57	15.8	0.03	0.05
WAS Splitter		35,144.29	360.79	34,419.41	0.08	7.44	7.57	722.41	0.03	2.47
WAS Splitter (U)		518.03	360.79	507.34	0.08	0.11	7.57	10.65	0.03	0.04
20% HAc		0	0	0	0	0	0	0	0	0
25% NaOH		0	0	0	0	0	0	0	0	0
RDT		155.43	81.48	146.67	25.43	45.77	4.85	8.73	0.02	0.03
RDT (U)		903.49	2,281.70	901.57	25.43	10.05	4.85	1.92	0.02	0.01
Sludge to Digesters		903.49	2,281.70	901.57	25.43	10.05	4.85	1.92	0.02	0.01

Model 9 - Current Capacity Annual Average MLE / NRCY

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6	580.84	4.2	406.59	7	7	3.5	153.68	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.09	489.28	4.36	419.24	6.99	6.99	3.56	155.42	0	
AB Inf. Channel	5.43	533.58	4.27	419.31	9.22	9.22	5.56	247.73	0.5	
Cell 1E	188.43	30,456.82	0.65	104.87	7.12	7.12	3.65	267.25	0.01	
Cell 2A	188.43	30,456.82	0.5	80.73	7.18	7.18	3.75	275.22	0	
Cell 1F	188.43	30,456.82	0.27	43.89	6.79	6.79	2.92	213.83	2	
Cell 2B	188.43	30,456.82	0.36	58.42	6.9	6.9	3.29	241.12	2	
Cell 2D	187.05	30,326.24	0.66	106.49	7.13	7.13	3.66	269.15	0.01	
Cell 3A	187.05	30,326.24	0.51	82.04	7.18	7.18	3.77	277.16	0	
Cell 3B	187.05	30,326.24	0.37	59.24	6.9	6.9	3.31	243.12	2	
Cell 2C	187.05	30,326.24	0.27	44.34	6.79	6.79	2.93	215.43	2	
Cell 3D	187.05	30,326.24	0.66	106.49	7.13	7.13	3.66	269.15	0.01	
Cell 4A	187.05	30,326.24	0.51	82.04	7.18	7.18	3.77	277.16	0	
Cell 4B	187.05	30,326.24	0.37	59.24	6.9	6.9	3.31	243.12	2	
Cell 3C	187.05	30,326.24	0.27	44.34	6.79	6.79	2.93	215.43	2	
Eff Channel 1	187.51	36,653.35	0.25	48.09	6.78	6.78	2.81	249.13	2	
Cell 5A	187.51	18,326.67	0.21	20.24	6.76	6.76	2.68	118.68	2	
Cell 5B	187.51	18,326.67	0.21	20.24	6.76	6.76	2.68	118.68	2	
Eff Channel 2	187.49	36,653.35	0.17	33.89	6.59	6.59	2.22	196.85	2	
Secondaries	0.73	72.04	0.17	17.11	6.59	6.59	2.22	99.37	2	
Denitrification Filters	0.29	27.73	0.17	16.74	6.59	6.59	2.22	97.27	2	
Plant Effluent	0.29	27.73	0.17	16.74	6.59	6.59	2.22	97.27	2	
Secondaries (U)	377.88	36,581.31	0.17	16.78	6.59	6.59	2.22	97.48	2	
NSL 1C	371.54	36,119.76	0	0.17	6.62	6.62	2.77	122.28	0	
NSL 1B	371.54	36,119.76	0.03	2.83	6.65	6.65	2.83	124.67	0	
NSL 1A	371.54	36,119.77	0.05	5.2	6.67	6.67	2.86	125.96	0	
NSL 1D	371.54	36,119.77	0.07	6.96	6.7	6.7	2.88	127.19	0	
Primary Clarifiers (U)	137.52	108.5	4.36	3.44	6.99	6.99	3.56	1.28	0	
Denitrification Filters (U)	21.24	44.31	0.17	0.36	6.59	6.59	2.22	2.1	2	
WAS Splitter	377.88	36,049.94	0.17	16.54	6.59	6.59	2.22	96.06	2	
WAS Splitter (U)	377.88	531.38	0.17	0.24	6.59	6.59	2.22	1.42	2	
20% HAc	0	0	0	0	2.11	2.11	-966.41	-6.58	0	
25% NaOH	0	0	0	0	14.91	14.91	7,970.05	90.51	0	
RDT	38.79	69.83	3.7	6.65	5.14	5.14	2.22	1.81	1.28	
RDT (U)	1,442.68	570.04	3.7	1.46	5.14	5.14	2.22	0.4	1.28	
Sludge to Digesters	1,442.68	570.04	3.7	1.46	5.14	5.14	2.22	0.4	1.28	

Model 10 - Current Capacity Max Month Min Week Temp MLE / NRCY

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	14.5	258.09	31,231.32	219.09	26,511.99	177.41	21,467.95	51.19	6,194.65
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	14.42	103.98	12,513.99	88.24	10,619.81	102.05	12,282.55	51.29	6,173.20
AB Inf. Channel	14.67	114.81	14,059.82	93.55	11,456.32	102.49	12,551.99	50.35	6,165.66
Cell 1E	16.94	5,294.67	748,543.47	2,879.01	407,024.97	962.41	136,062.22	3.02	426.78
Cell 2A	16.94	5,292.89	748,291.94	2,876.18	406,624.81	958.05	135,445.45	1.46	206.02
Cell 1F	16.94	5,286.13	747,336.78	2,868.58	405,550.49	950.44	134,369.57	0.99	139.69
Cell 2B	16.94	5,289.65	747,834.34	2,872.42	406,093.32	954.16	134,896.20	1.11	157.19
Cell 2D	17.01	5,256.10	746,308.92	2,858.36	405,856.78	955.9	135,727.86	3.08	437.94
Cell 3A	17.01	5,254.40	746,067.74	2,855.60	405,464.65	951.55	135,110.45	1.48	209.62
Cell 3B	17.01	5,251.21	745,614.38	2,851.88	404,936.44	947.7	134,562.76	1.12	159.21
Cell 2C	17.01	5,247.72	745,119.95	2,848.08	404,396.15	944	134,038.20	0.99	141.24
Cell 3D	17.01	5,256.10	746,308.92	2,858.36	405,856.78	955.9	135,727.86	3.08	437.94
Cell 4A	17.01	5,254.40	746,067.74	2,855.60	405,464.65	951.55	135,110.45	1.48	209.62
Cell 4B	17.01	5,251.21	745,614.38	2,851.88	404,936.44	947.7	134,562.76	1.12	159.21
Cell 3C	17.01	5,247.72	745,119.95	2,848.08	404,396.15	944	134,038.20	0.99	141.24
Eff Channel 1	29.22	5,259.51	1,282,493.32	2,853.85	695,890.65	945.15	230,467.93	0.97	235.89
Cell 5A	14.61	5,255.96	640,813.63	2,850.11	347,489.41	941.59	114,799.77	0.91	111.1
Cell 5B	14.61	5,255.96	640,813.63	2,850.11	347,489.41	941.59	114,799.77	0.91	111.1
Eff Channel 2	29.22	5,267.45	1,284,529.25	2,848.57	694,656.85	940.27	229,296.20	0.9	219.83
Secondaries	14.72	15.68	1,926.79	8.48	1,041.99	3.7	454.36	0.9	110.75
Denitrification Filters	14.47	3.19	385.36	1.73	208.4	1.47	177.59	0.9	108.87
Plant Effluent	14.47	3.19	385.36	1.73	208.4	1.47	177.59	0.9	108.87
Secondaries (U)	14.5	10,599.29	1,282,602.45	5,731.96	693,614.87	1,891.12	228,841.84	0.9	109.08
NSL 1C	14.54	10,458.84	1,269,467.05	5,662.13	687,255.12	1,876.15	227,722.38	4.71	572.25
NSL 1B	14.54	10,456.90	1,269,230.97	5,660.27	687,029.17	1,870.05	226,981.97	0.69	83.87
NSL 1A	14.54	10,453.60	1,268,830.57	5,657.23	686,660.36	1,866.68	226,572.25	0.32	39.08
NSL 1D	14.54	10,451.98	1,268,634.57	5,655.91	686,499.62	1,864.94	226,361.40	0.22	26.44
Primary Clarifiers (U)	0.09	23,791.98	18,770.99	20,190.71	15,929.72	11,666.59	9,204.50	51.29	40.47
Denitrification Filters (U)	0.25	738.82	1,541.44	399.54	833.59	132.66	276.77	0.9	1.88
WAS Splitter	14.31	10,599.29	1,265,353.66	5,731.96	684,286.94	1,891.12	225,764.31	0.9	107.62
WAS Splitter (U)	0.2	10,599.29	17,248.79	5,731.96	9,327.92	1,891.12	3,077.53	0.9	1.47
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.24	1,776.32	3,519.56	1,233.34	2,443.72	861.2	1,706.36	277.45	549.73
RDT (U)	0.05	72,828.97	31,676.02	50,566.96	21,993.44	24,211.27	10,530.38	277.45	120.67
Sludge to Digesters	0.05	72,828.97	31,676.02	50,566.96	21,993.44	24,211.27	10,530.38	277.45	120.67

Model 10 - Current Capacity Max Month Min Week Temp MLE / NRCY

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	408	49,371.41	88.91	10,759.02	319.09	38,612.39	7.96	962.74	44.2	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	218.34	26,278.54	89.81	10,809.56	128.53	15,468.97	8.02	965.49	39.63	
AB Inf. Channel	224.9	27,542.38	88.4	10,826.02	136.5	16,716.36	7.85	961.28	39.6	
Cell 1E	4,310.00	609,334.44	18.2	2,573.02	4,291.80	606,761.43	0.4	56.85	216.41	
Cell 2A	4,303.17	608,369.04	15.28	2,160.25	4,287.89	606,208.79	0.03	3.8	216.36	
Cell 1F	4,291.71	606,748.69	14.39	2,034.82	4,277.32	604,713.87	0	0.05	216.27	
Cell 2B	4,297.28	607,536.33	14.62	2,066.37	4,282.67	605,469.95	0	0.28	216.31	
Cell 2D	4,279.30	607,613.90	18.31	2,600.31	4,260.98	605,013.59	0.42	59.77	215.04	
Cell 3A	4,272.49	606,646.68	15.31	2,174.37	4,257.17	604,472.31	0.03	4.05	214.99	
Cell 3B	4,266.63	605,815.68	14.63	2,077.52	4,252.00	603,738.16	0	0.3	214.94	
Cell 2C	4,261.11	605,030.81	14.4	2,045.07	4,246.70	602,985.74	0	0.05	214.9	
Cell 3D	4,279.30	607,613.90	18.31	2,600.31	4,260.98	605,013.59	0.42	59.77	215.04	
Cell 4A	4,272.49	606,646.68	15.31	2,174.37	4,257.17	604,472.31	0.03	4.05	214.99	
Cell 4B	4,266.63	605,815.68	14.63	2,077.52	4,252.00	603,738.16	0	0.3	214.94	
Cell 3C	4,261.11	605,030.81	14.4	2,045.07	4,246.70	602,985.74	0	0.05	214.9	
Eff Channel 1	4,269.78	1,041,155.42	14.36	3,500.61	4,255.43	1,037,654.81	0	0.05	215.34	
Cell 5A	4,264.48	519,930.52	14.27	1,739.62	4,250.21	518,190.90	0	0.02	215.3	
Cell 5B	4,264.48	519,930.52	14.27	1,739.62	4,250.21	518,190.90	0	0.02	215.3	
Eff Channel 2	4,262.28	1,039,407.34	14.25	3,475.43	4,248.03	1,035,931.91	0	0.04	215.27	
Secondaries	26.9	3,304.76	14.25	1,750.86	12.65	1,553.90	0	0.02	13.57	
Denitrification Filters	16.83	2,031.91	14.25	1,721.13	2.57	310.78	0	0.02	13.09	
Plant Effluent	16.83	2,031.91	14.25	1,721.13	2.57	310.78	0	0.02	13.09	
Secondaries (U)	8,562.24	1,036,102.58	14.25	1,724.57	8,547.99	1,034,378.01	0	0.02	420.04	
NSL 1C	8,463.36	1,027,261.05	20.16	2,446.93	8,443.20	1,024,814.12	4.31	523.02	407.98	
NSL 1B	8,455.36	1,026,289.66	14.78	1,793.40	8,440.59	1,024,496.26	0.25	30.2	405.24	
NSL 1A	8,450.66	1,025,718.86	14.38	1,744.89	8,436.28	1,023,973.97	0.08	9.86	403.75	
NSL 1D	8,448.25	1,025,426.47	13.88	1,684.68	8,434.37	1,023,741.79	0.19	22.89	403.3	
Primary Clarifiers (U)	29,499.89	23,274.32	89.81	70.86	29,410.08	23,203.46	8.02	6.33	881.36	
Denitrification Filters (U)	610.09	1,272.85	14.25	29.73	595.83	1,243.12	0	0	41.34	
WAS Splitter	8,562.24	1,022,168.79	14.25	1,701.38	8,547.99	1,020,467.41	0	0.02	420.04	
WAS Splitter (U)	8,562.24	13,933.79	14.25	23.19	8,547.99	13,910.60	0	0	420.04	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	2,241.43	4,441.12	426.24	844.55	1,815.19	3,596.57	378.79	750.53	98.92	
RDT (U)	74,848.90	32,554.56	426.24	185.39	74,422.66	32,369.17	378.79	164.75	2,719.77	
Sludge to Digesters	74,848.90	32,554.56	426.24	185.39	74,422.66	32,369.17	378.79	164.75	2,719.77	

Model 10 - Current Capacity Max Month Min Week Temp MLE / NRCY

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent	5,348.57	44.2	5,348.57	30.06	3,637.03	0	0	0	0	
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0	
Primary Clarifiers	4,769.06	39.63	4,769.06	30.93	3,722.69	0	0	0	0	
AB Inf. Channel	4,849.51	39.4	4,825.06	30.36	3,718.50	0.19	23.6	0.01	0.85	
Cell 1E	30,595.49	215.09	30,408.73	10.22	1,445.15	1.07	151.11	0.25	35.65	
Cell 2A	30,587.97	212.04	29,977.03	7.21	1,018.81	3.43	484.72	0.89	126.22	
Cell 1F	30,574.94	206.74	29,228.59	2.1	297.05	8.25	1,165.91	1.28	180.45	
Cell 2B	30,581.26	209.19	29,574.13	4.44	627.38	5.85	826.74	1.28	180.39	
Cell 2D	30,533.99	213.79	30,355.23	10.39	1,474.84	1.01	142.97	0.25	35.78	
Cell 3A	30,526.46	210.76	29,925.51	7.4	1,050.40	3.34	474.12	0.89	126.84	
Cell 3B	30,519.75	207.92	29,522.90	4.64	659.03	5.73	813.94	1.29	182.91	
Cell 2C	30,513.45	205.46	29,172.84	2.28	323.75	8.11	1,151.79	1.33	188.82	
Cell 3D	30,533.99	213.79	30,355.23	10.39	1,474.84	1.01	142.97	0.25	35.78	
Cell 4A	30,526.46	210.76	29,925.51	7.4	1,050.40	3.34	474.12	0.89	126.84	
Cell 4B	30,519.75	207.92	29,522.90	4.64	659.03	5.73	813.94	1.29	182.91	
Cell 3C	30,513.45	205.46	29,172.84	2.28	323.75	8.11	1,151.79	1.33	188.82	
Eff Channel 1	52,509.33	205.28	50,055.19	1.64	400.81	8.79	2,144.44	1.27	309.7	
Cell 5A	26,249.70	203.98	24,869.17	0.49	60	10.85	1,322.75	0.47	57.78	
Cell 5B	26,249.70	203.98	24,869.17	0.49	60	10.85	1,322.75	0.47	57.78	
Eff Channel 2	52,495.94	203.67	49,667.03	0.26	62.77	11.4	2,780.22	0.2	48.69	
Secondaries	1,667.13	1.97	241.98	0.26	31.62	11.4	1,400.63	0.2	24.53	
Denitrification Filters	1,580.88	1.49	179.92	0.26	31.09	11.4	1,376.84	0.2	24.11	
Plant Effluent	1,580.88	1.49	179.92	0.26	31.09	11.4	1,376.84	0.2	24.11	
Secondaries (U)	50,828.81	408.44	49,425.05	0.26	31.15	11.4	1,379.59	0.2	24.16	
NSL 1C	49,519.73	403.22	48,942.02	0.37	45.38	4.59	557.17	0.17	20.53	
NSL 1B	49,187.07	403.25	48,944.85	0.55	66.64	1.88	228.47	0.11	13.75	
NSL 1A	49,006.16	403.26	48,946.76	0.8	96.8	0.45	54.2	0.04	5.2	
NSL 1D	48,951.36	403.27	48,947.44	0.98	118.95	0.03	3.52	0	0.41	
Primary Clarifiers (U)	695.36	881.36	695.36	30.93	24.4	0	0	0	0	
Denitrification Filters (U)	86.26	29.74	62.05	0.26	0.54	11.4	23.79	0.2	0.42	
WAS Splitter	50,145.25	408.44	48,760.37	0.26	30.73	11.4	1,361.04	0.2	23.84	
WAS Splitter (U)	683.56	408.44	664.68	0.26	0.42	11.4	18.55	0.2	0.32	
20% HAc	0	0	0	0	0	0	0	0	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	195.99	91.11	180.51	24.54	48.62	7.68	15.21	0.13	0.27	
RDT (U)	1,182.93	2,711.96	1,179.53	24.54	10.67	7.68	3.34	0.13	0.06	
Sludge to Digesters	1,182.93	2,711.96	1,179.53	24.54	10.67	7.68	3.34	0.13	0.06	

Model 10 - Current Capacity Max Month Min Week Temp MLE / NRCY

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6.2	750.25	4.34	525.18	7	7	3.5	192.11	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.22	628.11	4.47	537.74	6.99	6.99	3.55	193.84	0	
AB Inf. Channel	5.63	689.98	4.39	537.51	9.05	9.05	5.14	285.51	0.5	
Cell 1E	211.9	29,957.76	0.58	81.88	7.04	7.04	3.32	212.69	0	
Cell 2A	211.9	29,957.76	0.3	42.33	6.81	6.81	2.9	185.96	2	
Cell 1F	211.9	29,957.76	0.13	18.75	6.63	6.63	2.17	139.18	2	
Cell 2B	211.9	29,957.76	0.18	26.1	6.7	6.7	2.51	160.78	2	
Cell 2D	210.35	29,867.43	0.59	83.3	7.05	7.05	3.34	214.85	0	
Cell 3A	210.35	29,867.43	0.3	43.01	6.82	6.82	2.92	188.27	2	
Cell 3B	210.35	29,867.43	0.19	26.44	6.71	6.71	2.53	163.1	2	
Cell 2C	210.35	29,867.43	0.13	18.89	6.63	6.63	2.19	141.21	2	
Cell 3D	210.35	29,867.43	0.59	83.3	7.05	7.05	3.34	214.85	0	
Cell 4A	210.35	29,867.43	0.3	43.01	6.82	6.82	2.92	188.27	2	
Cell 4B	210.35	29,867.43	0.19	26.44	6.71	6.71	2.53	163.1	2	
Cell 3C	210.35	29,867.43	0.13	18.89	6.63	6.63	2.19	141.21	2	
Eff Channel 1	210.86	51,417.66	0.12	29.81	6.62	6.62	2.1	232.44	2	
Cell 5A	210.86	25,708.83	0.11	13.18	6.59	6.59	1.93	106.55	2	
Cell 5B	210.86	25,708.83	0.11	13.18	6.59	6.59	1.93	106.55	2	
Eff Channel 2	210.85	51,417.66	0.09	23.05	6.36	6.36	1.38	153.19	2	
Secondaries	0.72	88.71	0.09	11.61	6.36	6.36	1.38	77.17	2	
Denitrification Filters	0.22	26.84	0.09	11.42	6.3	6.3	1.38	75.87	2	
Plant Effluent	0.22	26.84	0.09	11.42	6.36	6.36	1.38	75.86	2	
Secondaries (U)	424.18	51,328.95	0.09	11.44	6.36	6.36	1.38	76.01	2	
NSL 1C	417.93	50,727.68	0	0.12	6.42	6.42	1.85	102.03	0	
NSL 1B	417.93	50,727.68	0	0.48	6.5	6.5	2.09	114.97	0	
NSL 1A	417.93	50,727.68	0.04	5.33	6.55	6.55	2.23	122.72	0	
NSL 1D	417.93	50,727.68	0.05	6.67	6.58	6.58	2.31	127.27	0	
Primary Clarifiers (U)	176.28	139.08	4.47	3.53	6.99	6.99	3.55	1.27	0	
Denitrification Filters (U)	29.66	61.87	0.09	0.2	6.3	6.3	1.38	1.31	2	
WAS Splitter	424.18	50,638.67	0.09	11.29	6.36	6.36	1.38	74.99	2	
WAS Splitter (U)	424.18	690.29	0.09	0.15	6.36	6.36	1.38	1.02	2	
20% HAc	0	0	0	0	2.12	2.12	-960.07	-6.54	0	
25% NaOH	0	0	0	0	15.16	15.16	7,970.05	90.51	0	
RDT	44.93	89.01	3.49	6.92	4.95	4.95	1.57	1.41	1.35	
RDT (U)	1,702.20	740.35	3.49	1.52	4.95	4.95	1.57	0.31	1.35	
Sludge to Digesters	1,702.20	740.35	3.49	1.52	4.96	4.96	1.51	0.3	1.35	

Model 11 - Buildout Annual Average MLE / NRCY

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	14.8	247.5	30,569.26	210.5	25,999.32	170.45	21,052.82	49.18	6,074.86
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	14.72	99.7	12,249.17	84.77	10,414.74	98.05	12,046.21	49.28	6,054.99
AB Inf. Channel	14.97	112.74	14,089.54	90.95	11,365.66	98.59	12,320.44	48.38	6,045.72
Cell 1E	24.69	6,170.68	1,271,532.70	3,201.73	659,749.69	961.3	198,085.30	2.67	550.42
Cell 2A	24.69	6,171.10	1,271,619.39	3,201.69	659,740.70	959.23	197,659.97	0.85	175.34
Cell 1F	24.69	6,165.02	1,270,367.33	3,194.75	658,312.44	953.07	196,389.21	1.1	226.38
Cell 2B	24.69	6,168.01	1,270,983.03	3,198.10	659,002.67	956.23	197,041.60	1.15	236.95
Cell 2D	24.77	6,125.56	1,266,063.32	3,178.68	656,986.94	954.81	197,344.30	2.73	563.45
Cell 3A	24.77	6,126.03	1,266,160.75	3,178.68	656,987.21	952.74	196,917.34	0.87	179.05
Cell 3B	24.77	6,122.98	1,265,529.49	3,175.13	656,253.18	949.76	196,301.52	1.16	239.4
Cell 2C	24.77	6,120.02	1,264,918.38	3,171.81	655,566.81	946.62	195,652.45	1.11	228.45
Cell 3D	24.77	6,125.56	1,266,063.32	3,178.68	656,986.94	954.81	197,344.30	2.73	563.45
Cell 4A	24.77	6,126.03	1,266,160.75	3,178.68	656,987.21	952.74	196,917.34	0.87	179.05
Cell 4B	24.77	6,122.98	1,265,529.49	3,175.13	656,253.18	949.76	196,301.52	1.16	239.4
Cell 3C	24.77	6,120.02	1,264,918.38	3,171.81	655,566.81	946.62	195,652.45	1.11	228.45
Eff Channel 1	29.82	6,133.79	1,526,668.63	3,178.14	791,023.43	947.54	235,838.96	1.08	268.27
Cell 5A	14.91	6,129.25	762,770.18	3,173.32	394,911.69	943.03	117,358.10	1.02	127.55
Cell 5B	14.91	6,129.25	762,770.18	3,173.32	394,911.69	943.03	117,358.10	1.02	127.55
Eff Channel 2	29.83	6,141.64	1,528,756.75	3,171.30	789,390.28	941.36	234,320.85	1.04	257.97
Secondaries	15.03	18.29	2,293.14	9.44	1,184.09	3.84	481.06	1.04	129.97
Denitrification Filters	14.78	3.72	458.63	1.92	236.82	1.61	198.02	1.04	127.8
Plant Effluent	14.78	3.72	458.63	1.92	236.82	1.61	198.02	1.04	127.8
Secondaries (U)	14.8	12,358.83	1,526,463.61	6,381.62	788,206.19	1,893.26	233,839.79	1.04	128.01
NSL 1C	14.85	12,212.28	1,513,420.67	6,312.03	782,225.12	1,880.42	233,033.44	4.63	574.37
NSL 1B	14.85	12,211.73	1,513,351.47	6,311.78	782,194.47	1,877.36	232,653.88	2.45	303.21
NSL 1A	14.85	12,210.09	1,513,148.26	6,310.57	782,043.77	1,876.49	232,546.52	3.22	399.27
NSL 1D	14.85	12,208.44	1,512,944.57	6,309.31	781,888.73	1,875.67	232,444.73	4.07	504.11
Primary Clarifiers (U)	0.09	23,288.49	18,373.76	19,800.82	15,622.11	11,439.97	9,025.71	49.28	38.88
Denitrification Filters (U)	0.25	879.29	1,834.51	454.03	947.27	135.66	283.04	1.04	2.16
WAS Splitter	14.63	12,358.83	1,509,445.60	6,381.62	779,418.76	1,893.26	231,232.79	1.04	126.58
WAS Splitter (U)	0.17	12,358.83	17,018.01	6,381.62	8,787.43	1,893.26	2,607.00	1.04	1.43
20% HAc	0	0	0	0	0	158,852.18	2,386.23	158,852.18	2,386.23
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.21	1,937.76	3,441.62	1,319.66	2,343.82	960.77	1,706.41	352.99	626.94
RDT (U)	0.05	79,448.19	30,974.61	54,105.96	21,094.39	25,271.98	9,852.83	352.99	137.62
Sludge to Digesters	0.05	79,448.19	30,974.61	54,105.96	21,094.39	25,271.98	9,852.83	352.99	137.62

Model 11 - Buildout Annual Average MLE / NRCY

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	392	48,416.70	85.42	10,550.97	306.58	37,865.73	7.64	944.13	42.5	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	209.79	25,774.58	86.31	10,604.27	123.48	15,170.31	7.71	947.12	38.12	
AB Inf. Channel	217.72	27,208.02	84.96	10,617.30	132.76	16,590.72	7.54	942.16	38.1	
Cell 1E	4,798.31	988,742.52	16.86	3,474.00	4,781.46	985,268.52	0.44	91.6	233.29	
Cell 2A	4,795.46	988,154.91	14.07	2,899.29	4,781.39	985,255.61	0.17	34.95	232.28	
Cell 1F	4,785.83	986,169.84	14.07	2,898.81	4,771.76	983,271.02	0	0.3	232.19	
Cell 2B	4,790.63	987,158.52	14.21	2,928.60	4,776.41	984,229.93	0.01	2.86	232.23	
Cell 2D	4,763.94	984,635.07	16.95	3,502.72	4,746.99	981,132.35	0.46	94.45	231.79	
Cell 3A	4,761.09	984,046.22	14.1	2,913.73	4,746.99	981,132.48	0.18	36.94	230.78	
Cell 3B	4,756.28	983,052.80	14.23	2,940.34	4,742.05	980,112.46	0.01	3.05	230.74	
Cell 2C	4,751.52	982,068.76	14.08	2,909.69	4,737.44	979,159.07	0	0.31	230.7	
Cell 3D	4,763.94	984,635.07	16.95	3,502.72	4,746.99	981,132.35	0.46	94.45	231.79	
Cell 4A	4,761.09	984,046.22	14.1	2,913.73	4,746.99	981,132.48	0.18	36.94	230.78	
Cell 4B	4,756.28	983,052.80	14.23	2,940.34	4,742.05	980,112.46	0.01	3.05	230.74	
Cell 3C	4,751.52	982,068.76	14.08	2,909.69	4,737.44	979,159.07	0	0.31	230.7	
Eff Channel 1	4,761.07	1,185,005.92	14.02	3,490.50	4,747.05	1,181,515.42	0	0.13	231.18	
Cell 5A	4,754.26	591,655.72	13.94	1,734.44	4,740.32	589,921.28	0	0.04	231.13	
Cell 5B	4,754.26	591,655.72	13.94	1,734.44	4,740.32	589,921.28	0	0.04	231.13	
Eff Channel 2	4,751.43	1,182,710.29	13.95	3,472.32	4,737.48	1,179,237.97	0	0.07	231.09	
Secondaries	28.05	3,518.22	13.95	1,749.36	14.11	1,768.86	0	0.03	9.76	
Denitrification Filters	16.82	2,074.03	13.95	1,720.26	2.87	353.77	0	0.03	9.23	
Plant Effluent	16.82	2,074.03	13.95	1,720.26	2.87	353.77	0	0.03	9.23	
Secondaries (U)	9,547.19	1,179,192.08	13.95	1,722.96	9,533.24	1,177,469.11	0	0.03	455.81	
NSL 1C	9,448.31	1,170,892.32	19.65	2,434.93	9,428.66	1,168,457.40	4.46	552.27	443.67	
NSL 1B	9,444.54	1,170,425.20	16.28	2,017.26	9,428.26	1,168,407.94	3.14	389.51	442.89	
NSL 1A	9,443.78	1,170,330.41	17.29	2,142.89	9,426.49	1,168,187.52	4.33	536.16	442.88	
NSL 1D	9,443.09	1,170,244.80	18.43	2,283.82	9,424.66	1,167,960.99	5.48	679.24	442.88	
Primary Clarifiers (U)	28,928.56	22,823.56	86.31	68.1	28,842.25	22,755.46	7.71	6.08	864.28	
Denitrification Filters (U)	692.21	1,444.19	13.95	29.1	678.26	1,415.09	0	0	40.88	
WAS Splitter	9,547.19	1,166,045.68	13.95	1,703.75	9,533.24	1,164,341.93	0	0.03	455.81	
WAS Splitter (U)	9,547.19	13,146.40	13.95	19.21	9,533.24	13,127.19	0	0	455.81	
20% HAc	216,000.00	3,244.69	216,000.00	3,244.69	0	0	216,000.00	3,244.69	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	2,472.77	4,391.84	528.98	939.52	1,943.78	3,452.32	481.98	856.04	104.85	
RDT (U)	80,224.13	31,277.13	528.98	206.24	79,695.15	31,070.89	481.98	187.91	2,881.23	
Sludge to Digesters	80,224.13	31,277.13	528.98	206.24	79,695.15	31,070.89	481.98	187.91	2,881.23	

Model 11 - Buildout Annual Average MLE / NRCY

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent	5,249.26	42.5	5,249.26	28.9	3,569.50	0	0	0	0	0
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0	0
Primary Clarifiers	4,683.23	38.12	4,683.23	29.76	3,656.08	0	0	0	0	0
AB Inf. Channel	4,760.76	37.96	4,743.79	29.2	3,649.42	0.13	16.22	0.01	0.76	
Cell 1E	48,072.41	231.84	47,773.33	7.2	1,483.08	1.05	215.43	0.41	83.64	
Cell 2A	47,862.92	231.83	47,771.47	7.48	1,542.19	0.29	58.74	0.16	32.71	
Cell 1F	47,845.78	226.15	46,601.27	1.7	350.65	4.84	998.03	1.2	246.48	
Cell 2B	47,854.17	228.7	47,125.98	4.25	876.65	2.55	526.21	0.98	201.98	
Cell 2D	47,908.31	230.37	47,613.68	7.34	1,517.36	1.01	208.73	0.42	85.9	
Cell 3A	47,698.69	230.36	47,611.83	7.63	1,576.83	0.26	54.48	0.16	32.38	
Cell 3B	47,689.94	227.24	46,967.46	4.41	912.22	2.51	518.7	0.99	203.78	
Cell 2C	47,681.56	224.67	46,435.50	1.83	378.36	4.78	988.61	1.25	257.44	
Cell 3D	47,908.31	230.37	47,613.68	7.34	1,517.36	1.01	208.73	0.42	85.9	
Cell 4A	47,698.69	230.36	47,611.83	7.63	1,576.83	0.26	54.48	0.16	32.38	
Cell 4B	47,689.94	227.24	46,967.46	4.41	912.22	2.51	518.7	0.99	203.78	
Cell 3C	47,681.56	224.67	46,435.50	1.83	378.36	4.78	988.61	1.25	257.44	
Eff Channel 1	57,538.93	224.36	55,842.03	1	248.34	5.67	1,410.85	1.15	286.05	
Cell 5A	28,763.17	223.38	27,799.35	0.18	21.96	7.61	946.47	0.14	17.36	
Cell 5B	28,763.17	223.38	27,799.35	0.18	21.96	7.61	946.47	0.14	17.36	
Eff Channel 2	57,522.30	223.2	55,557.22	0.08	20.02	7.87	1,958.16	0.03	6.92	
Secondaries	1,223.99	1.87	233.97	0.08	10.08	7.87	986.52	0.03	3.49	
Denitrification Filters	1,138.69	1.34	165.15	0.08	9.92	7.87	970.11	0.03	3.43	
Plant Effluent	1,138.69	1.34	165.15	0.08	9.92	7.87	970.11	0.03	3.43	
Secondaries (U)	56,298.32	447.92	55,323.25	0.08	9.93	7.87	971.63	0.03	3.44	
NSL 1C	54,982.67	442.88	54,884.45	0.3	37.13	0.75	92.52	0.05	5.71	
NSL 1B	54,885.47	442.88	54,884.60	0.51	63.1	0.01	0.79	0	0.09	
NSL 1A	54,884.60	442.88	54,884.60	0.66	81.51	0	0	0	0	
NSL 1D	54,884.60	442.88	54,884.60	0.77	95.58	0	0	0	0	
Primary Clarifiers (U)	681.88	864.28	681.88	29.76	23.48	0	0	0	0	
Denitrification Filters (U)	85.29	32.99	68.82	0.08	0.17	7.87	16.41	0.03	0.06	
WAS Splitter	55,670.67	447.92	54,706.47	0.08	9.82	7.87	960.8	0.03	3.4	
WAS Splitter (U)	627.65	447.92	616.78	0.08	0.11	7.87	10.83	0.03	0.04	
20% HAc	0	0	0	0	0	0	0	0	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	186.22	99.83	177.31	29.38	52.18	5	8.88	0.02	0.03	
RDT (U)	1,123.31	2,876.21	1,121.35	29.38	11.45	5	1.95	0.02	0.01	
Sludge to Digesters	1,123.31	2,876.21	1,121.35	29.38	11.45	5	1.95	0.02	0.01	

Model 11 - Buildout Annual Average MLE / NRCY

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6	741.07	4.2	518.75	7	7	3.5	196.08	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.05	620.69	4.33	531.43	6.99	6.99	3.55	197.81	0	
AB Inf. Channel	5.55	694.12	4.25	530.97	8.96	8.96	5.11	289.53	0.5	
Cell 1E	246.5	50,793.81	0.45	92.01	6.97	6.97	3.06	286.08	0.01	
Cell 2A	246.5	50,793.81	0.29	59.81	7.01	7.01	3.17	295.98	0	
Cell 1F	246.5	50,793.81	0.14	28.05	6.69	6.69	2.34	218.99	2	
Cell 2B	246.5	50,793.81	0.19	39.58	6.79	6.79	2.71	253.41	2	
Cell 2D	244.69	50,573.70	0.45	93.4	6.98	6.98	3.08	288.49	0.01	
Cell 3A	244.69	50,573.70	0.29	60.71	7.02	7.02	3.18	298.46	0	
Cell 3B	244.69	50,573.70	0.19	40.06	6.8	6.8	2.73	255.97	2	
Cell 2C	244.69	50,573.70	0.14	28.25	6.69	6.69	2.36	221.06	2	
Cell 3D	244.69	50,573.70	0.45	93.4	6.98	6.98	3.08	288.49	0.01	
Cell 4A	244.69	50,573.70	0.29	60.71	7.02	7.02	3.18	298.46	0	
Cell 4B	244.69	50,573.70	0.19	40.06	6.8	6.8	2.73	255.97	2	
Cell 3C	244.69	50,573.70	0.14	28.25	6.69	6.69	2.36	221.06	2	
Eff Channel 1	245.29	61,051.39	0.12	30.07	6.68	6.68	2.24	252.56	2	
Cell 5A	245.29	30,525.70	0.1	12.97	6.65	6.65	2.1	118.52	2	
Cell 5B	245.29	30,525.70	0.1	12.97	6.65	6.65	2.1	118.52	2	
Eff Channel 2	245.27	61,051.39	0.09	22.6	6.39	6.39	1.52	171.74	2	
Secondaries	0.82	102.93	0.09	11.39	6.39	6.39	1.52	86.52	2	
Denitrification Filters	0.24	29.51	0.09	11.2	6.39	6.39	1.52	85.08	2	
Plant Effluent	0.24	29.51	0.09	11.2	6.39	6.39	1.52	85.08	2	
Secondaries (U)	493.46	60,948.46	0.09	11.22	6.39	6.39	1.52	85.22	2	
NSL 1C	487.04	60,357.27	0	0.12	6.45	6.45	2.03	114	0	
NSL 1B	487.04	60,357.27	0	0.21	6.51	6.51	2.16	121.22	0	
NSL 1A	487.04	60,357.27	0.03	3.48	6.53	6.53	2.19	122.95	0	
NSL 1D	487.04	60,357.27	0.05	5.59	6.55	6.55	2.21	124.44	0	
Primary Clarifiers (U)	174.04	137.31	4.33	3.41	6.99	6.99	3.55	1.27	0	
Denitrification Filters (U)	35.19	73.42	0.09	0.19	6.39	6.39	1.52	1.44	2	
WAS Splitter	493.46	60,268.97	0.09	11.09	6.39	6.39	1.52	84.27	2	
WAS Splitter (U)	493.46	679.49	0.09	0.13	6.39	6.39	1.52	0.95	2	
20% HAc	0	0	0	0	2.11	2.11	-966.41	-6.58	0	
25% NaOH	0	0	0	0	14.91	14.91	7,970.05	90.51	0	
RDT	49.72	88.31	4.25	7.55	4.83	4.83	1.56	1.26	1.27	
RDT (U)	1,868.56	728.5	4.25	1.66	4.83	4.83	1.56	0.28	1.27	
Sludge to Digesters	1,868.56	728.5	4.25	1.66	4.83	4.83	1.56	0.28	1.27	

Model 12 - Buildout Max Month Min Week Temp MLE / NRCY

Elements	Flow [mgd]	Total suspended solids [mg/L]	Total suspended solids [lb /d]	Volatile suspended solids [mg/L]	Volatile suspended solids [lb /d]	BOD - Total Carbonaceous [mg/L]	BOD - Total Carbonaceous [lb /d]	BOD - Filtered Carbonaceous [mg/L]	BOD - Filtered Carbonaceous [lb /d]
Influent	18.5	258.09	39,846.85	219.09	33,825.64	177.41	27,390.14	51.19	7,903.52
Rotary Press Filtrate (50%)	0.02	399.29	53.67	279.29	37.54	142.15	19.11	141.47	19.01
Primary Clarifiers	18.42	103.82	15,960.21	88.11	13,545.27	101.97	15,676.77	51.27	7,882.08
AB Inf. Channel	18.67	119.54	18,629.73	95.83	14,935.09	103.42	16,117.76	50.51	7,871.82
Cell 1E	21.59	7,169.70	1,292,091.79	3,751.75	676,124.80	1,226.52	221,038.03	3	541.06
Cell 2A	21.59	7,167.86	1,291,760.63	3,748.98	675,625.26	1,222.19	220,258.63	1.43	258.31
Cell 1F	21.59	7,160.94	1,290,514.04	3,741.34	674,248.26	1,214.58	218,885.70	0.99	179
Cell 2B	21.59	7,164.55	1,291,163.42	3,745.22	674,947.75	1,218.32	219,560.86	1.1	198.75
Cell 2D	21.69	7,117.15	1,288,166.58	3,724.61	674,134.95	1,218.05	220,461.21	3.07	555.17
Cell 3A	21.69	7,115.39	1,287,848.63	3,721.91	673,646.18	1,213.74	219,681.35	1.45	262.69
Cell 3B	21.69	7,112.12	1,287,257.02	3,718.19	672,973.41	1,209.90	218,986.05	1.11	201.15
Cell 2C	21.69	7,108.56	1,286,611.96	3,714.35	672,277.73	1,206.19	218,314.02	1	180.84
Cell 3D	21.69	7,117.15	1,288,166.58	3,724.61	674,134.95	1,218.05	220,461.21	3.07	555.17
Cell 4A	21.69	7,115.39	1,287,848.63	3,721.91	673,646.18	1,213.74	219,681.35	1.45	262.69
Cell 4B	21.69	7,112.12	1,287,257.02	3,718.19	672,973.41	1,209.90	218,986.05	1.11	201.15
Cell 3C	21.69	7,108.56	1,286,611.96	3,714.35	672,277.73	1,206.19	218,314.02	1	180.84
Eff Channel 1	37.22	7,124.96	2,213,156.82	3,722.26	1,156,210.07	1,207.98	375,222.14	0.98	303.1
Cell 5A	18.61	7,121.31	1,106,012.17	3,718.44	577,511.91	1,204.36	187,049.26	0.93	144.48
Cell 5B	18.61	7,121.31	1,106,012.17	3,718.44	577,511.91	1,204.36	187,049.26	0.93	144.48
Eff Channel 2	37.22	7,134.62	2,216,359.97	3,716.75	1,154,603.56	1,202.98	373,705.23	0.93	287.51
Secondaries	18.72	21.28	3,324.54	11.08	1,731.91	4.51	704.75	0.93	144.62
Denitrification Filters	18.47	4.31	664.91	2.25	346.38	1.65	254.71	0.93	142.69
Plant Effluent	18.47	4.31	664.91	2.25	346.38	1.65	254.71	0.93	142.69
Secondaries (U)	18.5	14,334.06	2,213,035.43	7,467.27	1,152,871.66	2,415.96	373,000.49	0.93	142.89
NSL 1C	18.55	14,186.79	2,195,740.13	7,396.54	1,144,788.04	2,401.52	371,691.64	5.6	866.63
NSL 1B	18.55	14,185.01	2,195,464.55	7,394.83	1,144,523.48	2,395.05	370,690.44	1.09	168.66
NSL 1A	18.55	14,181.77	2,194,962.89	7,391.82	1,144,057.74	2,391.33	370,115.39	0.36	56.03
NSL 1D	18.55	14,180.10	2,194,704.82	7,390.43	1,143,842.97	2,389.54	369,837.47	0.25	39.29
Primary Clarifiers (U)	0.09	30,344.03	23,940.31	25,752.68	20,317.91	14,870.76	11,732.48	51.27	40.45
Denitrification Filters (U)	0.25	1,274.78	2,659.63	664.09	1,385.52	215.7	450.03	0.93	1.93
WAS Splitter	18.31	14,334.06	2,190,665.83	7,467.27	1,141,218.31	2,415.96	369,230.16	0.93	141.44
WAS Splitter (U)	0.19	14,334.06	22,369.60	7,467.27	11,653.35	2,415.96	3,770.33	0.93	1.44
20% HAc	0	0	0	0	0	158,852.18	2,783.94	158,852.18	2,783.94
25% NaOH	0	0	0	0	0	0	0	0	0
RDT	0.23	2,348.98	4,525.62	1,605.00	3,092.24	1,117.87	2,153.73	360.09	693.76
RDT (U)	0.05	96,308.04	40,730.56	65,804.80	27,830.14	31,429.14	13,292.00	360.09	152.29
Sludge to Digesters	0.05	96,308.04	40,730.56	65,804.80	27,830.14	31,429.14	13,292.00	360.09	152.29

Model 12 - Buildout Max Month Min Week Temp MLE / NRCY

Elements	COD - Total [mg/L]	COD - Total [lb /d]	COD - Filtered [mg/L]	COD - Filtered [lb /d]	COD - Particulate [mg/L]	COD - Particulate [lb /d]	COD - Volatile fatty acids [mg/L]	COD - Volatile fatty acids [lb /d]	N - Total N [mgN/L]	
Influent	408	62,991.11	88.91	13,727.02	319.09	49,264.09	7.96	1,228.33	44.2	
Rotary Press Filtrate (50%)	1,350.00	181.44	903.28	121.4	446.72	60.04	67.5	9.07	862	
Primary Clarifiers	217.95	33,507.37	89.62	13,777.72	128.34	19,729.65	8.01	1,231.08	39.43	
AB Inf. Channel	228.39	35,593.35	88.48	13,790.06	139.9	21,803.29	7.87	1,226.14	39.67	
Cell 1E	5,614.81	1,011,876.69	18.29	3,296.38	5,596.52	1,008,580.31	0.42	75.3	276.96	
Cell 2A	5,607.83	1,010,618.51	15.14	2,728.37	5,592.69	1,007,890.14	0.03	5.02	276.91	
Cell 1F	5,596.30	1,008,540.78	14.24	2,567.01	5,582.06	1,005,973.77	0	0.06	276.82	
Cell 2B	5,601.92	1,009,553.21	14.46	2,605.14	5,587.46	1,006,948.07	0	0.37	276.86	
Cell 2D	5,574.38	1,008,934.57	18.4	3,331.07	5,555.98	1,005,603.50	0.44	79.23	275.15	
Cell 3A	5,567.42	1,007,674.59	15.17	2,746.03	5,552.25	1,004,928.56	0.03	5.35	275.09	
Cell 3B	5,561.55	1,006,612.20	14.47	2,618.99	5,547.08	1,003,993.22	0	0.4	275.05	
Cell 2C	5,555.98	1,005,604.08	14.25	2,579.73	5,541.73	1,003,024.36	0	0.06	275	
Cell 3D	5,574.38	1,008,934.57	18.4	3,331.07	5,555.98	1,005,603.50	0.44	79.23	275.15	
Cell 4A	5,567.42	1,007,674.59	15.17	2,746.03	5,552.25	1,004,928.56	0.03	5.35	275.09	
Cell 4B	5,561.55	1,006,612.20	14.47	2,618.99	5,547.08	1,003,993.22	0	0.4	275.05	
Cell 3C	5,555.98	1,005,604.08	14.25	2,579.73	5,541.73	1,003,024.36	0	0.06	275	
Eff Channel 1	5,567.87	1,729,492.63	14.21	4,414.08	5,553.66	1,725,078.55	0	0.07	275.59	
Cell 5A	5,562.46	863,907.13	14.14	2,195.62	5,548.33	861,711.51	0	0.03	275.55	
Cell 5B	5,562.46	863,907.13	14.14	2,195.62	5,548.33	861,711.51	0	0.03	275.55	
Eff Channel 2	5,560.06	1,727,224.59	14.13	4,388.58	5,545.93	1,722,836.01	0	0.05	275.51	
Secondaries	30.67	4,791.74	14.13	2,207.49	16.54	2,584.25	0	0.02	13.72	
Denitrification Filters	17.48	2,694.87	14.13	2,178.02	3.35	516.85	0	0.02	13.09	
Plant Effluent	17.48	2,694.87	14.13	2,178.02	3.35	516.85	0	0.02	13.09	
Secondaries (U)	11,156.38	1,722,432.85	14.13	2,181.09	11,142.25	1,720,251.76	0	0.02	540.47	
NSL 1C	11,057.26	1,711,371.79	21.14	3,271.49	11,036.13	1,708,100.30	4.94	764.32	529.03	
NSL 1B	11,048.87	1,710,073.19	15.15	2,344.37	11,033.73	1,707,728.82	0.4	62.04	526.11	
NSL 1A	11,043.99	1,709,317.58	14.52	2,247.54	11,029.47	1,707,070.03	0.08	12.72	524.4	
NSL 1D	11,042.25	1,709,048.24	14.78	2,287.71	11,027.47	1,706,760.53	0.22	34.46	523.81	
Primary Clarifiers (U)	37,600.23	29,665.18	89.62	70.71	37,510.61	29,594.48	8.01	6.32	1,113.81	
Denitrification Filters (U)	1,005.05	2,096.88	14.13	29.47	990.92	2,067.40	0	0	59.85	
WAS Splitter	11,156.38	1,705,022.31	14.13	2,159.04	11,142.25	1,702,863.27	0	0.02	540.47	
WAS Splitter (U)	11,156.38	17,410.54	14.13	22.05	11,142.25	17,388.49	0	0	540.47	
20% HAc	216,000.00	3,785.48	216,000.00	3,785.48	0	0	216,000.00	3,785.48	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	2,904.43	5,595.77	542.02	1,044.27	2,362.41	4,551.50	492.39	948.65	122.38	
RDT (U)	97,400.80	41,192.71	542.02	229.23	96,858.78	40,963.48	492.39	208.24	3,514.70	
Sludge to Digesters	97,400.80	41,192.71	542.02	229.23	96,858.78	40,963.48	492.39	208.24	3,514.70	

Model 12 - Buildout Max Month Min Week Temp MLE / NRCY

Elements	N - Total N [lb N/d]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Total Kjeldahl Nitrogen [lb N/d]	N - Ammonia [mgN/L]	N - Ammonia [lb N/d]	N - Nitrate [mgN/L]	N - Nitrate [lb N/d]	N - Nitrite [mgN/L]	N - Nitrite [lb N/d]	
Influent	6,824.04	44.2	6,824.04	30.06	4,640.35	0	0	0	0	
Rotary Press Filtrate (50%)	115.86	862	115.86	818.9	110.06	0	0	0	0	
Primary Clarifiers	6,061.14	39.43	6,061.14	30.74	4,726.15	0	0	0	0	
AB Inf. Channel	6,182.48	39.51	6,158.00	30.31	4,724.28	0.15	23.29	0.01	1.19	
Cell 1E	49,913.21	275.69	49,684.37	10.24	1,845.90	1.02	183.44	0.25	45.39	
Cell 2A	49,903.79	272.64	49,134.86	7.24	1,305.17	3.37	607.01	0.9	161.92	
Cell 1F	49,887.22	267.39	48,187.20	2.17	391.95	8.12	1,463.75	1.31	236.27	
Cell 2B	49,895.30	269.81	48,624.51	4.5	810.23	5.76	1,038.54	1.29	232.25	
Cell 2D	49,799.88	273.94	49,581.20	10.41	1,883.77	0.96	173.34	0.25	45.33	
Cell 3A	49,790.46	270.91	49,034.10	7.43	1,345.38	3.28	593.86	0.9	162.5	
Cell 3B	49,781.99	268.1	48,524.01	4.7	850.47	5.65	1,022.76	1.3	235.22	
Cell 2C	49,773.93	265.65	48,081.25	2.35	426.23	7.99	1,446.40	1.36	246.28	
Cell 3D	49,799.88	273.94	49,581.20	10.41	1,883.77	0.96	173.34	0.25	45.33	
Cell 4A	49,790.46	270.91	49,034.10	7.43	1,345.38	3.28	593.86	0.9	162.5	
Cell 4B	49,781.99	268.1	48,524.01	4.7	850.47	5.65	1,022.76	1.3	235.22	
Cell 3C	49,773.93	265.65	48,081.25	2.35	426.23	7.99	1,446.40	1.36	246.28	
Eff Channel 1	85,604.78	265.62	82,507.09	1.72	534.07	8.66	2,690.48	1.31	407.21	
Cell 5A	42,795.95	264.29	41,047.17	0.53	82.23	10.71	1,664.00	0.55	84.78	
Cell 5B	42,795.95	264.29	41,047.17	0.53	82.23	10.71	1,664.00	0.55	84.78	
Eff Channel 2	85,587.37	263.98	82,003.81	0.29	90.8	11.26	3,498.60	0.27	84.96	
Secondaries	2,143.59	2.18	341.04	0.29	45.67	11.26	1,759.82	0.27	42.73	
Denitrification Filters	2,018.72	1.56	240.23	0.29	45.06	11.26	1,736.33	0.27	42.16	
Plant Effluent	2,018.72	1.56	240.23	0.29	45.06	11.26	1,736.33	0.27	42.16	
Secondaries (U)	83,443.78	528.94	81,662.78	0.29	45.13	11.26	1,738.78	0.27	42.22	
NSL 1C	81,879.70	523.72	81,058.60	0.47	72.48	5.09	788.49	0.21	32.61	
NSL 1B	81,427.51	523.74	81,061.83	0.62	95.5	2.22	344.02	0.14	21.66	
NSL 1A	81,163.96	523.76	81,064.17	0.84	130.54	0.59	90.96	0.06	8.84	
NSL 1D	81,071.50	523.77	81,065.14	1.02	158.58	0.04	5.7	0	0.66	
Primary Clarifiers (U)	878.75	1,113.81	878.75	30.74	24.25	0	0	0	0	
Denitrification Filters (U)	124.87	48.32	100.8	0.29	0.61	11.26	23.5	0.27	0.57	
WAS Splitter	82,600.32	528.94	80,837.32	0.29	44.67	11.26	1,721.20	0.27	41.8	
WAS Splitter (U)	843.46	528.94	825.46	0.29	0.46	11.26	17.58	0.27	0.43	
20% HAc	0	0	0	0	0	0	0	0	0	
25% NaOH	0	0	0	0	0	0	0	0	0	
RDT	235.78	114.72	221.02	28.87	55.62	7.48	14.41	0.18	0.35	
RDT (U)	1,486.43	3,507.03	1,483.19	28.87	12.21	7.48	3.16	0.18	0.08	
Sludge to Digesters	1,486.43	3,507.03	1,483.19	28.87	12.21	7.48	3.16	0.18	0.08	

Model 12 - Buildout Max Month Min Week Temp MLE / NRCY

Elements	P - Total P [mgP/L]	P - Total P [lb P/d]	P - Soluble PO4-P [mgP/L]	P - Soluble PO4-P [lb P/d]	pH []	pH []	Alkalinity [mmol/L]	Alkalinity [k/d]	Gas - Dissolved oxygen [mg/L]	
Influent	6.2	957.22	4.34	670.05	7	7	3.5	245.11	0	
Rotary Press Filtrate (50%)	126	16.93	119.7	16.09	7.6	7.6	50	3.05	0	
Primary Clarifiers	5.19	797.84	4.44	682.64	6.99	6.99	3.54	246.83	0	
AB Inf. Channel	5.79	901.78	4.37	681.06	8.7	8.7	4.78	338.05	0.5	
Cell 1E	279.89	50,440.25	0.47	84.21	6.9	6.9	2.83	231.53	0	
Cell 2A	279.89	50,440.25	0.22	40.44	6.72	6.72	2.42	197.47	2	
Cell 1F	279.89	50,440.25	0.09	17.01	6.52	6.52	1.69	138.17	2	
Cell 2B	279.89	50,440.25	0.13	24.04	6.61	6.61	2.03	165.54	2	
Cell 2D	277.83	50,285.91	0.47	85.61	6.91	6.91	2.85	234.19	0	
Cell 3A	277.83	50,285.91	0.23	41.04	6.72	6.72	2.44	200.3	2	
Cell 3B	277.83	50,285.91	0.13	24.31	6.61	6.61	2.05	168.39	2	
Cell 2C	277.83	50,285.91	0.09	17.1	6.52	6.52	1.71	140.67	2	
Cell 3D	277.83	50,285.91	0.47	85.61	6.91	6.91	2.85	234.19	0	
Cell 4A	277.83	50,285.91	0.23	41.04	6.72	6.72	2.44	200.3	2	
Cell 4B	277.83	50,285.91	0.13	24.31	6.61	6.61	2.05	168.39	2	
Cell 3C	277.83	50,285.91	0.09	17.1	6.52	6.52	1.71	140.67	2	
Eff Channel 1	278.51	86,511.83	0.09	26.92	6.51	6.51	1.62	228.57	2	
Cell 5A	278.51	43,255.92	0.08	12.05	6.46	6.46	1.44	101.63	2	
Cell 5B	278.51	43,255.92	0.08	12.05	6.46	6.46	1.44	101.63	2	
Eff Channel 2	278.49	86,511.83	0.07	21.7	6.11	6.11	0.82	115.5	2	
Secondaries	0.9	140.65	0.07	10.91	6.11	6.11	0.82	58.1	2	
Denitrification Filters	0.24	36.72	0.07	10.77	6.05	6.05	0.82	57.33	2	
Plant Effluent	0.24	36.72	0.07	10.77	6.11	6.11	0.82	57.32	2	
Secondaries (U)	559.44	86,371.18	0.07	10.78	6.11	6.11	0.82	57.4	2	
NSL 1C	553.13	85,610.05	0	0.12	6.23	6.23	1.25	87.56	0	
NSL 1B	553.13	85,610.05	0	0.21	6.34	6.34	1.49	104.86	0	
NSL 1A	553.13	85,610.06	0.04	5.54	6.38	6.38	1.64	114.83	0	
NSL 1D	553.13	85,610.06	0.05	7.02	6.41	6.41	1.69	118.91	0	
Primary Clarifiers (U)	223.47	176.31	4.44	3.5	6.99	6.99	3.54	1.27	0	
Denitrification Filters (U)	49.82	103.93	0.07	0.15	6.05	6.05	0.82	0.78	2	
WAS Splitter	559.44	85,498.13	0.07	10.67	6.11	6.11	0.82	56.82	2	
WAS Splitter (U)	559.44	873.05	0.07	0.11	6.11	6.11	0.82	0.58	2	
20% HAc	0	0	0	0	2.12	2.12	-960.07	-7.63	0	
25% NaOH	0	0	0	0	15.16	15.16	7,970.05	90.51	0	
RDT	58.09	111.92	4.13	7.96	4.7	4.7	0.98	0.86	1.33	
RDT (U)	2,216.59	937.44	4.13	1.75	4.7	4.7	0.98	0.19	1.33	
Sludge to Digesters	2,216.59	937.44	4.13	1.75	4.71	4.71	0.9	0.17	1.33	

Appendix D: TM 4 – Biosolids and Bioenergy

December 7, 2023

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Mason Farm WWTP Master Plan
TM 4 – Biosolids and Bioenergy (FINAL)

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd). Hazen is contracted to complete a Master Plan to identify near and long-term improvement projects that will help OWASA provide reliable and efficient wastewater treatment. Of increasing concern to OWASA is the treatment of biosolids formed as a byproduct of the liquid treatment process, and the energy recovery potential from biosolids processing.

The purpose of this task is to evaluate the capacity of existing solids handling equipment as well as alternatives to the existing temperature phase anaerobic digestion (TPAD) process. Biosolids production rates used in the evaluation were calculated from historical data and used in conjunction with influent flow projections to estimate growth in solids production. This Technical Memorandum (TM) also includes a review of OWASA's bioenergy production and bioenergy alternatives that could be developed alongside the biosolids treatment process.

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Acronyms and Abbreviations

2010 Study	2010 Hydraulic and Treatment Capacity Study	**OPEX**	Operational Expenses
AA/AVG365	Annual Average	**OWASA**	Orange Water and Sewer Authority
AACE	American Association of Cost Estimators	**PFAS**	Per- and Polyfluoroalkyl Substances
BOD	Biochemical Oxygen Demand	**PFOA**	Perfluorooctanoic Acid
CAPEX	Capital Expenses	**PFOS**	Perfluorooctane Sulfonic Acid
CEC	Contaminants of Emerging Concern	**PITT**	PFAS Innovative Treatment Team
CHP	Combined Heat and Power	**PSA**	Pressure Swing Adsorption
CNG	Compressed Natural Gas	**PSNC**	Public Service Company of North Carolina
DG	Digester Gas	**RAS**	Return Activated Sludge
EIA	Energy Information Administration	**RDT**	Rotary Drum Thickener
EPA	Environmental Protection Agency	**RFP**	Rotary Fan Press
FPS	Fermented Primary Sludge	**RFS2**	EPA Renewable Fuel Standards
gpm	Gallons per Minute	**RICE**	Reciprocating Internal Combustion Engine
HEX	Heat Exchanger	**RIN/ eRIN**	(electronic) Renewable Identification Number
HLR	Hydraulic Loading Rate	**RNG**	Renewable Natural Gas
HRT	Hydraulic Residence Time	**SCFM**	Standard Cubic Feet per Minute
ITC	Investment Tax Credit	**SCWO**	Super Critical Water Oxidation
IRA	Inflation Reduction Act of 2022	**TD**	Thermal Drying
MAD	Mesophilic Anaerobic Digestion	**TD-GAS**	Thermal Drying and Gasification
MAX07	Maximum Week	**TPAD**	Temperature Phase Anaerobic Digestion
MAX30/ MM	Maximum Month	**TS**	Total Solids
MCDA	Multi-Criteria Decision Analysis	**TSS**	Total Suspended Solids
MGAL	Million Gallons	**VFAs**	Volatile Fatty Aci
mgd	Million Gallons per Day	**VOC**	Volatile Organic Compounds
NG	Natural Gas	**VSR**	Volatile Solids Reduction
NPV	Net Present Value	**WAS**	Waste Activated Sludge
OPCC	Opinion of Probable Construction Cost	**WWTP**	Wastewater Treatment Plant

1. Introduction: Biosolids and Bioenergy Objectives

The Orange Water and Sewer Authority (OWASA) operates the Mason Farm Wastewater Treatment Plant (WWTP), which is permitted to discharge up to 14.5 million gallons per day (mgd). In 2010, Hazen completed a Hydraulic and Treatment Capacity Study (2010 Study), which evaluated existing facilities and provided recommendations to address hydraulic and treatment constraints at the Mason Farm WWTP. The results of the study evaluated numerous nutrient removal and biosolids treatment alternatives and recommended improvements to optimize treatment while minimizing operational costs. Some of the recommended improvements identified in the 2010 Study were implemented, which has resulted in significant savings in operational costs.

Several changes have occurred within the wastewater treatment industry since the 2010 Study, such as the increasing concern for treating emerging contaminants, and the development of advanced treatment technologies. Furthermore, the Mason Farm WWTP has undergone upgrades and operational changes that have improved treatment performance and the condition of existing infrastructure. Due to these ongoing changes, OWASA contracted Hazen to develop a new master plan (Master Plan). The primary objective of this Master Plan is to identify near and long-term improvement projects that will help OWASA provide reliable and efficient wastewater treatment. Ultimately, the Master Plan will be used to assist OWASA in making capital improvement decisions based on optimizing performance, reducing resource consumption, and accommodating flow and load conditions within the service area, all while considering regulatory implications.

In March 2023, OWASA identified core objectives for the Mason Farm WWTP in alignment with their vision "to be our community's trusted partner for clean water and environmental protection." OWASA's core solids management objective is to prepare for compliance with potential regulation of contaminants of emerging concern, and operate a land application program in a cost-effective manner with a focus on land disposal for the next 15 years. Detailed objectives that pertain to biosolids and bioenergy are listed below:

- OWASA will continue to operate its land application program (Class A Biosolids) with the expectation of phasing out land application over the planning period.
- OWASA will consider cost effectiveness in the ratio of land application to composted disposal annually in accordance with Board directives and continue to target a 75% to 25% land disposal to composting ratio.
- OWASA anticipates land application will not be a viable option and expects alternative methods of disposal or elimination of biosolids to become the primary method of biosolids management.
- OWASA will continue to operate its Mason Farm WWTP within the existing property boundary.
- Energy saving investments will need to pay for themselves through the net present value over the life of the asset and the social cost of carbon when selecting alternatives for OWASA's plant and operations.

One identified class of pollutants that has received a significant amount of attention lately are per- and polyfuoroalkyl substances (PFAS) compounds. PFAS compounds are a family of more than 12,000 synthetic fluorinated compounds, some of which were developed more than 60 years ago and are used widely across a range of commercial products. The unique physical and chemical properties of PFAS impart oil and water repellency, temperature resistance and friction reduction, thereby providing a wide range of applicability for products used by consumers and industry. PFAS have also been used in coatings for textiles, paper products, cookware, formulation of some firefighting foams, and have a range of applications in the aerospace, photographic imaging, semiconductor, automotive, construction, electronics, and aviation industries.

While the use of biosolid-based fertilizers can benefit plant health due to the carbon and nutrient content and reduce the need for alternative disposal options (e.g., incineration, landfilling), the presence of PFAS in biosolid-based fertilizers is a rapidly growing concern among the public and within regulatory agencies. PFAS loading to the environment from land application is controlled by the PFAS levels in the biosolids and the mass of biosolids applied per unit area, which is often driven by crop-specific nitrogen and/or phosphorus requirements.

In October 2021, the Environmental Protection Agency (EPA) announced the Agency's PFAS Strategic Roadmap outlining a whole-of-agency approach to addressing PFAS including direction for assessment and potential regulation in drinking water, wastewater, and biosolids. The EPA is currently conducting a risk assessment for two specific PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), in biosolids and are expected to complete the risk assessment by December 2024. Based on the risk assessment, a Final Rule, if it is determined that regulation is recommended, may be proposed as early as 2025-2026. **Figure 1-1** provides a potential timeline that indicates the rule could become effective as early as 2031, assuming a 5-year compliance schedule.

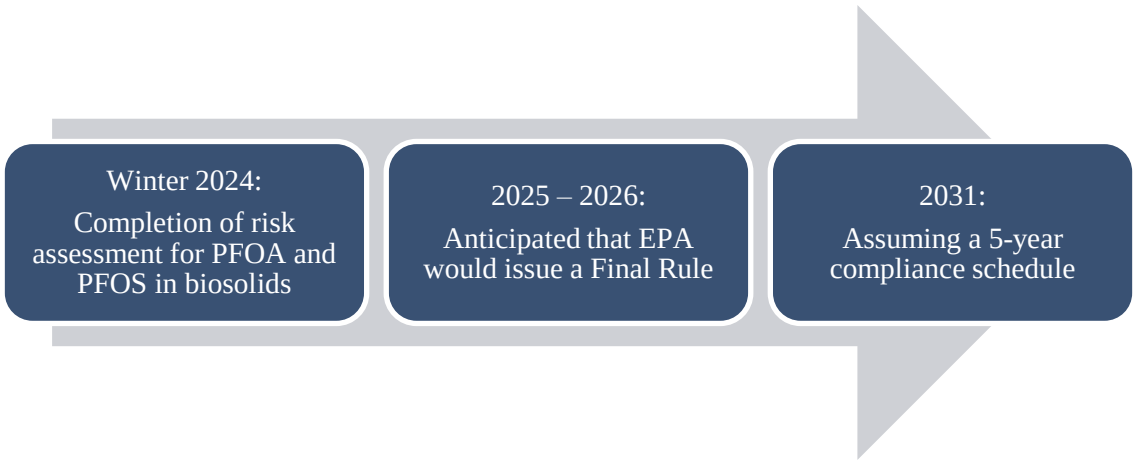


Figure 1-1: Potential PFAS Regulatory Timeline for Biosolids

The EPA established the PFAS Innovative Treatment Team (PITT) in Spring 2020 to identify disposal and destruction options for PFAS-contaminated media and waste. The stated goals of the PITT were:

- Assess current and emerging destruction methods being explored by EPA, universities, other research organizations, and industry.
- Explore the efficacy of methods, including consideration of potentially hazardous byproducts.
- Evaluate methods' feasibility, performance, and costs to better understand potential solutions.

The strong and stable chemical structure of PFAS requires high amounts of energy to break the carbon-fluorine bonds, making thermal treatment a good candidate for PFAS destruction in wastewater solids. The common types of thermal processes applied to municipal biosolids (incineration and thermal drying) do not operate at high enough temperatures to destroy the carbon-fluorine bond. The EPA PITT identified five technologies that have been demonstrated to destroy up to 99% of the initial PFAS compounds in substrates based on laboratory and pilot-scale results; of those five, pyrolysis or gasification and supercritical water oxidation (SCWO) are applicable to biosolids treatment.

Throughout this Master Plan, the near-term condition is defined as year 2037 while the long-term condition is defined as year 2070.

2. Sludge Production Estimates

Solids production rates and solids loading rates were established for the current plant average annual flow of 8.01 million gallons per day (mgd), the current permitted treatment capacity of 14.5 mgd, and the assumed buildout capacity of 18.5 mgd. Based on feedback from OWASA, flows are not expected to exceed 18.5 mgd within the planning period due to limited opportunity for additional development in the service area. The solids loading rates were used to assess each process in the solids handling train and evaluate its ability to handle the loading rates the facility could see at each of these peaking factors.

2.1 Historical Data Analysis

Influent historical data from January 2015 to September 2021 was provided by OWASA for analysis. The yearly average influent flow, biochemical oxygen demand (BOD), and total suspended solids (TSS) concentrations are presented in **Table 2-1**. These are the values presented in Technical Memorandum (TM) 1 – Flow and Load Development. The average concentration of influent BOD_5 was calculated from the influent cBOD data recorded, assuming BOD_5 is 85% cBOD. These concentrations were used in the sludge estimator tool, as described in more detail in the following section, to calculate the solids loadings for the Mason Farm WWTP.

Mass based peaking factors for BOD and TSS were calculated from the historical data by using the appropriate percentile for peaking factor divided by the median (50 percentile) value. The maximum month (MAX30) and peak week (MAX07) peaking factors were developed using the 91.7 and 98.1 percentile values, respectively. These values are presented in **Table 2-1.**

Table 2-1: Historic Influent Parameters

Parameter	Value	MAX30 Peaking Factor	MAX07 Peaking Factor
Influent BOD_5, mg/L	264.2	1.30	1.40
Influent TSS, mg/L	252.0	1.50	1.60
Influent Flow, mgd	8.01	1.25	--

2.2 Sludge Production Rates

Sludge production rates were developed using Hazen's spreadsheet-based sludge production estimator tool that predicts biomass growth and decay based on kinetic values and stoichiometric reactions typical of wastewater treatment plants treating primarily residential waste. **Table 2-2** provides a summary of the AVG365, MAX30, and MAX07 sludge production rates derived with the Hazen estimator tool. These sludge production rates are multiplied by the annual average flow rate to calculate estimated pre-digestion sludge production at various flows and loading conditions.

Table 2-2: Sludge Estimator Tool Pre-Digestion Sludge Production Rates

Loading Condition	AVG365	MAX30	MAX07
Solids Production Rate, lb/ MGAL	1,773	2,568	2,763

In addition to the sludge production estimated with the sludge production estimator tool, the impact of chemical solids produced from the addition of alum was added to the total solids production. Aluminum sulfate (48% concentration) is dosed in the liquid treatment train for chemical phosphorus removal. Alum reacts with soluble orthophosphate to form particulates that are subsequently removed in the secondary clarifiers, and which add to the total waste activated sludge (WAS) produced. **Table 2-3** shows the alum dose and estimated chemical solids production at the current flow rate, and scaled for the permitted treatment capacity, as well as buildout.

Table 2-3: Estimated Chemical Solids Production

Design Condition	Influent Flow, mgd	48% Alum Dose Rate, gph	Chemical Solids Production, lb/day
Current	8.01	28.9	1,394
14.5 mgd Capacity	11.6	41.9	2,018
18.5 mgd Capacity	14.8	53.5	2,575

Final biosolids production rates in pounds per day and pounds per million gallons for each of the projected plant flows are presented in **Table 2-4**. Final annual average biosolids production in pounds per million gallons totaled 1,947 with the addition of chemical solids.

Table 2-4: Estimated Total Solids Production

	Sludge Estimator Tool		Including Chemical Solids	
Flow Condition (AADF)	lb/day	lb/MGAL	lb/day	lb/MGAL
Current	14,197	1,773	15,595	1,947
14.5 mgd Capacity	20,566		22,585	
18.5 mgd Capacity	26,240		28,816	

Table 2-5 displays estimated sludge production rates for the AVG365, MAX30, and MAX07 loading conditions, which will be used to conduct the capacity evaluation for the current and projected wastewater flows.

Table 2-5: Solids Production Rates

Design Condition	AVG365	MAX30	MAX07
Primary Sludge, lb/MGAL	1,013	1,519	1,641
Waste Activated Sludge, lb/MGAL	760	1,049	1,122
Chemical Solids, lb/MGAL	174	226	249
Total Sludge Production Rate, lb/MGAL	1,947	2,794	3,012

3. Capacity and Redundancy Evaluation

The Mason Farm WWTP currently stabilizes biosolids on-site using a TPAD anaerobic digestion process to generate a Class A material suitable for land application. Primary solids produced at the facility are sent

to a fermenter and then blended with waste activated sludge from the secondary clarifiers to be thickened. Thickened combined solids are sent through a series of four anaerobic digesters and the digested solids can be dewatered or stored in the onsite sludge storage tank. From storage, OWASA sends some of the digested sludge to liquid land application while the remainder is dewatered by the rotary fan press and hauled offsite for composting by a third-party. **Figure 3-1** illustrates the existing solids process flow diagram at the Mason Farm WWTP.

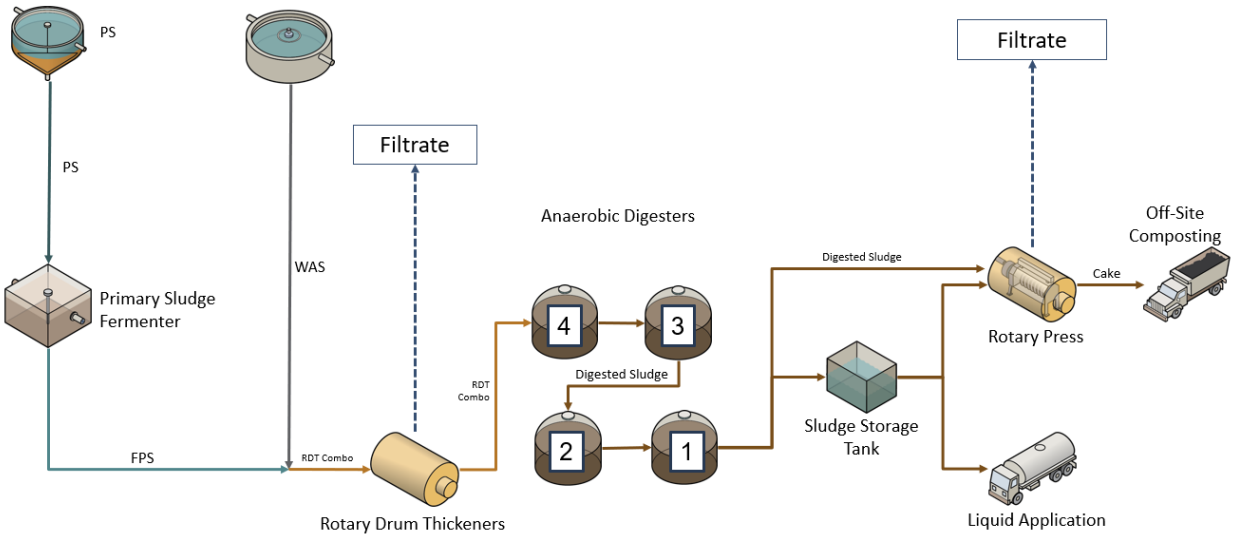


Figure 3-1: Existing Process Flow Diagram, Mason Farm WWTP

The following sections evaluate the capacity of the existing solids handling equipment under current annual average flow (8.01 mgd), permitted capacity (14.5 mgd), and assumed buildout (18.5 mgd). Capacity assessments were conducted for the primary sludge fermenter, rotary drum thickener, anaerobic digesters, digested sludge storage, and rotary press.

3.1 Primary Sludge Fermentation

Primary sludge is pumped through a grinder and into a fermenter tank. Under anaerobic conditions, the sludge is fermented, forming volatile fatty acids (VFAs). Fermented primary sludge (FPS) is blended with WAS then sent to rotary drum thickeners where the VFA-rich filtrate is separated from the solids and pumped to the nutrified sludge cells as a carbon source for return activated sludge (RAS) denitrification and biological phosphorus removal. The addition of these VFAs into the secondary process reduces the amount of supplemental carbon that must be purchased. Typical fermentation design criterion is a two to three day retention time, and the Process Control Plan prepared for the plant recommends an optimum hydraulic retention time (HRT) in the fermenter of at least 2 days. The primary sludge fermenter has a volume of 260,000 gallons; therefore, at a two-day retention time the estimated capacity of the fermenter is approximately 130,000 gallons per day of primary sludge. Estimated fermenter residence time as a function of plant influent flow is shown in **Figure 3-2**. This evaluation assumes a primary sludge concentration of 1.3% TS, which is consistent with recent performance and historical performance documented in the 2010 Master Plan.

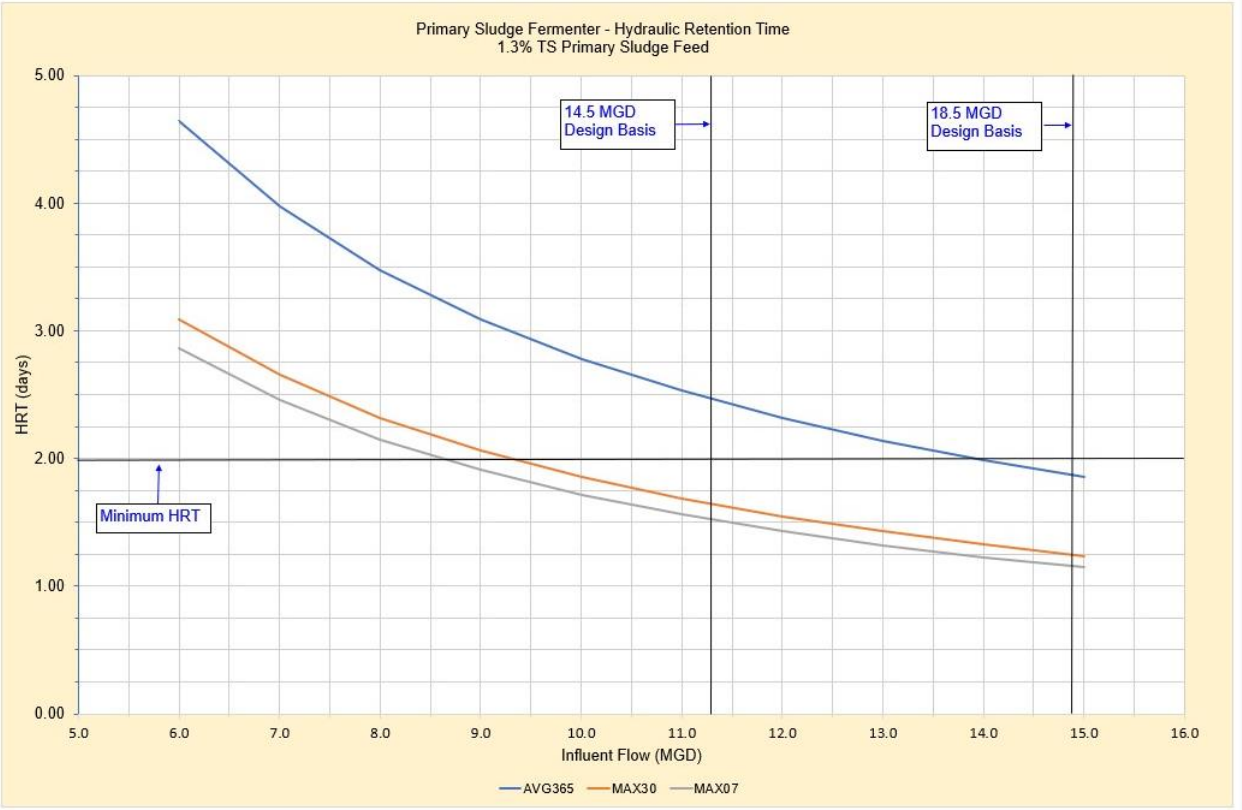


Figure 3-2: Primary Sludge Fermenter Capacity

The fermenter will drop below 2 days HRT at maximum month solids loading conditions as annual average flows approach 9.5 mgd. A 2-day HRT can be maintained at average annual solids loading conditions up to 14.0 mgd. As plant flows and solids loadings increase, the fermenter residence time will drop below two days resulting in a decrease in VFA production and increased demands for supplemental alternative carbon for the biological nutrient removal process. As flows and loads increase, OWASA may consider bypassing some primary sludge around the fermenter to the blend tank or aeration basins to maintain adequate hydraulic retention time in the fermenter and VFA production. Alternatively, additional fermenter capacity could be constructed to maintain a 2-day HRT at increased loading while also increasing redundancy of the fermentation process. An evaluation of fermenter capacity is recommended in conjunction with the nutrient removal carbon study.

3.2 Sludge Thickening

Thickening reduces the hydraulic loading to the digesters, decreasing the amount of water that needs to be heated and increasing the detention time of sludge in the digesters, which increases volatile solids reduction (VSR) and reduces the volume of sludge that must be managed for disposal. FPS and WAS can either be thickened separately or together on the rotary drum thickeners (RDTs). The current practice is to thicken FPS and WAS together.

Two RDTs are provided for thickening of FPS and WAS. The thickening process firm treatment capacity (one RDT in service) was evaluated across a range of loading conditions as shown in **Figure 3-3** based on continuous (24 hours per day) operation. Thickener feed will be a blend of 1.3% TS FPS and 0.8%TS WAS. Since the feedstock will be less than 1.5% TS, the thickener will operate in hydraulic loading rate (HLR) limited mode at 300 gpm maximum. As shown below, a single RDT has adequate capacity to thicken all sludge at the current rated 14.5 mgd design basis for all anticipated loading conditions while maintaining a standby unit. However, additional thickening capacity will be required to maintain a redundant thickener at the expanded capacity of 18.5 mgd.

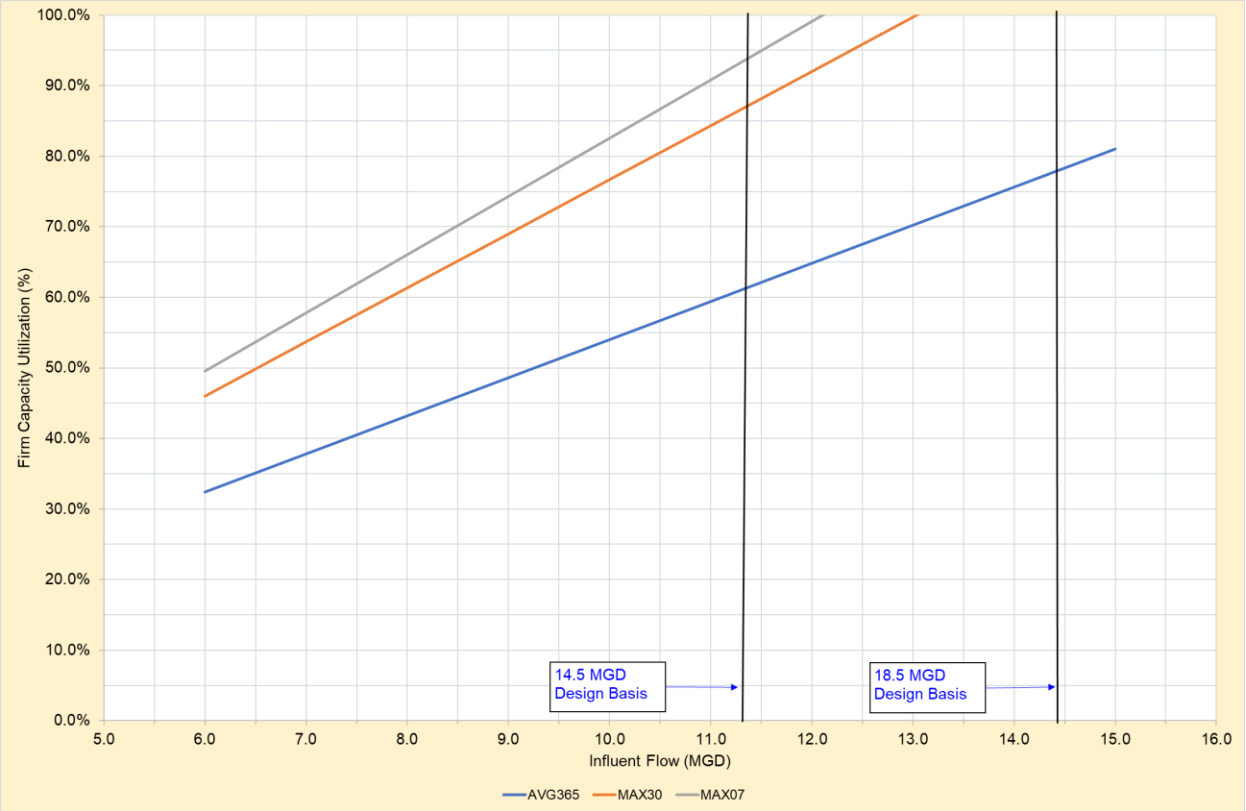


Figure 3-3: Rotary Drum Thickener Capacity

Additionally, it should be noted that implementing densification will decrease WAS percent total solids, thereby increasing the hydraulic loading to the RDTs; this will accelerate the need for additional thickening capacity.

3.3 Anaerobic Digestion

Thickened sludge (FPS and WAS) is pumped through the anaerobic digesters in series. The anaerobic digesters are configured to operate in a TPAD mode with the first stage operating at thermophilic temperatures (55-57 °C / 131.0-134.6 °F) followed by a second stage operating at mesophilic temperatures (35-40 °C / 95.0-104.0 °F). The anaerobic digestion process is configured to operate using the 40 CFR 503

"time and temperature" criteria to produce a Class A residuals product with regards to pathogen inactivation.

Thickened sludge is pumped into Digester No. 4 on a continuous basis and heated from ambient to thermophilic temperatures. Flow is then transferred from Digester No. 4 to Digester No. 3 where it is held unfed for a period of one day or more to meet the 40 CFR 503 time and temperature requirements. The minimum duration of the unfed holding time is dependent on the operating temperature of the thermophilic digester. Once the batch time-temperature requirements have been achieved, biosolids are transferred to Digester No. 2. which serves mainly as an equalization tank to accept batch transfers from Digester No. 3 and then transfer to Digester No. 1. Biosolids are further cooled in Digester No. 1 prior to transfer to the Biosolids Storage Tanks or biosolids dewatering. A process flow diagram is shown in **Figure 3-4.** Note, heat exchangers for digesters 1 and 2 and HEX No. 3 are not in service.

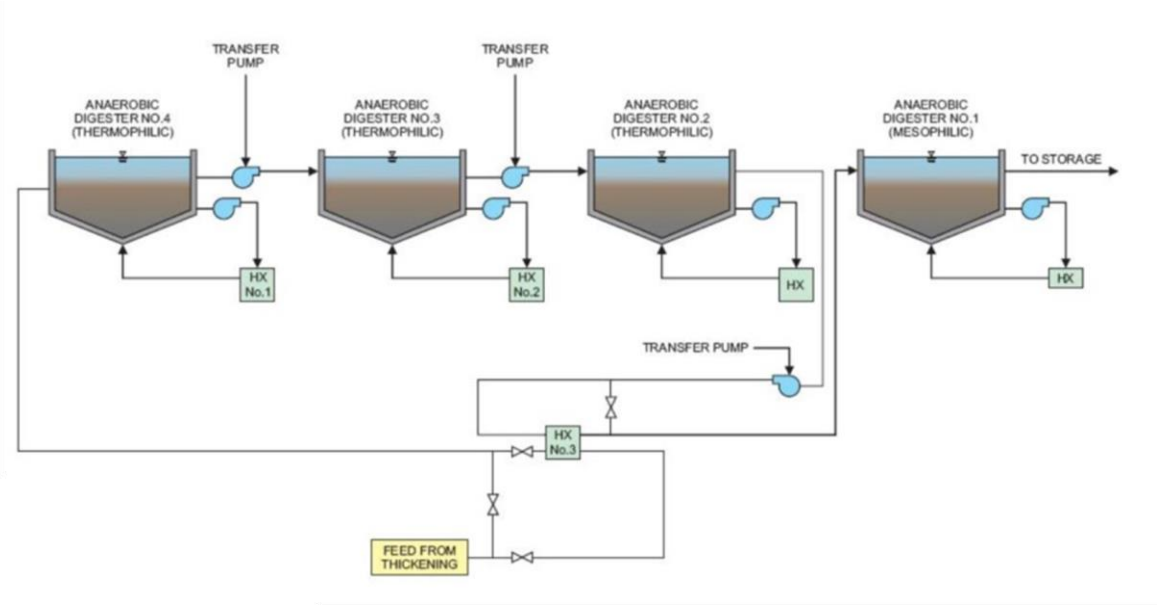


Figure 3-4: Existing Digester Process Flow, Mason Farm WWTP

The minimum holding time to achieve Class A as a function of temperature is shown in **Figure 3-5.** The Mason Farm WWTP currently runs the thermophilic digester above the required thermophilic range, at 135°F to 140°F, because of the transfer sludge pump's slower transfer rate and to minimize foaming which occurs at higher temperatures.

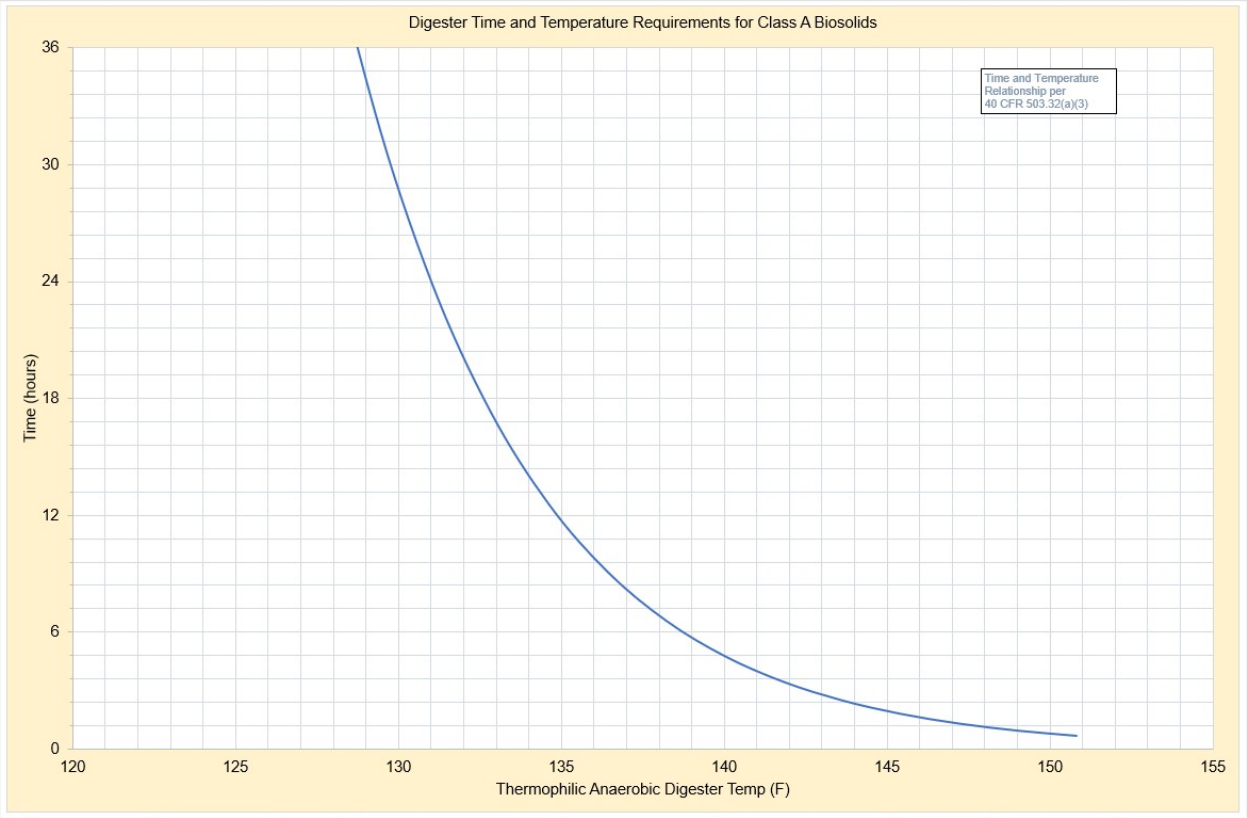


Figure 3-5: Class A Digester Time and Temperature Requirements

Based on continued operation in the present mode to achieve the 40 CRF 503 time and temperature requirements for Class A pathogen reduction, the capacity of the anaerobic digestion facility is determined by the thermophilic batch process in Digester No. 3. The Plant's Process Control Plan describes an operating scenario based on a 24-hour batch cycle time which includes the fill-hold-withdrawal operations. Furthermore, the Process Control Plan indicates that the Digester No. 3 volume per foot of sidewater depth is approximately 13,500 gallons with a maximum water level difference of 4.5 feet. Based on these parameters, Digester No. 3 could process approximately 60,000 gallons per batch cycle. Fill and withdrawal sludge transfer pumping capacity is approximately 960 gallons per minute. The daily digester No. 3 throughput capacity as a function of digester operating temperature is shown in **Figure 3-6**.

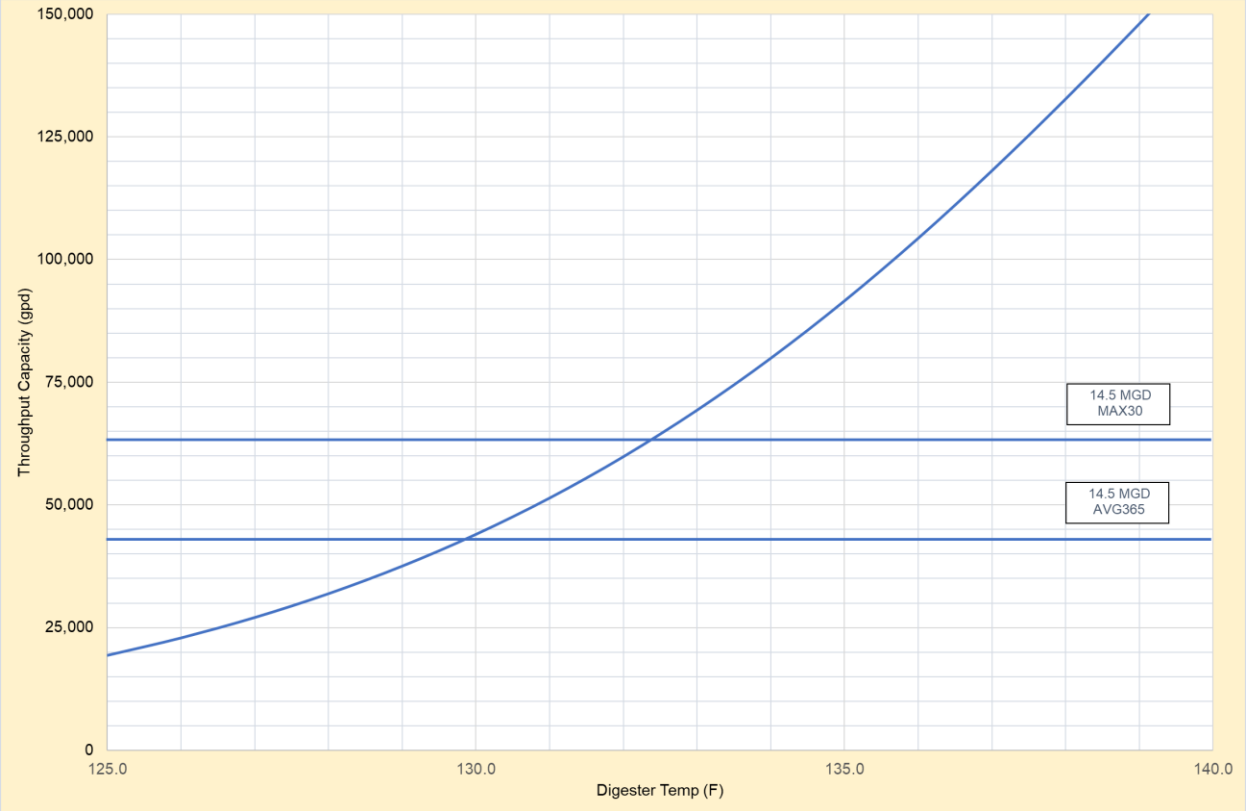


Figure 3-6: Digester 4 Throughput Capacity

Digester 4 is where sludge is initially heated from ambient temperature to the thermophilic range. Heat is produced by a heat exchanger (HEX1) with a stated capacity of 1.9 MMBTU/hour. When evaluating the capacity of HEX1, and the overall heating capacity of Digester 4, a thickened sludge concentration of 6% total solids was used to match RDT performance, and a worst-case heating demand from 50°F to 135°F, plus an additional 10% heat demand for maintenance heat. **Figure 3-7** shows Digester 4's initial and final heat demand as a function of digester feed rate. Under the specified conditions, HEX1 will be unable to meet heating demand at the 14.5 mgd MAX30 condition under worst case temperature condition. It is recommended to evaluate digester heating capacity and requirements as digester feed approaches 55,000 gallons per day.

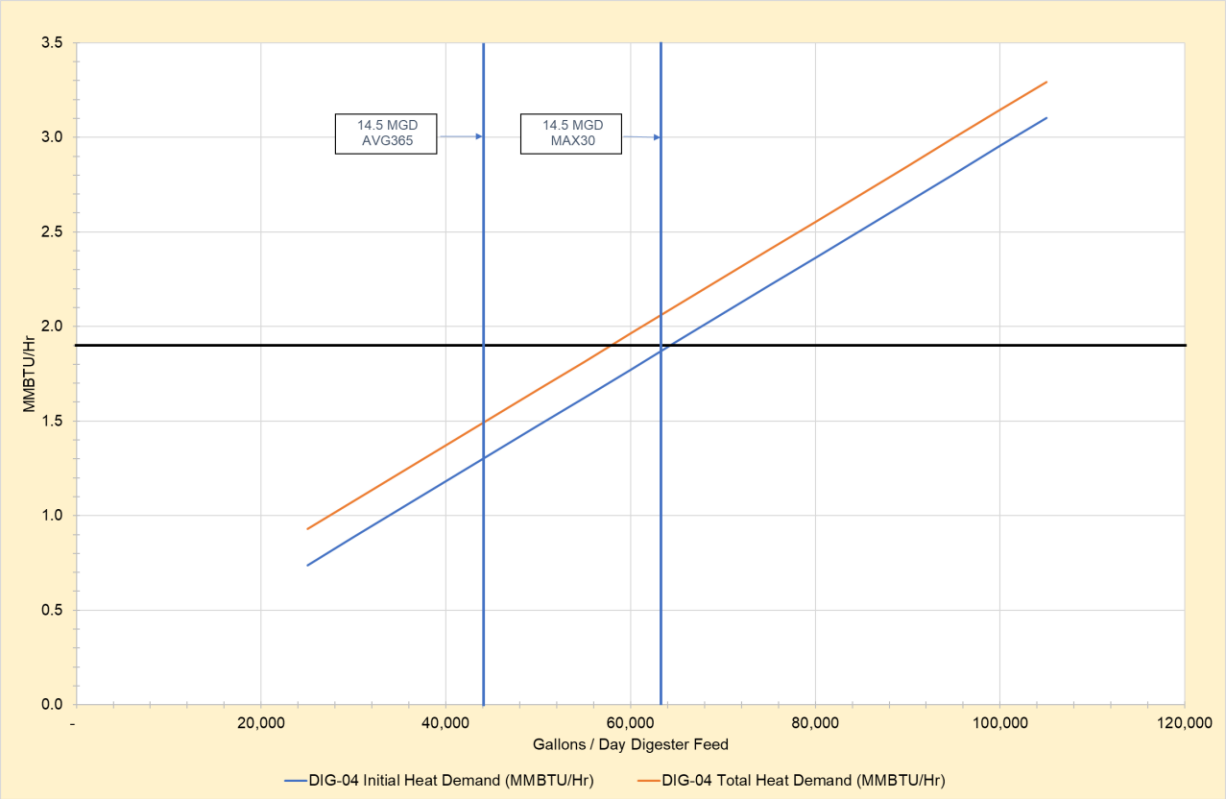


Figure 3-7: HEX1 Capacity

3.4 Biosolids Storage

Both on-site and off-site liquid biosolids storage is provided for anaerobically digested Class A biosolids. A total of 3.15 million gallons of storage is provided. A minimum of 30 days storage or an alternate disposal pathway is recommended. Some facilities, especially those that practice liquid land application, would benefit from more than 30 days of storage, since excessive rain may preclude liquid land application and necessitate extended liquid storage; Mason Farm WWTP also has flexibility to send dewatered cake to offsite composting. Estimated days of storage as a function of influent flow is shown in **Figure 3-8**. As shown, the existing storage volume is sufficient to meet the 30-day minimum storage time at the maximum month loading condition for buildout plant capacity of 18.5 mgd.

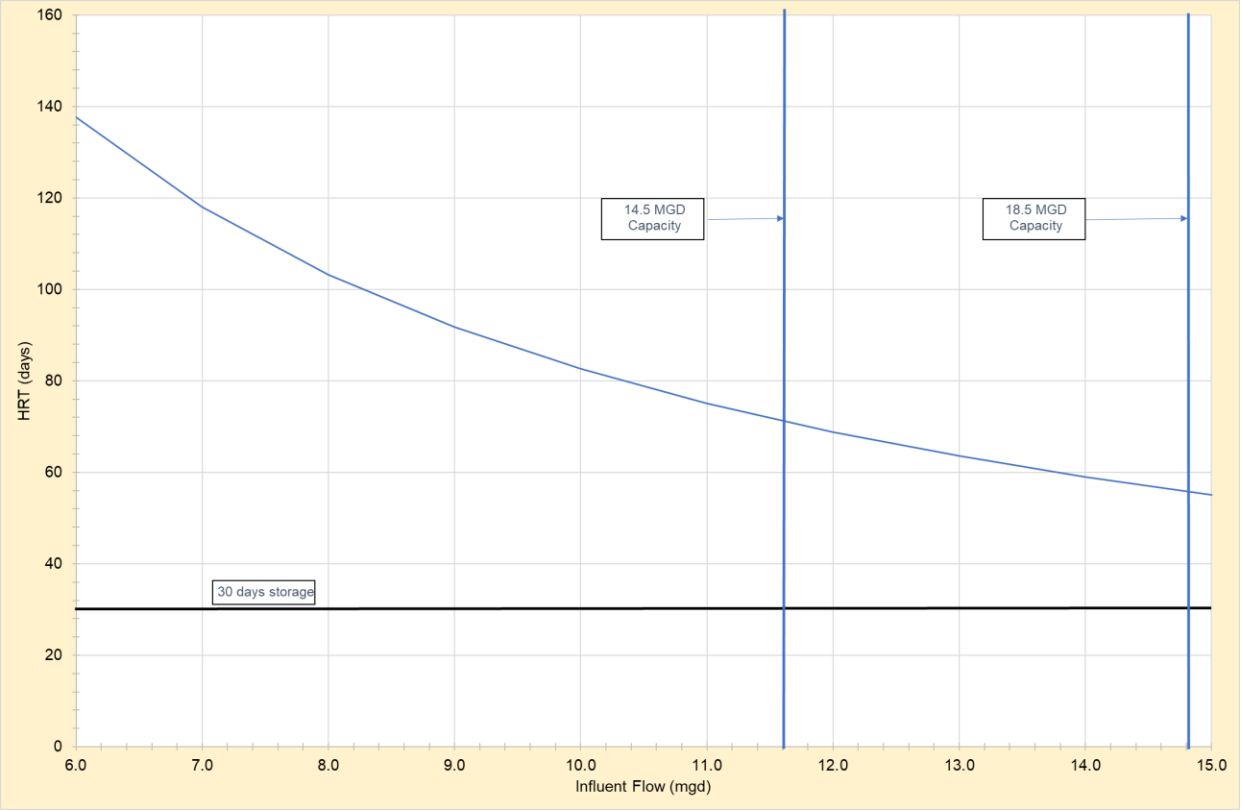


Figure 3-8: Digested Sludge Storage Capacity

3.5 Biosolids Dewatering

Digested sludge is pumped from the Biosolids Storage Tanks or directly from Digester No. 1 to the Biosolids Dewatering Facility. A rotary fan press (RFP) is installed to allow a portion of the biosolids to be dewatered and sent off-site for composting. The biosolids dewatering process does not limit the capacity of the solids treatment train since it is used to provide flexibility for disposal of biosolids and is not a mandatory process.

The RFP has a specified capacity of up to 70 gallons per minute (gpm) and is typically operated at a lower feed rate of approximately 35 gpm. RFP capacity was evaluated at 35 gpm and 70 gpm, assuming a 60-hour per week dewatering schedule to match receiving times at the McGill compost facility. As shown in **Figure 3-9**, the RFP operating 60 hours per week at 35 gpm is sufficient to dewater between 25 and 50% of the digested solids produced at the current 14.5 mgd capacity.

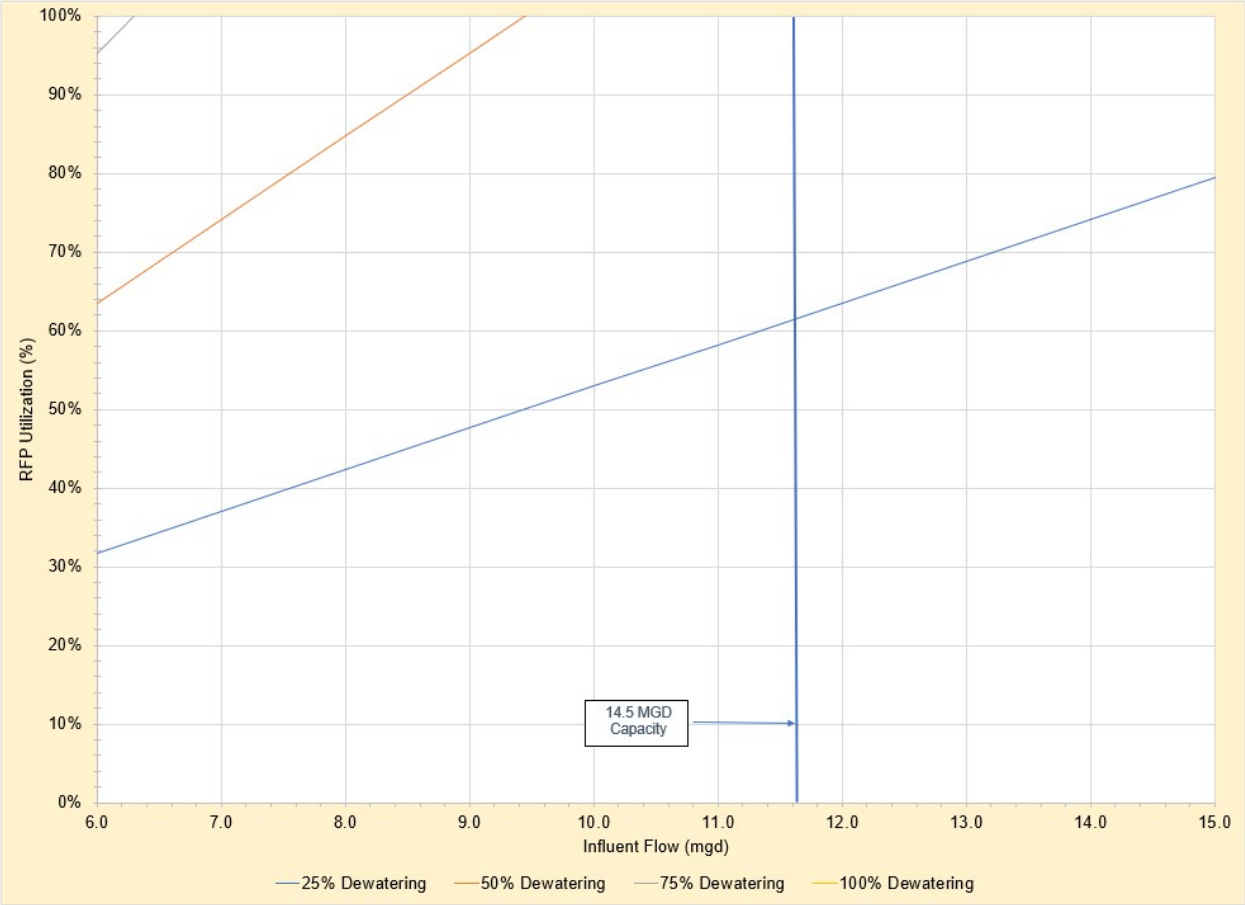


Figure 3-9: Rotary Fan Press Utilization at 35 GPM, 60 hr/week

The increased dewatering capacity realized with a higher loading rate of 70 gpm is shown in **Figure 3-10.** Operating 60 hours/week at 70 gpm enables dewatering of up to 75% of digested sludge at the current rated plant capacity of 14.5 mgd. Additional operating hours would be required to process all the sludge at the current plant capacity.

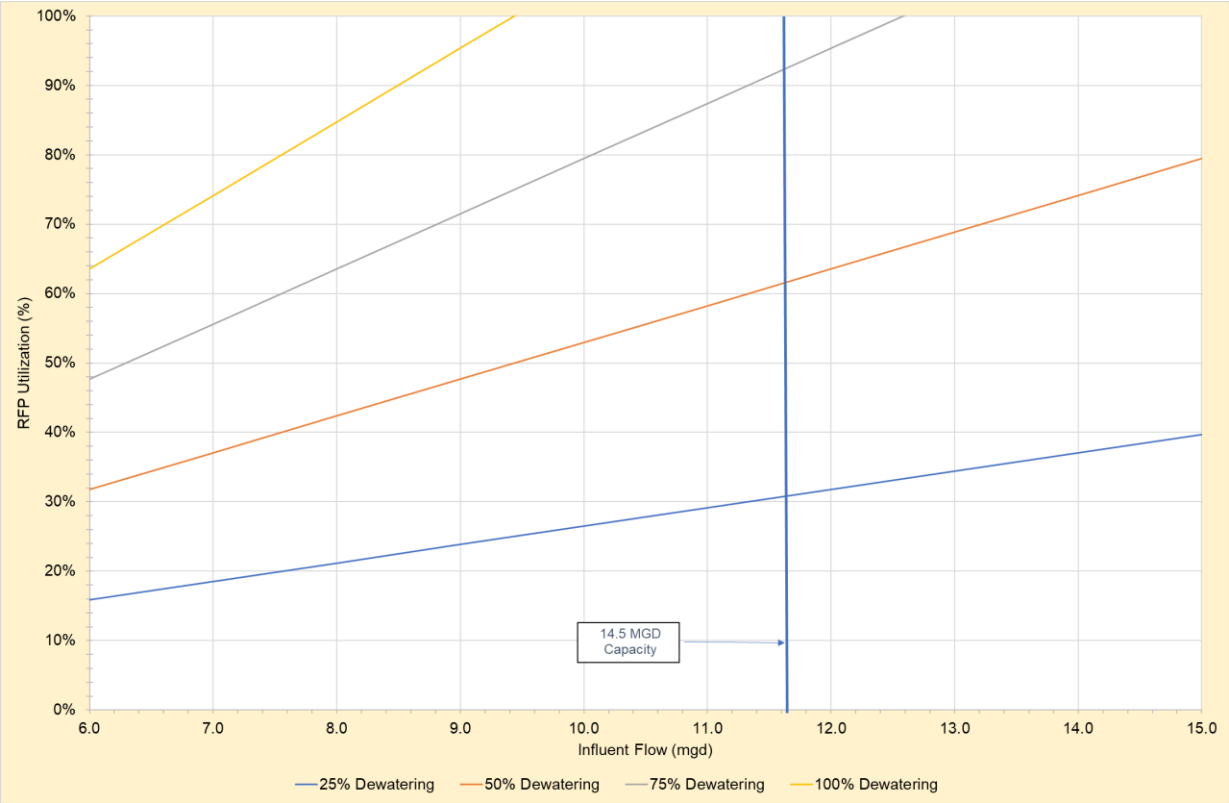


Figure 3-10: Rotary Fan Press Utilization at 70 GPM, 60 hr/week

Biosolids dewatering capacity is not necessarily capacity limiting. The dewatering process is utilized to supplement liquid land application, which is the primary means of ultimate residuals management for the Mason Farm WWTP. OWASA has an ultimate disposal goal of 75% liquid land application and 25% dewatered cake to offsite composting. If the Plant were to pivot in the future to increase goals for dewatering, additional dewatering units would be needed to increase capacity and redundancy.

3.6 Redundancy Evaluation

A redundancy evaluation of the major biosolids unit processes at the Mason Farm WWTP was performed. There is currently no redundancy in the primary sludge fermentation or dewatering processes, and limitations in solids processing to maintain TPAD when a digester tank is out of service.

While primary sludge fermentation is not a necessary process, OWASA staff view the fermenter as critical since it offers operational cost savings in reduced supplemental carbon feed. Unfortunately, there is not a clear path forward to construct additional fermentation capacity.

While there is adequate thickening capacity to maintain a standby RDT, thickening has been identified as a possible concern since there is no liquid sludge storage upstream of thickening.

While the TPAD process does not include redundant tankage, OWASA staff may modify operations to maintain Class A status with one digester out of service, by batch feeding Digester 3 or 4 to meet time and temperature requirements.

While there is only a single dewatering unit, OWASA's primary outlet for digested solids is via liquid land application. Therefore, redundancy is not critical.

4. Solids Processing Alternative Evaluation

4.1 Solids Alternatives

OWASA is interested in evaluating biosolids processes that produce a Class A biosolids product or demonstrate PFAS destruction in biosolids. A total of four (4) solids treatment alternatives, including the current TPAD process, were evaluated:

- Temperature-Phase Anaerobic Digestion (TPAD)
- Thermal Drying (TD)
- Thermal Drying + Gasification/ Pyrolysis (TD-GAS)
- Super Critical Water Oxidation (SCWO)

A process flow schematic and site plan are presented for each alternative, as well as estimated capital (CAPEX) and operating costs (OPEX) based on projected biosolids production estimates calculated using the sludge production estimates presented in Section 2 and the flow projections presented in TM 1. The CAPEX and OPEX costs are presented as the differential cost difference to switch to a technology other than the current TPAD process. The costs presented herein are not standalone costs. As described below, it was assumed anaerobic digestion is maintained with each of the three alternatives to TPAD but converted to mesophilic anerobic digestion (MAD).

Since there would be no specific stabilization requirements of digestion when a subsequent process is utilized (TD, TD-GAS or SCWO), operating in a MAD configuration will allow increased capacity and redundancy. The benefit of operating digestion is reducing mass and the necessary size for downstream equipment, as well as generating biogas for possible beneficial use. Additionally, eliminating digestion at the WWTP would require addition of liquid sludge storage volume, to decouple wasting from primary and secondary clarifiers from downstream processes and prevent impacts to liquid treatment when solids processing was down. The necessary addition of liquid sludge storage as well as the likely difficulty in reclaiming current digester site footprint following demolition would decrease or eliminate any opening of site plan for other future processes.

Rehabilitation and operating costs for the current process (thickening and digestion) are not included in the costs presented herein.

4.2 Temperature Phase Anaerobic Digestion (TPAD)

The Mason Farms WWTP currently utilizes a TPAD process to produce Class A biosolids. Since OWASA's objectives indicate a plan to phase out land application within the planning horizon, the existing TPAD process is generally capable of handling solids loadings for the current 14.5 mgd capacity, so no new infrastructure is required. Rehabilitation may be required to keep the existing equipment in good working order.

4.3 Mesophilic Anaerobic Digestion (MAD) & Thermal Drying (TD)

Thermal drying is a process that evaporates a significant amount of water from sludge to produce dried material, typically with greater than 90% dry product solids (less than 10% moisture content). The dried product meets Class A pathogen status if it is greater than 90%TS for blended sludge (PS and WAS). The dried material can be pelletized or granular for either method of drying and can be used as a fertilizer or as a renewable fuel. Utilities realize a significant reduction in final product mass and volume with thermal drying, which can provide significant cost savings if hauling and disposal costs are high.

Dryers are generally divided into two categories depending on the method of drying:

- Direct drying: Direct drying can also be described as convection drying where the heat source, typically hot air, comes into direct contact with the material being dried. As an example, a drum dryer is a direct dryer, as are some forms of belt dryers.

- Indirect drying: Indirect drying can also be described as conduction drying, where the heat source does not come into direct contact with material being dried. Indirect dryers include screw dryers and paddle dryers.

Based on the sludge loading and compact site at the Mason Farm WWTP, screw drying technology was evaluated for the Master Plan. The process flow diagram for incorporating a thermal dryer with MAD at Mason Farm WWTP is shown in **Figure 4-1**.

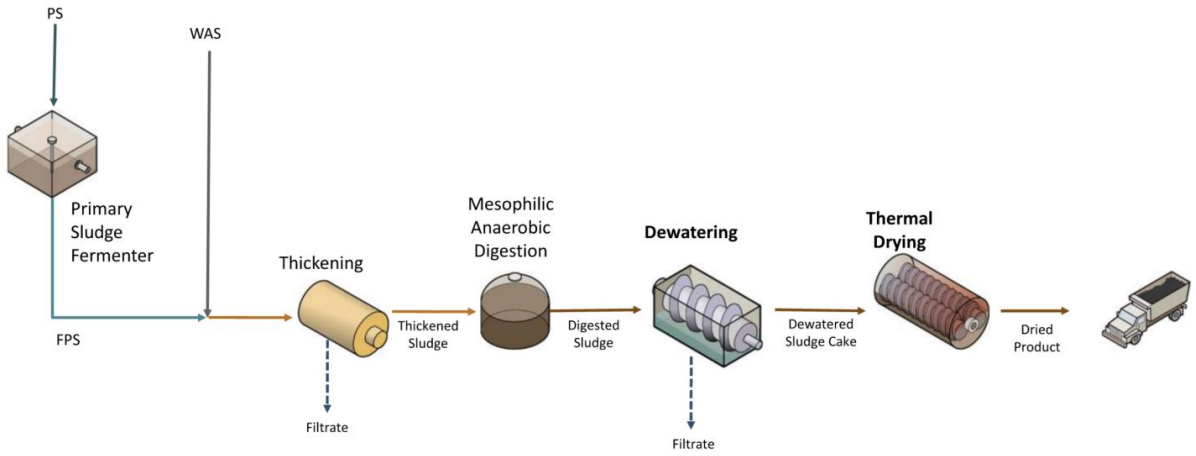


Figure 4-1: Mesophilic Anaerobic Digestion + Thermal Drying Process Flow Diagram

A new dewatering facility would be required to implement thermal drying to increase firm dewatering capacity to process all digested sludge at plant design capacity. The new dewatering facility would be located adjacent to the new drying process to minimize conveyance/pumping of dewatered cake. Additionally, a new odor control facility would be constructed to serve both the dewatering and drying facilities. A proposed site plan is presented in **Figure 4-2**.

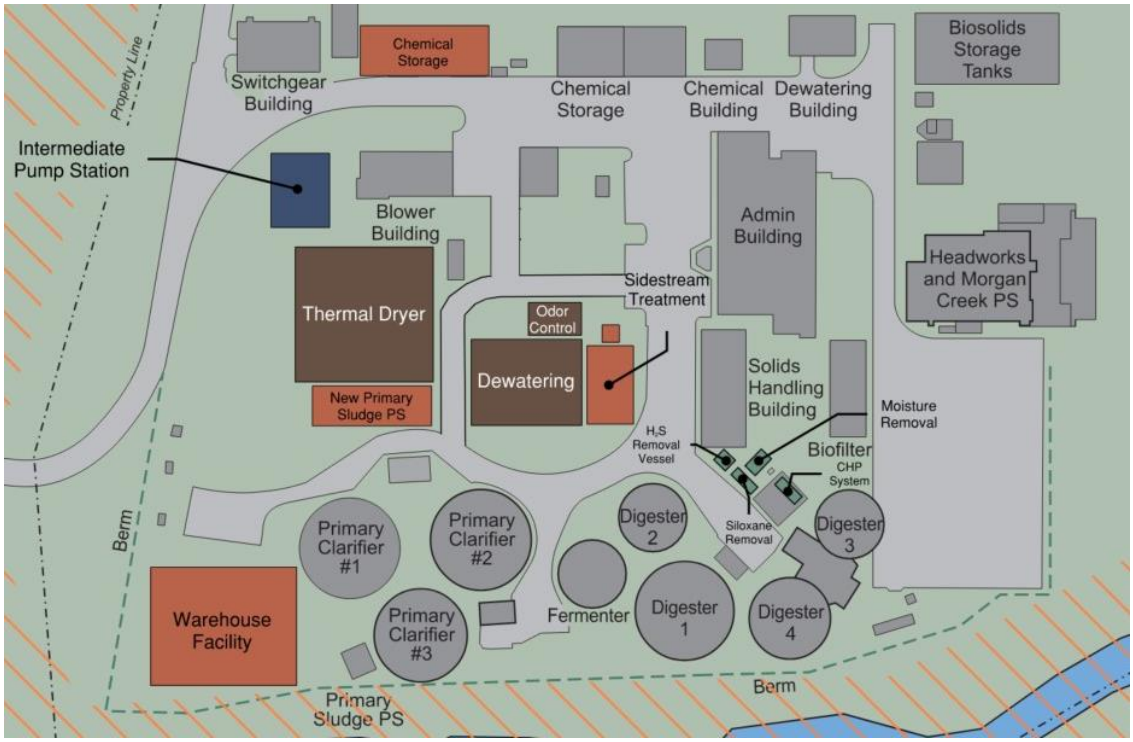


Figure 4-2: Mesophilic Anaerobic Digestion + Thermal Drying Site Plan

4.4 MAD & TD & Gasification/Pyrolysis (GAS)

Gasification and pyrolysis are thermochemical processes that decompose carbonaceous materials by exposing them to high temperatures. The main difference between the two is the amount of oxygen present. Gasification takes place with a limited amount of oxygen, while pyrolysis occurs in the absence of oxygen. Typically, temperatures for gasification are between 1,100-1,800°F (593-982°C), and for pyrolysis are 390-1,100°F (200-593°C) but can vary by technology provider. Both produce heat, a combustible fuel gas (known as "syngas" for gasification and "pyrogas" for pyrolysis) and a charcoal-like solid substance called biochar. Pyrolysis also produces bio-oils and tars, which are typically oxidized for energy production. In many cases with no digestion, the process is thermodynamically favorable, because the generated syn/pyrogas is thermally oxidized allowing for thermal energy to be captured and recycled back into the thermal drying process, which is a required pretreatment step for either gasification or pyrolysis. Additionally, gasification with thermal oxidation has been demonstrated to destroy PFAS compounds in biosolids.

Figure 4-3 presents a process flow diagram of thermal drying and gasification implemented at Mason Farm WWTP, converting the existing digestion process to MAD.

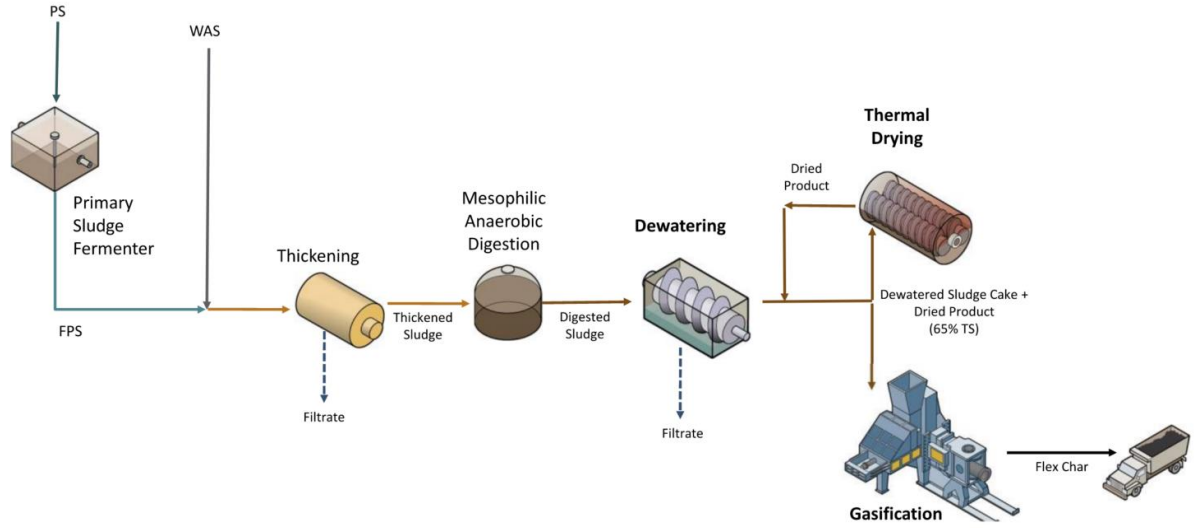


Figure 4-3: MAD + Thermal Drying + Gasification Process Flow Diagram

As with the thermal drying alternative, a new dewatering facility would be required to implement gasification. A separate facility was envisioned adjacent to the new dewatering building to house the thermal dryer and gasifier as well as the thermal oxidizer and other ancillary equipment. A proposed site plan is presented in **Figure 4-4**.

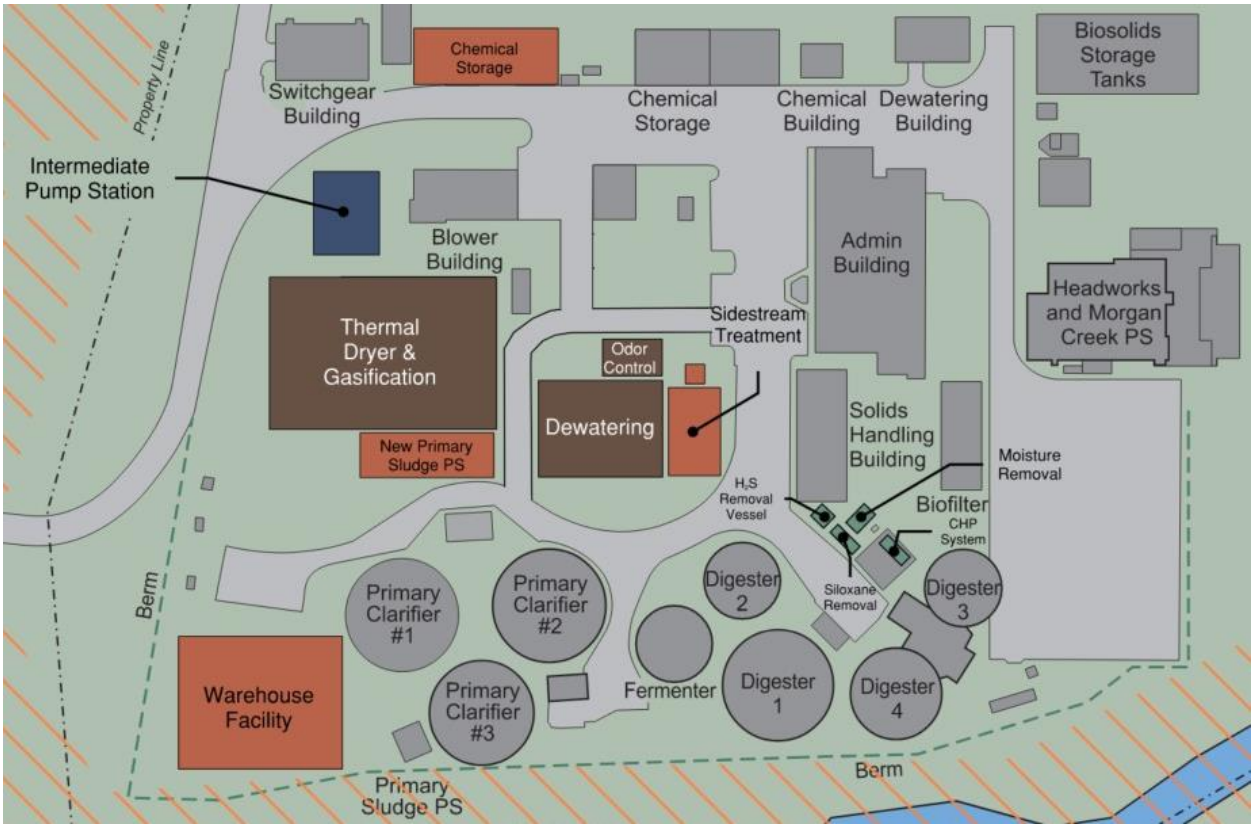


Figure 4-4: Mesophilic Anaerobic Digestion + Thermal Drying + Gasification Site Plan

4.5 MAD & Super Critical Water Oxidation (SCWO)

SCWO was also evaluated as a PFAS-destruction alternative. As with thermal drying and gasification, it was decided to maintain anaerobic digestion to reduce the size of downstream equipment and generate biogas for possible beneficial use. The current TPAD process would be converted to MAD to increase capacity and redundancy with the existing tankage. The final biosolids treatment alternative that was considered is Super Critical Water Oxidation (SCWO), a proprietary technology that presents a route for PFAS and CEC destruction, while simultaneously providing greater than 99% conversion of carbon to energy.

SCWO is expected to be autogenous on the scale that was envisioned for Mason Farm WWTP. The fundamental principle of SCWO is that when in the supercritical phase, organics dissolve rapidly, become fully oxidized, and are rapidly converted into clean water, carbon dioxide, reusable heat, and inert minerals. The process operates at the supercritical phase temperature and pressure of ~3,200 psi and 374°C (705°F). It is important to note that peak temperatures in SCWO are not high enough to produce large amounts of NOx or SOx, and the technology is not classified as combustion technology by the EPA.

SCWO provides a promising way to remove PFAS. In laboratory settings, SCWO was able to achieve greater than 99% destruction of all PFAS in the liquid phase, and targeted analyses of the liquid phase showed promising results with regards to other contaminants of concern. More rigorous examinations of the influent and effluent composition, including gas-phase products, are currently being conducted. A SCWO unit, commercialized by 374Water Inc., with a capacity of 6 wet tons per day (AirSCWO 6) will be piloted in California at the Orange County Sanitation District (Plant 1), with the goal of demonstrating process continuity, reliability and PFAS destruction potential in the air phase. Delivery of the unit is expected to occur in November 2023.

Figure 4-5 presents the process flow diagram to implement SCWO with MAD at the Mason Farm WWTP.

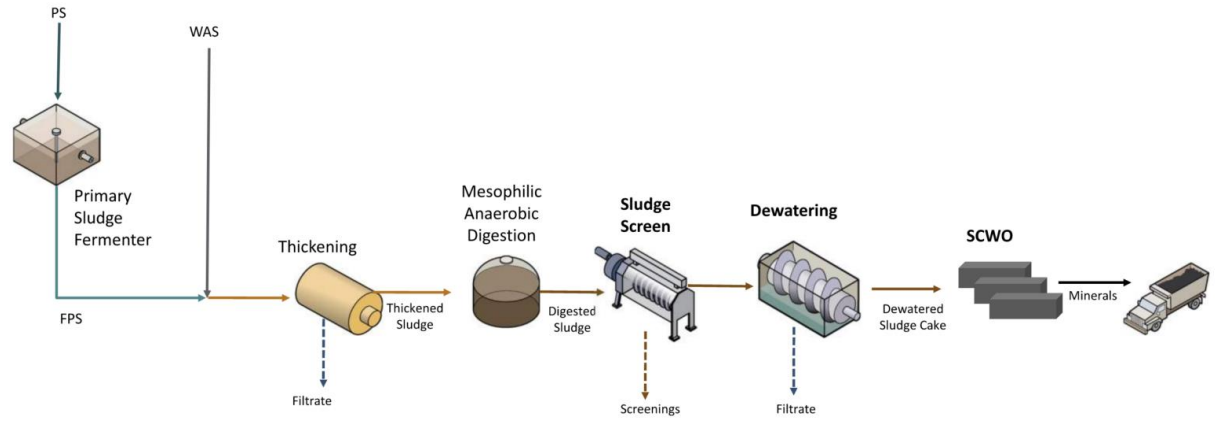


Figure 4-5: MAD + SCWO Process Flow Diagram

374 Water has commercialized SCWO in the United States for application for municipal, industrial and defense industries. The pilot unit developed in conjunction with Duke University was sized for 1 wet ton per day. The next size developed is 6 wet ton/day, and has been fabricated and awaiting shipping to the OC San site. Due to the solids loading, 374 Water proposed two AirSCWO 30 units for the 14.5 mgd plant capacity, with a third to be installed for build out capacity of 18.5 mgd. Each AirSCWO unit consists of three shipping containers, each approximately 40ft long x 8ft wide x 9 ft high. The sludge must be screened and dewatered upstream of SCWO. Sludge screens could be installed in the Rotary Fan Press building where the current RFP is located, and a new dewatering building be constructed adjacent to the SCWO process. A proposed site plan is presented in **Figure 4-6.**

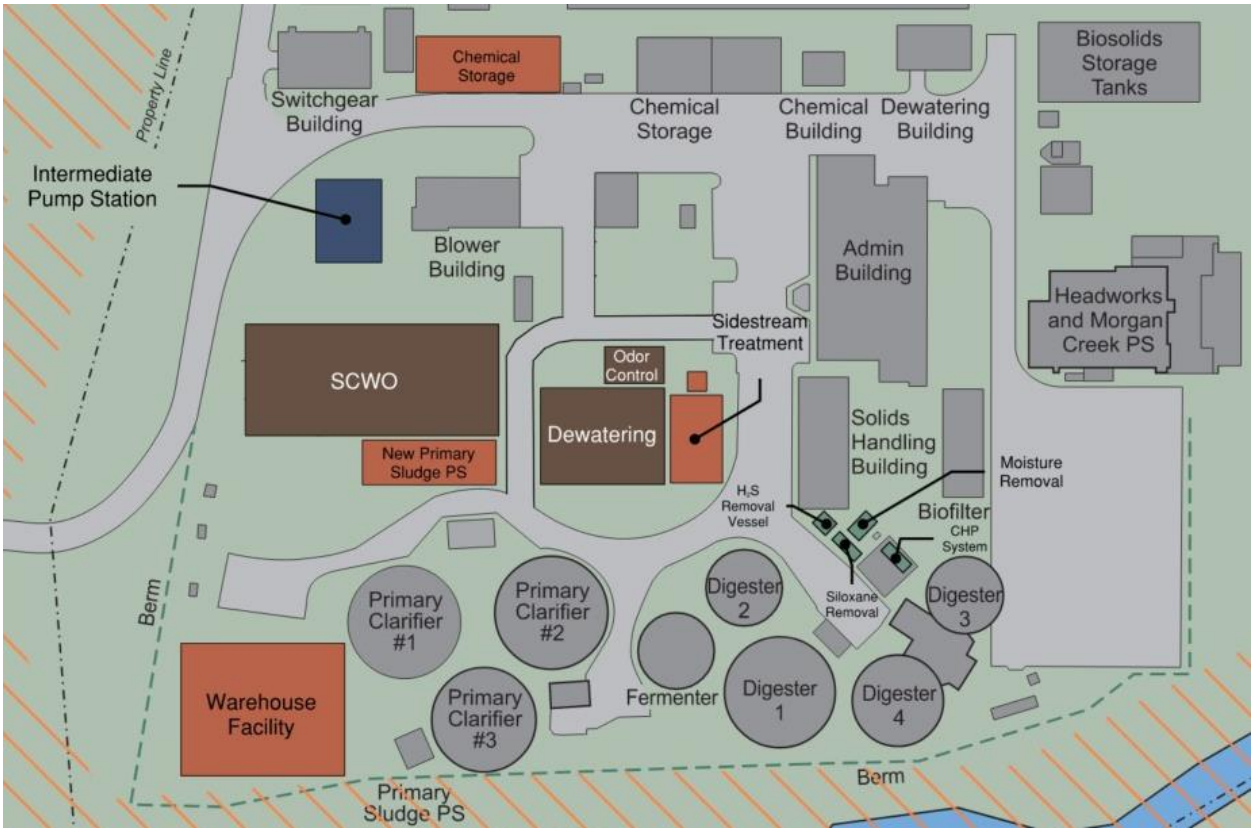


Figure 4-6: Proposed MFWWTP Site Plan with Mesophilic Anaerobic Digestion + SCWO

5. Financial Evaluation of Biosolids Alternatives

5.1 Financial Assumptions

A 20-year net present cost evaluation of each biosolids treatment alternative was conducted, and a differential cost analysis was performed to highlight the financial burden of each alternative relative to maintaining the current TPAD process. Both operational (OPEX) and capital costs (CAPEX) were included in this analysis.

Table 5-1 summarizes the operational components that were included in the OPEX for each alternative. Items common to each alternative, such as thickening and digestion, were not included. Additional operating costs were calculated for the biosolids alternatives which require dewatering of all solids, as that is an increase from the status quo. The biosolids alternatives would require additional staff to operate and maintain the new equipment at Mason Farm WWTP. After discussion with OWASA, it was decided to not include any additional labor costs for these alternatives since those costs would likely be offset by land application employees who would no longer be required. The TPAD alternative only includes disposal costs, which, fortunately for OWASA, are low compared to other utilities ($5/wet ton). Zero disposal cost (or revenue) was included for thermal drying, gasification and SCWO; this is a conservative assumption, since there would likely be a small revenue realized from selling a thermally dried product, biochar from gasification, or minerals from SCWO.

Table 5-1: OPEX Developed to Differentiate Between Alternatives

	TPAD	MAD + TD	MAD + Gasification	MAD + SCWO
Digester Heating	X	X	X	X
Dewatering O&M		X	X	X
Maintenance (new processes ONLY)		X	X	X
Natural Gas	X	X	X	X
Electricity (New processes ONLY)		X	X	X
Fuel Supplement		X	X	X
Hauling/ Disposal	X			

Assumptions were made regarding operation costs and rate escalations. These assumptions, summarized below, were based on historical trends and market knowledge. These assumptions are consistent throughout this TM.

Operating Cost assumptions include:

- For the status quo, 75% of biosolids will go to liquid land application and 25% to off-site composting
- Zero disposal/revenue for thermal drying, gasification and SCWO.
- 5% annual increase in compost tipping fee
- 3% annual increase in lime cost
- Interest Rate: 5%, assumed rate on municipal bonds
- Discount Rate: 5%, risk-free rate of return
- Construction Escalation Rate: 5%
- Natural Gas Cost Escalation Rate: 2.2%, EIA Annual Energy Outlook
- Electricity Cost Escalation Rate: 1.7% EIA Annual Energy Outlook
- O&M & Other Costs: 3%, average inflation rate

5.2 Capital Cost Estimate

Hazen prepared high-level capital cost estimates for each biosolids treatment alternative consistent with AACE (American Association of Cost Estimators) guidelines for a Class 5 estimate. Cost estimates are based on a 0% to 2% level of design development and accuracy will range from a low end of -20% to -50% (average – 35%) and from a high end of +30% to +100% (average +65%). These cost estimates were based on 2023 vendor quotes and recent bid prices for similarly sized projects. **Table 5-2** presents the CAPEX for the three alternatives evaluated; no capital costs were estimated for continuing the current TPAD process. It should be noted that **Table 5-2** only considers the cost of construction new infrastructure and does not include costs to rehabilitate existing equipment, such as thickening and digestion, which would be common to all alternatives.

Table 5-2: Opinion of Probable Construction Cost (OPCC)

		Dewatering + TD	Dewatering + TD + Gasification	Screening + Dewatering + SCWO
Material and Labor Subtotal		$47,000,000	$64,500,000	$46,000,000
Contingencies	40%	$18,000,000	$25,800,000	$18,400,000
Opinion of Probable Construction Cost (OPCC)		$65,800,000	$90,300,000	$64,400,000
Engineering	10% - thermal drying, 20% - gasification, SCWO	$6,580,000	$18,060,000	$12,880,000
Construction Management	10%	$6,580,000	$9,030,000	$6,440,000
Total Estimated Construction Cost in 2023 Dollars		**$78,960,000**	**$117,390,000**	**$83,720,000**

*OPCC does not include costs to rehabilitate existing equipment, which is common to all alternatives

CAPEX and OPEX were combined to develop a 20-year net present differential cost of each biosolids alternative compared to the current TPAD process, shown in **Table 5-3**. OWASA is aware that investment is needed in the existing biosolids infrastructure at Mason Farm WWTP, and those costs would be required for all alternatives and to maintain the status quo TPAD operation. Additionally, these estimates omit OPEX items common to each alternative, i.e. thickening, digestion, etc. The net present differential costs capture the additional cost of implementing a particular biosolids process after investment in existing WWTP biosolids infrastructure.

Table 5-3: 20-Year Net Present Differential Costs (2023 Dollars)

Biosolids Alternative	Biosolids CAPEX	OPEX				Net Present Differential* Cost
		Natural Gas	Disposal	Biosolids O&M**	Electricity	
TPAD	$0	$0	$2,100,000	$0	$0	**$2,100,000**

MAD + TD	$78,900,000	$600,000	$0	$3,300,000	$1,500,000	**$84,300,000**
MAD + TD + Gasification	$117,400,000	$0	$0	$6,800,000	$1,300,000	**$125,500,000**
MAD + SCWO	$83,700,000	$0	$0	$4,900,000	$100,000	**$88,700,000**

* Differential Costs exclude common costs between alternatives: CAPEX and OPEX for thickening and digestion
**Biosolids O&M includes chemicals, and maintenance

6. Multi Criteria Decision Analysis

6.1 Introduction: HazenConverge

As part of the Master Plan, a multi-criteria decision analysis (MCDA) tool, HazenConverge, was utilized to provide comparison of the alternatives based on criteria weighting that reflect OWASA's goals and objectives.

6.2 Decision Criteria

HazenConverge allows the user to define criteria and weightings for each criterion to reflect the extent to which a criterion drives the decision-making process. OWASA provided a list of core objectives regarding plant operation goals and visions to be incorporated within the MCDA. From the list of core objectives, draft criteria to be used in the HazenConverge biosolids evaluation were developed. Following discussion at the Biosolids and Energy workshop, minor changes to the criteria and weights were made. The final criteria, presented in **Table 6-1**, were selected to capture the true differences between the alternatives and reduce any potential overlap between them.

The selected weightings for each criterion are displayed in **Table 6-1,** and were developed in partnership with OWASA administrative and WWTP staff to reflect key areas of concern. The relative weightings of the criteria are especially important as the results of the MCDA can vary based on the level of importance placed on certain criteria. Criteria such as Life Cycle Cost and Addressing of CECs are weighted higher, as funding constraints and regulatory requirements will largely drive which alternatives are viable.

Table 6-1: HazenConverge Criteria for Biosolids Evaluation

Criteria	User-Assigned Weightings
Technology Maturity	20
Operational Complexity	20
Address CECs (PFAS, Microplastics)	30
Energy Recovery Potential	10
Life Cycle Cost	40

*Use a scale of 0-100 for user-assigned weightings; weightings do not have to add up to 100.

Each biosolids alternative and the status quo were scored in each criterion, as shown in **Table 6-2**. Each criterion has a positive or negative correlation. For example, Life Cycle Cost was given a negative

correlation meaning the lower the Life Cycle Cost, the higher score the alternative is given. The Life Cycle Cost score only includes biosolids technology, not bioenergy recovery.

Table 6-2: HazenConverge Scoring for Biosolids Alternatives

Criteria	Weight	TPAD	MAD + TD	MAD + TD + Gasification	MAD + SCWO
Technology Maturity	20	5	5	2	1
Operational Complexity	20	1	3	5	5
Address CECs	30	0	0	5	5
Energy Recovery Potential	10	5	1	5	5
Life Cycle Cost	40	1	4	5	4

6.3 Results

The results of HazenConverge MCDA analysis are presented in **Figure 6-1**. More favorable outcomes are indicated by the higher score (i.e. larger bar) with lower scoring alternatives shown with smaller bars.

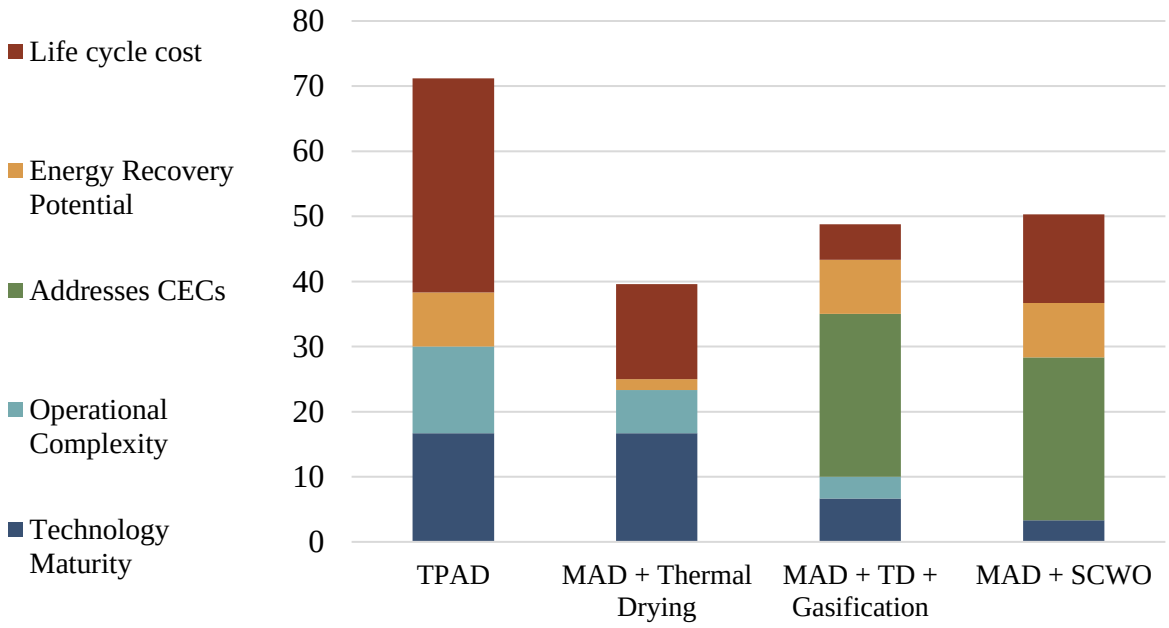


Figure 6-1: HazenConverge Biosolids Alternatives Analysis Results

6.4 Recommendations

OWASA is fortunate to have very low biosolids disposal costs, which make the current TPAD operation most favorable. As such, there is currently no driver to move to thermal drying or other advanced thermal treatment technologies, and it is recommended that OWASA continue to treat biosolids to a Class A material with TPAD and land apply liquid or dewater for offsite composting. Driven by a significantly

lower life-cycle cost, the current method of biosolids disposal meets both internal and external treatment goals and the most efficient use of current resources.

OWASA is forward thinking in investigating possible future regulatory changes, related to PFAS, that could significantly change the way biosolids are treated and disposed from the Mason Farm WWTP. Gasification/pyrolysis and SCWO are both demonstrated to destroy PFAS in biosolids and were included in this Master Plan to help OWASA explore how they could respond to regulatory limits for PFAS in biosolids. It is prudent to conduct testing of PFAS compounds in the biosolids generated at Mason Farm WWTP.

While both MAD+TD+GAS and MAD+SCWO have similar HazenConverge scores, the CAPEX to implement SCWO is significantly less than the Gasification alternative. It should be noted that SCWO is behind gasification in technology maturity, so it will be important to continue to follow both technologies as they develop in the coming years and as installations potentially increase within the industry.

A trigger-based roadmap as part of Task 7 will include recommendations with their associated triggers that will determine when these recommendations should be implemented. A summary of these trigger-based recommendations, which will be incorporated into Task 7, include:

1. Continue to implement digester rehabilitation projects
2. Continue monitoring viability of land-applying biosolids
3. Continue monitoring gasification/pyrolysis and SCWO technologies as they mature and increase in their number of installations
4. Conduct testing of PFAS compounds in biosolids
5. Initiate PFAS destruction technology study
6. Initiate primary sludge fermenter evaluation in conjunction with nutrient removal carbon study
7. Increase thickening capacity

7. Bioenergy Recovery Introduction

Bioenergy recovery alternatives to produce usable energy from OWASA's digester gas resources were evaluated and included in this TM. The bioenergy recovery strategies and recommendations herein were based on digester gas production, site conditions, energy costs, renewable energy market conditions, and on-site heat demands.

Currently, OWASA offsets purchased natural gas by utilizing digester gas in their digester heating boilers. A dual-membrane Dystor gas holder on Digester 1 collects digester gas at 8-9 inches water column (W.C.) and the gas is directed to two hot water boilers (1 duty, 1 standby). The system does not include digester gas pretreatment.

This bioenergy section of this TM includes the following:

- Existing digester gas utilization capacity and condition assessment of the existing system (gas holder, conveyance, boilers, and flare)
- Overview of the evaluated bioenergy recovery alternatives
- Overview of the energy markets and funding opportunities associated with each bioenergy recovery alternative
- Near- and long-term bioenergy recovery recommendations and the conditions that would warrant investments in long term bioenergy recovery alternatives

8. Bioenergy Recovery Alternatives

The bioenergy recovery alternatives evaluated in this study are summarized in the following sections.

8.1 Thermal Systems

Thermal systems represent what is currently implemented at the Mason Farm WWTP. Thermal systems utilize digester gas on-site to generate thermal energy to meet the plant's thermal energy demands (i.e. digester heating, building heating, etc.). Other potential uses for thermal energy generated from digester gas includes sludge thermal drying and/or sludge gasification. OWASA currently uses raw, untreated digester gas to fuel hot water boilers to provide heat to digesters. When digester gas production exceeds heat demands, excess digester gas is flared.

The existing boilers have required frequent maintenance, with the tubes needing replacement every 2-3 years, due to the lack of digester gas pretreatment. For the evaluation herein, a new digester gas pretreatment system is included. The pretreatment system consists of gas chilling / moisture removal and activated carbon scrubbing vessels to remove contaminants like hydrogen sulfide and siloxanes. OWASA should consider installing digester gas pretreatment for their existing biogas utilization system. A digester gas pretreatment system would require capital investment and would have ongoing annual maintenance, but it would reduce the frequency of boiler maintenance.

8.2 Combined Heat and Power (CHP)

The CHP alternative explores technologies and strategies that utilize digester gas to produce a combination of electric and thermal energy. The generated electric energy offsets the purchased utility power. The generated thermal energy recovered from the exhaust and engine cooling systems can be used to supply the digester heat demands. New CHP systems typically convert 35%-40% of their energy input to electricity and 35%-40% to recoverable thermal energy, making them nearly 70%-80% efficient if 100% of the thermal energy can be utilized. The most common type of CHP system utilizes Reciprocating Internal Combustion Engines (RICE) and are commonly used for digester gas utilization applications; a picture of

a RICE is shown in **Figure 8-1**. Other types of CHP systems that are less frequently deployed at wastewater plants include Microturbines, Fuel Cells, and Linear Generators.

All CHP systems require digester gas pretreatment systems to operate reliability and efficiently. Typical digester gas pretreatment systems include hydrogen sulfide, moisture, and siloxane treatment systems to chemical compounds that are harmful to CHP engines.



Figure 8-1: 335 kW CHP System Example

8.3 Renewable Natural Gas (RNG)

RNG is a carbon-neutral fuel that is physically and chemically identical to natural gas. RNG is produced by removing contaminants, like hydrogen sulfide (H_2S), moisture, volatile organic compounds (VOCs) and siloxanes from digester gas and concentrating it to >98% methane. Technologies commonly used for converting digester gas to RNG include pressure swing adsorption (PSA), molecular filters (membranes), chemical scrubbing, and water scrubbing. RNG production technologies are typically 90-99% efficient at recovering energy (methane) from biogas. Byproducts from the RNG conversion process (tail gas) are generally treated using an onsite thermal oxidizer. Revenue would be generated from the sale of RNG into the transportation sector as a renewable fuel to produce D3 Renewable Identification Numbers (D3 RINS), which are sold to oil and gas companies who are mandated to blend renewable fuels or purchase RINs to meet compliance under the US Renewable Fuels Standard.

There are two primary pathways into the transportation fuels market:

- Pathway 1 – Direct Vehicle Fueling. RNG would be compressed and stored for onsite vehicle fueling. The RNG could be used to fuel compressed natural gas (CNG) capable vehicle fleet, such as refuse trucks, to offset purchased liquid fuels (i.e. diesel and gasoline). The RNG could also be sold to other agencies with CNG vehicles at the retail CNG prices.
- Pathway 2 – Pipeline Injection. RNG would be injected into the local gas utility's pipeline and distribution system to transportation fuel customers. The RNG will generate revenue through methane sales and through the generation of renewable energy commodities that can be

traded/sold to parties obligated to meet the renewable energy requirements under the EPA Renewable Fuel Standards (RFS2). Based on discussions with various third party RNG marketing companies, RNG can also be sold as a renewable material to corporations who manufacture goods from natural gas such as plastics and chemicals.

9. Existing Bioenergy Recovery Data

9.1 Digester Gas Production

Digester gas production was estimated for both TPAD and MAD digestion alternatives and are shown in **Figure 9-1**. Digester gas production projections were based on plant flow/loadings projections and the volatile solids destruction within the digesters. Current (2023) digester gas production with the existing TPAD process was estimated to be 78 SCFM (AA). Compared to traditional MAD, TPAD was estimated to produce 40% more digester gas.

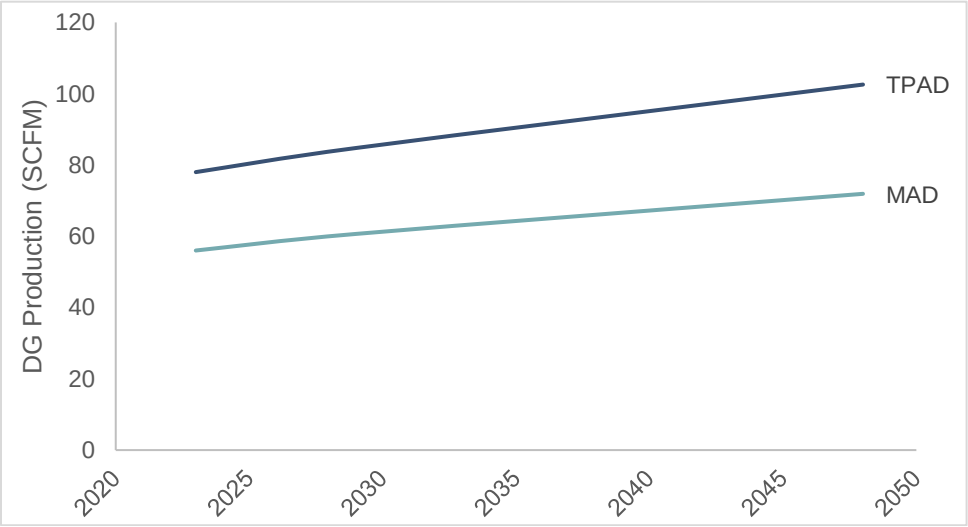


Figure 9-1: Projected Digester Gas Production (2023-2048)

9.2 Digestion Heat Requirements

Digester heat demands were estimated for both TPAD and MAD digestion process alternatives and were based on a model of sludge heating and heat losses through digester surfaces. The heat demands were calculated for assumed operating temperatures of 140 °F and 98 °F for TPAD and MAD, respectively. Max monthly heat demands were calculated for max monthly loading rates and low winter ambient temperature. WWTP staff noted that flow sensors which measure digester gas combusted in the boilers are inaccurate and/or unreliable. Therefore, existing boiler fuel consumption data was not used to calculate the current digester heat demands. The average annual (AA) and maximum monthly (MM) projected digester heating demands are shown on **Figure 9-2**.

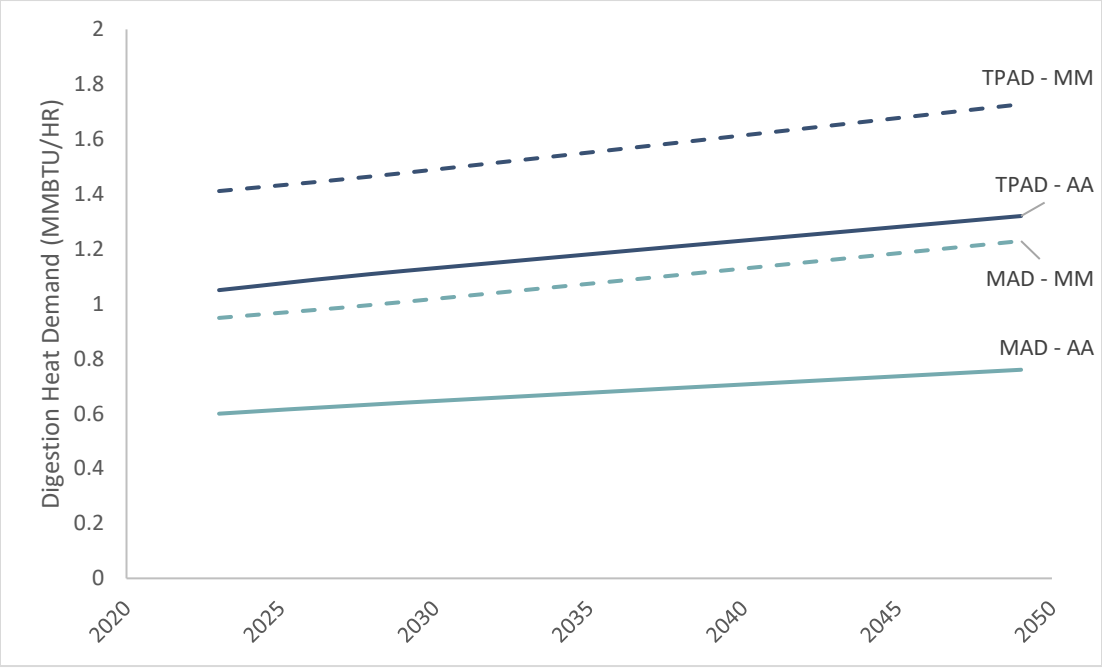


Figure 9-2: Digester Heat Demands

10. Existing Digester Gas Infrastructure Capacity and Condition Assessment

A capacity and condition assessment was performed to understand the condition of existing biogas utilization infrastructure, including digester gas (DG) storage, conveyance, boilers, and flares.

10.1 DG Storage

The existing infrastructure for storing digester gas is a 60,000 Dystor dual-membrane gas holder atop Digester 1 as shown in the photograph in **Figure 10-1**. The gas holder was originally installed in 2006, but the inner membrane was replaced as part of the digester rehab project in 2018 and then again under its warranty in 2020. No issues were noted by plant staff, and visual inspection of the holder confirmed that

there are no obvious problems with its condition. The system was originally installed in 2006, however, replacement may be needed within the next 10 years. The gas holder collects digester gas produced by the fermenter and the other digesters, which have fixed covers that don't offer any storage. A blower maintains 10-11 inches W.C. between the inner and outer membrane; this pressure is enough to deliver digester gas to the boiler system and flare.



Figure 10-1: Dystor Gas Holder

Currently, minimal digester gas storage is necessary because OWASA is using digester gas in its boilers, which require less fuel than the average rate of digester gas production. For this reason, it was assumed that the gas holder should have capacity to store 1 hour of annual average gas production. The current capacity of gas holder (60,000 gal) should be sufficient over the near-term (2037) and long-term (2070) planning horizons for both TPAD and MAD, as illustrated in **Figure 10-2**.

If OWASA were to implement an alternative digester gas utilization strategy, as discussed in subsequent sections, additional digester gas storage may be warranted. CHP and RNG are generally designed to maximize utilization of digester gas, so storage is usually designed to hold 2-4 hours' worth of annual average digester gas production to smooth variability and provide consistent gas flow to these systems. It would be worth evaluating additional gas storage in this case.

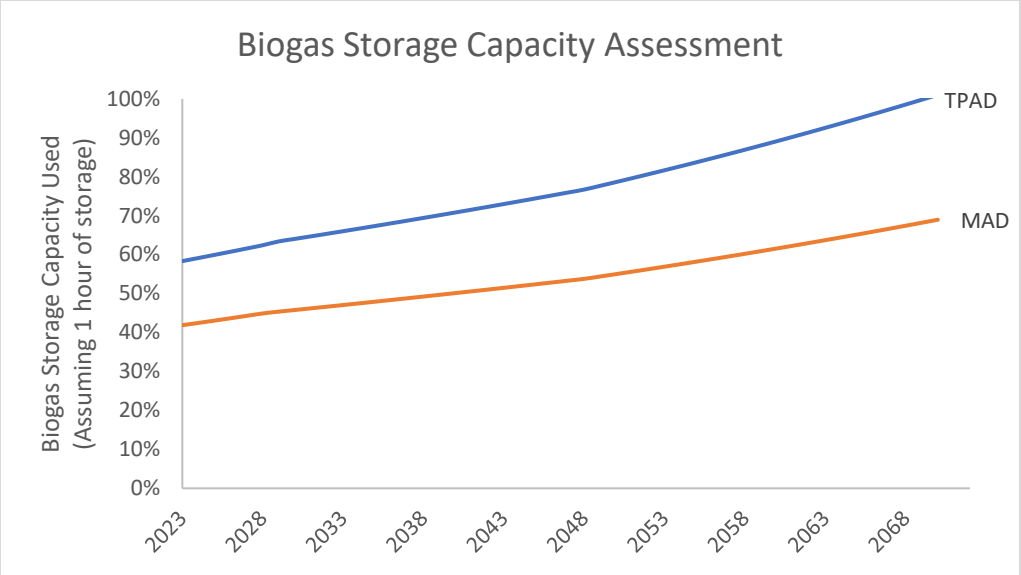


Figure 10-2: Biogas Storage Capacity Assessment (60,000 Gal)

10.2 Conveyance

Digester gas is conveyed through 10" diameter stainless steel piping from the digesters to the boiler, as shown in **Figure 10-3**. As part of the 2018 digester rehab project, outdoor piping was insulated to resolve issues with condensate occasionally freezing and causing high head-loss. Based on visual inspection, there are no signs of corrosion, and plant staff did not note any additional issues with the system.



Figure 10-3: Existing Gas Conveyance

10.3 Boilers

The existing boilers are duty and standby 2.5 MMBTU/HR Cleaver Brooks boilers installed in 2000. The boilers are shown in **Figure 10-4**. The boilers were recently cleaned and retubed. Significant siloxane buildup was noted during the cleanout. Plant staff noted that the boilers are generally cleaned and retubed every 2-3 years at a cost of ~$50k. Installation of a digester gas pretreatment system would reduce the frequency of this boiler maintenance and improve reliability of the boiler system.



Figure 10-4: Existing Boilers

The 2.5 MMBTU/HR boilers were projected to have sufficient capacity over the near-term (2037) and long-term (2070) planning horizons, for both TPAD and MAD digestion heat demands, as demonstrated in **Figure 10-5**. Heat demands (Digestion Heat Requirements) were estimated for max monthly flow and winter minimum sludge and ambient temperature conditions. The boiler – heat exchanger system was assumed to be 85% efficient at converting fuel energy into useful heat.

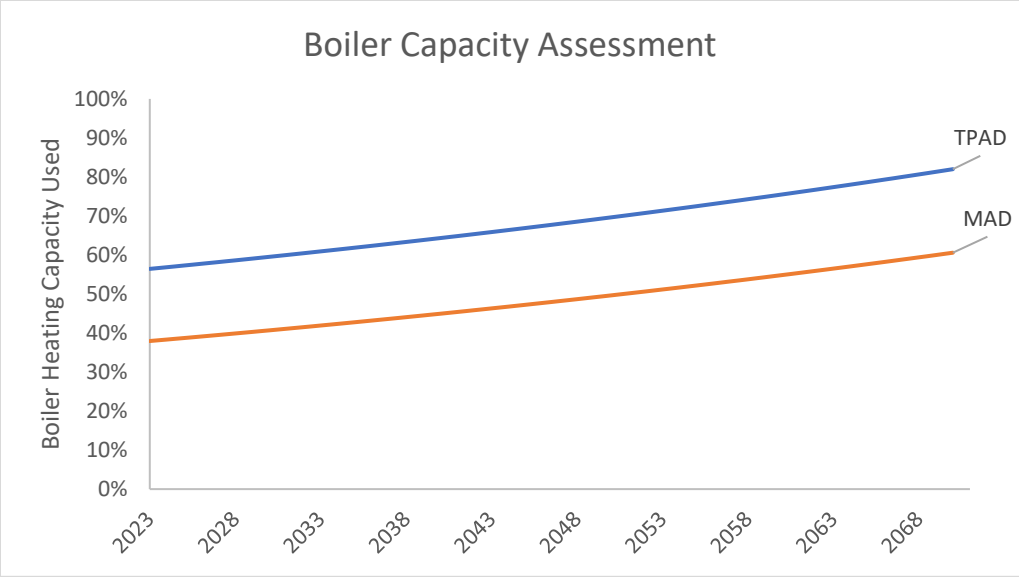


Figure 10-5: Boiler (2.5 MMBTU/HR) Capacity Assessment

10.4 Flare

The plant has a primary flare and a backup flare. Nameplate info for the backup flare could not be located, and at the time of this report, the backup flare was recently rebuilt and painted (**Figure 10-6**). No additional technical information was available for the backup flare. For purposes of this evaluation, it was assumed that this flare would remain as a backup. The primary flare, which did have nameplate info, is rated to combust 25,580 SCFH of digester gas. The primary flare capacity projection is summarized in **Figure 10-7**. As shown on **Figure 10-7**, the primary flare has sufficient capacity to flare all biogas produced over the near- and long-term planning horizons.



Figure 10-6: Existing Flares

The primary flare is projected to have sufficient capacity to combust waste digester gas for the near-term (2037) and long-term (2070) horizons, for both TPAD and MAD gas production rates as shown in **Figure 10-7**. DG production was estimated for max week flow conditions to determine the amount of capacity used.

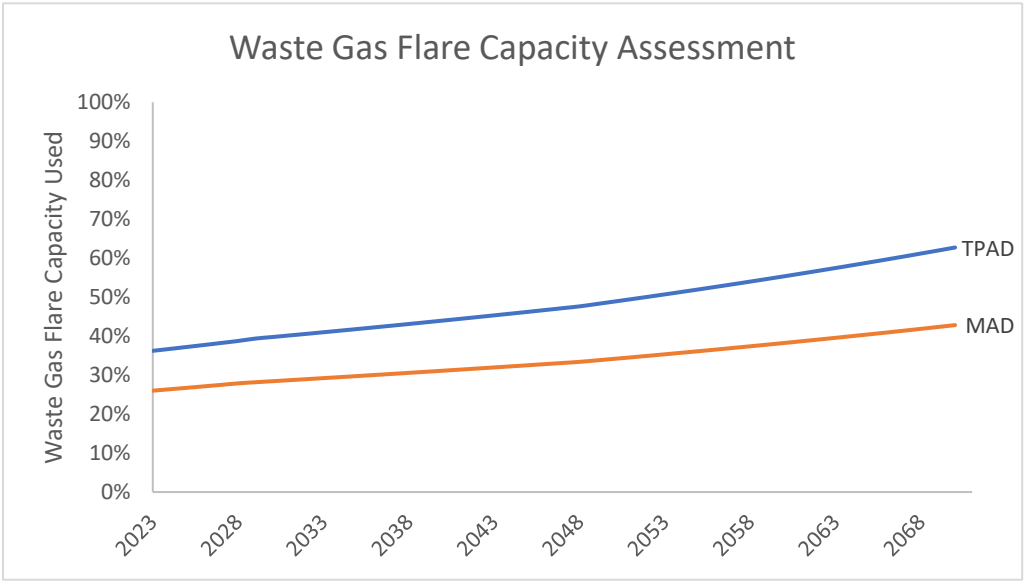


Figure 10-7: Primary Waste Gas Flare (25,580 SCFH) Capacity Assessment

11. Biogas Utilization Alternatives Evaluation

This section describes the assumptions, energy results, and financial results of the following digester gas utilization alternatives included in this evaluation:

- Thermal energy production
- Electricity production using Combined Heat and Power (CHP) systems.
- Renewable natural gas (RNG) production

11.1 Modeling Approach

An energy and financial balance model was created to perform a cost/benefit/risk comparison of the biogas utilization alternatives. This model was developed using Hazen's Energy Balance and Analysis Tool (EBAT), which models the complex relationship between energy production, energy demands, and energy costs to provide long-term cost/benefit assessments of biogas generation and utilization alternatives. The EBAT model was customized to the processes and economic/financial conditions unique to Mason Farm WWTP. The EBAT model calculates cost/revenues on an annual basis for each year in nominal dollars over a 20-year life cycle, with the assumed project horizon being 2028-2047. To simplify the 20-year life cycle costs, the revenue and cost data are shown in terms of net present values (NPV) which represent the cumulative 20-year life cycle cost/revenue in present day dollars. This study takes the following elements into consideration:

- Current digester gas production and projection
- Digester gas energy content
- Boiler heat demands
- Seasonal variations in boiler heat demands
- CHP electrical efficiency
- RNG methane recovery efficiency
- Expected equipment uptimes
- Estimated capital costs for CHP, RNG, and Biogas Pretreatment Systems
- Value of electricity offset savings
- Wholesale value of methane and utility wheeling charges
- Average market value of D3 RINs
- Biosolids production
- Biosolids disposal costs
- Biosolids process gas demands
- Long-term projections of natural gas and electricity costs
- Estimated pipeline interconnection costs
- The social cost of carbon

11.2 Financial Assumptions

11.2.1 Purchased Energy Cost Assumptions

Electricity costs were determined by analyzing OWASA's Duke Energy billing data from 2017-2021. The average unit cost of electricity over this period was $0.06/kWh. Electricity prices have risen sharply since the start of the project to $0.08/kWh, so a recent bill (September 2023) was used to update the analysis. **Figure 11-1** summarizes the energy and demand charges from the recent bill. Electricity prices were escalated in the financial analysis to project electricity costs over the assumed project horizon (2028-2047).

Since CHP systems typically have one or more downtime events during each electricity billing period, it was assumed the demand fraction of the electricity costs would not be realized as a part of the revenue generated by the CHP system. Therefore, the CHP revenue projections and calculations were based on the energy component of the energy cost only ($0.05/kWH).

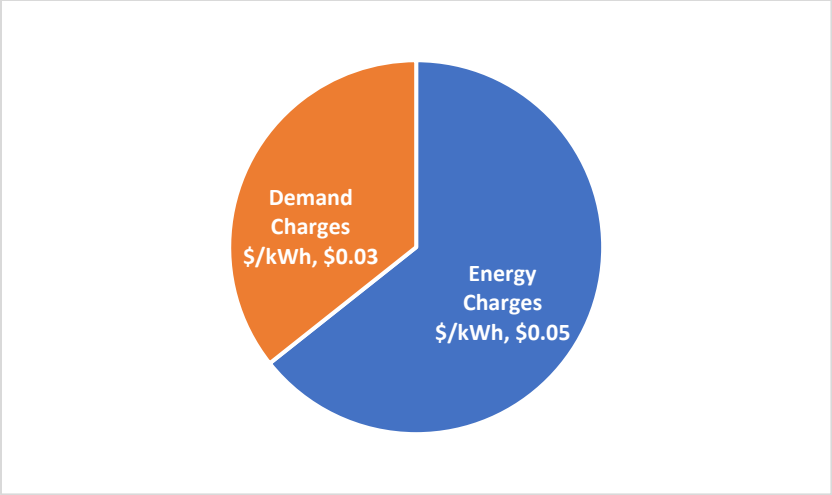


Figure 11-1: Electricity Cost Breakdown

Natural gas unit costs were determined by analyzing OWASA's PSNC billing data from 2017-2021. The average unit cost over this period was $6.06/MMBTU. Natural gas prices were escalated in the financial analysis to project the cost of natural gas over the project horizon (2028-2047).

11.2.2 RNG Revenue Market Assumptions

Revenue from RNG is typically from sales of the methane and the sales of the environmental/renewable energy attributes. By selling the RNG into the transportation sector as a renewable fuel, the RNG would also qualify to generate environmental attributes knows as RINs. Selling the RNG into the transportation sector will require the RNG to be injected into the natural gas pipeline network to service as a physical pathway to a transportation customer. For purposes of this study, it was assumed that RNG would be pipeline injected into PSNC's grid at the location shown on **Figure 11-2**. PSNC provided a preliminary feasibility analysis and stated that this point was feasible and that approximately 4,000 feet of pipeline extension would be needed to deliver RNG from Mason Farm WWTP (**Appendix A**).

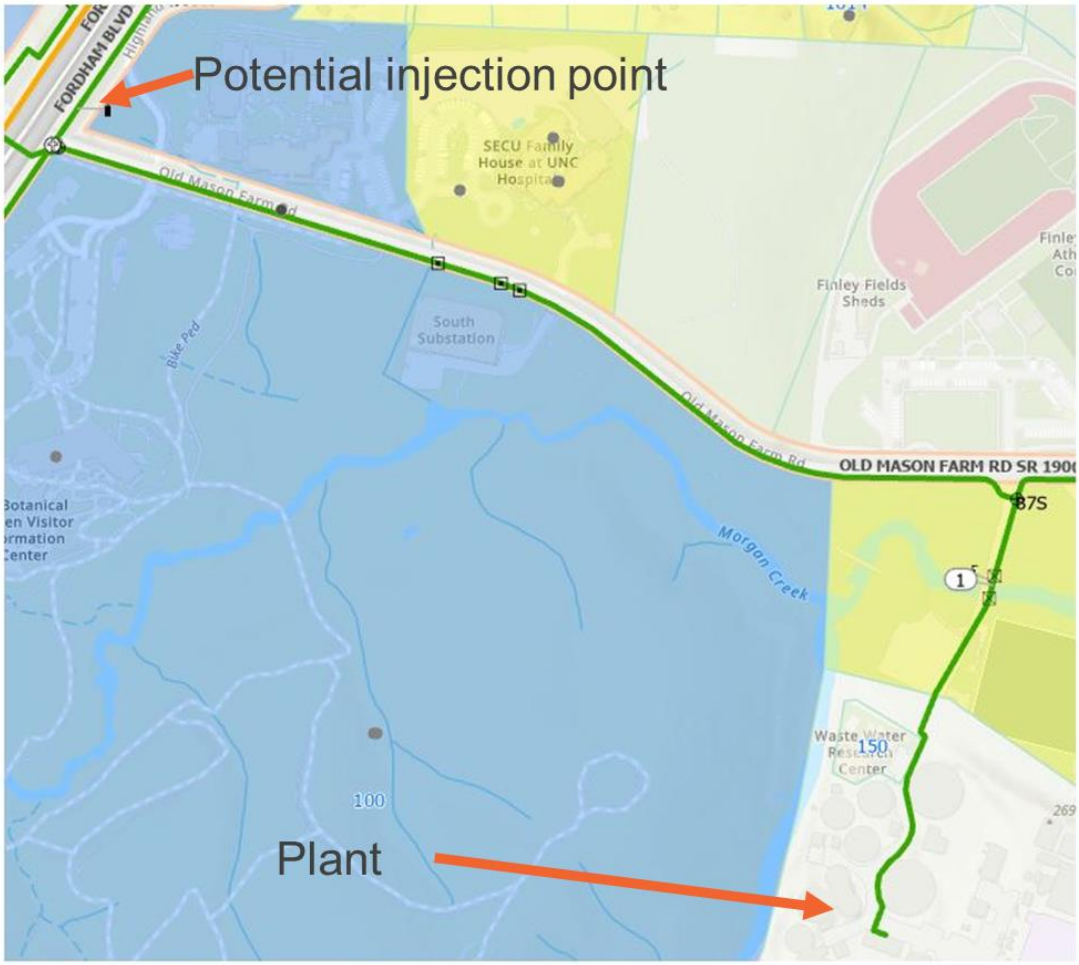


Figure 11-2: Assumed Injection Point and Pipeline Extension Length (PSNC)

Once RNG is pipeline injected, it can be sold to a customer in the transportation sector as a renewable vehicle fuel so that D3 RINs can be generated. The historical average value of D3 RINs was projected over the 20 year project horizon to estimate RIN revenue in the financial model, shown **Figure 11-3**.

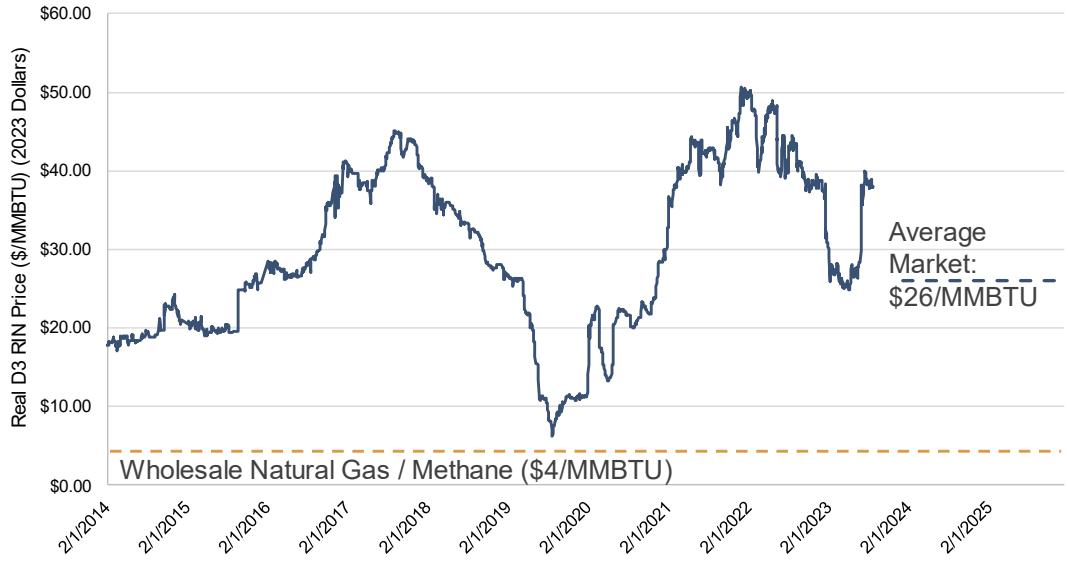


Figure 11-3: D3 RIN Market Projection

11.2.3 Rate Assumptions

The rate assumptions used for the financial analysis are:

- Interest Rate: 5%, assumed rate on municipal bonds
- Discount Rate: 5%, risk-free rate of return
- Construction Escalation Rate: 5%
- Natural Gas Cost Escalation Rate: 2.2%, EIA Annual Energy Outlook
- Electricity Cost Escalation Rate: 1.7% EIA Annual Energy Outlook
- Escalation rate on O&M, Labor, & Other Costs: 3%, average inflation rate

11.3 Proposed Site Plans (Bioenergy Equipment)

Preliminary site plans were developed for each alternative: DG to Thermal Systems (**Figure 11-4**), CHP (**Figure 11-5**), and RNG (**Figure 11-6**).

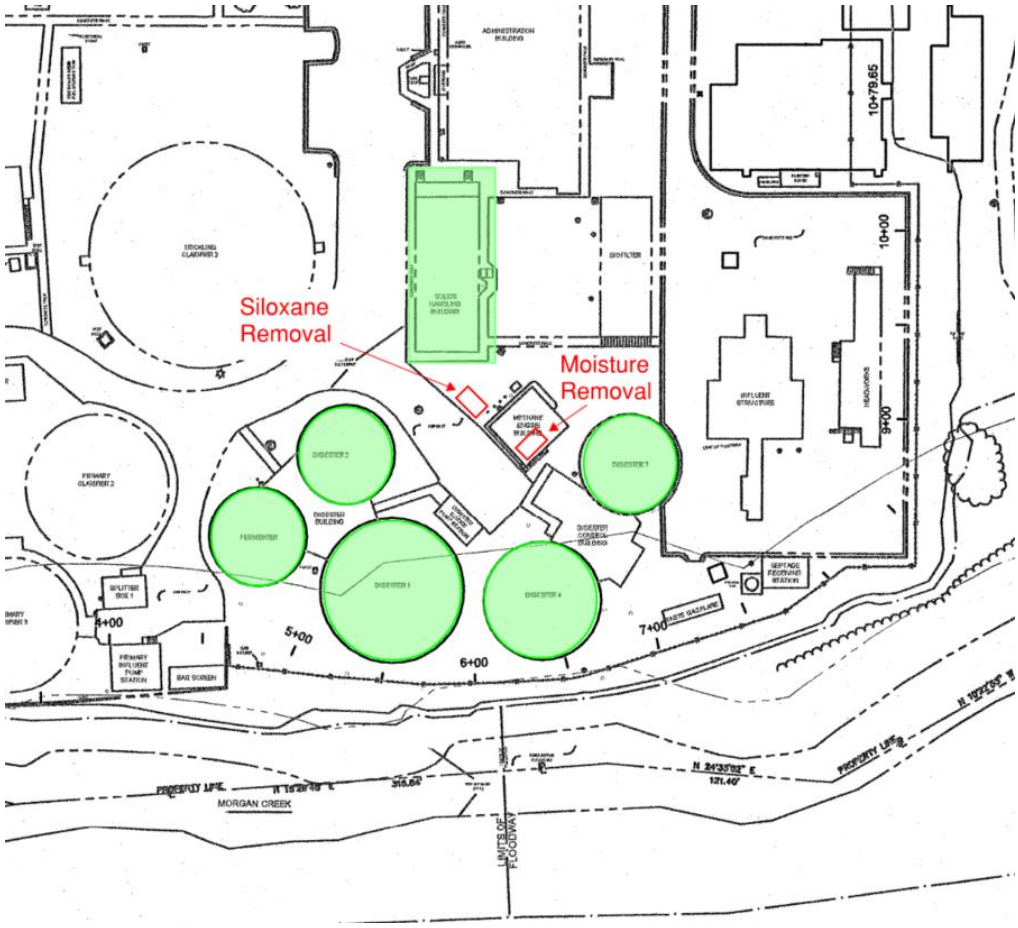


Figure 11-4: Proposed DG to Thermal Systems Site Plan

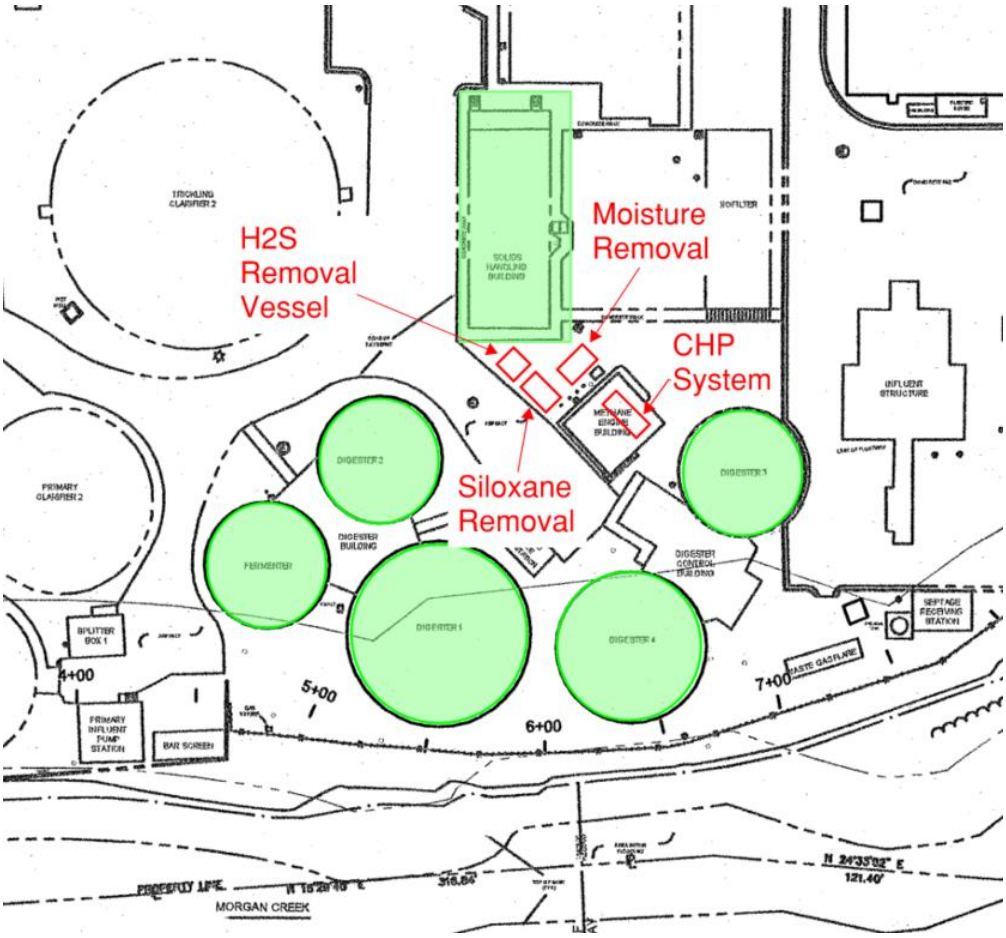


Figure 11-5: Proposed CHP Site Plan

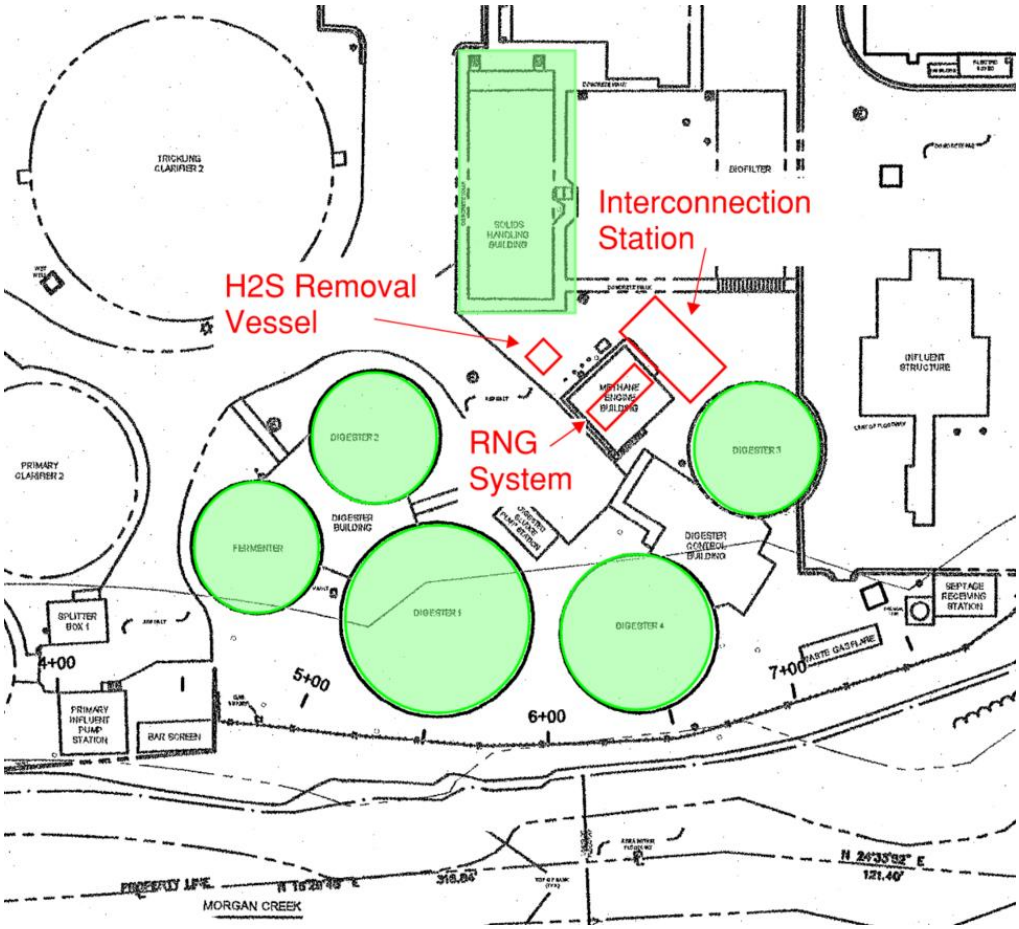


Figure 11-6: Proposed RNG Site Plan

11.4 Opinion of Probable Cost

A high-level Opinion of Probable Cost (OPCC) was estimated for each biogas utilization alternative by combining recent vendor equipment quotes with costs for construction, labor, electrical and I&C integration, contractor overhead & profit, bonds & insurance, and 40% for contingencies.

Costs for biogas pretreatment, consisting of moisture removal and H_2S and siloxane removal systems, were included for all alternatives, including the DG to Thermal Systems. While OWASA currently does not pretreat DG used in their boilers, other biosolids process thermal systems, like thermal dryer or gasification/pyrolysis, may require DG conditioning so it was included to be conservative.

Engineering and construction management costs were added to develop the total estimated construction cost for each alternative; these are shown in **Table 11-1**.

Table 11-1: Biogas Utilization Capital Costs

		DG to Thermal Systems	CHP	RNG
Material and Labor Subtotal		$1,000,000	$2,410,000	$5,300,000
Contingencies	40%	$400,000	$960,000	$2,120,000
OPCC		$1,400,000	$3,370,000	$7,400,000
Engineering	10%	$140,000	$340,000	$750,000
Construction Management	10%	$160,000	$370,000	$820,000
Total Estimated Construction Cost in 2023 Dollars		**$1,700,000**	**$4,100,000**	**$9,000,000**

11.5 Funding Outlook

In addition to traditional competitive grant programs for renewable energy projects, the most impactful incentive to consider is the Investment Tax Credit (ITC) from Section 48 of the US Tax Code. The recently passed 2022 Inflation Reduction Act (IRA) made the following changes to the ITC incentives:

1. Made ITCs available to non-taxed entities, such as utilities, as a refundable tax credit, or "Direct Pay".
2. Expanded the Energy Investment Tax Credit to include Qualified Biogas Property (i.e. RNG and biogas conditioning systems), as well as biogas to CHP systems. However, the deadline for Qualified Biogas Property is to have a construction start of December 2024.
3. ITC deadline for "Clean Electricity Technologies" was extended to 2032, but it is required to show that lifecycle greenhouse gas emissions are 0 g CO2 / kWh in the case of combustion technologies. In our view, producing electricity from digester gas is a net neutral technology; however, the administrator (Treasury Department) has not yet published guidance related to GHG emissions of combustion technologies and is accepting public comments.

The December 2024 construction start deadline for RNG is too immediate to make the ITC for RNG feasible; however, because the Clean Electricity Tax Credit has a construction start deadline of December 2031, biogas to CHP could qualify for a credit worth 6-50% of capital cost. A scenario that includes the 30% credit for CHP was modeled and the results are provided in Scenario 2: With ITC for CHP below.

11.6 Potential eRIN Pathway

On December 1, 2022, the EPA proposed the SET rule, which consisted of proposed Renewable Volume Obligations (RVOs) for 2023-2025, changes to co-digestion classification of D3 versus D5 RINs, and a proposal to open a pathway for renewable electricity to qualify as a renewable fuel (eRIN Pathway).

The proposed eRIN pathway would allow a DG-fueled CHP to produce RINs at a rate of 1 RIN per 8 kWh, which would provide additional value from a CHP system.

While the EPA decided to not include this eRIN pathway in their June 21st, 2023, final rule, they continue to assess the comments received on their proposed regulations and work on a potential path forward for the eRIN program.

eRINs were not included in the baseline financial results because the regulations have not been finalized; however, the results with eRINs for CHP were modeled as a separate scenario (Scenario 3: With eRINs for CHP) to determine if that would be a major driver for CHP.

11.7 Results

Results below are presented for three different scenarios: the baseline, the baseline with ITC for CHP, and the baseline with eRINs for CHP. The baseline scenario (no funding nor eRINs included) was modeled with and without the social cost of carbon. OWASA advised to use $40/ton (in 2018 dollars) for the social cost of carbon. This cost was escalated to a 2023 $/ton value.

CHP and RNG maximize the use of DG compared to using DG solely for digester heating (**Figure 11-7**). DG could be fully utilized if Sludge Drying were implemented, but as discussed in the analysis of Biosolids Alternatives, Sludge Drying is not advised. Fully utilizing DG (rather than flaring) provides environmental benefits because it offsets CO_2 that would otherwise be emitted during production of electricity or combustion of gas.

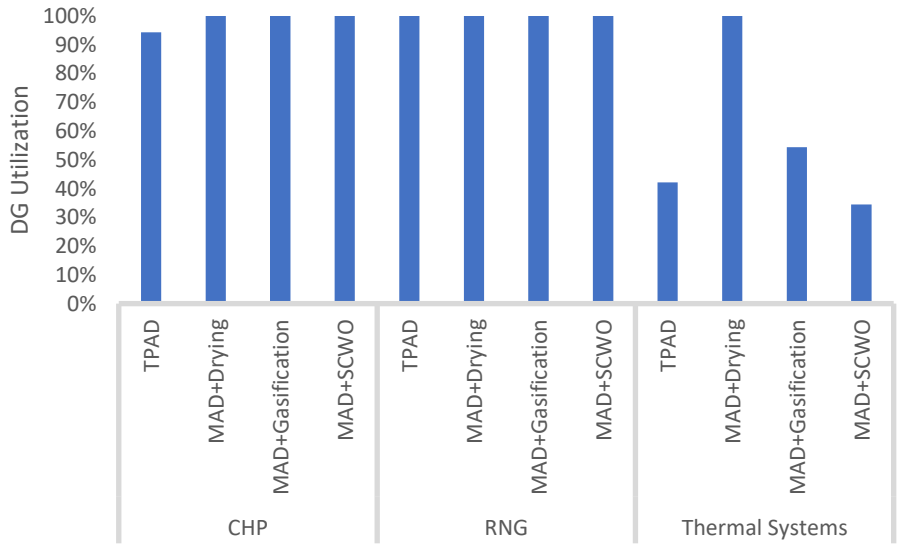


Figure 11-7: DG Utilization of Each Alternative

11.7.1 Scenario 1: Baseline

Under the baseline scenario, neither CHP nor RNG were found to have a positive 20-year NPV **(Figure 11-8**). Inclusion of the social cost of carbon in the financial model improved the 20-year NPV of CHP and RNG alternatives, however, the 20-year NPV remains to be negative for all of the alternatives (**Figure 11-9**).

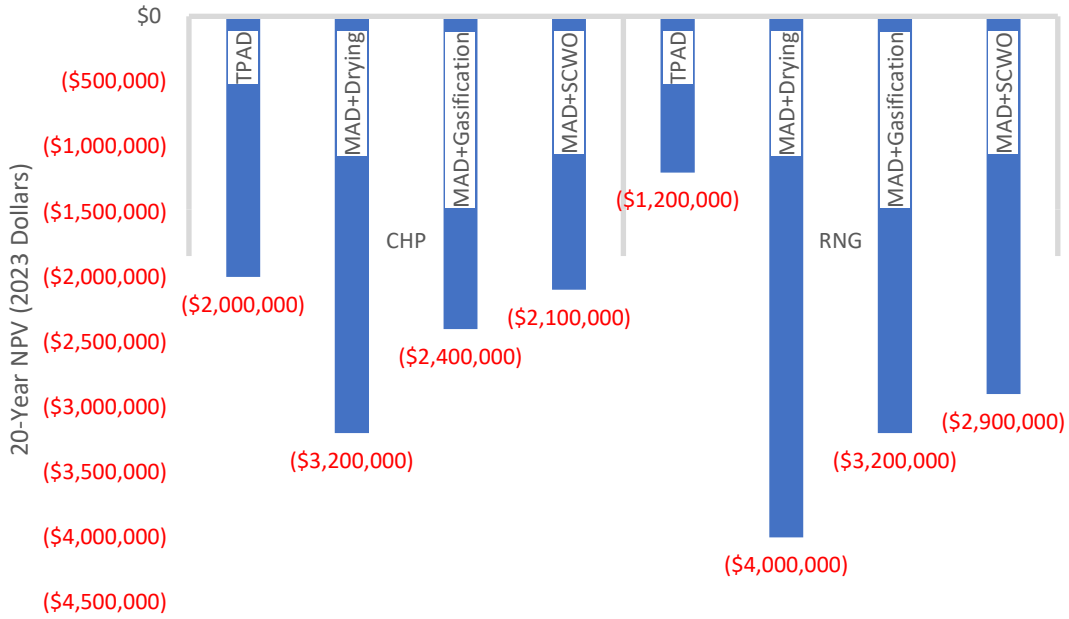


Figure 11-8: Biogas Utilization NPV Without the Social Cost of Carbon

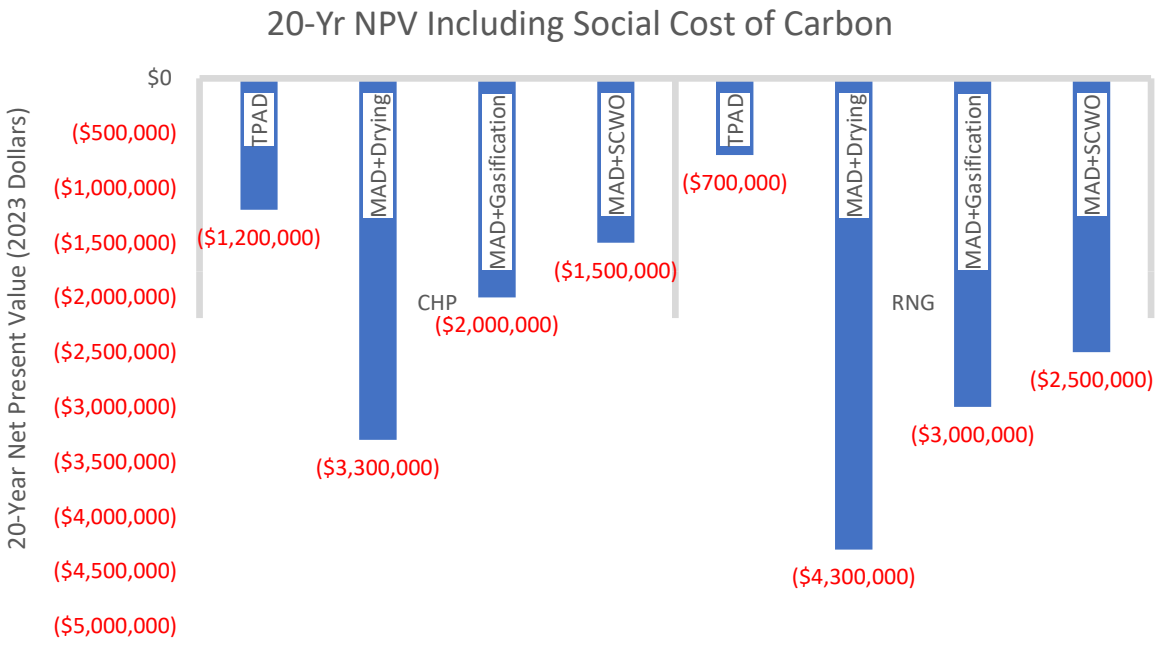


Figure 11-9: Biogas Utilization NPV with the Social Cost of Carbon

11.7.2 Scenario 2: With ITC for CHP

The financials were modeled with the 30% Clean Electricity Tax Credit (Scenario 2: With ITC for CHP) for CHP. The ITC improves the 20-year NPV of CHP, but, still, CHP is not expected to have a positive value (**Figure 11-10**).

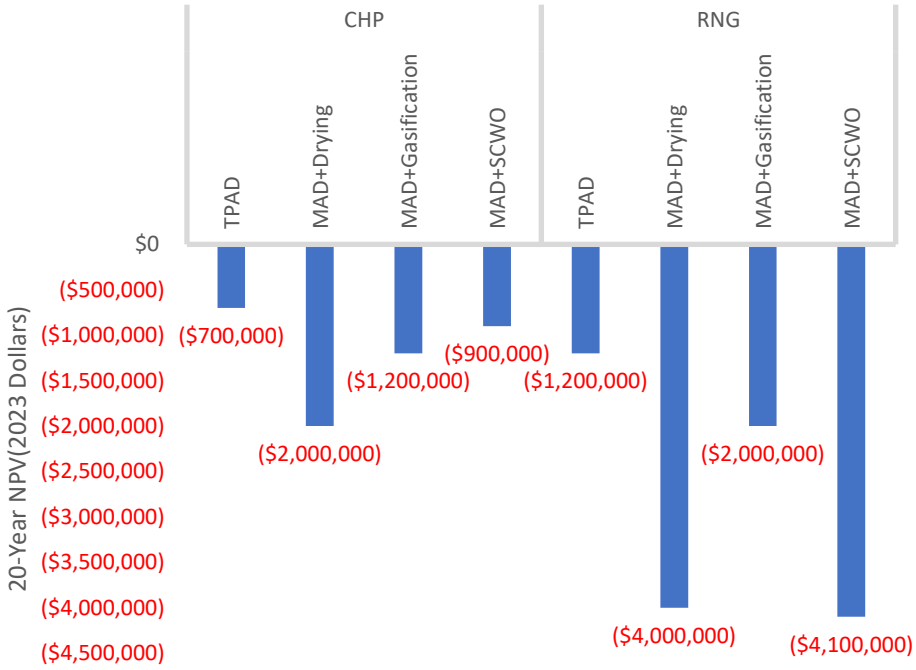


Figure 11-10: Biogas Utilization NPV with 30% ITC Funding

11.7.3 Scenario 3: With eRINs for CHP

If the eRIN program (Potential eRIN Pathway) is finalized, CHP is expected to have a positive 20-year NPV under all biosolids process alternatives **(Figure 11-11**). Thus, the eRIN pathway is a driver that could make CHP financially compelling.

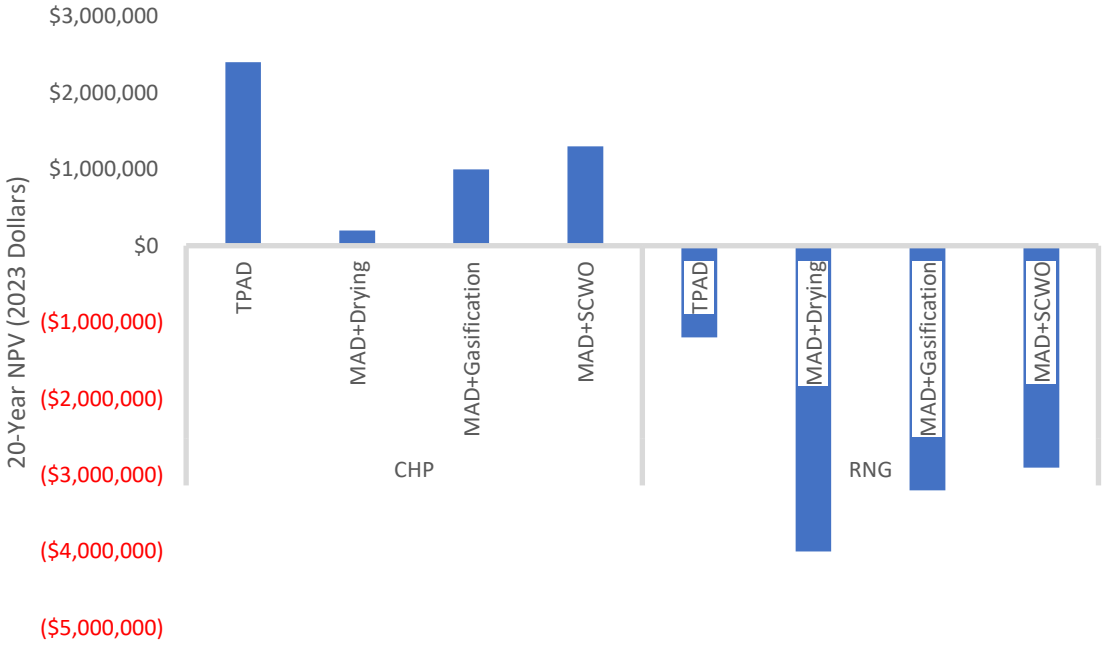


Figure 11-11: Biogas Utilization NPV with eRIN Pathway

11.8 Considerations

The alternative with the least risk is DG to Thermal Systems because it has the lowest capital cost, and its financial benefits (NG cost savings) are relatively stable and predictable. Additionally, the DG to Thermal Systems alternative poses the lowest impact to existing operations of the WWTP and the site's emissions profile. CHP and RNG require higher capital investments, and the financial benefits (NG and electricity cost savings for CHP, revenues for RNG) do not underwrite the investments in either alternative. There are funding and incentives for CHP and RNG that could improve their financial pro forma.

A summary of considerations for evaluation of biogas utilization alternatives is provided in **Table 11-2**.

Table 11-2: Summary of Biogas Utilization Considerations

	DG to Thermal Systems	CHP	RNG
Financial Value	Low capital cost Low energy prices = low savings	High capital cost Low energy prices = Low revenue potential. Potential for eRINs to boost benefit	Higher capital cost Strong RIN Market = High revenue potential
Operations	Minimal change to existing operations	High O&M costs and labor	High O&M costs and labor
Revenue Volatility	Stable and predictable	Stable and predictable	Higher level of volatility but showing signs of stability
Funding Availability	Minimal	Potential ~30% if construction starts before 2032 (Section 48e ITC)	~30% *if construction starts before 2025* (Section 48 ITC)
Emissions	Low site emissions from combustion of biogas in boilers	Higher NOx, CO site emissions from internal combustion engine	Minimal NOx, CO site emissions because RNG combusted off-site

11.9 Recommendations

Under current/baseline conditions, it is recommended to continue using DG to heat digesters since neither CHP nor RNG provides a positive 20-year NPV. The list below includes conditions or "triggers" that could warrant OWASA to further explore or implement CHP or RNG. The most notable trigger is the eRIN pathway, which could create a compelling financial case for CHP. These biogas utilization triggers will be implemented into the trigger-based roadmaps which will be developed as part of Task 7.

- Thermal systems
  - Baseline recommendation: Use biogas to heat digesters. Use biogas in sludge drying systems if these systems are needed to meet regulatory or other drivers.
- CHP
  - If eRIN pathway develops and substantially boosts value of electricity production.
  - If additional funding opportunities develop that would create a financial justification for CHP.
  - If OWASA's objective is to minimize flaring
- RNG
  - If funding specific to RNG is available or RIN market strengthens further.
  - If OWASA's objective is to minimize flaring.

Appendix A: PSNC Feasibility Analysis

Behr, Adam

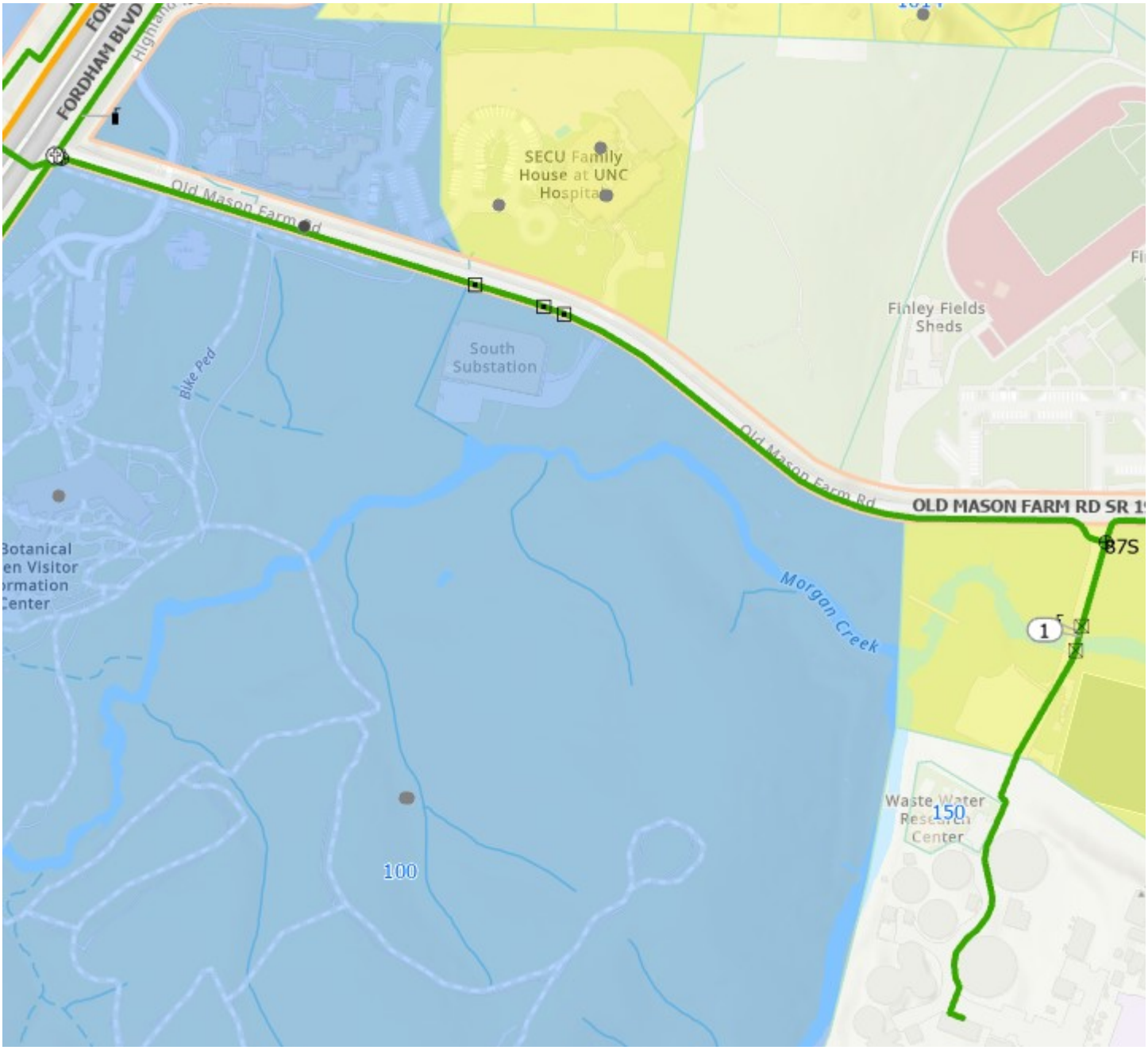
From: GREGORY STATON <gregory.staton@dominionenergy.com>
Sent: Friday, July 7, 2023 1:42 PM
To: Behr, Adam
Cc: Lisk, Bryan R.; WILLIAM MCELRATH; JEREMIAH O'KEEFFE
Subject: FW: RNG Discussion

You don't often get email from gregory.staton@dominionenergy.com. Learn why this is important

Adam,

Lee asked me to send you a map showing the location of the gas line that serves OWASA. The green line is the 60 psi line that serves OWASA and the yellow line on Fordham Blvd is the high pressure line.

Let me know if you have any questions.



Greg Staton
Gas Development Services Consultant

Mailing Address:
66 N. Chatham Pkwy
Chapel Hill, NC 27517
M: 919-819-9882

Domini Energy

From: Behr, Adam <ABehr@hazenandsawyer.com>
Sent: Wednesday, July 5, 2023 3:49 PM

To: Lee McElrath (Gas Distribution - 5P) <lee.mcelrath@dominionenergy.com>; Lisk, Bryan R. <blisk@hazenandsawyer.com>
Cc: Jeremiah O'KEEFFE (Gas Distribution - 5P) <jeremiah.okeeffe@dominionenergy.com>
Subject: [EXTERNAL] RE: RNG Discussion

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Hi Lee and Jeremiah,

Hope y'all had a nice holiday weekend.

I think you mentioned that you have a rough sketch of the pipe routing from Mason Farm WWTP to the high-pressure line along 15-501. Are you able to share that with us so we can include it in our report to Orange County Water and Sewer Authority as justification for the ~4,000 ft of pipeline extension that we are assuming?

Thanks,

Adam Behr, EIT

Assistant Engineer | Hazen and Sawyer
4011 Westchase Blvd. Raleigh, NC 27607
919-833-7152 (main) | 334-306-1022 (cell)
abehr@hazenandsawyer.com | hazenandsawyer.com

From: WILLIAM MCELRATH <lee.mcelrath@dominionenergy.com>
Sent: Wednesday, June 28, 2023 10:49 AM
To: Behr, Adam <ABehr@hazenandsawyer.com>; Lisk, Bryan R. <blisk@hazenandsawyer.com>
Cc: JEREMIAH O'KEEFFE <jeremiah.okeeffe@dominionenergy.com>
Subject: RNG Discussion

Caution! *External email – think before you click*

Gentlemen,

Enjoyed our discussion on Monday and let us know if we can be of further assistance as you work with potential projects in our service area.

Best Regards,

Lee McElrath, CEM
Manager, Key Accounts & Commercial Service
Dominon Energy NC Gas
828-230-7118
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ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
S. DANIEL SMITH
Director

NORTH CAROLINA
Environmental Quality

June 19, 2020

Ms. Monica Dodson
Wastewater Treatment and Biosolids Recycling Manager
Orange Water & Sewer Authority
400 Jones Ferry Road
Carrboro, North Carolina 27510

Subject: Final NPDES Permit Renewal
Permit NC0025241
Mason Farm WWTP
Orange County
Grade IV Biological WPCS
SIC Code 4952

Dear Ms. Dodson:

Division personnel have reviewed and approved your application for renewal of the subject permit. Accordingly, we are forwarding the attached NPDES permit. This permit is issued pursuant to the requirements of North Carolina General Statute 143-215.1 and the Memorandum of Agreement between North Carolina and the U.S. Environmental Protection Agency dated October 15, 2007 (or as subsequently amended).

Please note that the receiving stream is listed as impaired for **benthos and fish community** on the North Carolina **2018** 303(d) Impaired Waters List. Addressing impaired waters is a high priority with the Division, and instream data will continue to be evaluated. If there is noncompliance with permitted effluent limits and stream impairment can be attributed to your facility, then mitigative measures may be required.

The following change was made to the 2nd draft permit sent to you on April 21, 2020:

- Deleted bullet 3 on page 2 in the letter because OWASA received an approved Authorization to Construct (ATC) permit dated December 10, 2012.

The final permit maintains the following significant changes identified in the letter sent on April 2, 2019 and April 21, 2020:

- The Division acknowledges the facility has an approved Authorization to Construct (ATC) permit dated December 10, 2012. Per S.L. 2013-395 (S515), the TN limit becomes effective on January 1, 2021 with an ATC permit for construction, installation, or alteration of the treatment works for compliance with the TN limits.
- All references for BOD in the first draft permit were corrected to CBOD.
- The language regarding Practical Quantitation Limit (PQL) has been revised.

- An email address for electronic submittal of toxicity testing results has been added to the Chronic Toxicity Permit Limit [See A. (3)].
- The specific three years in which the Effluent Pollutant Scans shall be performed have been changed from 2020, 2021, and 2022 to 2021, 2022, and 2023 in the Special Condition A. (4).
- Parameter codes and means for electronic submittal have been added to the Effluent Pollutant Scan [See A. (4)].
- Special Condition A. (9) Mercury Minimization Plan (MMP) has been removed from the permit after a reevaluation of the effluent mercury data.
- Based on no reasonable potential for Nitrate to exceed water quality standards but predicted maximum effluent concentration is greater than 50% of allowable discharge concentration, limits for Nitrate Nitrogen (NO_3-N) have been removed from the permit, and monitoring frequency has been reduced from monthly to quarterly [See Section A. (1)].
- Weekly monitoring for NO_3-N + NO_2-N has been added to the permit for calculation of Total Nitrogen [See Section A. (1)].
- Quarterly monitoring requirements for total copper, total zinc and total mercury have been removed from the permit based on no reasonable potential to exceed water quality standards [See Section A. (1)].
- The Permittee reported Total Arsenic, Total Lead and Total Silver at less than detection, with detection levels < 10.0 µg/L for Total Arsenic and < 5.0 µg/L for Total Lead and Total Silver. The allowable monthly discharge concentrations for your facility are 11.9 µg/L for Total Arsenic, 7.1 µg/L for Total Lead and 0.06 µg/L for Total Silver. DWR's laboratory identifies the target Practical Quantification Limits (PQLs) for Total Arsenic and Total Lead as 2.0 µg/L and for Total Silver as 1.0 µg/L. In accordance with 15A NCAC 2B .0500 all test procedures must produce minimum detection and reporting levels that are below the allowable discharge concentration and all data generated must be reported down to the minimum detection level or lower reporting level of the procedure. The Permittee should use sufficiently sensitive test methods when analyzing effluent data, including performing Effluent Pollutant Scans. Following is a link to DWR's *METHODS, PQLs, QA* to view target PQL's:

  https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa

- Some of the wording has changed in Section A. (2). Instream Monitoring Requirements, please review carefully.
- Some of the wording has changed in Special Condition A. (3). Chronic Toxicity Permit Limit, please review each paragraph carefully.
- Special Condition A. (4) has been modified to include the specific three years in which the Effluent Pollutant Scans shall be performed (2021, 2022, and 2023). In addition, at the end of the Special Condition, 2nd species Toxicity Testing Requirements for municipal permit renewals per Federal Regulations [40 CFR 122.21(j)(5)] have been added.
- Some of the wording has changed in Special Condition A. (5). Nutrient Allocations and A. (6). Annual Limits for Total Nitrogen or Total Phosphorus, please review each paragraph carefully.
- Effluent mercury data was reviewed from January 2014 to May 2018. The Permittee started testing effluent mercury using EPA test Method 1631E in January 2014. In accordance with the 2012 Mercury TMDL NPDES Guidance the permittee needs to show annual mean effluent concentrations below the Water Quality Based Effluent Limitation (WQBEL) of

12.5 ng/L, and all individual values below the Technology Based Effluent Limitation (TBEL) of 47 ng/L. A review of the data showed that the annual averages were below the WQBEL and no individual value exceeded the TBEL, therefore, no mercury limitation is required.

- Federal regulations require electronic submittal of all discharge monitoring reports (DMRs) and program reports. The requirement to continue reporting discharge monitoring data electronically using the NC DWR's Electronic Discharge Monitoring Report (eDMR) internet application has been updated in the permit. [See Special Condition A. (9)]
- Regulatory citations have been added to the permit.

If any parts, measurement frequencies or sampling requirements contained in this permit are unacceptable to you, you have the right to an adjudicatory hearing upon written request within thirty (30) days following receipt of this letter. This request must be in the form of a written petition, conforming to Chapter 150B of the North Carolina General Statutes, and filed with the Office of Administrative Hearings (6714 Mail Service Center, Raleigh, North Carolina 27699-6714). Unless such demand is made, this decision shall be final and binding.

Please note that this permit is not transferable except after notice to the Division. The Division may require modification or revocation and reissuance of the permit. This permit does not affect the legal requirements to obtain other permits which may be required by the Division of Water Resources or any other Federal, State, or Local governmental regulations.

If you have any questions concerning this permit, please contact Min Xiao at (919) 707-3644 or via email at Min.Xiao@ncdenr.gov.

Sincerely,

for S. Daniel Smith, Director
Division of Water Resources, NCDEQ

Hardcopy: NPDES Files
Central Files

Ecopy: US EPA Region 4
DWR/Ecosystems Branch/Mark Vander Borgh
DWR/Aquatic Toxicology Branch/Hannah Headrick

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER RESOURCES

PERMIT

TO DISCHARGE WASTEWATER UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of North Carolina General Statute 143-215.1, other lawful standards and regulations promulgated and adopted by the North Carolina Environmental Management Commission, and the Federal Water Pollution Control Act, as amended,

Orange Water and Sewer Authority

is hereby authorized to discharge wastewater from a facility located at the

Mason Farm WWTP
170 Old Mason Farm Road
Chapel Hill, North Carolina
Orange County

to receiving waters designated as Morgan Creek in the Cape Fear River Basin

in accordance with effluent limitations, monitoring requirements, and other conditions set forth in Parts I, II, III, and IV hereof.

This permit shall become effective ..... August 1, 2020.

This permit and authorization to discharge shall expire at midnight on ..... July 31, 2025.

Signed this day ..... June 19, 2020.

for S. Daniel Smith, Director
Division of Water Resources
By Authority of the Environmental Management Commission

SUPPLEMENT TO PERMIT COVER SHEET

All previous NPDES Permits issued to this facility, whether for operation or discharge are hereby revoked, and as of this issuance, any previously issued permit bearing this number is no longer effective. Therefore, the exclusive authority to operate and discharge from this facility arises under the permit conditions, requirements, terms, and provisions included herein.

Orange Water and Sewer Authority

is hereby authorized to:

1. Continue to operate an existing 14.5 MGD wastewater treatment facility consisting of the following components:
   - Influent screen
   - Grit removal
   - Primary clarifiers
   - Aerobic/anoxic basins
   - Secondary clarifiers
   - Primary sludge fermenter
   - UV disinfection system
   - Anaerobic digester
   - Gravity belt thickeners
   - Sludge holding tank

   The facility is located at the Mason Farm Wastewater Treatment Plant on 170 Old Mason Farm Road in Chapel Hill, Orange County, and

2. Continue to operate a water reuse and distribution system to provide beneficial reuse of treated effluent from the Mason Farm WWTP as conditioned in Non-Discharge Permit WQ0031506, and

3. Discharge from said treatment works via Outfall 001, at the location specified on the attached map into the Morgan Creek, currently classified as WS-IV NSW water in subbasin 03-06-06 [HUC: 03030002] of the Cape Fear River Basin.

PART I - MONITORING, CONTROLS, AND LIMITATIONS FOR PERMITTED DISCHARGES

A.(1.) EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

[15A NCAC 02B.0400 et seq., 02B.0500 et seq.] **Grade IV Biological WPCS** [15A NCAC 08G .0302]

(a.) Beginning on the effective date of this permit and lasting until permit expiration, the Permittee is authorized to discharge treated wastewater through Outfall 001. Such discharges shall be limited and monitored[1] by the Permittee as specified below:

EFFLUENT CHARACTERISTICS		DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS		
	Parameter Code	Monthly Average	Weekly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location
Flow	*50050*	14.5 MGD			Continuous	Recording	Influent or Effluent
Total Monthly Flow (MG)	*82220*	Monitor & Report			Monthly	Recording or Calculated	Influent or Effluent
CBOD, 5-day, 20°C [2] (April 1 – October 31)	*80082*	4.0 mg/L	6.0 mg/L		2/Week [3]	Composite	Influent and Effluent
CBOD, 5-day, 20°C [2] (November 1 – March 31)	*80082*	8.0 mg/L	12.0 mg/L		2/Week [3]	Composite	Influent and Effluent
Total Suspended Solids [2]	*CO530*	30.0 mg/L	45.0 mg/L		2/Week [3]	Composite	Influent and Effluent
NH_3 as N (April 1 – October 31)	*CO610*	1.0 mg/L	3.0 mg/L		2/Week [3]	Composite	Effluent
NH_3 as N (November 1 – March 31)	*CO610*	2.0 mg/L	6.0 mg/L		2/Week [3]	Composite	Effluent
Fecal Coliform (geometric mean)	*31616*	200/100 mL	400/100 mL		2/Week [3]	Grab	Effluent
pH	*00400*	Between 6.0 and 9.0 standard units			Daily	Grab	Effluent
Dissolved Oxygen	*00300*	Daily Average not less than 6.0 mg/L			Daily	Grab	Effluent
Temperature (°C)	*00010*				Daily	Grab	Effluent
Conductivity (µmhos/cm)	*00094*				Daily	Grab	Effluent
Total Residual Chlorine [4]	*50060*			18 µg/L	Daily	Grab	Effluent
Nitrate as N	*00620*	Monitor & Report (mg/L)			Quarterly	Composite	Effluent
TKN [5]	*00625*	Monitor & Report (mg/L)			Weekly	Composite	Effluent
NO_3-N + NO_2-N [5]	*00630*	Monitor & Report (mg/L)			Weekly	Composite	Effluent
Total Nitrogen [5]	*CO600*	Monitor & Report (mg/L)			Weekly	Composite	Effluent
TN Load [6, 7, 8]	*QM600*	Monitor & Report (lb/mo)			Monthly	Calculated	Effluent
TN Load [6, 7, 8]	*QY600*	134,375 lb/yr			Annually	Calculated	Effluent
Total Phosphorus	*CO665*	Monitor & Report (mg/L)			Weekly	Composite	Effluent
TP Load [6, 8]	*QM665*	Monitor & Report (lb/mo)			Monthly	Calculated	Effluent
TP Load [6, 8]	*QY665*	10,188 lb/yr			Annually	Calculated	Effluent
Chronic Toxicity [9]	*TGP3B*				Quarterly	Composite	Effluent
Effluent Pollutant Scan	*NC01*	Monitor and Report			Footnote 10	Footnote 10	Effluent

Footnotes:

1. The Permittee shall submit discharge monitoring reports electronically using the NC DWR's eDMR application system [see A. (9)].
2. The monthly average effluent CBOD5 and Total Suspended Solids concentrations shall not exceed 15% of the respective influent value (85% removal).
3. 2/Week monitoring for CBOD5, TSS, NH3-N, and fecal coliform for influent and effluent must occur on any two non-consecutive days during the calendar week (Sunday through Saturday).

Footnotes continue on next page

Footnotes (continued):

4. Total residual chlorine shall be monitored only if chlorine is added to the treatment process. The Division shall consider all effluent TRC values reported below 50 µg/L to be in compliance with the permit. However, the permittee shall continue to record and submit all values reported by a North Carolina certified laboratory.
5. TN = TKN + NO3-N + NO2-N where TN is Total Nitrogen, TKN is Total Kjeldahl Nitrogen, and NO3-N + NO2-N are Nitrate and Nitrite Nitrogen, respectively.
6. TN or TP Load is the mass quantity of Total Nitrogen or Phosphorus discharged in a given period of time. See Special Condition A. (7) Calculation and Reporting of Nutrient Loads.
7. The Division acknowledges the facility has an approved Authorization to Construct (ATC) permit dated December 10, 2012. Per S.L. 2013-395 (S515), the TN limit becomes effective on January 1, 2021 with an ATC permit for construction, installation, or alteration of the treatment works for compliance with the TN limits.
8. Compliance with mass limits shall be determined in accordance with Special Condition A. (6) Annual Limits for Total Nitrogen or Total Phosphorus.
9. Chronic Toxicity (Ceriodaphnia) limit at 90% with testing in February, May, August and November [See Special Condition A. (3)].
10. The permittee shall perform three effluent pollutant scans during the term of this permit [see A. (4)].

(b.) There shall be no discharge of floating solids or visible foam in other than trace amounts.

A.(2.) INSTREAM MONITORING REQUIREMENTS

[15A NCAC 02B.0500 et seq.]

Sample Location [1]	Measurement Frequency		Parameters [2, 3]	Sample Type
UP1 DN1 DN2	October - May	Weekly	Temperature Dissolved Oxygen Conductivity Fecal Coliform	Grab
	June - September	3/week		
	June-September	Once every 2 weeks	Total Phosphorous PO_4 NH_3 Total Kjendahl Nitrogen NOx	
DN3 DN4	April-October	Monthly [4]	Temperature Dissolved Oxygen Conductivity Fecal Coliform Secchi depth Chlorophyl-a	

Footnotes:

1. Sample locations:
   UP1 - Upstream location at Morgan Creek at the bridge at the plant entrance
   DN1 - Downstream location #1 at Morgan Creek at the cement ford downstream of outfall
   DN2 - Downstream location #2 at Morgan Creek at the Farrington Road bridge
   DN3 - Downstream location # 3 at Morgan Creek at the mouth of Morgan Creek
   DN4 - Downstream Location # 4 at Jordan Lake at the old railroad grade
2. Sampling of temperature and DO at the surface and one-meter intervals to a depth equal to the Secchi depth. If the Secchi depth is less than 1.0 meters, sample at 0.5-meter intervals.
3. Instream sampling (Upstream and Downstream monitoring) is waived for all parameters as long as the Permittee retains membership in the Upper Cape Fear River Basin Association (UCFRBA), which is conducting a coordinated instream monitoring effort. If the Permittee's membership in the UCFRBA is terminated, the Permittee must immediately notify the Division in writing, and the instream monitoring requirements specified in this permit shall be reinstated immediately.
4. Monthly sampling at DN3 and DN4 should be separated at least two weeks within the appropriate month.

A.(3.) CHRONIC TOXICITY PERMIT LIMIT (QUARTERLY) [15A NCAC 02B.0200]

The effluent discharge shall at no time exhibit observable inhibition of reproduction or significant mortality to ***Ceriodaphnia dubia*** at an effluent concentration of **90%**.

The permit holder shall perform at a minimum, ***quarterly*** monitoring using test procedures outlined in the "North Carolina *Ceriodaphnia* Chronic Effluent Bioassay Procedure," Revised December 2010, or subsequent versions or "North Carolina Phase II Chronic Whole Effluent Toxicity Test Procedure" (Revised- December 2010) or subsequent versions. The tests will be performed **during the months of February, May, August and November**. These months signify the first month of each three-month toxicity testing quarter assigned to the facility. Effluent sampling for this testing must be obtained during representative effluent discharge and shall be performed at the NPDES permitted final effluent discharge below all treatment processes.

If the test procedure performed as the first test of any single quarter results in a failure or ChV below the permit limit, then multiple-concentration testing shall be performed at a minimum, in each of the two following months as described in "North Carolina Phase II Chronic Whole Effluent Toxicity Test Procedure" (Revised-December 2010) or subsequent versions.

All toxicity testing results required as part of this permit condition will be entered on the Effluent Discharge Monitoring Form (MR-1) for the months in which tests were performed, using the parameter code **TGP3B** for the pass/fail results and **THP3B** for the Chronic Value. Additionally, DWR Form AT-3 (original) is to be sent to the following address:

Attention: North Carolina Division of Water Resources
Water Sciences Section/Aquatic Toxicology Branch
1621 Mail Service Center
Raleigh, NC 27699-1621

Or, results can be sent to the email, ATForms.ATB@ncdenr.gov.

Completed Aquatic Toxicity Test Forms shall be filed with the Water Sciences Section no later than 30 days after the end of the reporting period for which the report is made.

Test data shall be complete, accurate, include all supporting chemical/physical measurements and all concentration/response data, and be certified by laboratory supervisor and ORC or approved designate signature. Total residual chlorine of the effluent toxicity sample must be measured and reported if chlorine is employed for disinfection of the waste stream.

Should there be no discharge of flow from the facility during a month in which toxicity monitoring is required, the permittee will complete the information located at the top of the aquatic toxicity (AT) test form indicating the facility name, permit number, pipe number, county, and the month/year of the report with the notation of "No Flow" in the comment area of the form. The report shall be submitted to the Water Sciences Section at the address cited above.

Should the permittee fail to monitor during a month in which toxicity monitoring is required, monitoring will be required during the following month. Assessment of toxicity compliance is based on the toxicity testing quarter, which is the three month time interval that begins on the first day of the month in which toxicity testing is required by this permit and continues until the final day of the third month.

Should any test data from this monitoring requirement or tests performed by the North Carolina Division of Water Resources indicate potential impacts to the receiving stream, this permit may be re-opened and modified to include alternate monitoring requirements or limits.

NOTE: Failure to achieve test conditions as specified in the cited document, such as minimum control organism survival, minimum control organism reproduction, and appropriate environmental controls, shall constitute an invalid test and will require immediate follow-up testing to be completed no later than the last day of the month following the month of the initial monitoring.

A.(4.) EFFLUENT POLLUTANT SCAN

[G.S. 143-215.1(b)]

(a.) The Permittee shall perform a total of three (3) Effluent Pollutant Scans for all parameters listed below. **One scan must be performed in each of the following years: 2021, 2022, and 2023.** Analytical methods shall be in accordance with 40 CFR Part 136 and shall be sufficiently sensitive to determine whether parameters are present in concentrations greater than applicable standards and criteria. Samples should be collected with one quarterly toxicity test each year, and must represent seasonal variation [i.e., do not sample in the same quarter every year]. Unless otherwise indicated, metals shall be analyzed as "total recoverable."

Ammonia (as N)	*CO610*	Trans-1,2-dichloroethylene	*34546*	Bis (2-chloroethyl) ether	*34273*
Chlorine (total residual, TRC)	*50060*	1,1-dichloroethylene	*34501*	Bis (2-chloroisopropyl) ether	*34283*
Dissolved oxygen	*00300*	1,2-dichloropropane	*CO541*	Bis (2-ethylhexyl) phthalate	*CO100*
Nitrate / Nitrite	*00630*	1,3-dichloropropylene	*77163*	4-bromophenyl phenyl ether	*34636*
Kjeldahl nitrogen	*00625*	Ethylbenzene	*34371*	Butyl benzyl phthalate	*34292*
Oil and grease	*00556*	Methyl bromide	*34413*	2-chloronaphthalene	*34581*
Phosphorus	*CO665*	Methyl chloride	*34418*	4-chlorophenyl phenyl ether	*34641*
Total dissolved solids	*70295*	Methylene chloride	*34423*	Chrysene	*34320*
Hardness	*00900*	1,1,2,2-tetrachloroethane	*81549*	Di-n-butyl phthalate	*39110*
Antimony	*01097*	Tetrachloroethylene	*34475*	Di-n-octyl phthalate	*34596*
Arsenic	*01002*	Toluene	*34010*	Dibenzo(a,h)anthracene	*34556*
Beryllium	*01012*	1,1,1-trichloroethane	*34506*	1,2-dichlorobenzene	*34536*
Cadmium	*01027*	1,1,2-trichloroethane	*34511*	1,3-dichlorobenzene	*34566*
Chromium	*CO034*	Trichloroethylene	*39180*	1,4-dichlorobenzene	*34571*
Copper	*01042*	Vinyl chloride	*39175*	3,3-dichlorobenzidine	*34631*
Lead	*01051*	*Acid-extractable compounds:*		Diethyl phthalate	*34336*
Mercury (Method 1631E)	*COMER*	P-chloro-m-cresol	*34452*	Dimethyl phthalate	*34341*
Nickel	*01067*	2-chlorophenol	*34586*	2,4-dinitrotoluene	*34611*
Selenium	*01147*	2,4-dichlorophenol	*34601*	2,6-dinitrotoluene	*CO626*
Silver	*01077*	2,4-dimethylphenol	*34606*	1,2-diphenylhydrazine	*34346*
Thallium	*01059*	4,6-dinitro-o-cresol	*34657*	Fluoranthene	*CO376*
Zinc	*01092*	2,4-dinitrophenol	*34616*	Fluorene	*34381*
Cyanide	*00720*	2-nitrophenol	*34591*	Hexachlorobenzene	*CO700*
Total phenolic compounds	*32730*	4-nitrophenol	*34646*	Hexachlorobutadiene	*CO702*
Volatile organic compounds:		Pentachlorophenol	*39032*	Hexachlorocyclo-pentadiene	*34386*
Acrolein	*34210*	Phenol	*34694*	Hexachloroethane	*34396*
Acrylonitrile	*34215*	2,4,6-trichlorophenol	*34621*	Indeno(1,2,3-cd)pyrene	*34403*
Benzene	*34030*	*Base-neutral compounds:*		Isophorone	*34408*
Bromoform	*32104*	Acenaphthene	*34205*	Naphthalene	*34696*
Carbon tetrachloride	*32102*	Acenaphthylene	*34200*	Nitrobenzene	*34447*
Chlorobenzene	*34301*	Anthracene	*CO220*	N-nitrosodi-n-propylamine	*34428*
Chlorodibromomethane	*34306*	Benzidine	*39120*	N-nitrosodimethylamine	*34438*
Chloroethane	*85811*	Benzo(a)anthracene	*CO526*	N-nitrosodiphenylamine	*34433*
2-chloroethyl vinyl ether	*34576*	Benzo(a)pyrene	*34247*	Phenanthrene	*34461*
Chloroform	*32106*	3,4 benzofluoranthene	*34230*	Pyrene	*34469*
Dichlorobromomethane	*32101*	Benzo(ghi)perylene	*34521*	1,2,4-trichlorobenzene	*CO551*
1,1-dichloroethane	*34496*	Benzo(k)fluoranthene	*34242*		
1,2-dichloroethane	*32103*	Bis (2-chloroethoxy) methane	*34278*		

b. **Reporting.** Test results shall be reported electronically using the Division's eDMR system or on DWR Form DMR-PPA-1(or on a form approved by the Director) by December 31st of each designated

sampling year. The Permittee must at least report completion of the test in the eDMR system by entering "1" or "Y" for parameter code NC01 - Annual Pollutant Scan. If utilizing the DWR Form submit to the following address:

NC DEQ / DWR / NPDES Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617.

Or the form may be uploaded at: https://edocs.deq.nc.gov/Forms/NPDES_WW-EDMR-Supplemental-Form

c. **Additional Toxicity Testing Requirements for Municipal Permit Renewal.** Please note that Municipal facilities that are subject to the Effluent Pollutant Scan requirements listed above are also subject to additional toxicity testing requirements specified in Federal Regulation 40 CFR 122.21(j)(5). The US EPA requires four (4) toxicity tests for a test organism other than the test species currently required in this permit. The multiple species tests should be conducted either quarterly for a 12-month period prior to submittal of the permit renewal application, or four tests performed at least annually in the four and one half year period prior to the application. These tests shall be performed for acute or chronic toxicity, whichever is specified in this permit. The multiple species toxicity test results shall be filed with the Aquatic Toxicology Branch at the following address:

North Carolina Division of Water Resources
Water Sciences Section/Aquatic Toxicology Branch
1621 Mail Service Center
Raleigh, North Carolina 27699-1621

Or, results can be sent to the email, ATForms.ATB@ncdenr.gov.

Contact the Division's Aquatic Toxicology Branch at 919-743-8401 for guidance on conducting the additional toxicity tests and reporting requirements. Results should also be summarized in Part E (Toxicity Testing Data) of EPA Municipal Application Form 2A, when submitting the permit renewal application to the NPDES Permitting Unit.

A.(5.) NUTRIENT ALLOCATIONS

[15A NCAC 02B .0270]

(a.) The following table lists the Total Nitrogen (TN) and Total Phosphorus (TP) allocations assigned to, acquired by, or transferred to the Permittee in accordance with the Jordan Lake nutrient management rule (T15A NCAC 02B .0270) and the status of each as of permit issuance. The allocations in this table are not enforceable limits nor do they supersede any TN or TP limit established elsewhere in this permit or in the NPDES permit of a compliance association of which the Permittee is a Co-Permittee Member.

Total Nitrogen Allocation

ALLOCATION TYPE	SOURCE	DATE	ALLOCATION AMOUNT (1)		STATUS
			Delivered (lb/yr)	Discharge (lb/yr)	
Base	Assigned by Rule (T15A NCAC 02B .0270)	8/11/09	84,656	134,375	Active
		TOTAL	**84,656**	**134,375**	Active

Footnote:

1. Nitrogen Transport Factor = 63%

Total Phosphorus Allocation

ALLOCATION TYPE	SOURCE	DATE	ALLOCATION AMOUNT (1)		STATUS
			Delivered (lb/yr)	Discharge (lb/yr)	
Base	Assigned by Rule (T15A NCAC 02B .0270)	8/11/09	4,789	10,188	Active
		TOTAL	**4,789**	**10,188**	Active

Footnote:

1. Phosphorus Transport Factor = 47%

(b.) Any addition, deletion, or modification of the listed allocation(s) (other than to correct typographical errors) or any change in status of any of the listed allocations shall be considered a major modification of this permit and shall be subject to the public review process afforded such modifications under state and federal rules.

A.(6.) ANNUAL LIMITS FOR TOTAL NITROGEN OR TOTAL PHOSPHORUS

[G.S. 143-215.1(b)]

Total Nitrogen (TN) and Total Phosphorus (TP) allocations and load limits for NPDES dischargers in the Jordan Lake watershed are annual limits and apply on a calendar year basis.

For any given calendar year, the Permittee shall be in compliance with the annual TN (or TP) Load limit in this Permit if:

the Permittee's annual TN (or TP) Load is less than or equal to the effective limit, or

the Permittee is a Co-Permittee Member of a compliance association.

If the Permittee is not a co-permittee member of a compliance association and the Permittee's cumulative annual TN discharge exceeds the effective TN Load limit in this permit at any point during the calendar year, the Permittee is in violation of its TN Load limit, and each day of a continuing violation shall constitute a separate violation.

The TN (or TP) Load limit in this Permit may be modified as the result of allowable changes in the Permittee's allocations.

Allowable changes include those resulting from purchase of TN (or TP) allocation from an authorized mitigation banker, the Ecosystem Enhancement Program, or other source allowed under applicable regulations; purchase, sale, trade, or lease of allocation between the Permittee and other dischargers; regionalization; and other transactions approved by the Division.

The Permittee may request a modification of the TN (or TP) Load limit in this Permit to reflect allowable changes in its allocation(s).

Upon receipt of timely and proper application, the Division will modify the permit as appropriate and in accordance with state and federal program requirements.

Changes in TN (or TP) limits become effective on January 1 of the year following permit modification. The Division must receive application no later than August 31 for changes proposed for the following calendar year.

Any requests for modification should be sent to:

NCDEQ/Division of Water Resources
NPDES Complexing Permitting

1617 Mail Service Center
Raleigh, NC 27699-1617

If the Permittee is a member and co-permittee of an approved compliance association on January 1 of a given year, its TN and TP discharges during that year are governed by that association's group NPDES permit and the limits therein.

The Permittee shall be considered a Co-Permittee Member for any given calendar year in which it is identified as such in Appendix A of the association's group NPDES permit.

Association roster(s) and members' TN and TP allocations will be updated annually and in accordance with state and federal program requirements.

If the Permittee intends to join or leave a compliance association, the Division must be notified of the proposed action in accordance with the procedures defined in the association's NPDES permit.

Upon receipt of timely and proper notification, the Division will modify the permit as appropriate and in accordance with state and federal program requirements.

Membership changes in a compliance association become effective on January 1 of the year following modification of the association's permit.

The TN and TP monitoring and reporting requirements in this Permit remain in effect throughout the term of the Permit and are not affected by the Permittee's membership in a compliance association.

A.(7.) CALCULATION OF TOTAL NITROGEN OR TOTAL PHOSPHORUS LOADS
[G.S. 143-215.1(b)]

(a) The Permittee shall calculate monthly and annual TN and TP Loads as follows:

Monthly TN (or TP) Load (lb/mo) = TN (or TP) × TMF × 8.34

where:

TN or TP	=	the average Total Nitrogen or Total Phosphorus concentration (mg/L) of the composite samples collected during the month
TMF	=	the Total Monthly Flow of wastewater discharged during the month (MG/mo)
8.34	=	conversion factor, from (mg/L x MG) to pounds

Annual TN (or TP) Load (lb/yr) = Sum of the 12 Monthly TN (or TP) Loads for the calendar year

(b) The Permittee shall report monthly Total Nitrogen and Total Phosphorus results (mg/L and lb/mo) in the appropriate discharge monitoring report for each month and shall report each calendar year's results (lb/yr) with the December report for that year.

A.(8.) NUTRIENT MONITORING RE-OPENER
[G.S. 143-215.1(b)]

Pursuant to N.C. General Statutes Section 143-215.1 and the implementing rules found in Title 15A of the North Carolina Administrative Code, Subchapter 02H, specifically, 15A NCAC 02H.0112(b)(1) and 02H.0114(a), and Part II, Sections B.12. and B.13. of this Permit, the Director of DWQ may reopen this permit to require supplemental nutrient monitoring of the discharge. The additional monitoring will be to support water quality modeling efforts within the Cape Fear River Basin, and shall be consistent with a monitoring plan developed jointly by the Division and affected stakeholders.

A.(9.) ELECTRONIC REPORTING - DISCHARGE MONITORING REPORTS
[G.S. 143-215.1(b)]

Federal regulations require electronic submittal of all discharge monitoring reports (DMRs) and program reports. The final NPDES Electronic Reporting Rule was adopted and became effective on December 21, 2015.

NOTE: This special condition supplements or supersedes the following sections within Part II of this permit (*Standard Conditions for NPDES Permits*):

- Section B. (11.) Signatory Requirements
- Section D. (2.) Reporting
- Section D. (6.) Records Retention
- Section E. (5.) Monitoring Reports

1. **Reporting Requirements [Supersedes Section D. (2.) and Section E. (5.) (a)]**

The permittee shall report discharge monitoring data electronically using the NC DWR's Electronic Discharge Monitoring Report (eDMR) internet application.

Monitoring results obtained during the previous month(s) shall be summarized for each month and submitted electronically using eDMR. The eDMR system allows permitted facilities to enter monitoring data and submit DMRs electronically using the internet. The eDMR system may be accessed at: https://deq.nc.gov/about/divisions/water-resources/edmr.

If a permittee is unable to use the eDMR system due to a demonstrated hardship or due to the facility being physically located in an area where less than 10 percent of the households have broadband access, then a temporary waiver from the NPDES electronic reporting requirements may be granted and discharge monitoring data may be submitted on paper DMR forms (MR 1, 1.1, 2, 3) or alternative forms approved by the Director. Duplicate signed copies shall be submitted to the following address:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

See "How to Request a Waiver from Electronic Reporting" section below.

Regardless of the submission method, the first DMR is due on the last day of the month following the issuance of the permit or in the case of a new facility, on the last day of the month following the commencement of discharge.

Starting on **December 21, 2020**, the permittee must electronically report the following compliance monitoring data and reports, when applicable:

- Sewer Overflow/Bypass Event Reports;
- Pretreatment Program Annual Reports; and
- Clean Water Act (CWA) Section 316(b) Annual Reports.

NPDES Electronic Reporting Rule – Phase 2 Extension. EPA is proposing to extend the Phase 2 deadline from December 21, 2020, to December 21, 2023. The electronic reporting date will be extended if the implementation date is extended as a final regulation change in the federal register.

The permittee may seek an electronic reporting waiver from the Division (see "How to Request a Waiver from Electronic Reporting" section below).

2. Electronic Submissions

In accordance with 40 CFR 122.41(l)(9), the permittee must identify the initial recipient at the time of each electronic submission. The permittee should use the EPA's website resources to identify the initial recipient for the electronic submission.

Initial recipient of electronic NPDES information from NPDES-regulated facilities means the entity (EPA or the state authorized by EPA to implement the NPDES program) that is the designated entity for receiving electronic NPDES data [see 40 CFR 127.2(b)].

EPA plans to establish a website that will also link to the appropriate electronic reporting tool for each type of electronic submission and for each state. Instructions on how to access and use the appropriate electronic reporting tool will be available as well. Information on EPA's NPDES Electronic Reporting Rule is found at:
https://www.federalregister.gov/documents/2015/10/22/2015-24954/national-pollutant-discharge-elimination-system-npdes-electronic-reporting-rule

Electronic submissions must start by the dates listed in the "Reporting Requirements" section above.

3. How to Request a Waiver from Electronic Reporting

The permittee may seek a temporary electronic reporting waiver from the Division. To obtain an electronic reporting waiver, a permittee must first submit an electronic reporting waiver request to the Division. Requests for temporary electronic reporting waivers must be submitted in writing to the Division for written approval at least sixty (60) days prior to the date the facility would be required under this permit to begin submitting monitoring data and reports. The duration of a temporary waiver shall not exceed 5 years and shall thereupon expire. At such time, monitoring data and reports shall be submitted electronically to the Division unless the permittee re-applies for and is granted a new temporary electronic reporting waiver by the Division. Approved electronic reporting waivers are not transferrable. Only permittees with an approved reporting waiver request may submit monitoring data and reports on paper to the Division for the period that the approved reporting waiver request is effective.

Information on eDMR and the application for a temporary electronic reporting waiver are found on the following web page:

http://deq.nc.gov/about/divisions/water-resources/edmr

4. **Signatory Requirements [Supplements Section B. (11.) (b) and Supersedes Section B. (11.) (d)]**

   All eDMRs submitted to the permit issuing authority shall be signed by a person described in Part II, Section B. (11.)(a) or by a duly authorized representative of that person as described in Part II, Section B. (11.)(b). A person, and not a position, must be delegated signatory authority for eDMR reporting purposes.

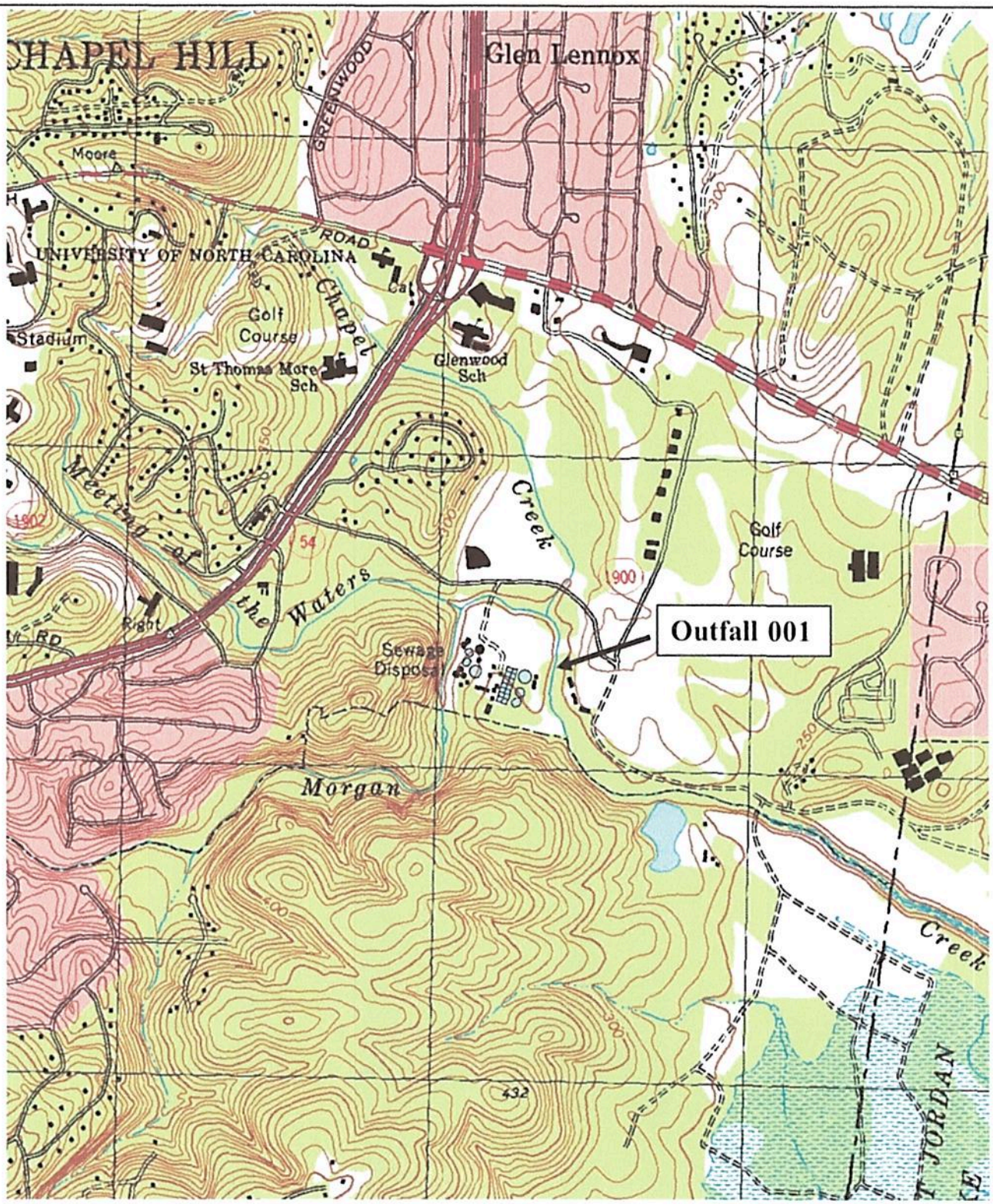
   For eDMR submissions, the person signing and submitting the DMR must obtain an eDMR user account and login credentials to access the eDMR system. For more information on North Carolina's eDMR system, registering for eDMR and obtaining an eDMR user account, please visit the following web page:

   http://deq.nc.gov/about/divisions/water-resources/edmr

   Certification. Any person submitting an electronic DMR using the state's eDMR system shall make the following certification [40 CFR 122.22]. NO OTHER STATEMENTS OF CERTIFICATION WILL BE ACCEPTED:

   "I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

5. **Records Retention [Supplements Section D. (6.)]**
   The permittee shall retain records of all Discharge Monitoring Reports, including eDMR submissions. These records or copies shall be maintained for a period of at least 3 years from the date of the report. This period may be extended by request of the Director at any time [40 CFR 122.41].



OWASA - Mason Farm WWTP

State Grid/Quad:	D22NE / Chapel Hill	**Latitude:**	35° 53' 43" N
County:	Orange	**Longitude:**	79° 01' 26" W
Receiving Stream:	Morgan Creek	**Drainage Basin:**	Cape Fear
Stream Class:	WS-IV, NSW	**Sub-Basin/HUC:**	03-06-06 03030002

North



Facility Location
not to scale

NPDES Permit No. NC0025241
Orange County

PART II
STANDARD CONDITIONS FOR NPDES PERMITS

Section A. Definitions

2/Month
Samples are collected twice per month with at least ten calendar days between sampling events. These samples shall be representative of the wastewater discharged during the sample period.

3/Week
Samples are collected three times per week on three separate calendar days. These samples shall be representative of the wastewater discharged during the sample period.

Act or "the Act"
The Federal Water Pollution Control Act, also known as the Clean Water Act (CWA), as amended, 33 USC 1251, et. seq.

Annual Average
The arithmetic mean of all "daily discharges" of a pollutant measured during the calendar year. In the case of fecal coliform, the geometric mean of such discharges.

Arithmetic Mean
The summation of the individual values divided by the number of individual values.

Bypass
The known diversion of waste streams from any portion of a treatment facility including the collection system, which is not a designed or established or operating mode for the facility.

Calendar Day
The period from midnight of one day until midnight of the next day. However, for purposes of this permit, any consecutive 24-hour period that reasonably represents the calendar day may be used for sampling.

Calendar Week
The period from Sunday through the following Saturday.

Calendar Quarter
One of the following distinct periods: January through March, April through June, July through September, and October through December.

Composite Sample
A sample collected over a 24-hour period by continuous sampling or combining grab samples of at least 100 mL in such a manner as to result in a total sample representative of the wastewater discharge during the sample period. The Director may designate the most appropriate method (specific number and size of aliquots necessary, the time interval between grab samples, etc.) on a case-by-case basis. Samples may be collected manually or automatically. Composite samples may be obtained by the following methods:

(1) Continuous: a single, continuous sample collected over a 24-hour period proportional to the rate of flow.
(2) Constant time/variable volume: a series of grab samples collected at equal time intervals over a 24 hour period of discharge and combined proportional to the rate of flow measured at the time of individual sample collection, or
(3) Variable time/constant volume: a series of grab samples of equal volume collected over a 24 hour period with the time intervals between samples determined by a preset number of gallons passing the sampling point. Flow measurement between sample intervals shall be determined by use of a flow recorder and totalizer, and the preset gallon interval between sample collection fixed at no greater than 1/24 of the expected total daily flow at the treatment system, or

(4) Constant time/constant volume: a series of grab samples of equal volume collected over a 24-hour period at a constant time interval. Use of this method requires prior approval by the Director. This method may only be used in situations where effluent flow rates vary less than 15 percent. The following restrictions also apply:

- Influent and effluent grab samples shall be of equal size and of no less than 100 milliliters
- Influent samples shall not be collected more than once per hour.
- Permittees with wastewater treatment systems whose detention time < 24 hours shall collect effluent grab samples at intervals of no greater than 20 minutes apart during any 24-hour period.
- Permittees with wastewater treatment systems whose detention time exceeds 24 hours shall collect effluent grab samples at least every six hours; there must be a minimum of four samples during a 24-hour sampling period.

Continuous flow measurement
Flow monitoring that occurs without interruption throughout the operating hours of the facility. Flow shall be monitored continually except for the infrequent times when there may be no flow or for infrequent maintenance activities on the flow device.

Daily Discharge
The discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants measured in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the day. (40 CFR 122.2; see also "Composite Sample," above.)

Daily Maximum
The highest "daily discharge" during the calendar month.

Daily Sampling
Parameters requiring daily sampling shall be sampled 5 out of every 7 days per week unless otherwise specified in the permit. Sampling shall be conducted on weekdays except where holidays or other disruptions of normal operations prevent weekday sampling. If sampling is required for all seven days of the week for any permit parameter(s), that requirement will be so noted on the Effluent Limitations and Monitoring Page(s).

DWR or "the Division"
The Division of Water Resources, Department of Environmental Quality.

Effluent
Wastewater discharged following all treatment processes from a water pollution control facility or other point source whether treated or untreated.

EMC
The North Carolina Environmental Management Commission

EPA
The United States Environmental Protection Agency

Facility Closure
Cessation of all activities that require coverage under this NPDES permit. Completion of facility closure will allow this permit to be rescinded.

Geometric Mean
The Nth root of the product of the individual values where N = the number of individual values. For purposes of calculating the geometric mean, values of "0" (or "< [detection level]") shall be considered = 1.

Grab Sample
Individual samples of at least 100 mL collected over a period of time not exceeding 15 minutes. Grab samples can be collected manually. Grab samples must be representative of the discharge (or the receiving stream, for instream samples).

Hazardous Substance
Any substance designated under 40 CFR Part 116 pursuant to Section 311 of the CWA.

Instantaneous flow measurement
The flow measured during the minimum time required for the flow measuring device or method to produce a result in that instance. To the extent practical, instantaneous flow measurements coincide with the collection of any grab samples required for the same sampling period so that together the samples and flow are representative of the discharge during that sampling period.

Monthly Average (concentration limit)
The arithmetic mean of all "daily discharges" of a pollutant measured during the calendar month. In the case of fecal coliform or other bacterial parameters or indicators, the geometric mean of such discharges.

Permit Issuing Authority
The Director of the Division of Water Resources.

Quarterly Average (concentration limit)
The arithmetic mean of all samples taken over a calendar quarter.

Severe property damage
Substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage excludes economic loss caused by delays in production.

Toxic Pollutant:
Any pollutant listed as toxic under Section 307(a)(1) of the CWA.

Upset
An incident beyond the reasonable control of the Permittee causing unintentional and temporary noncompliance with permit effluent limitations and/or monitoring requirements. An upset does not include noncompliance caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

Weekly Average (concentration limit)
The arithmetic mean of all "daily discharges" of a pollutant measured during the calendar week. In the case of fecal coliform or other bacterial parameters or indicators, the geometric mean of such discharges.

Section B. General Conditions

1. Duty to Comply
   The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the CWA and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application [40 CFR 122.41].

   a. The Permittee shall comply with effluent standards or prohibitions established under section 307(a) of the CWA for toxic pollutants and with standards for sewage sludge use or disposal established under section 405(d) of the CWA within the time provided in the regulations that establish these standards or prohibitions or standards for sewage sludge use or disposal, even if the permit has not yet been modified to incorporate the requirement.

   b. The CWA provides that any person who violates section[s] 301, 302, 306, 307, 308, 318 or 405 of the Act, or any permit condition or limitation implementing any such sections in a permit issued under section 402, or any requirement imposed in a pretreatment program approved under sections 402(a)(3) or 402(b)(8) of the Act, is subject to a civil penalty not to exceed $37,500 per day for each violation. [33 USC 1319(d) and 40 CFR 122.41(a)(2)]

   c. The CWA provides that any person who negligently violates sections 301, 302, 306, 307, 308, 318, or 405 of the Act, or any condition or limitation implementing any of such sections in a permit issued under section 402 of the Act, or any requirement imposed in a pretreatment program approved under section 402(a)(3) or 402(b)(8) of the Act, is subject to criminal penalties of $2,500 to $25,000 per day of violation, or

imprisonment of not more than 1 year, or both. In the case of a second or subsequent conviction for a negligent violation, a person shall be subject to criminal penalties of not more than $50,000 per day of violation, or by imprisonment of not more than 2 years, or both. [33 USC 1319(c)(1) and 40 CFR 122.41(a)(2)]

d. Any person who knowingly violates such sections, or such conditions or limitations is subject to criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment for not more than 3 years, or both. In the case of a second or subsequent conviction for a knowing violation, a person shall be subject to criminal penalties of not more than $100,000 per day of violation, or imprisonment of not more than 6 years, or both. [33 USC 1319(c)(2) and 40 CFR 122.41(a)(2)]

e. Any person who *knowingly* violates section 301, 302, 303, 306, 307, 308, 318 or 405 of the Act, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of the Act, and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine of not more than $250,000 or imprisonment of not more than 15 years, or both. In the case of a second or subsequent conviction for a knowing endangerment violation, a person shall be subject to a fine of not more than $500,000 or by imprisonment of not more than 30 years, or both. An organization, as defined in section 309(c)(3)(B)(iii) of the CWA, shall, upon conviction of violating the imminent danger provision, be subject to a fine of not more than $1,000,000 and can be fined up to $2,000,000 for second or subsequent convictions. [40 CFR 122.41(a)(2)]

f. Under state law, a civil penalty of not more than $25,000 per violation may be assessed against any person who violates or fails to act in accordance with the terms, conditions, or requirements of a permit. [North Carolina General Statutes § 143-215.6A]

g. Any person may be assessed an administrative penalty by the Administrator for violating section 301, 302, 306, 307, 308, 318 or 405 of this Act, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of this Act. Administrative penalties for Class I violations are not to exceed $16,000 per violation, with the maximum amount of any Class I penalty assessed not to exceed $37,500. Penalties for Class II violations are not to exceed $16,000 per day for each day during which the violation continues, with the maximum amount of any Class II penalty not to exceed $177,500. [33 USC 1319(g)(2) and 40 CFR 122.41(a)(3)]

2. Duty to Mitigate
The Permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit with a reasonable likelihood of adversely affecting human health or the environment [40 CFR 122.41(d)].

3. Civil and Criminal Liability
Except as provided in permit conditions on "Bypassing" (Part II.C.4), "Upsets" (Part II.C.5) and "Power Failures" (Part II.C.7), nothing in this permit shall be construed to relieve the Permittee from any responsibilities, liabilities, or penalties for noncompliance pursuant to NCGS 143-215.3, 143-215.6 or Section 309 of the Federal Act, 33 USC 1319. Furthermore, the Permittee is responsible for consequential damages, such as fish kills, even though the responsibility for effective compliance may be temporarily suspended.

4. Oil and Hazardous Substance Liability
Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the Permittee from any responsibilities, liabilities, or penalties to which the Permittee is or may be subject to under NCGS 143-215.75 et seq. or Section 311 of the Federal Act, 33 USG 1321. Furthermore, the Permittee is responsible for consequential damages, such as fish kills, even though the responsibility for effective compliance may be temporarily suspended.

5. Property Rights
The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations [40 CFR 122.41(g)].

6. Onshore or Offshore Construction
This permit does not authorize or approve the construction of any onshore or offshore physical structures or facilities or the undertaking of any work in any navigable waters.

7. Severability
The provisions of this permit are severable. If any provision of this permit, or the application of any provision of this permit to any circumstances, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby [NCGS 150B-23].

8. Duty to Provide Information
The Permittee shall furnish to the Permit Issuing Authority, within a reasonable time, any information which the Permit Issuing Authority may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee shall also furnish to the Permit Issuing Authority upon request, copies of records required by this permit [40 CFR 122.41(h)].

9. Duty to Reapply
If the Permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the Permittee must apply for and obtain a new permit [40 CFR 122.41(b)].

10. Expiration of Permit
The Permittee is not authorized to discharge after the expiration date. In order to receive automatic authorization to discharge beyond the expiration date, the Permittee shall submit such information, forms, and fees as are required by the agency authorized to issue permits no later than 180 days prior to the expiration date unless permission for a later date has been granted by the Director. (The Director shall not grant permission for applications to be submitted later than the expiration date of the existing permit.) [40 CFR 122.21(d)] Any Permittee that has not requested renewal at least 180 days prior to expiration, or any Permittee that does not have a permit after the expiration and has not requested renewal at least 180 days prior to expiration, will subject the Permittee to enforcement procedures as provided in NCGS 143-215.6 and 33 USC 1251 et. seq.

11. Signatory Requirements
All applications, reports, or information submitted to the Permit Issuing Authority shall be signed and certified [40 CFR 122.41(k)].

    a. All permit applications shall be signed as follows:

        (1) For a corporation: by a responsible corporate officer. For the purpose of this Section, a responsible corporate officer means: (a) a president, secretary, treasurer or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions for the corporation, or (b) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures .

        (2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

        (3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official [40 CFR 122.22].

    b. All reports required by the permit and other information requested by the Permit Issuing Authority shall be signed by a person described in paragraph a. above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

        (1) The authorization is made in writing by a person described above;

        (2) The authorization specified either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or well field, superintendent, a position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.); and

        (3) The written authorization is submitted to the Permit Issuing Authority [40 CFR 122.22]

c. Changes to authorization: If an authorization under paragraph (b) of this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph (b) of this section must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative [40 CFR 122.22]

d. Certification. Any person signing a document under paragraphs a. or b. of this section shall make the following certification [40 CFR 122.22]. NO OTHER STATEMENTS OF CERTIFICATION WILL BE ACCEPTED:

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

12. Permit Actions
This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition [40 CFR 122.41(f)].

13. Permit Modification, Revocation and Reissuance, or Termination
The issuance of this permit does not prohibit the permit issuing authority from reopening and modifying the permit, revoking and reissuing the permit, or terminating the permit as allowed by the laws, rules, and regulations contained in Title 40, Code of Federal Regulations, Parts 122 and 123; Title 15A of the North Carolina Administrative Code, Subchapter 02H .0100; and North Carolina General Statute 143.215.1 et. al.

14. Annual Administering and Compliance Monitoring Fee Requirements
The Permittee must pay the annual administering and compliance monitoring fee within thirty days after being billed by the Division. Failure to pay the fee in a timely manner in accordance with 15A NCAC 02H .0105(b)(2) may cause this Division to initiate action to revoke the permit.

Section C. Operation and Maintenance of Pollution Controls

1. Certified Operator
Owners of classified water pollution control systems must designate operators, certified by the Water Pollution Control System Operators Certification Commission (WPCSOCC), of the appropriate type and grade for the system, and, for each classification must [T15A NCAC 08G .0201]:

a. designate one Operator In Responsible Charge (ORC) who possesses a valid certificate of the type and grade at least equivalent to the type and grade of the system;

b. designate one or more Back-up Operator(s) in Responsible Charge (Back-up ORCs) who possesses a valid certificate of the type of the system and no more than one grade less than the grade of the system, with the exception of no backup operator in responsible charge is required for systems whose minimum visitation requirements are twice per year; and

c. submit a signed completed "Water Pollution Control System Operator Designation Form" to the Commission (or to the local health department for owners of subsurface systems) countersigned by the designated certified operators, designating the Operator in Responsible Charge (ORC) and the Back-up Operator in Responsible Charge (Back-up ORC):

(1) 60 calendar days prior to wastewater or residuals being introduced into a new system; or

(2) within 120 calendar days following:

- receiving notification of a change in the classification of the system requiring the designation of a new Operator in Responsible Charge (ORC) and Back-up Operator in Responsible Charge (Back-up ORC) of the proper type and grade; or
- a vacancy in the position of Operator in Responsible Charge (ORC) or Back-up Operator in Responsible Charge (Back-up ORC).

(3) within seven calendar days of vacancies in both ORC and Back-up ORC positions replacing or designating at least one of the responsibilities.

The ORC of each Class I facility (or the Back-up ORC, when acting as surrogate for the ORC) must:

- Visit the facility as often as is necessary to insure proper operation of the treatment system; the treatment facility must be visited at least weekly
- Comply with all other conditions of 15A NCAC 08G .0204.

The ORC of each Class II, III and IV facility (or the Back-up ORC, when acting as surrogate for the ORC) must:

- Visit the facility as often as is necessary to insure proper operation of the treatment system; the treatment facility must be visited at least five days per week, excluding holidays
- Properly manage and document daily operation and maintenance of the facility
- Comply with all other conditions of 15A NCAC 08G .0204.

2. Proper Operation and Maintenance

The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the Permittee to install and operate backup or auxiliary facilities only when necessary to achieve compliance with the conditions of the permit [40 CFR 122.41(e)].

NOTE: Properly and officially designated operators are fully responsible for all proper operation and maintenance of the facility, and all documentation required thereof, whether acting as a contract operator [subcontractor] or a member of the Permittee's staff.

3. Need to Halt or Reduce not a Defense

It shall not be a defense for a Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the condition of this permit [40 CFR 122.41(c)].

4. Bypassing of Treatment Facilities

a. Bypass not exceeding limitations [40 CFR 122.41(m)(2)]

The Permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of Paragraphs b. and c. of this section.

b. Notice [40 CFR 122.41(m)(3)]

(1) Anticipated bypass. If the Permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass; including an evaluation of the anticipated quality and effect of the bypass.

(2) Unanticipated bypass. The Permittee shall submit notice of an unanticipated bypass as required in Part II.E.6. (24-hour notice).

c. Prohibition of Bypass

(1) Bypass from the treatment facility is prohibited and the Permit Issuing Authority may take enforcement action against a Permittee for bypass, unless:

(A) Bypass was unavoidable to prevent loss of life, personal injury or severe property damage;

(B) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(C) The Permittee submitted notices as required under Paragraph b. of this section.

(2) Bypass from the collection system is prohibited and the Permit Issuing Authority may take enforcement action against a Permittee for a bypass as provided in any current or future system-wide collection system permit associated with the treatment facility.

(3) The Permit Issuing Authority may approve an anticipated bypass, after considering its adverse effects, if the Permit Issuing Authority determines that it will meet the three conditions listed above in Paragraph c. (1) of this section.

5. Upsets
   a. Effect of an upset [40 CFR 122.41(n)(2)]: An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph b. of this condition are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.
   b. Conditions necessary for a demonstration of upset: Any Permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
      (1) An upset occurred and that the Permittee can identify the cause(s) of the upset;
      (2) The Permittee facility was at the time being properly operated; and
      (3) The Permittee submitted notice of the upset as required in Part II.E.6.(b) of this permit.
      (4) The Permittee complied with any remedial measures required under Part II.B.2. of this permit.
   c. Burden of proof [40 CFR 122.41(n)(4)]: The Permittee seeking to establish the occurrence of an upset has the burden of proof in any enforcement proceeding.

6. Removed Substances
   Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be utilized/disposed of in accordance with NCGS 143-215.1 and in a manner such as to prevent any pollutant from such materials from entering waters of the State or navigable waters of the United States except as permitted by the Commission. The Permittee shall comply with all applicable state and Federal regulations governing the disposal of sewage sludge, including 40 CFR 503, Standards for the Use and Disposal of Sewage Sludge; 40 CFR Part 258, Criteria For Municipal Solid Waste Landfills; and 15A NCAC Subchapter 2T, Waste Not Discharged To Surface Waters. The Permittee shall notify the Permit Issuing Authority of any significant change in its sludge use or disposal practices.

7. Power Failures
   The Permittee is responsible for maintaining adequate safeguards (as required by 15A NCAC 02H .0124) to prevent the discharge of untreated or inadequately treated wastes during electrical power failures either by means of alternate power sources, standby generators or retention of inadequately treated effluent.

Section D. Monitoring and Records

1. Representative Sampling
   Samples collected and measurements taken, as required herein, shall be representative of the permitted discharge. Samples collected at a frequency less than daily shall be taken on a day and time that is representative of the discharge for the period the sample represents. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other wastestream, body of water, or substance. Monitoring points shall not be changed without notification to and the approval of the Permit Issuing Authority [40 CFR 122.41(j)].

2. Reporting
   Monitoring results obtained during the previous month(s) shall be summarized for each month and reported on a monthly Discharge Monitoring Report (DMR) Form (MR 1, 1.1, 2, 3) or alternative forms approved by the Director, postmarked no later than the last calendar day of the month following the completed reporting period.

   The first DMR is due on the last day of the month following the issuance of the permit or in the case of a new facility, on the last day of the month following the commencement of discharge. Duplicate signed copies of these, and all other reports required herein, shall be submitted to the following address:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

3. Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to ensure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than 10% from the true discharge rates throughout the range of expected discharge volumes. Flow measurement devices shall be accurately calibrated at a minimum of once per year and maintained to ensure that the accuracy of the measurements is consistent with the accepted capability of that type of device. The Director shall approve the flow measurement device and monitoring location prior to installation.

Once-through condenser cooling water flow monitored by pump logs, or pump hour meters as specified in Part I of this permit and based on the manufacturer's pump curves shall not be subject to this requirement.

4. Test Procedures

Laboratories used for sample analysis must be certified by the Division. Permittees should contact the Division's Laboratory Certification Section (919 733-3908) or visit https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch for information regarding laboratory certifications.

Facilities whose personnel are conducting testing of field-certified parameters only must hold the appropriate field parameter laboratory certifications.

Test procedures for the analysis of pollutants shall conform to the EMC regulations (published pursuant to NCGS 143-215.63 et. seq.), the Water and Air Quality Reporting Acts, and to regulations published pursuant to Section 304(g), 33 USC 1314, of the CWA (as amended), and 40 CFR 136; or in the case of sludge use or disposal, approved under 40 CFR 136, unless otherwise specified in 40 CFR 503, unless other test procedures have been specified in this permit [40 CFR 122.41].

To meet the intent of the monitoring required by this permit, all test procedures must produce minimum detection and reporting levels that are below the permit discharge requirements and all data generated must be reported down to the minimum detection or lower reporting level of the procedure. If no approved methods are determined capable of achieving minimum detection and reporting levels below permit discharge requirements, then the most sensitive (method with the lowest possible detection and reporting level) approved method must be used.

5. Penalties for Tampering

The CWA provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both [40 CFR 122.41].

6. Records Retention

Except for records of monitoring information required by this permit related to the Permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR 503), the Permittee shall retain records of all monitoring information, including:

- all calibration and maintenance records
- all original strip chart recordings for continuous monitoring instrumentation
- copies of all reports required by this permit
- copies of all data used to complete the application for this permit

These records or copies shall be maintained for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time [40 CFR 122.41].

7. Recording Results
For each measurement or sample taken pursuant to the requirements of this permit, the Permittee shall record the following information [40 CFR 122.41]:

   a. The date, exact place, and time of sampling or measurements;
   b. The individual(s) who performed the sampling or measurements;
   c. The date(s) analyses were performed;
   d. The individual(s) who performed the analyses;
   e. The analytical techniques or methods used; and
   f. The results of such analyses.

8. Inspection and Entry
The Permittee shall allow the Director, or an authorized representative (including an authorized contractor acting as a representative of the Director), upon the presentation of credentials and other documents as may be required by law, to;

   a. Enter, at reasonable times, upon the Permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
   b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
   c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
   d. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the CWA, any substances or parameters at any location [40 CFR 122.41(i)].

Section E Reporting Requirements

1. Change in Discharge
All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit.

2. Planned Changes
The Permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility [40 CFR 122.41(l)]. Notice is required only when:

   a. The alteration or addition to a permitted facility may meet one of the criteria for new sources at 40 CFR 122.29(b); or
   b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR 122.42(a)(1); or
   c. The alteration or addition results in a significant change in the Permittee's sludge use or disposal practices, and such alteration, addition or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.

3. Anticipated Noncompliance
The Permittee shall give advance notice to the Director of any planned changes to the permitted facility or other activities that might result in noncompliance with the permit [40 CFR 122.41(l)(2)].

4. Transfers
This permit is not transferable to any person without prior written notice to and approval from the Director in accordance with 40 CFR 122.61. The Director may condition approval in accordance with NCGS 143-215.1, in

particular NCGS 143-215.1(b)(4)b.2., and may require modification or revocation and reissuance of the permit, or a minor modification, to identify the new permittee and incorporate such other requirements as may be necessary under the CWA [40 CFR 122.41(l)(3), 122.61] or state statute.

5. Monitoring Reports
Monitoring results shall be reported at the intervals specified elsewhere in this permit [40 CFR 122.41(l)(4)].
   a. Monitoring results must be reported on a Discharge Monitoring Report (DMR) (See Part II.D.2) or forms provided by the Director for reporting results of monitoring of sludge use or disposal practices.
   b. If the Permittee monitors any pollutant more frequently than required by this permit using test procedures approved under 40 CFR Part 136 and at a sampling location specified in this permit or other appropriate instrument governing the discharge, the results of such monitoring shall be included in the calculation and reporting of the data submitted on the DMR.
6. Twenty-four Hour Reporting
   a. The Permittee shall report to the Director or the appropriate Regional Office any noncompliance that potentially threatens public health or the environment. Any information shall be provided orally within 24 hours from the time the Permittee became aware of the circumstances. A written submission shall also be provided within 5 days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance, and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance [40 CFR 122.41(l)(6)].
   b. The Director may waive the written report on a case-by-case basis for reports under this section if the oral report has been received within 24 hours.
   c. Occurrences outside normal business hours may also be reported to the Division's Emergency Response personnel at (800) 858-0368 or (919) 733-3300.
7. Other Noncompliance
The Permittee shall report all instances of noncompliance not reported under Part II.E.5 and 6. of this permit at the time monitoring reports are submitted. The reports shall contain the information listed in Part II.E.6. of this permit [40 CFR 122.41(l)(7)].
8. Other Information
Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information [40 CFR 122.41(l)(8)].
9. Noncompliance Notification
The Permittee shall report by telephone to either the central office or the appropriate regional office of the Division as soon as possible, but in no case more than 24 hours or on the next working day following the occurrence or first knowledge of the occurrence of any of the following:
   a. Any occurrence at the water pollution control facility which results in the discharge of significant amounts of wastes which are abnormal in quantity or characteristic, such as the dumping of the contents of a sludge digester; the known passage of a slug of hazardous substance through the facility; or any other unusual circumstances.
   b. Any process unit failure, due to known or unknown reasons, that render the facility incapable of adequate wastewater treatment such as mechanical or electrical failures of pumps, aerators, compressors, etc.
   c. Any failure of a pumping station, sewer line, or treatment facility resulting in a by-pass without treatment of all or any portion of the influent to such station or facility.

   Persons reporting such occurrences by telephone shall also file a written report within 5 days following first knowledge of the occurrence. Also see reporting requirements for municipalities in Part IV.C.2.c. of this permit.
10. Availability of Reports
Except for data determined to be confidential under NCGS 143-215.3 (a)(2) or Section 308 of the Federal Act, 33 USC 1318, all reports prepared in accordance with the terms shall be available for public inspection at the offices

of the Division. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in NCGS 143-215.1(b)(2) or in Section 309 of the Federal Act.

11. Penalties for Falsification of Reports
The CWA provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $25,000 per violation, or by imprisonment for not more than two years per violation, or by both [40 CFR 122.41].

12. Annual Performance Reports
Permittees who own or operate facilities that primarily collect or treat municipal or domestic wastewater and have an average annual flow greater than 200,000 gallons per day shall provide an annual report to the Permit Issuing Authority and to the users/customers served by the Permittee (NCGS 143-215.1C). The report shall summarize the performance of the collection or treatment system, as well as the extent to which the facility was compliant with applicable Federal or State laws, regulations and rules pertaining to water quality. The report shall be provided no later than sixty days after the end of the calendar or fiscal year, depending upon which annual period is used for evaluation.

The report shall be sent to:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

PART III
OTHER REQUIREMENTS

Section A. Construction

a. The Permittee shall not commence construction of wastewater treatment facilities, nor add to the plant's treatment capacity, nor change the treatment process(es) utilized at the treatment plant unless (1) the Division has issued an Authorization to Construct (AtC) permit or (2) the Permittee is exempted from such AtC permit requirements under Item b. of this Section.

b. In accordance with NCGS 143-215.1(a5) [SL 2011-394], no permit shall be required to enter into a contract for the construction, installation, or alteration of any treatment work or disposal system or to construct, install, or alter any treatment works or disposal system within the State when the system's or work's principle function is to conduct, treat, equalize, neutralize, stabilize, recycle, or dispose of industrial waste or sewage from an industrial facility and the discharge of the industrial waste or sewage is authorized under a permit issued for the discharge of the industrial waste or sewage into the waters of the State. Notwithstanding the above, the permit issued for the discharge may be modified if required by federal regulation.

c. Issuance of an AtC will not occur until Final Plans and Specifications for the proposed construction have been submitted by the Permittee and approved by the Division.

Section B. Groundwater Monitoring

The Permittee shall, upon written notice from the Director, conduct groundwater monitoring as may be required to determine the compliance of this NPDES permitted facility with the current groundwater standards.

Section C. Changes in Discharges of Toxic Substances

The Permittee shall notify the Permit Issuing Authority as soon as it knows or has reason to believe (40 CFR 122.42):

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels";

   (1) One hundred micrograms per liter (100 µg/L);

   (2) Two hundred micrograms per liter (200 µg/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 µg/L) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;

   (3) Five times the maximum concentration value reported for that pollutant in the permit application.

b. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels";

   (1) Five hundred micrograms per liter (500 µg/L);

   (2) One milligram per liter (1 mg/L) for antimony;

   (3) Ten times the maximum concentration value reported for that pollutant in the permit application.

Section D. Facility Closure Requirements

The Permittee must notify the Division at least 90 days prior to the closure of any wastewater treatment system covered by this permit. The Division may require specific measures during deactivation of the system to prevent adverse impacts to waters of the State. This permit cannot be rescinded while any activities requiring this permit continue at the permitted facility.

PART IV
SPECIAL CONDITIONS FOR MUNICIPAL FACILITIES

Section A. Definitions

In addition to the definitions in Part II of this permit, the following definitions apply to municipal facilities:

Indirect Discharge or Industrial User
Any non-domestic source that discharges wastewater containing pollutants into a POTW regulated under section 307(b), (c) or (d) of the CWA. [40 CFR 403.3 (i) and (j) and 15A NCAC 02H .0903(b)(11)]

Interference
Inhibition or disruption of the POTW treatment processes; operations; or its sludge process, use, or disposal which causes or contributes to a violation of any requirement of the Permittee's (or any satellite POTW's if different from the Permittee) NPDES, collection system, or non-discharge permit or prevents sewage sludge use or disposal in compliance with specified applicable State and Federal statutes, regulations, or permits. [15A NCAC 02H .0903(b)(14)]

Pass Through
A discharge which exits the POTW into waters of the State in quantities or concentrations which, alone or with discharges from other sources, causes a violation, including an increase in the magnitude or duration of a violation, of the Permittee's (or any satellite POTW's, if different from the Permittee) NPDES, collection system, or non-discharge permit. [15A NCAC 02H .0903(b)(23)]

Publicly Owned Treatment Works (POTW)
A treatment works as defined by Section 212 of the CWA, which is owned by a State or local government organization. This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes the collection system, as defined in 15A NCAC 2T .0402, only if it conveys wastewater to a POTW treatment plant. The term also means the local government organization, or municipality, as defined in section 502(4) of the CWA, which has jurisdiction over indirect discharges to and the discharges from such a treatment works. In this context, the organization may be the owner of the POTW treatment plant or the owner of the collection system into which an indirect discharger discharges. This second type of POTW may be referred to as a "satellite POTW organization." [15A NCAC 02H .0903(b)(26)]

"Significant Industrial User" or "SIU"
An Industrial User that discharges wastewater into a publicly owned treatment works and that [15A NCAC 02H .0903(b)(33)]:

1. Discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, noncontact cooling and boiler blowdown wastewaters); or
2. Contributes process wastewater which makes up five percent or more of the NPDES or non-discharge permitted flow limit or organic capacity of the POTW treatment plant. In this context, organic capacity refers to BOD, TSS and ammonia; or
3. Is subject to categorical standards under 40 CFR Part 403.6 and 40 CFR Parts 405-471; or
4. Is designated as such by the Permittee on the basis that the Industrial User has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, or the POTW's effluent limitations and conditions in its NPDES or non-discharge permit, or to limit the POTW's sludge disposal options;
5. Subject to approval under 15A NCAC 02H .0907(b), the Permittee may determine that an Industrial User meeting the criteria in paragraphs 1 or 2 of this definition above has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the POTW's effluent limitations and conditions in its NPDES or non-discharge permit, or to limit the POTW's sludge disposal options, and thus is not a Significant Industrial User (SIU); or
6. Subject to approval under 15A NCAC 02H .0907(b), the Permittee may determine that an Industrial User meeting the criteria in paragraph 3 of this definition above meets the requirements of 40 CFR Part 403.3(v)(2) and thus is a non-significant categorical Industrial User.

Section B. Publicly Owned Treatment Works (POTWs)

All POTWs must provide adequate notice to the Director of the following [40 CFR 122.42(b)]:

1. Any new introduction of pollutants into the POTW from an indirect discharger, regardless of the means of transport, which would be subject to section 301 or 306 of CWA if it were directly discharging those pollutants; and
2. Any substantial change in the volume or character of pollutants being introduced by an indirect discharger as influent to that POTW at the time of issuance of the permit.
3. For purposes of this paragraph, adequate notice shall include information on (1) the quality and quantity of effluent introduced into the POTW, and (2) any anticipated impact that may result from the change of the quantity or quality of effluent to be discharged from the POTW.

Section C. Municipal Control of Pollutants from Industrial Users.

1. Effluent limitations are listed in Part I of this permit. Other pollutants attributable to inputs from Industrial Users discharging to the POTW may be present in the Permittee's discharge. At such time as sufficient information becomes available to establish limitations for such pollutants, this permit may be revised to specify effluent limitations for any or all of such other pollutants in accordance with best practicable technology or water quality standards.
2. Prohibited Discharges
   a. The Permittee shall develop and enforce their Pretreatment Program to implement the prohibition against the introduction of pollutants or discharges into the waste treatment system or waste collection system which cause or contribute to Pass Through or Interference as defined in 15A NCAC 02H .0900 and 40 CFR 403. [40 CFR 403.5(a)(1)]
   b. The Permittee shall develop and enforce their Pretreatment Program to implement the prohibitions against the introduction of the following wastes in the waste treatment or waste collection system [40 CFR 403.5(b)]:
      (1) Pollutants which create a fire or explosion hazard in the POTW, including, but not limited to, wastestreams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21;
      (2) Pollutants which cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the works is specifically designed to accommodate such discharges;
      (3) Solid or viscous pollutants in amounts which cause obstruction to the flow in the POTW resulting in Interference;
      (4) Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a Discharge at a flow rate and/or pollutant concentration which will cause Interference with the POTW;
      (5) Heat in amounts which will inhibit biological activity in the POTW resulting in Interference, but in no case heat in such quantities that the temperature at the POTW Treatment Plant exceeds 40°C (104°F) unless the Division, upon request of the POTW, approves alternate temperature limits;
      (6) Petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin in amounts that will cause Interference or Pass Through;
      (7) Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems; or
      (8) Any trucked or hauled pollutants, except at discharge points designated by the POTW.
   c. The Permittee shall investigate the source of all discharges into the POTW, including slug loads and other unusual discharges, which have the potential to adversely impact the Permittee's Pretreatment Program and/or the operation of the POTW.

      The Permittee shall report such discharges into the POTW to the Director or the appropriate Regional Office. Any information shall be provided orally within 24 hours from the time the Permittee became aware of the circumstances. A written submission shall also be provided within 5 days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the discharge; the investigation into possible sources; the period of the discharge, including exact dates and times; if the discharge has not ceased, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance,

3. With regard to the effluent requirements listed in Part I of this permit, it may be necessary for the Permittee to supplement the requirements of the Federal Pretreatment Standards (40 CFR, Part 403) to ensure compliance by the Permittee with all applicable effluent limitations. Such actions by the Permittee may be necessary regarding some or all of the industries discharging to the municipal system.
4. The Permittee shall require any Industrial User (IU) discharging to the POTW to meet Federal Pretreatment Standards developed under Section 307(b) of the Act as amended (which includes categorical standards and specific local limits, best management practices and narrative requirements). Prior to accepting wastewater from any Significant Industrial User (SIU), the Permittee shall either develop and submit to the Division a new Pretreatment Program or, as necessary, a modification of an existing Pretreatment Program, for approval as required under section D below as well as 15A NCAC 02H .0907(a) and (b). [40 CFR 122.44(j)(2)]
5. This permit shall be modified, or alternatively, revoked and reissued, to incorporate or modify an approved POTW Pretreatment Program or to include a compliance schedule for the development of a POTW Pretreatment Program as required under Section 402 (b)(8) of the CWA and implementing regulations or by the requirements of the approved State pretreatment program, as appropriate.

Section D. Pretreatment Programs

Under authority of sections 307 (b) and (c) and 402(b)(8) of the CWA and implementing regulations 40 CFR 403, North Carolina General Statute 143-215.3(14) and implementing regulations 15A NCAC 02H .0900, and in accordance with the approved pretreatment program, all provisions and regulations contained and referenced in the pretreatment program submittal are an enforceable part of this permit. [40 CFR 122.44(j)(2)]

The Permittee shall operate its approved pretreatment program in accordance with Section 402(b)(8) of the CWA, 40 CFR 403, 15A NCAC 02H .0900, and the legal authorities, policies, procedures, and financial provisions contained in its pretreatment program submission and Division approved modifications thereof. Such operation shall include but is not limited to the implementation of the following conditions and requirements. Terms not defined in Part II or Part IV of this permit are as defined in 15A NCAC 02H .0903 and 40 CFR 403.3.

1. Sewer Use Ordinance (SUO)
   The Permittee shall maintain adequate legal authority to implement its approved pretreatment program. [15A NCAC 02H .0903(b)(32), .0905 and .0906(b)(1); 40 CFR 403.8(f)(1) and 403.9(b)(1) and (2)]

2. Industrial Waste Survey (IWS)
   The Permittee shall implement an IWS consisting of the survey of users of the POTW collection system or treatment plant, as required by 40 CFR 403.8(f)(2)(i-iii) and 15A NCAC 02H .0905 [also 40 CFR 122.44(j)(1)], including identification of all Industrial Users that may have an impact on the POTW and the character and amount of pollutants contributed to the POTW by these Industrial Users and identification of those Industrial Users meeting the definition of SIU. Where the Permittee accepts wastewater from one or more satellite POTWs, the IWS for the Permittee shall address all satellite POTW services areas, unless the pretreatment program in those satellite service areas is administered by a separate Permittee with an approved Pretreatment Program. The Permittee shall submit a summary of its IWS activities to the Division at least once every five years, and as required by the Division. The IWS submission shall include a summary of any investigations conducted under paragraph C.2.c. of this Part. [15A NCAC 02H .0903(b)(13), .0905 and .0906(b)(2); 40 CFR 403.8(f)(2) and 403.9]

3. Monitoring Plan
   The Permittee shall implement a Division-approved Monitoring Plan for the collection of facility specific data to be used in a wastewater treatment plant Headworks Analysis (HWA) for the development of specific pretreatment local limits. Effluent data from the Plan shall be reported on the DMRs (as required by Parts II.D and II.E.5.). [15A NCAC 02H .0903(b)(16), .0906(b)(3) and .0905]

4. Headworks Analysis (HWA) and Local Limits
   The Permittee shall obtain Division approval of a HWA at least once every five years, and as required by the Division. Within 180 days of the effective date of this permit (or any subsequent permit modification) the Permittee shall submit to the Division a written technical evaluation of the need to revise local limits (i.e., an updated HWA or documentation of why one is not needed) [40 CFR 122.44]. The Permittee shall develop, in accordance with 40 CFR 403.5(c) and 15A NCAC 02H .0909, specific Local Limits to implement the prohibitions listed in 40 CFR 403.5(a) and (b) and 15A NCAC 02H .0909. Pursuant to 40 CFR 403.5, local limits are

enforceable Pretreatment Standards as defined by 40 CFR 403.3(1). [15A NCAC 02H .0903(b)(10), .0905, and .0906(b)(4)]

5. Industrial User Pretreatment Permits (IUP) & Allocation Tables
In accordance with NCGS 143-215.1, the Permittee shall issue to all Significant Industrial Users, permits for operation of pretreatment equipment and discharge to the Permittee's collection system or treatment works. These permits shall contain limitations, sampling protocols, reporting requirements, appropriate standard and special conditions, and compliance schedules as necessary for the installation of treatment and control technologies to assure that their wastewater discharge will meet all applicable pretreatment standards and requirements. The Permittee shall maintain a current Allocation Table (AT) which summarizes the results of the HWA and the limits from all IUPs. Permitted IUP loadings for each parameter cannot exceed the treatment capacity of the POTW as determined by the HWA. [15A NCAC 02H .0906(b)(6), .0909, .0916, and .0917; 40 CFR 403.5, 403.8(f)(1)(iii); NCGS 143-215.67(a)]

6. Authorization to Construct (AtC)
The Permittee shall ensure that an Authorization to Construct permit (AtC) is issued to all applicable Industrial Users for the construction or modification of any pretreatment facility. Prior to the issuance of an AtC, the proposed pretreatment facility and treatment process must be evaluated for its capacity to comply with all Industrial User Pretreatment Permit (IUP) limitations. [15A NCAC 02H .0906(b)(7) and .0905; NCGS 143-215.1(a)(8)]

7. POTW Inspection & Monitoring of their IUs
The Permittee shall conduct inspection, surveillance, and monitoring activities as described in its Division approved pretreatment program in order to determine, independent of information supplied by Industrial Users, compliance with applicable pretreatment standards. [15A NCAC 02H .0908(e); 40 CFR 403.8(f)(2)(v)] The Permittee must:

   a. Inspect all Significant Industrial Users (SIUs) at least once per calendar year;
   b. Sample all Significant Industrial Users (SIUs) at least once per calendar year for all SIU permit-limited parameters including flow except as allowed under 15A NCAC .0908(e); and
   c. At least once per year, document an evaluation of any non-significant categorical Industrial User for compliance with the requirements in 40 CFR 403.3(v)(2), and either continue or revoke the designation as non-significant.

8. IU Self Monitoring and Reporting
The Permittee shall require all Industrial Users to comply with the applicable monitoring and reporting requirements outlined in the Division-approved pretreatment program, the industry's pretreatment permit, or in 15A NCAC 02H .0908. [15A NCAC 02H .0906(b)(5) and .0905; 40 CFR 403.8(f)(1)(v) and (2)(iii); 40 CFR 122.44(j)(2) and 40 CFR 403.12]

9. Enforcement Response Plan (ERP)
The Permittee shall enforce and obtain appropriate remedies for violations of all pretreatment standards promulgated pursuant to section 307(b) and (c) of the CWA (40 CFR 405 et. seq.), prohibitive discharge standards as set forth in 40 CFR 403.5 and 15A NCAC 02H .0909, specific local limitations, and other pretreatment requirements. All remedies, enforcement actions and other, shall be consistent with the Enforcement Response Plan (ERP) approved by the Division. [15A NCAC 02H .0903(b)(7), .0906(b)(8) and .0905; 40 CFR 403.8(f)(5)]

10. Pretreatment Annual Reports (PAR)
The Permittee shall report to the Division in accordance with 15A NCAC 02H .0908. In lieu of submitting annual reports, Modified Pretreatment Programs developed under 15A NCAC 02H .0904 (b) may be required to submit a partial annual report or to meet with Division personnel periodically to discuss enforcement of pretreatment requirements and other pretreatment implementation issues.

    For all other active pretreatment programs, the Permittee shall submit two copies of a Pretreatment Annual Report (PAR) describing its pretreatment activities over the previous calendar year to the Division at the following address:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
Pretreatment, Emergency Response, and Collection Systems (PERCS) Unit
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

These reports shall be submitted by March 1 of each year and shall contain the following:

a. Narrative
A narrative summary detailing actions taken, or proposed, by the Permittee to correct significant non-compliance and to ensure compliance with pretreatment requirements;

b. Pretreatment Program Summary (PPS)
A pretreatment program summary (PPS) on forms or in a format provided by the Division;

c. Significant Non-Compliance Report (SNCR)
A list of Industrial Users (IUs) in significant noncompliance (SNC) with pretreatment requirements, and the nature of the violations on forms or in a format provided by the Division;

d. Industrial Data Summary Forms (IDSF)
Monitoring data from samples collected by both the POTW and the Significant Industrial Users (SIUs). These analytical results must be reported on Industrial Data Summary Forms (IDSF) or on other forms or in a format provided by the Division;

e. Other Information
Copies of the POTW's allocation table, new or modified enforcement compliance schedules, public notice of IUs in SNC, a summary of data or other information related to significant noncompliance determinations for IUs that are not considered SIUs, and any other information, upon request, which in the opinion of the Director is needed to determine compliance with the pretreatment implementation requirements of this permit;

11. Public Notice
The Permittee shall publish annually a list of Industrial Users (IUs) that were in significant noncompliance (SNC) as defined in the Permittee's Division-approved Sewer Use Ordinance with applicable pretreatment requirements and standards during the previous twelve month period. This list shall be published within four months of the applicable twelve-month period. [15A NCAC 02H .0903(b)(34), .0908(b)(5) and .0905 and 40 CFR 403.8(f)(2)(viii)]

12. Record Keeping
The Permittee shall retain for a minimum of three years records of monitoring activities and results, along with support information including general records, water quality records, and records of industrial impact on the POTW and shall retain all other Pretreatment Program records as required by 15A NCAC 02H .0908(f). [15A NCAC 02H .0908(f); 40 CFR 403.12(o)]

13. Pretreatment Program Resources
The Permittee shall maintain adequate funding and qualified personnel to accomplish the objectives of its approved pretreatment program. and retain a written description of those current levels of inspection. [15A NCAC 02H .0906(b)(9) and (10) and .0905; 40 CFR 403.8(f)(3), 403.9(b)(3)]

14. Modification to Pretreatment Programs
Modifications to the approved pretreatment program including but not limited to local limits modifications, POTW monitoring of their Significant Industrial Users (SIUs), and Monitoring Plan modifications, shall be considered a permit modification and shall be governed by 40 CFR 403.18, 15 NCAC 02H .0114 and 15A NCAC 02H .0907.

15A NCAC 02B .0262 JORDAN WATER SUPPLY NUTRIENT STRATEGY: PURPOSE AND SCOPE

PURPOSE. The purpose of this Rule, 15A NCAC 02B .0263 through .0273 and .0311(p) shall be to restore and maintain nutrient-related water quality standards in B. Everett Jordan Reservoir; protect its classified uses as set out in 15A NCAC 02B .0216, including use as a source of water supply for drinking water, culinary and food processing purposes; and maintain or enhance protections currently implemented by local governments in existing water supply watersheds. These Rules, as further enumerated in Item (3) of this Rule, together shall constitute the Jordan water supply nutrient strategy, or Jordan nutrient strategy. Additional provisions of this Rule include establishing the geographic and regulatory scope of the Jordan nutrient strategy, defining its relationship to existing water quality regulations, setting specific nutrient mass load goals for Jordan Reservoir, providing for the use of adaptive management to restore Jordan Reservoir, and citing general enforcement authorities. The following provisions further establish the framework of the Jordan water supply nutrient strategy:

(1) SCOPE. B. Everett Jordan Reservoir is hereafter referred to as Jordan Reservoir. All lands and waters draining to Jordan Reservoir are hereafter referred to as the Jordan watershed. Jordan Reservoir and all waters draining to it have been supplementally classified as Nutrient Sensitive Waters (NSW) pursuant to 15A NCAC 02B .0101(e)(3) and 15A NCAC 02B .0223. Water supply waters designated WS-II, WS-III, and WS-IV within the Jordan watershed shall retain their classifications. The remaining waters in the Jordan watershed are classified WS-V as of the initial effective date of this Rule, August 11, 2009. The requirements of all of these water supply classifications shall be retained and applied except as specifically noted in Item (6) of this Rule and elsewhere within the Jordan nutrient strategy. Pursuant to G.S. 143-214.5(b), the entire Jordan watershed shall be designated a critical water supply watershed and through the Jordan nutrient strategy given additional, more stringent requirements than the state minimum water supply watershed management requirements. These requirements supplement the water quality standards applicable to Class C waters, as described in Rule .0211 of this Section, which apply throughout the Jordan watershed.

(2) STRATEGY GOAL. Pursuant to G.S. 143-215.1(c5), 143-215.8B, and 143B-282(c) and (d) of the Clean Water Responsibility Act of 1997, the Environmental Management Commission establishes the goal of reducing the average annual loads of nitrogen and phosphorus delivered to Jordan Reservoir from all point and nonpoint sources of these nutrients located within its watershed, as specified in Item (5) of this Rule, and provides for adaptive management of the strategy and goal, as specified in Item (8) of this Rule.

(3) RULES ENUMERATED. The second rule in the following list provides definitions for terms that are used in more than one rule of the Jordan nutrient strategy. An individual rule may contain additional definitions that are specific to that Rule. The rules of the Jordan nutrient strategy are titled as follows:
   (a) Rule. 0262 - Purpose and Scope;
   (b) Rule. 0263 - Definitions;
   (c) Rule. 0264 - Agriculture;
   (d) Rule. 0265 - Stormwater Management for New Development;
   (e) Rule. 0266 - Stormwater Management for Existing Development;
   (f) Rule. 0267 - Protection of Existing Riparian Buffers;
   (g) Rule. 0268 - Mitigation for Riparian Buffers;
   (h) Rule. 0269 - Riparian Buffer Mitigation Fees to the NC Ecosystem Enhancement Program;
   (i) Rule. 0270 - Wastewater Discharge Requirements;
   (j) Rule. 0271 - Stormwater Requirements for State and Federal Entities;
   (k) Rule. 0272 - Fertilizer Management;
   (l) Rule. 0273 - Options for Offsetting Nutrient Loads; and
   (m) Rule. 0311 - Cape Fear River Basin.

(4) RESERVOIR ARMS AND SUBWATERSHEDS. For the purpose of the Jordan nutrient strategy, Jordan Reservoir is divided into three arms and the Jordan watershed is divided into three tributary subwatersheds as follows:
   (a) The Upper New Hope arm of the reservoir, identified by index numbers 16-41-1-(14), 16-41-2-(9.5), and 16-41-(0.5) in the Schedule of Classifications for the Cape Fear River Basin, 15A NCAC 02B .0311, encompasses the upper end of the reservoir upstream of SR 1008, and its subwatershed encompasses all lands and waters draining into it.

(b) The Lower New Hope arm of the reservoir, identified by index number 16-41-(3.5) in the Schedule of Classifications for the Cape Fear River Basin, 15A NCAC 02B .0311, lies downstream of SR 1008 and upstream of the Jordan Lake Dam, excluding the Haw River arm of the reservoir, and its subwatershed encompasses all lands and waters draining into the Lower New Hope arm of the reservoir excluding those that drain to the Upper New Hope arm of the reservoir and the Haw River arm of the reservoir.

(c) The Haw River arm of the reservoir, identified by index number 16-(37.5) in the Schedule of Classifications for the Cape Fear River Basin, 15A NCAC 02B .0311, lies immediately upstream of Jordan Lake Dam, and its subwatershed includes all lands and waters draining into the Haw River arm of the reservoir excluding those draining into the Upper and Lower New Hope arms.

(5) NUTRIENT REDUCTION GOALS. Each arm of the lake has reduction goals, total allowable loads, point source wasteload allocations, and nonpoint source load allocations for both nitrogen and phosphorus based on a field-calibrated nutrient response model developed pursuant to provisions of G.S. 143-215.1(c5). The reduction goals and allocations shall be met collectively by the sources regulated under the Jordan nutrient strategy. The reduction goals are expressed in terms of a percentage reduction in delivered loads from the baseline years, 1997-2001, while allocations are expressed in pounds per year of allowable delivered load. Each arm and subwatershed shall conform to its respective allocations for nitrogen and phosphorus as follows:

(a) The at-lake nitrogen goals for the arms of Jordan Reservoir are as follows:

(i) The Upper New Hope arm has a 1997-2001 baseline nitrogen load of 986,186 pounds per year and a nitrogen Total Maximum Daily Load (TMDL) reduction goal of 35 percent. The resulting TMDL includes a total allowable load of 641,021 pounds of nitrogen per year: a point source mass wasteload allocation of 336,079 pounds of nitrogen per year, and a nonpoint source mass load allocation of 304,942 pounds of nitrogen per year.

(ii) The Lower New Hope arm has a 1997-2001 baseline nitrogen load of 221,929 pounds per year and a nitrogen TMDL capped at the baseline nitrogen load. The resulting TMDL includes a total allowable load of 221,929 pounds of nitrogen per year: a point source mass wasteload allocation of 6,836 pounds of nitrogen per year, and a nonpoint source mass load allocation of 215,093 pounds of nitrogen per year.

(iii) The Haw River arm has a 1997-2001 baseline nitrogen load of 2,790,217 pounds per year and a nitrogen TMDL reduction goal of eight percent. The resulting TMDL includes a total allowable load of 2,567,000 pounds of nitrogen per year: a point source mass wasteload allocation of 895,127 pounds of nitrogen per year, and a nonpoint source mass load allocation of 1,671,873 pounds of nitrogen per year.

(b) The at-lake phosphorus goals for the arms of Jordan Reservoir are as follows:

(i) The Upper New Hope arm has a 1997-2001 baseline phosphorus load of 87,245 pounds per year and a phosphorus TMDL reduction goal of five percent. The resulting TMDL includes a total allowable load of 82,883 pounds of phosphorus per year: a point source mass wasteload allocation of 23,108 pounds of phosphorus per year, and a nonpoint source mass load allocation of 59,775 pounds of phosphorus per year.

(ii) The Lower New Hope arm has a 1997-2001 baseline phosphorus load of 26,574 pounds per year and a phosphorus TMDL capped at the baseline phosphorus load. The resulting TMDL includes a total allowable load of 26,574 pounds of phosphorus per year: a point source mass wasteload allocation of 498 pounds of phosphorus per year, and a nonpoint source mass load allocation of 26,078 pounds of phosphorus per year.

(iii) The Haw River arm has a 1997-2001 baseline phosphorus load of 378,569 pounds per year and a phosphorus TMDL reduction goal of five percent. The resulting TMDL includes a total allowable load of 359,641 pounds of phosphorus per year: a point source mass wasteload allocation of 106,001 pounds of phosphorus per year, and a nonpoint source mass load allocation of 253,640 pounds of phosphorus per year.

(c) The allocations established in this Item may change as a result of allocation transfer between point and nonpoint sources to the extent provided for in rules of the Jordan nutrient strategy and pursuant to requirements on the sale and purchase of load reduction credit set out in 15A NCAC 02B .0273.

(6) RELATION TO WATER SUPPLY REQUIREMENTS. The following water supply requirements shall apply:

(a) For all waters designated as WS-II, WS-III, or WS-IV within the Jordan watershed, the requirements of water supply 15A NCAC 02B .0214 through .0216 shall remain in effect with the exception of Sub-Item (3)(b) of those Rules addressing nonpoint sources. The nonpoint source requirements of Sub-Item (3)(b) of those Rules are superseded by the requirements of this Rule and 15A NCAC 02B .0263 through .0269, and .0271 through .0273, except as specifically stated in any of these Rules. For WS-II, WS-III, and WS-IV waters, the retained requirements of 15A NCAC 02B .0214 through .0216 are the following:

(i) Item (1) of 15A NCAC 02B .0214 through .0216 addressing best usages;

(ii) Item (2) of 15A NCAC 02B .0214 through .0216 addressing predominant watershed development conditions, discharges expressly allowed watershed-wide, general prohibitions on and allowances for domestic and industrial discharges, Maximum Contaminant Levels following treatment, and the local option to seek more protective classifications for portions of existing water supply watersheds;

(iii) Sub-Item (3)(a) of 15A NCAC 02B .0214 through .0216 addressing waste discharge limitations; and

(iv) Sub-Items (3)(c) through (3)(h) of 15A NCAC 02B .0214 through .0216 addressing aesthetic and human health standards.

(b) For waters designated WS-V in the Jordan Watershed, the requirements of Rules .0263 through .0273 and .0311 of this Subchapter shall apply. The requirements of 15A NCAC 02B .0218 shall also apply except for Sub-Items (3)(e) through (3)(h) of that Rule, which shall only apply where:

(i) The designation of WS-V is associated with a water supply intake used by an industry to supply drinking water for their employees; or

(ii) Standards set out in 15A NCAC 02B .0218(3)(e) through (3)(h) are violated at the upstream boundary of waters within those watersheds that are classified as WS-II, WS-III, or WS-IV. This Sub-Item shall not be construed to alter the nutrient reduction requirements set out in 15A NCAC 02B .0262(5) or 15A NCAC 2B .0275(3).

(7) APPLICABILITY. Types of parties responsible for implementing rules within the Jordan nutrient strategy and, as applicable, their geographic scope of responsibility, are identified in each rule. The specific local governments responsible for implementing Rules .0265, .0266, .0267, .0268, and .0273 of this Subchapter shall be as follows:

(a) Rules .0265, .0266, .0267, .0268, and .0273 of this Subchapter shall be implemented by all incorporated municipalities, as identified by the Office of the Secretary of State, with planning jurisdiction within or partially within the Jordan watershed. As of August 11, 2009, those municipalities are:

(i) Alamance;
(ii) Apex;
(iii) Burlington;
(iv) Carrboro;
(v) Cary;
(vi) Chapel Hill;
(vii) Durham;
(viii) Elon;
(ix) Gibsonville;
(x) Graham;
(xi) Green Level;
(xii) Greensboro;
(xiii) Haw River;

(xiv) Kernersville;
(xv) Mebane;
(xvi) Morrisville;
(xvii) Oak Ridge;
(xviii) Ossipee;
(xix) Pittsboro;
(xx) Pleasant Garden;
(xxi) Reidsville;
(xxii) Sedalia;
(xxiii) Stokesdale;
(xxiv) Summerfield; and
(xxv) Whitsett.

(b) Rules .0265, .0266, .0267, .0268, and .0273 of this Subchapter shall be implemented by the following counties for the portions of the counties where the municipalities listed in Sub-Item (7)(a) do not have an implementation requirement:
(i) Alamance;
(ii) Caswell;
(iii) Chatham;
(iv) Durham;
(v) Guilford;
(vi) Orange;
(vii) Rockingham; and
(viii) Wake.

(c) A unit of government may arrange through interlocal agreement or other instrument of mutual agreement for another unit of government to implement portions or the entirety of a program required or allowed under any of the rules listed in Item (3) of this Rule to the extent that such an arrangement is otherwise allowed by statute. The governments involved shall submit documentation of any such agreement to the Division. No such agreement shall relieve a unit of government from its responsibilities under these Rules.

(8) ADAPTIVE MANAGEMENT. The Division shall evaluate the effectiveness of the Jordan nutrient strategy no sooner than ten years following the effective date and periodically thereafter as part of the review of the *Cape Fear River Basinwide Water Quality Plan*. The Division shall base its evaluation on, at a minimum, trend analyses as described in the monitoring section of the *B. Everett Jordan Reservoir, North Carolina Nutrient Management Strategy and Total Maximum Daily Load*, and lake use support assessments. Both of these documents can be found on the Division's website at www.ncwater.org. The Division may also develop additional watershed modeling or other source characterization work. Any nutrient response modeling and monitoring on which any recommendation for adjustment to strategy goals may be based shall meet the criteria set forth in G.S. 143-215.1(c5) and meet or exceed criteria used by the Division for the monitoring and modeling used to establish the goals in Item (5) of this Rule. Any modification to these Rules as a result of such evaluations would require additional rulemaking.

(9) LIMITATION. The Jordan nutrient strategy may not fully address significant nutrient sources in the Jordan watershed in that these Rules do not directly address atmospheric sources of nitrogen to the watershed from sources located both within and outside of the watershed. As better information becomes available from ongoing research on atmospheric nitrogen loading to the watershed from these sources, and on measures to control this loading, the Commission may undertake separate rule making to require such measures it deems necessary from these sources to support the goals of the Jordan nutrient strategy.

(10) ENFORCEMENT. Failure to meet requirements of Rules .0262, .0264, .0265, .0266, .0267, .0268, .0269, .0270, .0271, .0272 and .0273 of this Subchapter may result in imposition of enforcement measures as authorized by G.S. 143-215.6A (civil penalties), G.S. 143-215.6B (criminal penalties), and G.S. 143-215.6C (injunctive relief).

History Note: *Authority G.S. 143-214.1; 143-214.5; 143-214.7; 143-215.1; 143-215.3(a)(1); 143-215.6A; 143-215.6B; 143-215.6C; 143-215.8B; 143B-282(c); 143B-282(d); S.L. 2005-190; S.L. 2006-259; S.L. 2012-187;*
Eff. August 11, 2009;
Amended Eff. January 1, 2014; September 1, 2011.