WOODARD
&CURRAN

LAKE COUNTY WATER AUTHORITY NUTRIENT REDUCTION FACILITY

SITE ASSESSMENT

FINAL

210 S. Florida Ave, Suite 220
Lakeland, FL 33801
800.426.4262

woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

0231754.02
Lake County Water Authority
April 2021

TABLE OF CONTENTS

SECTION **PAGE NO.**

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Lake County Water Authority (LCWA) has identified $4.5M in capital improvement projects for its Nutrient Reduction Facility (NuRF) on the Apopka-Beauclair Canal. These projects were recommended by Pegasus Engineering and Environmental Research & Design in a report (Pegasus report) submitted to the Authority in February 2020. The intent of these improvements is to address operational issues that have persisted since heavy rains from Hurricane Irma caused an extended period of high-water flow rates through the facility in the fall of 2017. Woodard & Curran has performed this independent review of the report. Additionally, we have included an assessment of the facility's operation to evaluate the capability of proposed improvements to overcome the ongoing operational issues.

Lake County Water Authority's overall objective for the NuRF is to reliably treat the entire volume of water flowing through the Apopka-Beauclair Canal, up to a maximum flow rate of 300 cubic feet per second (cfs). While the NuRF already has the capacity to treat this maximum flow rate on a short term basis, its present operational challenges are the result of poor reliability of certain existing components and inadequate ability to remove and ultimately dispose of the treatment residuals that accumulate over time. The flow rates through the canal, and therefore through the NuRF, are highly variable, and because the treatment ponds provide significant volume for the temporary storage of residuals (or "floc"), it is not necessary that dredging and dewatering capacity be as high as the 300 cfs equivalent. However, the current intake, dredging, and dewatering equipment and processes are insufficiently reliable and lack sufficient capacity for extended periods of high flow, which results in persistent and occasionally severe limitations on the overall performance and cost-effectiveness of the NuRF.

While not explicitly included in the scope of Woodard & Curran's assessment, we note that the NuRF's capacity for onsite sludge storage is very nearly consumed, and once that point is reached, the NuRF will no longer be able to operate at all. **Therefore, LCWA's highest priority for the NuRF should be to identify and arrange for an off-site disposal option and begin hauling dewatered sludge off-site as soon as possible.**

With this caveat, Woodard & Curran's overall recommendation is that LCWA proceed with certain facility improvements now, while deferring and potentially eliminating the need for some others. The priority improvements should include the new dredges, the alum injection and mixing system, real time phosphorus monitoring, and an automated screening technology for the primary inflow station. Only after these priority improvements have been completed can further improvements, especially to the floc dewatering process, be properly assessed and specified.

Woodard & Curran's recommendation for each of the initially proposed improvements is summarized in the following table.

Table E-1: Proposed Improvements

Facility Component and Proposed Improvement (Pegasus)	W&C Recommendation	W&C Assessment of Priority/Sequence	Estimated Cost W&C Recommendation
1. Primary Inflow Station (Construct cantilever sheet pile deflector wall and new skimmer structure) - $430,804	Implement an automated screening system at the inflow instead of the proposed cantilever wall and skimmer.	High priority.	$1,545,000
2. Alum Injection and Mixing System Improvements - $160,985	Proceed with recommended improvements with further mixing enhancements. Implement real time	High priority.	$359,000

Facility Component and Proposed Improvement (Pegasus)	W&C Recommendation	W&C Assessment of Priority/Sequence	Estimated Cost W&C Recommendation
	monitoring to enable reduction in alum use and floc generation.		
3A. Floc Dredging System (Replace Dredges) - $621,466 3B. Additional Dredge Piping – $71,632 3C. Rehab Existing Floc Storage Tank- $100,480	New dredges have been ordered. Proceed while addressing dredge onboarding considerations.	High priority.	LWCA is already proceeding with this improvement. $793,578
4. Localized Flooding at Dewatering Building - $77,963	Not included in assessment scope.	n/a	LCWA is already proceeding with this improvement. $77,963
5A. Additional Floc Dewatering - $1,575,000 5B. New Dewatering Building - $679,965 5C. Additional Floc Storage Tank - $368,500	Assess additional improvements to refine and expand floc dewatering, considering remaining grit in the feed and polymer applicability to the new feed. Defer expansion until an assessment based on the performance of the new dredges, alum mixing, and inflow improvements is completed.	Assess additional improvements after the new dredges, alum mixing, and inflow improvements are operational.	None at present time.
6. On-site Sludge Handling - $357,374	Defer expansion assessment until a comprehensive cost evaluation is completed, considering the performance of recommended improvements, potential additional improvements, and offsite sludge disposal requirements.	Cost evaluation should be completed after assessing polymer applicability to the feed from the new dredges, once they are operating.	None at present time.
7. Sludge Disposal and Reuse Options – cost not included	Not included in assessment scope.	n/a	n/a
8. Process Water Wells – cost not included	A water sample containing high iron should be tested and the results provided to vendors to confirm water compatibility with the centrifuge and polymer.	Concurrent with new dredges.	None.

Facility Component and Proposed Improvement (Pegasus)	W&C Recommendation	W&C Assessment of Priority/Sequence	Estimated Cost W&C Recommendation
9. Alternative Treatment Technologies (no recommendation) – cost not included	Not included in assessment scope.	n/a	n/a
10. Instrumentation and Controls (not evaluated)	Replace damaged controls and implement a single communication platform for ease of operations, automation, and expandability.	Concurrent with new dredges.	$195,000
Total Cost: $4,444,169			**$2,971,000 for priority improvements.**

In summary, Woodard & Curran recommends the following next steps:

1. Continue with dredging system improvements, including installing new dredges and additional dredge piping, and rehabilitation of the existing floc storage tank. The new dredges should be onboarded in a manner that ensures complete pond coverage and a consistent floc free of grit to the dewatering equipment, including an effective sand and grit prevention system. If the new dredges are unable to prevent sand and grit from adversely affecting the dewatering process, a dedicated grit removal technology should then be evaluated. A repair of dredge operations controls and rail guidance must be completed prior to dredges being activated.

2. Implement an automated, self-cleaning and redundant screening system at the inflow instead of the proposed cantilever wall and skimmer. A screening system is critical to prevent debris entry and ensure the new dredges operate within their design parameters. Woodard & Curran's observations during high flows suggest that the volume of incoming debris cannot be safely removed manually, so an automated, self-cleaning system is needed to ensure the NuRF equipment is protected under such conditions.

3. Implement the proposed alum injection and mixing improvements, with further mixing enhancements. Additionally, install an automatic phosphorus analyzer to facilitate real time alum control and dosage. These improvements will improve the performance of the settling ponds and enable reduced alum usage.

4. Upon completion of items 1, 2, and 3, assess further improvements to refine and potentially expand the floc dewatering process, based on the new floc characteristics, remaining grit in the feed from the dredges, and polymer applicability to that feed. These improvements will help generate a sludge that is more easily handled and potentially stacked and will reduce the proportional volume of sludge being generated, thereby potentially reducing subsequent handling and offsite disposal costs. The timing of this recommendation assumes the centrifuge has been returned to service and is operating reliably and is operated and maintained in accordance with manufacturer specifications.

5. Defer onsite sludge handling improvements until an arrangement is made for offsite hauling and disposal, which should be done immediately. This will allow onsite handling improvements to be assessed and/or designed with long-term operational requirements taken into account.

1. INTRODUCTION AND PURPOSE

1.1 Introduction

Lake County Water Authority (LCWA) operates the Nutrient Reduction Facility (NuRF), located on the Apopka-Beauclair Canal. The facility is designed to improve water quality by removing phosphorous that would otherwise enter Lake County's Harris Chain of Lakes. The NuRF began operations in March 2009 and during its first eight years received only low to moderate flows of water – generally less than 50 cfs, with several periods of higher flows of 100 to 250 cfs for as many as 14 consecutive days. These flow rates, *which are controlled by St. Johns River Water Management District (SJRWMD)*, were well within the facility's 300 cfs design capacity.

Then in September 2017, heavy rainfalls from Hurricane Irma caused the NuRF to receive incoming water flows right at its maximum design capacity of 300 cfs for 30 days straight. Flows averaged more than 250 cfs for another 30 days afterward. These sustained high flow rates over a period of two months caused a series of operational issues to surface that the NuRF is still recovering from. In February 2020, LCWA received a report produced by Pegasus Engineering and Environmental Research & Design (the NuRF's original designer) that evaluated the facility and recommended a set of capital improvements aimed at improving reliability, decreasing down time, improving efficiency, and increasing the treatment capacity to address these ongoing operational issues. The capital improvements recommended in this report (Pegasus Report) consisted of 10 projects with an estimated construction cost of $4.5M.

Given the size of this potential investment, LCWA staff requested that Woodard & Curran perform an independent review of the NuRF, examining the original site evaluation report submitted by Pegasus and providing either support for the improvements recommended or offering additional or alternative suggestions for achieving LCWA's goals for the facility's operation.

In comparison to the original site evaluation, Woodard & Curran's independent review is intended to be more limited in scope, because LCWA is already moving forward with some of the projects recommended in the Pegasus report (specifically, improving dredging equipment and capacity). Also, the pressing operational need to move forward with additional improvements would not allow time to prepare preliminary designs and evaluate the longer-term investigations that were addressed in the Pegasus Report (i.e., alternative water treatment technologies and sludge disposal and reuse options). Therefore, this evaluation is intended as a qualitative review of the near-term operational needs of the NuRF to improve the reliability of its water treatment, floc dewatering, existing process well water quality, and on-site sludge handling processes. However, the long-term integration of these near-term needs with longer-term investigations is also discussed.

1.2 Operational Goals

Prior to evaluating and recommending any improvements to the NuRF, Woodard & Curran first sought to clarify LCWA's operational goals for the facility. Specifically, what is the desired capacity that the NuRF should be able to treat reliably?

The flows in the Apopka-Beauclair canal can be highly variable over time. Having the ability to treat more flow through the facility requires a greater capital cost, but that also means that during periods of low flows – which history has shown can be prolonged – much of that capacity will not be needed and therefore provide little benefit. On the other hand, providing for lesser capacity generally reduces the need for capital investment, but also means water would bypass the NuRF untreated during periods of higher flows in the canal.

Based on discussions with staff, we understand that LCWA's goal is to be able to reliably treat a sustained flow rate of 300 cfs. While this is the facility's original design flow rate, given that the NuRF experienced a number of operational issues when these flow conditions were encountered in 2017, improvements must be made to the facility to achieve this goal. However, such improvements should be focused not on increasing the overall design treatment capacity of the NuRF, but on being able to reliably treat sustained flows of 300 cfs.

1.3 Existing Capacity Analysis

To provide insight into the priority of recommended capital improvements relative to LCWA's operational goal, Woodard & Curran evaluated the design capacity of the facility as a function of the seven individual processes that NuRF comprises. These are:

1. Inflow and Outflow Structures
2. Alum Injection and Mixing
3. Settling Ponds
4. Dredging
5. Floc Conveyance and Storage
6. Dewatering
7. Sludge Handling

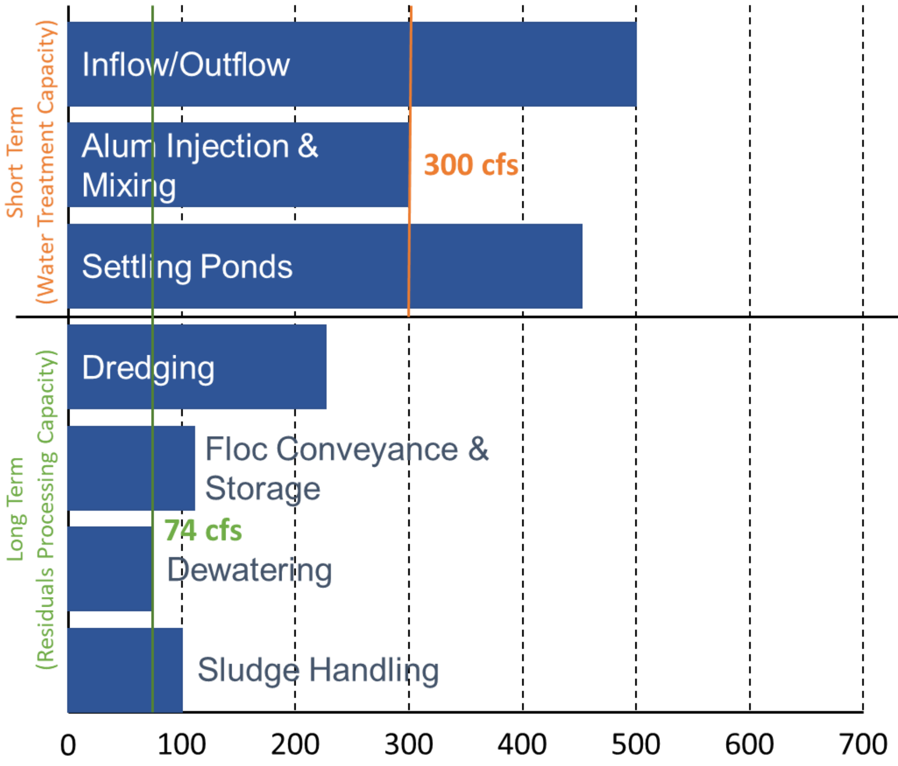
To perform this evaluation, the capacity of each these processes was converted into the equivalent of cubic feet per second of flow through the NuRF, using the same assumptions made in the Pegasus Report. The results of this evaluation are shown in Figure 1-1. Due to the settling ponds' ability to store large volumes of floc, the first three processes collectively determine the short-term capacity of the NuRF (although backups in the subsequent processes can also affect capacity). For the purpose of this evaluation, we have defined short-term capacity as the maximum average flow rate that can be treated effectively over a 10-day period.

In this case, the capacity of the settling ponds themselves are determined by their ability to accumulate floc until their remaining volume is insufficient to meet the 1.5-hour residence time requirement for treated water at a flow rate of 300 cfs (per FDEP Operating Permit). Using the values in Table 6 of the Pegasus Report (p, 23), assuming a partially dredged pond at the start (i.e., floc elevation 55 feet), the capacity of either pond would reach the detention time limit in 15 days at a flow rate of approximately 300 cfs, assuming that floc is not concurrently being removed from the settling pond. With concurrent floc removal and the same assumptions, the capacity of either pond would reach the detention time limit is 47 days.

Once the short-term capacity of the facility is reached, at which point the settling ponds have no more room to accumulate floc, the capacity of the facility is then limited by the collective capacity of the next four process steps (4-7). Effectively, these represent the ability to maintain available pond volume by removing and disposing of floc at the rate it accumulates. The flow rates through the canal, and therefore through the NuRF, are highly variable, and because the treatment ponds provide significant volume for the temporary storage of residuals (or "floc"), it is not necessary that dredging and dewatering capacity be as high as the 300 cfs equivalent. And since dredging and dewatering equipment represents a higher proportion of the NuRF's capital and operating costs, it is more cost-effective to limit the capacity of this process than to have such equipment sit idle much, if not most, of the time. The average flow rate over the 12-year operating life of the NuRF is less than 50 cfs.

In its present configuration, the dewatering equipment (i.e., centrifuge) limits the long-term sustained capacity of the NuRF to 74 cfs. While this appears well short of the 300 cfs operational goal, it is important to recognize that the processes 4-7 currently require staff to be on site for operation. Therefore, the capacity of these processes depends directly on number of hours per day that the NuRF is staffed. This capacity evaluation is based on the NuRF being staffed for one eight-hour shift per day, which means the capacity of these processes could be effectively doubled by running an additional eight-hour shift during periods where higher flows required it. The less frequently these high flows are encountered, the more cost-effective adding a second shift would be compared to the capital cost of twice as much equipment. The dewatering capacity of the NuRF is discussed in more detail in Sections 6.4 through 6.7.

Figure 1-1: NuRF Capacity (Current)



Inflow/Outflow capacity assumed capable of 500+ cfs. Max observed historical flow of Apopka-Beauclair Canal is 754 cfs.

Alum injection capacity (300 cfs) limited by 30 gpm max output of one alum pump. Fixed dose rate of 13 mg Al / liter equates to 1 gpm per 10 cfs. Assumes sufficient mixing.

Settling pond capacity (450 cfs) based on max average flow rate sustained over 10-day period, starting with fully dredged pond, until floc accumulation exceeds 1.5 hr detention time requirement at 300 cfs, without dredging.

Dredging capacity (222 cfs) based on each dredge (2) pumping at 600 gpm capacity for eight hours per day, and that such capacity just balances out floc production assuming dredge mix is 50% floc by volume.

Floc Conveyance & Storage capacity (111 cfs) based on dredge pipe capacity of 600 gpm limited to one dredge operating at a time, reducing dredge capacity above by half.

Dewatering capacity (74 cfs) based on 400 gpm of dredge material (50% floc) throughput of single centrifuge operating eight hours per day.

Sludge Handling capacity (99 cfs) based on reported output of 18 cy sludge from centrifuge when operating continuously at 400 gpm for eight hours, and staff reported capability to dispose 24 cy on site per eight hour shift.

2. OPERATIONS AND MAINTENANCE EVALUATION METHODOLOGY

The capacity analysis described above, and the priority improvements identified as a result, are based upon the capacity of the individual NuRF processes as designed. Inherent in the use of design capacity is the assumption that these processes are performing as intended, or as specified in the original design. In reality, the performance of these processes is affected by real world operating conditions and actual equipment performance. As discussed above, real world operating conditions during Hurricane Irma indicated a strong need to make the NuRF more resilient under high flow conditions.

To assess the actual performance of the various NuRF processes, Woodard & Curran conducted an operations and maintenance evaluation, which included multiple site inspections, interviews with LCWA staff, discussions with technology vendors, and reviews by our internal operations and maintenance experts. This evaluation focused on the following areas:

- Inflow Flow Station
- Alum Injection and Mixing
- Process Well Water Quality
- Floc Dewatering
- Sludge Handling

Each of the areas is discussed in the following sections.

Where W&C recommended improvements that were substantially different than those in the Pegasus report, cost estimates at the study or feasibility level were developed based on the Association of Advancement of Cost Engineering (AACE) cost estimating system.[1] Costs for key equipment were obtained directly from technology vendors. A difference between W&C cost estimates and those in the Pegasus report is our use of a 30% construction contingency due to the limited timeframe available for our report. In comparison, the Pegasus report used a 10% contingency as its authors may have been better able to define their proposed improvements.

Data collection, sampling, etc. and survey were not conducted as part of this evaluation. While efforts were made to align the recommendations with future operational goals, the recommended improvements are not able to fully reflect future insights that may be gained as operational changes are implemented and data is collected. All of the recommended improvements are planned to proceed through design and construction, where it is expected that the engineer or contractor will obtain any additional data necessary to fully implement the recommendation.

Several vendors indicated ongoing COVID related disruptions to their supply chains, and the potential for related *force majeure* (unforeseeable) impacts on construction costs. As a result, construction cost estimates should be periodically updated to assess unforeseen cost impacts. The inflow system improvements are particularly vulnerable due to the amount of steel in that area.

---

[1] AACE International Recommended Practice No. 18R-97. Cost Estimate Classification System as Applied in Engineering, Procurement and Construction for the Process Industries.

3. INFLOW SYSTEM

3.1 Introduction

Leaves, branches, logs, and wildlife have all been identified in the treatment process stream. The current bollards discourage marine traffic and they are spaced too widely to stop all but very large or very long items from entering. The debris that has entered the floc ponds has resulted in down time for the existing dredge pumps. The vegetation in the inflow stream also takes up volume in the settling ponds and consumes a portion of the alum and polymer doses, resulting in potential inefficiencies for the treatment process. Improvements to the inflow system to prevent debris entry are therefore warranted, and ideally would be implemented as soon as possible.

The proposed cantilever sheetpile wall and skimmer concepts in the Pegasus report would certainly be an improvement from the current bollards. However, these concepts do not incorporate screening, which would ensure that floating and suspended debris, including highly mobile solids and materials entering from the north, cannot enter the system. During W&C support of the facility during high flows near 300 cfs, W&C staff observed heavy debris loading coming into the facility. A conservative approach to debris loading is warranted to ensure the facility is not disrupted by debris loading from high flows in the future. Rather than a cantilever wall and skimmer, the use of a screening technology is recommended to ensure that floating and suspended debris cannot enter the system and ensure the new dredge pumps design specification for solids passage is met. Several applicable technologies and their potential implementation are discussed in this section.

3.2 Flow and Process Characteristics

The table below shows the intake flow distribution from NuRF inception in 2009 to early 2021 (excluding periods when flow was zero due to facility outage). As shown, 71.8% of the daily flows were less than 50 cfs, 15.2% of the daily flows were between 49 and 150 cfs, 11.4% of the daily flows were between 149 and 300 cfs, and 1.6% of the daily flows were 300 cfs or greater. The flow regime is quite variable with periods of low flows, medium flows and high flows. The intake system was observed to be relatively quiescent - without significant debris movement during low flows. During W&C support of the facility during high flows near 300 cfs, W&C staff observed heavy debris loading coming into the facility. More observational data would be useful and should be gathered during design, recognizing that debris loading is likely to be variable and difficult to characterize. A conservative approach to debris loading is warranted to ensure the facility is not disrupted by debris loading from high flows in the future.

Table 3-1: NuRF Flow Distribution March 3, 2009 through January 3, 2021

Flow Regime	Flow Range (cfs)	Number of Days	Days (%)
Low	1 to 49	1470	71.8%
Mid	50 to 149	310	15.2%
High	150 to 299	266	11.4%
Very High (Design)	> 299	32	1.6%

The NuRF is comparable, in terms of design flow rate, to power plants which typically deploy intake screens or racks to prevent debris and wildlife impingement and entrainment in their cooling flows.[1] The screen or rack is used to

---

[1] Final Regulations to Establish Requirements for Cooling Water Intake Structures at Existing Facilities, EPA, May 2014)

prevent suspended objects from entering the facility. Various screening strategies for intake flows are discussed in a Technical Development document prepared by EPA for power plants.[1] Ideally, an intake screen or rack would be mounted to the existing intake structure.

LCWA has ordered new Mudcat 40E electric dredges to replace the Crisafulli FLUMP dredges. The Mudcats can pass 4” solids, which is an improvement from the 2.25” solids that were passed by the Crisafulli FLUMPs. Implementation of intake screening concurrent with the deployment of the new dredges is critical to ensure the new dredges are operating within their design criteria and protect the investment from the type of damage that the old dredges experienced. As such, inflow screening should be a high priority.

3.3 Maintenance and Redundancy Concerns

While an intake screen is relatively straight-forward and inexpensive to install, the ability to keep an intake screen clean is an important design issue. If the screen becomes clogged, the facility will not be able to treat water. Since the NuRF functions as a bypass for water draining from Lake Apopka into Lake Beauclair, flow that is unable to be routed through the NuRF due to clogging could contribute to offsite flooding. Clogging must be quickly removed to prevent these issues.

Currently, operators use a long rake to remove vegetation that gets wrapped about the intake bollards. The bollards have approximately 24” spacing. Implementing screening with a spacing less than 4” to enable the new dredges to work within their design parameters will capture far more debris than the bollards. W&C observations during high flows suggest that this volume of debris can be too much for manual removal. High debris loads are generally more likely to occur during adverse weather, thunderstorms, etc. Since the inflow structure is out in the open there will be safety hazards associated with manual cleaning under storm conditions.

Self-cleaning automation technology is recommended to keep screening clear and flowing, especially under high flows. While this technology adds cost, it will enable the screening to reliably fulfill its purpose of keeping debris out of the floc ponds. The self-cleaning automation technology should also incorporate redundancy in case of equipment downtime. This will then enable the new dredges to reliably operate within their design specification for solids passage.

3.4 Inflow Screening Options

This section discusses several options for automated self-cleaning inflow screening, as follows:

- Bar rack with traversing grab rake
- Automated bar screen
- Cylindrical wedgewire screen

Each of these options are established technologies with strong track records in the water industry.

3.4.1 Bar Rack with Traversing Grab Rake

A bar rack with traversing grab rake involves the installation of an angled vertical screen rack, mounted to the intake structure on the canal side. A typical slot width for the screen rack is 2”-4”. A cantilevered hoist is then installed with a rake bucket above the screen rack. Additional structural support would be provided by new posts and concrete pads along the headwall.

---

[1] Technical Development Document for the Final 316(b) Phase II Existing Facilities Rule, EPA,

The hoist is mounted to a traversing monorail that spans the rack and intake structure. The rake bucket cleans debris off the screen rack and the bucket traverses to deposit the screening in a bin. Pressure sensors are used to determine the cleaning frequency and alarm if the pressure drop across the bar rack is too high.

An advantage of a bar rack with traversing grab rake is the moving parts are above ground and readily accessible for maintenance. Since the system would collect and remove debris from the canal, there should not be any issues with debris accumulation in the canal. However, handling and disposal of the debris would need to be coordinated. Operators or an outside vendor would have to empty the debris bin and dispose of the material either on or offsite. The debris bin would be located on the canal berm just north of the inflow structure.

Compared to a sheetpile wall or cylindrical wedgewire screen, the hydraulic effects of a bar rack with traversing grab rack would be minimal and shouldn't require a detailed evaluation of the Apopka-Beauclair Canal. A minor modification to the facility's environmental resource permit (ERP) would be needed.

Figure 3-1: Traversing Grab Rake

(Source: Evoqua)

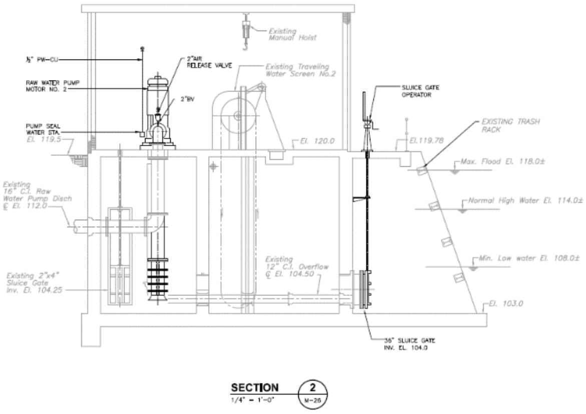
3.4.2 Automated Bar Screen

An automated bar screen rotates the screen on a chain through the intake flow, collecting and depositing debris onto a conveyor or guide which routes the screenings to a bin or hopper. This type of screen would require new concrete structures for support and to guide flow through the screen, and a mezzanine/access walkway inside the intake channel. A typical slot width for an automated bar screen is 1”-2”. The design and hydraulics of the new structure and screen would require evaluation to ensure the design flow can pass through the slot and channel guide. These screens are often designed for lower flows than the NuRF and a number of screens may be necessary to pass the design flow.

An automated bar screen is commonly deployed in new applications where the intake structure is designed to integrate with the bar screen. A disadvantage of this option for the NuRF is that the amount of concrete structure work that would be required to mount the screen and channelize the flow. An advantage of this option for the NuRF is that hydraulic evaluation of the Apopka-Beauclair canal would not be needed since the screen would be constructed in the intake channel. A cross section of an automated bar screen is shown in the figure below.

Figure 3-2: Automated Bar Screen Application

(Source Town of Billerica)



3.4.3 Rotating Cylindrical Wedgewire Screen

A rotating cylindrical wedgewire screen mounted to the intake structure on the Apopka-Beauclair Canal side is another screen option. This type of screen is fabricated as a hollow cylinder with a fine slot width (typically less than 0.25”). It is well suited for use with an airburst or jet backwashing system, which can usually generate sufficient velocity to backwash the screen. The screen rotates through a backwash stream with a guide brush to prevent fouling. Pressure sensors are used to determine the backwash frequency and alarm if the pressure drop across the screen gets too high.

A rotating cylindrical wedgewire screen would be mounted to the Apopka-Beauclair canal side of the intake structure using a grouted adaptor. New pilings installed in the canal would provide structural support. The screen would extend along the canal berm in using a manifolded T configuration to provide an extended surface area for intake flow. A submersible pump or above grade air compressor would provide the source for backwash. This type of screen is commonly deployed in new and retrofit applications to reduce intake velocities to less than 0.5 feet per second.

An advantage of a wedgewire screen is the large surface area of the intake and lower velocity (compared to other screen types) to reduce the amount of debris being pulled towards the intake. Also, a new concrete structure is not needed for this type of screen. A disadvantage of a wedgewire screen is the small slot width is more subject to biological growth fouling (than larger slots) and maintenance needs to be done by divers in case of clogging. There is also a potential for long term debris accumulation in the broader canal area around the screen because debris is not being extracted from the canal. There will likely have to be a detailed hydraulic and navigational evaluation of the canal because the screen would extend beyond the existing bollards, thus requiring a modification to the facility’s environmental resource permit (ERP).

A photo of a rotating cylindrical wedgewire screen is shown in the figure below.

Figure 3-3: Rotating Cylindrical Wedgewire Screen with Cleaning Brush and Backwash System

(Source: ISI)

3.5 Inflow System Summary and Recommendations

- Rather than the cantilever wall proposed in the Pegasus report, the use of a screening technology is recommended to ensure that both floating and suspended debris do not enter the system and damage the dredge pumps. Several applicable technologies and their potential implementation are discussed in this section.

- Inflow screening should be a high priority. Screening will allow the new Mudcat dredges that LCWA has purchased to operate within their design specification for solids passage by preventing solids larger than 4" in diameter from entering the floc ponds. Implementation of inflow screening concurrent with the deployment of the new dredges is critical to ensure the new dredges are reliable and maintain a consistent floc feed to the dewatering system.

- Self-cleaning automation technologies with redundancy for equipment downtime are recommended to keep inflow screening clear and flowing. When a screen becomes clogged, it will be necessary to quickly remove the clog to ensure the system continues to flow. W&C observations during high flows suggest that the volume of debris can be too much for safe manual removal. More observational data on debris loading would be useful and should be gathered during design, recognizing that debris loading is likely to be variable.

- A bar rack with traversing grab rakes aligns well with the Mudcat design specification for solids passage. This automated, self-cleaning system would be able to use the existing intake structure at the Apopka-Beauclair canal for mounting. It would store the removed vegetation in a bin or dumpster for offsite removal by a vendor. Implementation of this type of system is recommended in lieu of the proposed cantilever wall and skimmer system in the Pegasus report.

4. ALUM INJECTION AND MIXING

4.1 Injection and Mixing

Efficient utilization of alum requires aggressive mixing due to the high viscosity and "stickiness" of the alum. Alum also should be well dispersed amongst the flow with multiple injection points. The current drip and aerator system is not providing the required aggressive mixing and dispersal required for optimal efficiency, resulting in inefficient application of alum. Excess alum addition also has the potential to reduce residence time in the settling ponds and limit the overall treatment capacity of the facility. Therefore, improvements to the existing system are warranted. The Pegasus recommendations to use a pumped carrier water for alum conditioning, and dispersed high velocity injection for dispersal are well established strategies to improve injection and mixing.

The use of a carrier water involves injection of the alum on the suction side of a new feed pump so the alum passes through the pump impeller, which provides very strong and rapid mixing. The alum is thus conditioned or spread out into the carrier water and better equipped to mix with the flow during the next step. Given the history of debris issues at the facility, the carrier water should either be filtered to prevent clogging or a clean, potable-style supply type used.

The conditioned alum/carrier water mixture would then be dispersed into the flow using a high velocity injection system. A series of nozzles would be positioned at 1-foot spacing perpendicular to the channel bottom. The nozzles would disperse the mixture throughout the flow while generating turbulence to further disperse the alum. The treated water would then enter the floc ponds for settling.

Currently, alum is being introduced at the intake structure. The Pegasus report recommends the new system be installed immediately upstream of the floc ponds. Positioning the new system at this location would likely reduce re-treating of water during low flows when winds on the lake cause water to slosh back and forth in the channel. However, this location would also limit the use of the intake channel for the reaction time, which is an important purpose of the channel.

The use of a split chemical feed is another common strategy to improve mixing. In this case, injection points would be located at the intake structure and ahead of each pond entrance. The proposed debris skimmer in the intake channel would be eliminated by using a screened intake. The primary injection location near the existing drip point at the intake structure would be kept to provide more contact time for treatment in the channel. Secondary injection locations would be provided immediately upstream of the floc ponds.

The use of baffles and channel turbulence is another common strategy to improve mixing. In this case, submerged concrete or jersey barriers would be used to create a rolling pattern and add mixing or turbulence in the channel. This low-cost approach would help more of the channel volume be applied to mixing.

The goal is to ensure that treatment is completed in the channel so that the capacity in the ponds is used for settling. The pumped carrier water and dispersed high velocity injection concepts recommended in the Pegasus report, along with further enhancements to distribute the injection points and obtain better mixing in the channel, are recommended to improve the alum injection and mixing system.

4.2 Real Time Monitoring

The alum dose rate is presently based on a single jar test, taken once per week, with results increased to be conservative, and then, modulated proportionally to the daily rate of inflow. Based on historic testing, there have been many cases where alum was being fed to an influent which had total phosphorous levels that were already below the NuRF's effluent goals, resulting in overfeeding of alum, excess sludge generation, and reduced residence time in the settling ponds.

A real time (one result per hour) phosphorus analyzer has good potential to facilitate alum dosage proportional to actual incoming total phosphorus concentrations (in addition to inflow) and thus enable a reduction in alum overfeeding. There have been major technology advances in monitoring over the past decade, and on-line analyzers are now frequently used in capacities where historically lab testing would have been needed. The 10 parts per billion (ppb) total phosphorus detection limit of the analyzer is well below the effluent limit of the NuRF. The resolution or accuracy of this device can be confirmed by comparing its measurements against lab tested samples where necessary.

Given the historic rate of alum use at the facility and the injection mixing and mixing improvements discussed above, the ability to more frequently measure incoming phosphorus has strong potential to facilitate a reduction in alum use. Over time, the more frequent phosphorus measurements would enable the NuRF to more accurately track total phosphorus removal and facilitate training and tools for operators to optimize the dosing rate. It is recommended that real-time monitoring be implemented.

4.3 Alum Injection and Mixing Summary and Recommendations

- The current drip and aerator system is not providing the required aggressive mixing and dispersal required for optimal efficiency.
- Proceed with carrier water/alum and dispersed injection system for more effective mixing as conceived in Pegasus report, with further enhancements to distribute injection points to obtain better mixing in the channel.
- Establish the primary alum feed at the intake structure with secondary feeds immediately upstream of the floc ponds. Further operational enhancements could include the use of submerged concrete or jersey barriers to create turbulence in the influent channel to improve mixing.
- Implement real time phosphorus monitoring. Reduce alum dose rate considering real time phosphorus concentrations and the performance of the new injection and mixing system.

5. PROCESS WELL WATER QUALITY

Despite filtering, the existing process/potable water well system has experienced occasional red staining due to high iron concentrations. The Pegasus report suggested a potential long-term operating and maintenance concern for the centrifuge (in addition to discoloring the sink and toilet). However, the manufacturer representative for the centrifuge expressed little concern over iron concentrations in the process water. A water sample containing high iron should be tested and the results provided to the manufacturer to confirm the water compatibility with the centrifuge before proceeding with any improvements. Compared to high iron concentrations, grit in the floc is a more significant concern for the manufacturer. Assuming the manufacturer confirms compatibility with high iron concentrations, improving the process water quality for the centrifuge should be a low priority for LCWA, as long as sufficient capacity remains in the existing well system.

The existing wells experienced challenges during drilling and were terminated in the shallow surficial aquifer system, a geologic formation primarily comprised of sand, silts and clays. Due to these constituents, iron concentrations in the surficial aquifer system vary and often exceed the drinking water standard of 0.3 mg/l[1]. Additionally, the dense clays and sands that were experienced during drilling limit the production capacity of the existing wells. According to the Pegasus report, the current capacity is sufficient for operation of one centrifuge but is not sufficient to add a second centrifuge operating simultaneously. Therefore, new supply alternatives would need to be considered for a dewatering expansion.

The Pegasus report recommended evaluation of additional alternatives to improve process water quality and support a dewatering expansion. The poor water quality in the existing wells could be treated, or a new water source could be introduced to help improve water quality and capacity. Three options for improving process water quality were discussed in the Pegasus report:

- Install a new well into the Upper Floridan aquifer;
- Install a greensand treatment system to remove iron from the existing wells;
- Use treated water from the floc ponds.

Each option is discussed below.

5.1 Install a New Well into the Upper Floridan Aquifer

Groundwater from the surficial aquifer in Lake County is mostly used for domestic self-supply (e.g., single family residences). Public supply, agricultural and industrial withdrawals primarily use groundwater from the deeper Upper Floridan aquifer.[2] The Upper Floridan aquifer typically provides good quality water with iron concentrations below drinking water standards due to its limestone matrix and location beginning approximately 200 feet below ground.

A review of consumptive use permits within a 12-mile radius of the NuRF suggested that groundwater is commonly sourced from the Upper Floridan aquifer for projects similar in size to the NuRF (see table below). These projects are comparable to the water use requirements of the NuRF, whose original plans were reported by the Pegasus report to have specified three wells with a capacity of 144,000 gpd (e.g., 100 gpm) each, for a total planned capacity of 432,000 gpd. So, the Upper Floridan aquifer has been a viable option for nearby water users similar to the NuRF.

---

[1] Technical Publication SJ2006-1, Water Supply Assessment 2003, St. Johns River Water Management District.

[2] Lake County Water Supply Plan, 2007. Water Resource Associates.

According to the centrifuge manufacturer, the centrifuge flow requirement is 100 gpm approximately 5 minutes per hour, or approximately 12,000 gpd of actual water use. Depending on water requirements for additional dewatering, a new Upper Floridan aquifer well from 4”-12” diameter could be installed. A water sample would be collected from the well during testing. Assuming good water quality, the test well would then be converted to a production well. With the thick layer of overburden above the Upper Floridan aquifer and common use of the Upper Floridan aquifer in the area, good water quality is expected.

Since the Upper Floridan aquifer is much more productive than the surficial aquifer, one new well would provide the capacity for the NuRF. The well would be sized to accommodate future dewatering equipment as necessary. The water from new an Upper Floridan aquifer well typically requires nominal treatment for aeration and disinfection.

Table 5-1: Selected Groundwater Withdrawals Within a 12-mile Radius of the NuRF

Project	Type	Average Withdrawal (see note 1) (gpd)	Water Source
Twin Lakes-Cherry Lake	Citrus Grove	239,000	Upper Floridan aquifer
Renegade Environmental	Office	100,000	Upper Floridan aquifer
Homan Farms	Citrus Grove	295,000	Upper Floridan aquifer
Tremendous Quality	Nursery	178,000	Upper Floridan aquifer
E-76 CPL	Citrus Grove	307,000	Upper Floridan aquifer
NuRF	Industrial/Office	432,000	Surficial aquifer

Relative to drilling, the mixed clays and consolidated sands in the surficial aquifer at the site can be challenging for conventional mud rotary/air rotary drilling. Dual rotary drilling with a surface casing can address more variable conditions and is likely warranted at the site. The well design and drilling specification for an Upper Floridan aquifer well should be prepared by a qualified local geologist to ensure the proper equipment is used and the proper depth for the production capacity is reached.

A Florida Department of Health permit will be required for a new Upper Floridan aquifer well. If the withdrawal will be greater than 100,000 gpd, a new SJRWMD CUP would be required.

5.2 Install a Greensand Treatment System

Greensand, a silica or glauconite-based mineral coated with manganese dioxide, is a common treatment media for iron removal. A chlorine or potassium permanganate-based oxidizing agent would be added to oxidize the iron for contact with the media, and a backwash system would remove the treated iron from the filter. Residuals would be blended with the existing spoil onsite.

Water quality characterization from the existing process wells will be necessary to design and size the greensand treatment system. The required sample parameters are shown in the table below. Since the existing water quality is variable, with red staining on and off, sampling should be performed during a staining event to ensure the problematic iron concentrations are determined.

Table 5-2: Process Wells Water Quality Characterization

Water Quality Sample Parameters
pH, Alkalinity, Iron, Manganese, Calcium, Magnesium, Total Organic Carbon

The new treatment system would require residuals pumping, and a building expansion with new stormwater management infrastructure. Compared to a new Upper Floridan aquifer well, this alternative would have additional O&M requirements for media replacement and chemical use, and it would also not be able to supply additional water for new dewatering equipment.

5.3 Use Treated Water from Floc Ponds

The treated water in the floc ponds has good water quality and would be an acceptable source for the centrifuge process. Since the centrifuge process water would be recirculated back into the pond the flow capacity is not limited. The primary concern with this source is the possibility of entraining floc into the 1” flushing system for the centrifuge and clogging the centrifuge’s flushing system.[1]

Fresh floc is readily mobilized, and historically has formed piles along the berms near the inflow structure. The floc when mobilized would be difficult to keep out of an intake system. The planned introduction of the MudCats and potential changes to the alum introduction pattern also have the potential to alter the floc distribution. These issues pose risks to planning to draw from the ponds for centrifuge flushing at this time.

A new water channel section, downstream of the floc settling ponds but upstream of the outflow canal, would address floc entrainment. This option would re-purpose the upstream end of the outflow channel for centrifuge process water withdrawal. A new segment of outflow channel would be constructed to convey water from the cooling water channel to the downstream end of the outflow channel. A new weir gate and culvert would deliver treated water from the new canal section to the outflow channel. This new channel section would solely contain treated water and would be hydraulically separated from the outflow channel, thus isolating the treated water for centrifuge use.

Depending on the process water requirement from a second centrifuge or other dewatering equipment, a new submersible pump and intake structure would withdraw at least 100 gpm and transmit it through new piping to the dewatering building.

The advantage to using treated water from the existing process is an unlimited source of good quality water. This disadvantage is that the existing process does not have treated water separate from floc, and significant infrastructure would be needed to secure and deliver this separate water to the centrifuge.

---

[1] The Pegasus report described the centrifuge process water as cooling water. According to the manufacturer, the centrifuge does not use cooling water, but it does use flushing water.

5.4 Process Well Water Quality Summary and Recommendations

- The Pegasus report identified the need for additional evaluation of options to address the potential effect of high iron concentrations in the existing surficial well system on the centrifuge and add flow capacity for expansion. This section discusses a new Upper Floridan well, a greensand treatment system, and use of treated water from the floc ponds for process water supply to the centrifuge.
- Groundwater is commonly sourced from the Upper Floridan aquifer for projects in the immediate vicinity of the NuRF. The Upper Floridan aquifer has been a viable option for nearby water users whose water requirements are similar in size to the NuRF. Dual rotary drilling with a surface casing should be able to address the variable conditions present at the site if a new Upper Floridan aquifer well is needed.
- The manufacturer representative for the centrifuge and the polymer vendors expressed little concern over iron concentrations in the process water. A water sample containing high iron should be tested and the results provided to the centrifuge manufacturer and polymer vendors to confirm the water compatibility with the dewatering process before proceeding with any improvements.
- Grit in the floc was a more significant concern for the manufacturer than high iron concentrations in the process water. Assuming the manufacturers confirms water compatibility with the centrifuge, improving the process water quality for the centrifuge should be a low priority, for as long as sufficient capacity remains in the existing wells.

6. FLOC DEWATERING

Currently, operating one manual shift per day, the centrifuge design is for dewatering of 74 cfs, which is approximately ¼ of the NuRF design capacity of 300 cfs. This rate is a limiting factor for the NuRF during extended periods of moderate to high flow, when floc accumulation in the settling ponds exceeds the capability of the centrifuge to remove and dewater the floc. For this reason, the Pegasus report recommended an additional centrifuge, new building and new floc storage tank at a construction cost of approximately $2.6 million. The addition of a second duplicate centrifuge would increase the design capacity to 148 cfs. The purpose of this section is to discuss the floc dewatering operation and potential for expansion as recommended in the Pegasus report.

6.1 Settling Ponds and MudCats Onboarding

The purchase of the new MudCat 40E dredges offer several expected benefits for the settling ponds and floc dewatering compared to the existing Crisafulli FLUMPs. According to their design specifications, the MudCats should be able to provide a more consistent supply of floc near the centrifuge's target density, due to their ability to adjust their vertical position and discharge rate in real time in response to floc density in comparison to the Crisafulli's. This should reduce inconsistent floc densities and improve dewatering performance.

Currently, the Crisafulli dredges are unable to reach the pond bottoms. There is an approximately 5' thick layer of aging floc on the bottom that can't be dredged. (The on-call dredging company has so far removed this layer in a portion of the west pond.) This aging floc has the effect of placing the floc setting ponds out of balance as young, lower density floc is removed from the surface while older, higher density floc remains on the bottom. According to vendors, floc has often been supplied to the centrifuge in the 0.5-1.0% density range, which is below the 1-2% target for the centrifuge indicated in the Pegasus report (LCWA has indicated that densities above 1.5% have caused processing issues at the facility). The MudCats, with depth extensions, can dredge all the way to the pond bottom. The feature when implemented will enable the whole pond volume to be fully used for settling as originally designed. It will facilitate development of a more even-aged, consistent density floc for dewatering.

As the MudCats are onboarded, the deeper floc should be sampled and tested before it is pumped to the centrifuge. The presence of old, consolidated material in the deeper floc could be an issue for the centrifuge. The centrifuge manufacturer will perform the testing and confirm the viability of the deeper floc for the centrifuge.

The existing rail system for the dredges should also be extended to reduce uneven floc buildup near the inflow culverts. According to the Pegasus report, this accumulation occurs under low flows. It is another potential source of variable density floc that would limits the performance of the dewatering system.

The presence of sand, grit and small rocks were readily observed in the onsite sludge. Compared to a municipal water/wastewater sludge, the sludge appears to be high in sand and grit. While a centrifuge is able to tolerate these materials to some degree, in drinking water and wastewater applications, sand and grit are typically removed prior to processing since they take up volume in the treatment process and contribute to O&M issues. The centrifuge manufacturer also expressed concern over debris and grit in the feed and its potential impacts on the centrifuge. The existing dredges were likely making contact with the pond banks and mobilizing sand and grit into the floc. The Mudcats should be programmed with limits to prevent contact with the pond bank/bottom to reduce mobilization of this material, and to help automate a consistent dredging scheme in the ponds. Currently, the dredges are being manually operated from the shoreline.

Onboarding and deployment of the Mudcats is important because the new floc characteristics will not be fully known until the new dredges are operational. The new floc characteristics and performance improvements from the new dredges will not be known until the new dredges are fully operational. After these performance improvements are known, additional improvements to refine and expand floc dewatering should be assessed. For example, a grit separator could potentially be installed to remove the sand and grit from the floc, but the Mudcats may obviate the need for this improvement by not hitting the pond banks. Similarly, a thickener may be considered but the Mudcats may improve the floc density over time by being able to draw deeper in the ponds as floc re-accumulates after the contractor's pond dredging, potentially to a point where a thickener isn't warranted. A grit separator and/or thickener would be significant expenditures that are not identified in the Pegasus report. The new dredges have significant potential to improve floc consistency and dewatering performance, but these performance improvements should be demonstrated to ensure coordination with the following expenditures that will likely be needed to further refine and expand dewatering capabilities.

6.2 Existing Centrifuge

The existing Westfalia centrifuge is the most important and highest cost component of the NuRF's floc dewatering process. The centrifuge spins at a high speed to remove water from the floc by centrifugal force. As discussed in the existing capacity analysis above, the single centrifuge is the primary limiting factor for the long-term sustained capacity of the NuRF.

The LCWA reported good performance from the centrifuge until the centrifuge scroll (i.e., screw shaft) was damaged last year and the centrifuge was taken out of service. It has remained out-of-service since the damage to the scroll due to the long lead time with parts, which are manufactured in Germany. The new scroll is expected to arrive in mid-April.

The resiliency of the centrifuge and difficulty obtaining parts in a timely fashion are significant issues that should be considered with any expansion. As mentioned in the Pegasus report, a similar second centrifuge may be able to share parts with the existing centrifuge, but it could also result in having parts issues that span both centrifuges.

The LCWA indicated that several investigations have been commissioned to evaluate the cause of the scroll failure. One investigation used a tracer and noted the propagation of hairline cracks throughout the metal and attributed the damage to a weld failure. The centrifuge manufacturer has attributed the damage to a weld failure, but also expressed concern about the presence of debris and grit in the feed. As mentioned above, consideration of additional pre-treatment of the floc is warranted due to the importance of the centrifuge for dewatering.

In 2015, a macerator was installed to pre-treat the floc from the settling pond ahead of the existing centrifuge. The macerator shreds vegetation and other debris to prevent these materials from clogging the centrifuge. Since the macerator is already providing a shredded floc, a grit separator may be used to remove higher density sand, grit and small rocks from the shredded floc – that is, if the new dredges are still mobilizing this material in the floc. Keeping inorganic materials away, either via a grit separator or automation of the new dredges, will improve centrifuge performance by removing the higher density materials from the floc before dewatering. This should also help extend the life of the centrifuge once it returns to service.

6.3 Dewatering Process

Even with the centrifuge running, the effectiveness of the current dewatering has been somewhat limited. This can be seen with the challenges with sludge handling. Ideally, a dewatered sludge would be able to be stacked onsite in large stockpiles. However, the existing sludge rehydrates and becomes slippery with rain and does not hold the slope of a stockpile. The low and inconsistent density floc feed and issues with the polymer feed are likely contributors to this issue. Once an effective polymerization is in place with a consistent density feed floc, the sludge is less likely to rehydrate with rain. At that point the sludge may become stackable, making sludge handling much easier.

Polymers are commonly used to improve dewatering of dredge materials. Polymers are available in cationic, anionic, and non-ionic formulations and at different densities. The NuRF is equipped with an existing polymer system using a high charge structured cationic emulsion. However, the effectiveness of the polymer has been limited by variations in the floc density and challenges with the polymer application. The presence of sand and grit in the floc has the potential to differentially mix with polymers and may reduce the dispersion of polymer in the floc. Also, the existing polymer emulsion is only lightly pre-conditioned, which makes it less likely to mix evenly with the slurry (than a fully pre-conditioned polymer).

The polymer system is manually operated with dosing rates estimated by the operator based on the floc appearance. Assuming the new dredges are reliably and effectively operational, the feed system should be capable of providing a more consistent floc density. If this is achieved, a more consistent floc will allow for more consistent and effective polymer dosing. Jar testing of the new floc (with the new dredges) should be conducted to determine the polymer dosing and consider changes in polymer composition and pre-conditioning.

Similar to the alum injection improvements discussed earlier, an assessment of polymer applicability to the improved feed will be warranted in concert with the new dredges. This assessment should consider improved polymer conditioning and polymer selection. It should also address the use and availability of process water for make down, and its iron content. A well-conditioned polymer can be obtained directly from a vendor, or improved onsite polymer conditioning can be conducted, likely making use of the existing make-down system with additional process water storage. If existing process water is used for make-down, the presence of high iron concentrations in the process water should be coordinated with the polymer selection to avoid interference. If a new, consistent floc from the new dredges can be achieved, improved polymer implementation will subsequently help to optimize dewatering performance.

Several vendors have begun assessing applicability of various polymers and other chemicals to the NuRF. In some cases, a blend of multiple polymers can act in concert to improve dewatering beyond what is achievable with a single polymer. A bacteria added to the floc ponds may be able to consume organics in the feed to enhance polymer performance and reduce sludge volume. The use of an iron salt may also be evaluated in conjunction with the polymers. If a consistent floc can be achieved by the new dredges, these assessments of various polymers and other chemicals should be advanced to a cost-benefit evaluation. Initial discussions with vendors suggest that a stackable sludge with a 20% to 40% reduction in volumes may be possible through improvements to chemical selection and application. This would be a significant improvement and would help extend the capacity of the onsite sludge storage.

6.4 Shift Operations and Automation

Currently, operating one manual shift per day, the centrifuge design is for 74 cfs of processing, which is approximately ¼ of the NuRF design capacity of 300 cfs. For this reason, the Pegasus report recommended an additional centrifuge, new building and new floc storage tank at a construction cost of approximately $2.6 million. The addition of a second duplicate centrifuge would increase the design capacity to 148 cfs. Flows at the NuRF have been less than 150 cfs approximately 87% of the time since 2009, so this improvement would address the vast majority of flow conditions. However, flows at the NuRF have been less than 50 cfs approximately 72% of the time since 2009, so a new centrifuge also has the potential to sit idle for extended periods. In comparison, automation and additional shift operations have potential to increase dewatering capacity without incurring any significant capital costs.

An alternative to the construction cost of a new centrifuge is to add a second manual operating shift, which would increase the design processing rate of the centrifuge to 148 cfs. To consider this alternative, a cost comparison was generated to consider the labor cost of the second shift against the cost of a new centrifuge and its appurtenances (new floc pumping system, conveyor, polymer addition system, controls, etc.) as indicated in the Pegasus report). Assuming a full time second shift at a labor cost of $65,000 per year, it would take 24 years to spend the $1.575 million construction cost of a new centrifuge and appurtenances. This basic comparison assumes that inflation effects on the present value of money and increases in labor cost simply cancel out over time and does not consider the cost of a new floc tank. The 24-year time period for amortization of the second shift is in-line with an expected 20 to 30-year design life for the centrifuge and associated equipment. It suggests, from a present value perspective, that the cost of a second full-time shift is approximately equivalent to the construction cost of a new centrifuge.

A second shift has been deployed in the past on an on-call basis during high flows. According to LCWA, the current budget for on-call shift support is $15,000 per year. At a labor cost of $28 per hour, approximately 13 weeks of support would be available. Historically, flows have been above 50 cfs approximately 28% of the time, or 15 weeks per year. Considering this agreement with the same assumption above, it would take 105 years to spend the construction cost of a new centrifuge and appurtenances at the labor cost mentioned above. Clearly, there are cost benefits to continuing or expanding current shift operations (compared to a new centrifuge). Also, if a consistent floc feed in achieved, it may be possible to automate centrifuge and polymer operations.

6.5 Floc Feed Quality

Currently, the issues with the low and inconsistent floc feed likely result in an operating dewatering capacity (based on solids removal) that is well below the facility's design dewatering capacity. As shown in Table 6-1, the current floc feed is generally approximately ½ of the target density of the centrifuge. Since solids are not currently being removed from the floc ponds at their design rate, the effective floc pond removal rate for the centrifuge is likely closer to a 37 cfs equivalent, instead of the design rate of 74 cfs. A consistent, higher density feed from the new dredges would increase the operating floc removal rate from the settling ponds, improve the efficiency of the centrifuge and potentially achieve the design capacity of the centrifuge.

Table 6-1: Potential Effect of Dredging Improvements on Dewatering Operations

Flow Description	Fraction Solids	Notes
Floc feed flow (historic)	0.75%	Vendor estimates in 0.5% to 1.0% range
Incoming flow (with dredging improvements)	1.50%	Centrifuge target density 1-2% (Pegasus report)
Potential capacity change	100%	

6.6 Settling Ponds Hydraulic Residence Time

The hydraulic residence time in the settling ponds is a function of the inflow rate and the available volume in the ponds above the floc elevation. As the floc elevation in the pond increases, the hydraulic residence time decreases. The FDEP permit requires a minimum hydraulic residence time of 1.5 hrs with one pond in operation. During periods of high flows, floc can be generated more quickly than it can be removed by the dewatering process. There are several potential factors which may contribute to this issue. These include:

- Excess alum dosing, which can create more floc than necessary to treat the water and take up volume in the ponds.
- Depth limitations of the existing dredges, which can reduce the density of the floc being fed to the centrifuge and limit the rate of solids removal and processing.
- Limited shift and automation capabilities for the floc removal and dewatering systems, which can reduce equipment runtimes.
- Capacity limitations of the existing centrifuge, floc storage tank, and sludge conveyor, which can reduce the rate of solids processing after removal from the settling ponds (the LCWA is already proceeding with dredging improvements to increase the rate of floc removal from the settling ponds).

Table 6 of the Pegasus report indicated a maximum of 30 days of fill time at 300 cfs to reach the minimum hydraulic residence time, assuming a partially-filled settling pond at the beginning of the period and no floc removal during filling. Table 7 of the Pegasus report indicated a maximum of 47 days of fill time at 300 cfs, assuming a partially-filled settling pond with daily floc removal during filling. These estimates are dependent on the extent to which the settling pond has been filled prior to the 300 cfs period, and they do not incorporate a reduction in alum dose expected to be possible with the alum injection and mixing improvements. For the purpose of this evaluation, a maximum of 10 days of fill time is assumed as an operating target for floc elevations to return to pre-300 cfs levels with floc removal during filling.

6.7 Hurricane Irma and Operational Capacity

The potential effect of various improvements on dewatering operations were considered against the persistent high flows experienced during Hurricane Irma and the 10 days target for floc elevations to return to pre-300 cfs levels. The following improvements were evaluated:

- Operating more than 1 shift per day.
- Higher density floc feed (i.e., increased rate of solids removal from settling ponds).
- Use of a second centrifuge.

A reduction in alum dose expected to be possible with the alum injection and mixing improvements was excluded from the analysis.

Calculations were then performed to consider the potential effect of each alternative on floc removal and processing. The objective was to determine a combination of potential improvements that would allow for a net reduction in floc in the settling ponds to occur within 10 days of the hurricane, or the establishment of 300 cfs operational dewatering capacity. Table 6-2 shows the result of the evaluation. As discussed above, the daily operating rate of the existing centrifuge is estimated to be less than its design capacity due to the density issues with the existing dredge feed. The potential effect during Irma of additional shifts, improved centrifuge efficiency, and a second centrifuge are shown in the table. As shown, no single improvement, nor any combination of two improvements, reaches the performance goal during Irma. Rather, all three components combined (additional shifts, improved dewatering efficiency, and an additional centrifuge) would be required.

Table 6-2: Dewatering Alternative Evaluation – Hurricane Irma Period Beginning September 2, 2017

Estimated Daily Dewatering Rate (cfs)	1 Centrifuge with Increased Shifts	Potential Improvement to Floc Feed Density with 1 Centrifuge	2 Centrifuges with Increased Shifts	Potential Improvement to Floc Feed Density with 2 Centrifuges	Duration to Net Reduction in Floc after Irma (days)	Net Reduction in Floc < 10 days, or 300 cfs Dewatering?
37	1 centrifuge, 1 shift	No efficiency improvement			> 1,238	No
74	1 centrifuge, 1 shift	100% efficiency improvement			967	No
74	1 centrifuge, 2 shifts	No efficiency improvement	2 centrifuge, 1 shift	No efficiency improvement	967	No
111	1 centrifuge, 3 shifts	No efficiency improvement			486	No
148	1 centrifuge, 2 shifts	100% efficiency improvement	2 centrifuge, 1 shift	100% efficiency improvement	187	No

Estimated Daily Dewatering Rate (cfs)	1 Centrifuge with Increased Shifts	Potential Improvement to Floc Feed Density with 1 Centrifuge	2 Centrifuges with Increased Shifts	Potential Improvement to Floc Feed Density with 2 Centrifuges	Duration to Net Reduction in Floc after Irma (days)	Net Reduction in Floc < 10 days, or 300 cfs Dewatering?
148			2 centrifuge, 2 shift	No efficiency improvement	187	No
222	1 centrifuge, 3 shifts	100% efficiency improvement			88	No
222			2 centrifuge, 3 shifts	No efficiency improvement	88	No
296			2 centrifuge, 2 shifts	100% efficiency improvement	4	Yes
444			2 centrifuge, 3 shifts	100% efficiency improvement	0	Yes

The above analysis assumes the centrifuge is restored to service and is subsequently reliable. It also assumes that the target solids feed percentage is actually achieved by the new dredges. However, there are uncertainties associated with these assumptions. The new floc characteristics and performance improvements from the new dredges will not be known until the new dredges are operational. After these performance improvements are known, additional improvements to refine and expand floc dewatering should be assessed. For example, a grit separator could potentially be installed to remove the sand and grit from the floc, but the Mudcats may obviate the need for this improvement by not hitting the pond banks. Similarly, a thickener may be considered but the Mudcats may improve the floc density by drawing deeper in the ponds, potentially to a point where a thickener isn't warranted. A grit separator and/or thickener would be significant expenditures that are not identified in the Pegasus report. The selection of the most suitable dewatering equipment to further refine and expand capacity will be a function of determinations that should occur after the new dredges are fully operational.

Similarly, if reliability issues with the centrifuge resurface, it will be necessary to assess the actual floc generated by the new dredges to determine appropriate dewatering equipment for replacement, increased capacity or redundancy. Ultimately, if a well refined process is obtained, confidence would be gained towards replacement or expansion. Also, a well refined process would lend itself to automation to increase capacity through extended run times.

From a reliability perspective, a screw press is a possible alternative to a centrifuge. Several screw press options are available with better parts support than the centrifuge. A screw press is also more robust to variable floc conditions than the centrifuge, particularly at low flows. However, until the new MudCats are fully operational, neither a new centrifuge nor a screw press can be fully assessed.

6.8 Floc Dewatering Summary and Recommendations

- The LCWA's purchase of the new MudCat 40E dredges as discussed in the Pegasus report offer several expected benefits for the settling ponds and floc dewatering compared to the existing Crisafulli FLUMPs. The new dredges have the capability to provide a more consistent supply of floc near the centrifuge's target density, due to their ability to adjust their vertical position and discharge rate in real time in response to floc density in comparison to the Crisafulli's. This has good potential to reduce inconsistent floc densities and improve dewatering performance if effectively implemented.

- Onboarding and deployment of the Mudcats will be important because the actual floc characteristics will not be known until the new dredges are fully operational. As the MudCats are onboarded, several steps should be taken:
    - The deeper floc should be sampled and tested before it is pumped to the centrifuge. The potential presence of old, consolidated material in the deeper floc could be an issue for the centrifuge, even with the density sensors for the new dredges.
    - Automation of the new dredges to avoid hitting the pond banks and mobilize sand and grit, and help automate a consistent dredging scheme in the ponds.
    - The existing rail system for the dredges should also be extended to reduce floc buildup near the inflow culverts.
    - Additional improvements to optimize and expand floc dewatering should be assessed once the new dredges are fully operational. The selection of the most suitable dewatering equipment to further refine and expand capacity should be based on a determination that occurs after the new dredges are fully operational.
- The potential effect during Hurricane Irma of additional shifts, improved centrifuge efficiency, and a second centrifuge on dewatering was evaluated. All three components combined (additional shifts, improved dewatering efficiency, and an additional centrifuge) would be required to maintain processing volume in the settling ponds during this event.
- The existing centrifuge has produced a substantially dewatered sludge, but the dewatering process has not produced a strongly polymerized sludge that does not rehydrate with rain. Thus, the sludge can't be stacked and stockpiled. An inconsistent floc feed density and limitations of the current polymer system are likely contributing to this issue.
- An assessment to refine and expand the dewatering process and polymer applicability based on the improved floc feed will be warranted after the new dredges are fully operational. This assessment should consider the new floc density, sand and grit in the new floc, and polymer conditioning and polymer selection. It should also address the use and availability of process water for make down and its iron content.
- Initial discussions with vendors suggest that a 20%-40% reduction in sludge volume may be achievable through improvements to the current additive systems, in concert with effective performance from the new dredges. Achieving reductions in sludge volume would be functionally equivalent to adding dewatering capacity.
- The above analysis assumes the centrifuge is restored to service and is subsequently reliable. From a reliability perspective, a screw press is a possible alternative to a centrifuge. Several screw press options are available with better parts support than the centrifuge. A screw press is also more robust to variable floc conditions than the centrifuge, particularly at low flows. Screw presses are more commonly used in low flow applications then centrifuges. However, until the new MudCats are fully operational, neither a new centrifuge nor a screw press can be fully assessed.

7. SLUDGE HANDLING

7.1 Sludge Storage and Handling

After more than 10 years of NuRF operation, sizable quantities of sludge have already been generated and are now being stored onsite. Operational challenges associated with the existing sludge include challenges moving and stacking the material, the presence of wet conditions, equipment access across the material, and ultimately, its final disposition. A significant volume of sludge has accumulated onsite since 2009, and space limitations at the site will eventually limit onsite storage without further improvements.

Though not tasked for evaluation as part this report, the LCWA is separately evaluating offsite disposal options for the sludge. Several offsite disposal options have now been identified. If one of these options is found to be viable, a one-touch hauling solution could be deployed onsite, where dewatering sludge is simply deposited from the conveyor into a hauling container for pickup and delivery to the disposal facility by a vendor. This potential solution would strongly affect the needs for LCWA's sludge handling infrastructure.

The Pegasus report discussed access improvements to facilitate onsite sludge storage, including onsite haul routes, new geoweb roads, aggregate, and excavation and grading. The proposed geoweb roads, which involve the installation of a rigid plastic, aggregate filled grid with geotextile underlay to provide structural support over soft soils, are common and reasonable solutions to the heavy equipment access issues. The proposed road configuration includes several loops through the storage area, which would provide good long-term access for ongoing onsite storage. However, if a suitable offsite disposal option is identified, some or all of this onsite infrastructure could become unnecessary. The proposed improvements may buy time to store more material onsite, though over the long term, offsite disposal will eventually become necessary.

Currently, the sludge does not stack well under wet conditions. The improvements to Alum Injection and Mixing and Floc Dewatering discussed above should contribute to better sludge handling and ultimately a reduction in sludge production (proportional to flow being treated). If onsite storage will be long term, the all-terrain stacker mentioned in the Pegasus report is a good solution for drier materials that may be stacked. The cost of an all-terrain stacker was not included in the proposed improvements.

Currently, sludge is being transported from the conveyor to the storage fields using a small bobcat, which has to scoop sludge off the storage area floor, then deliver a relatively small quantity of sludge to the storage fields. Purchase of a tracked front end loader would allow larger quantities of sludge to be transferred per trip, and the bucket could be positioned immediately under the conveyor to catch the sludge without having to scoop it off the floor. Additionally, the new front-end loader would be better able to move through the storage fields compared to the bobcat. However, as with the other access improvements, this equipment could eventually become unnecessary if a suitable offsite disposal option is implemented.

7.2 Sludge Handling Summary and Recommendations

- While not explicitly included in the scope of Woodard & Curran's assessment, we note that the NuRF's capacity for onsite sludge storage is very nearly consumed, and once that point is reached, the NuRF will no longer be able to operate at all. Therefore, LCWA's highest priority for the NuRF should be to identify and arrange for an off-site disposal option and begin hauling dewatered sludge off-site as soon as possible.

- The geoweb access roads discussed in the Pegasus report are a common and reasonable solution to the heavy equipment access issues through the sludge. However, if a suitable offsite disposal option is identified, some or all of this onsite infrastructure could become unnecessary.

- If a suitable offsite disposal option is identified, a one-touch hauling solution could be deployed, where dewatering sludge is simply deposited from the conveyor into a hauling container for pickup and delivery to the disposal facility by a vendor. This solution would strongly affect the needs for LCWA's sludge handling infrastructure.

- Currently, the sludge does not stack well under wet conditions. The improvements to Alum Injection and Mixing and Floc Dewatering discussed above should contribute to better sludge handling and ultimately a reduction in sludge production (proportional to flow being treated). These improvements may buy time to store more material onsite, though over the long term, offsite disposal will eventually become necessary.

- If onsite storage will be long term, an all-terrain stacker and a tracked front end loader in addition to the geoweb access roads conceived in the Pegasus report would help sludge handling operations. The all-terrain stacker assumes that improvements to Floc Dewatering ultimately result in a stackable sludge. The costs of this equipment are not included in the costs identified in the Pegasus report.

- A cost analysis should be conducted to compare the present value cost of onsite sludge handling against offsite hauling and disposal. This analysis should consider:

    - Cost of offsite disposal, including any start-up costs for onsite containers and site access.

    - Cost of geoweb access roads proposed in the Pegasus report.

    - Cost of all-terrain stacker and tracked front end loader needed to effectively handle sludge onsite.

    - Long term onsite storage capacity considering the potentially stackable sludge once the Alum Injection and Mixing and Flow Dewatering improvements are implemented.

8. INSTRUMENTATION AND CONTROLS

8.1 Instrumentation and Controls

While not explicitly included the scope of our assessment, since large construction improvements are being considered for the NuRF, a preliminary review of the facility's instrumentation and controls was conducted, and recommendations prepared. In general, there are significant opportunities to improve automation. Much of the automation equipment at the facility is in need of repair or replacement. Some of the electrical panels have evidence of arc flash burns / charring inside. Other control panels have insect nests or water inside. The master programmable logic controller (PLC) panel at the equipment and chemical storage building requires rewiring, labeling and documentation which makes retrofit or replacement cost effective. The additional instrumentation and control equipment planned at the site will require expansion of the input-output (IO) and communication modules and this should be taken into account when re-designing the master PLC panel. Using a single platform (Allen Bradley or like) increases the efficient and reduces downtime of automated systems. Using a single communication protocol to communicate to devices will allow for easy replacement / upgrade planning in the future.

Supervisory control and data acquisition (SCADA) software should be selected and installed to fit the application. The two SCADA software alternatives most compatible with the planned upgrades are Allen Bradley Rockwell Factory Talk Site Edition and Trihedral VTSCADA. The vendor panels would need to variable tables for the PLC and human machine interface (HMI) to write to and read from. The existing screens from the vendor package can be duplicated on the SCADA software to make changes and monitor and control the same points on the SCADA computer. The master control panel would also include an Allen Bradley PLC which works well with either software. Features of the SCADA software include historical data logging, reporting and alarm notification.

The master programmable logic controller (PLC) panel contains a vision series Unitronics PLC. This PLC is the master in a point to multipoint 900 MHZ spread spectrum wireless IO radio system that collects information throughout the facility. The radio units are made by Wilkerson, the protocol used to communicate between the PLC and Wilkerson radio is Modbus RTU.

Considering the addition of the automated dredging system and condition of the existing control panel, a replacement master control panel should be installed which should include an Allen Bradley Compact Logix PLC. Keeping a standard model PLC onsite will allow for a reduced number of replacement parts as well as reducing compatibility issues moving forward. Existing conductors and conduit can remain, being re-terminated once the new control panel is in place. Using Allen Bradley Ethernet IP protocol to communicate between control panels and the SCADA software will improve system reliability and operational efficiency.

The existing remote instrumentation IO panels spread throughout the facility (including locations on the north and south sides of settling pond and the intake structure) are remote nodes reporting data back to the master PLC panel via the Wilkerson radios. Phoenix Contact Radio line wireless IO point to multipoint is a similar system to the Wilkerson which will make for an easy replacement. These existing control panels should be cleaned, repaired, and reused; existing conductors can be re-terminated on the new hardware once installed. New 24VDC power supplies, fusing and surge protectors on the antennas and 4-20mA analog signal wires should be included in the retrofit.

The centrifuge control panel located in the dewatering building originally consisted of an Allen Bradley SLC 5/05 PLC and was replaced with a Unitronics vision PLC. The PLC code from the original vendor would have been converted to Unitronics version of ladder logic line by line. Since the programming languages are similar but not identical there is concern that safety and equipment interlocks would not match the vendors original specifications. Additionally, the centrifuge manufacturer has developed new control software to optimize output based on feed density that was not available when the centrifuge was originally installed. It is recommended that the centrifuge vendor supply a new, preprogrammed Allen Bradley PLC to be retrofitted into the existing control panel. Another option is to have the vendor supply the original documented .RSS file and convert the ladder logic to the modern .ACD file format. This would allow a modern Control Logix L71 or L81 processor to be installed and rewired point for point to match the original installation. The new software should be evaluated after the dredging improvements have been implemented, including the hardware and programming to replace the existing centrifuge controls.

8.2 Instrumentation and Controls Summary and Recommendations

In general, there are significant opportunities to improve automation. Much of the automation equipment at the facility is in need of repair or replacement.

It is recommended to replace damaged controls and implement a single communication platform for ease of operations, automation and expandability.

New centrifuge control software to optimize output based on feed density should be evaluated after the dredging improvements have been implemented, including hardware and programming to replace the existing centrifuge controls.

APPENDIX A: CONSTRUCTION COST ESTIMATES

Engineer's Estimate of Conceptual Project Costs

Lake County Water Authority
Nutrient Reduction Facility
Operational Evaluation

Alum Injection and Mixing System with Further Enhancements

Item No.	Item Description	Qty	Unit	Unit Price	Extended Amount	Notes
2.1	Base Subtotal	1	LS	$146,350	$146,350	Pegasus
2.2	Real Time Analyzer	1	LS	$65,000	$65,000	Hach
2.3	Sample pump and shed	1	LS	$65,000	$65,000	Allowance
				Subtotal	**$276,350**	
				Contingency (30%)	**$82,905**	Class 4
				Total	**$359,255**	

Engineer's Estimate of Conceptual Project Costs

Lake County Water Authority
Nutrient Reduction Facility
Operational Evaluation

Self-Cleaning Bar Rack with Traversing Grab Rake

Item No.	Item Description	Qty	Unit	Unit Price	Extended Amount	Notes
1.1	Mobilization	1	LS	8%	$82,040	Pegasus
1.2	Dewatering, diversion and temporary shoring	1	LS	$25,000	$25,000	Pegasus
1.3	Pollution prevention	1	LS	$2,500	$2,500	Pegasus
1.4	Clearing, grubbing and demolition	1	LS	$5,000	$25,000	Pegasus
1.5	Excavation and grading	1	LS	$10,000	$10,000	Pegasus
1.6	Dumpster	2	LS	$10,000	$20,000	Allow.
1.7	Bar rack with 2 traversing grab rakes	1	EA	$925,000	$925,000	Evoqua
1.8	Heavy duty pavement for mount points	80	SY	$225	$18,000	
1.9	Open block enclosure for dumpster	2	LS	$25,000	$50,000	Allow.
1.1	Electrical and controls	1	LS	$25,000	$25,000	Allow.
				Subtotal	**$1,188,540**	
				Contingency (30%)	**$356,562**	Class 4
				Total	**$1,545,102**	

WOODARD
&CURRAN

woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS