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# MEMO

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| ***Date:*** | September 10, 2021 - Amendment |
| ***Subject:*** | C-43 West Basin Storage Reservoir Water Quality Component<br>Deliverable 10.1.5: Final WQC Plan Selection Memorandum |

## 1.0 Background/Introduction

The South Florida Water Management District (SFWMD) selected J-Tech for the implementation and delivery of the C-43 West Basin Storage Reservoir (WBSR) Water Quality Feasibility Study (WQFS), which reviewed existing pertinent studies/literature; evaluated applicable water quality treatment technologies suitable for use; and conducted a cost-benefit, alternatives, and trade-off analysis (J-Tech, 2020). The analysis identified cost-effective, available, technically feasible, conventional and innovative biological, chemical, and physical treatment technologies for water quality improvement for eventual pre-treatment, in-reservoir treatment, and/or post-treatment application to the C-43 WBSR.

The most cost-effective options that reduce nutrients, with an emphasis on nitrogen, and improve the quality of water leaving the C-43 WBSR to the Caloosahatchee River and its downstream estuary, while maintaining the current C-43 WBSR construction design, schedule, and project purpose were selected for further evaluation. These technologies were combined into alternatives that were further assessed through a Siting Evaluation (J-Tech, 2021a) and finally Conceptual Design (J-Tech, 2021b).

This deliverable provides a refined alternatives summary matrix of the five (5) options for post-storage treatment, which will work in conjunction with the in-reservoir alum system that is being designed separately (J-Tech, 2021c). This memorandum and alternatives matrix summarize the findings of the WQC Siting Evaluation and Conceptual Design to help SFWMD select the Water Quality Component (WQC) Plan.

## 2.0 WQC Options

From the Siting Evaluation, four alternatives were developed: (1) post-storage alum treatment, (2) sand filter and Bold and Gold®, (3) hybrid wetland treatment technology (HWTT), and (4) stormwater treatment area (STA) and Bold and Gold®. Prior to finalization of the Siting Evaluation, a full-scale STA was included in the list of alternatives based on the proven ability for STAs to reduce nutrient loads and stakeholder preference for natural treatment systems. The full-scale STA was eliminated from further consideration due to high land acquisition and capital construction costs. Based on comments received during the Draft Conceptual Design, J-Tech identified an additional option that acknowledges nutrient reductions expected from the in-reservoir alum treatment system, minimized costs, provided confident water quality treatment methods, will minimize losses to seepage, can successfully treat all reservoir flows from both cells to the identified water quality targets, and has flexibility in design components for future expansion. Option 5 is a post-storage 150-acre sand filter located on the S-5 parcel which will remove suspended solids and nutrients to meet the WQC targets.

In the final design report, all the options treatment sizing and costs were refined to account for nutrient removal benefits from the in-reservoir alum treatment. All options can achieve the discharge target objectives

established for this study under the average flow condition of 457 cubic feet per second (cfs). Options 1, 2, and 4 are estimated to achieve substantially lower total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) concentrations based on the alum treatment efficiency and vendor estimated performance for the Bold and Gold® media. Table 2-1 summarizes the five options under consideration for the WQC.

**Table 2-1. WQC Option Summary**

| Option | Description | Area (ac) | Capital Cost ($ millions) | O&M Cost ($ millions) | Net Present Value (NPV) Cost ($ millions) | TN Concentration Reduction (mg/L) | 50-year TN Removal (pounds)* | NPV Unit Cost per TN Pound | Annual Cost per TN Pound | TP Concentration Reduction (mg/L) | 50-year TP Removal (pounds)* | NPV Unit Cost per TP Pound | Annual Cost per TP Pound |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Alum Treatment (Post-storage) | 16 | $92 | $5.1 | $259 | 0.74 | 17,019,200 | $15.22 | $14.98 | 0.048 | 1,103,948 | $234.61 | $230.99 |
| 2 | Sand Filter and Bold and Gold® | 216 (92 sand filter, 124 Bold and Gold®) | $422 | $1.1 | $460 | 0.41 | 9,429,557 | $48.76 | $5.83 | 0.069 | 1,586,925 | $289.74 | $34.66 |
| 3 | HWTT** | 292 | $85 | $4.0 | $213 | 0.14 | 3,219,849 | $66.28 | $62.78 | 0.018 | 413,981 | $515.51 | $488.29 |
| 4 | STA and Bold and Gold® | 967 (868 STA, 99 Bold and Gold®) | $421 | $1.2 | $460 | 0.30 | 6,899,676 | $66.61 | $8.70 | 0.068 | 1,563,927 | $293.88 | $38.36 |
| 5 | Sand Filter | 150 | $130 | $1.4 | $175 | 0.11 | 2,529,881 | $68.98 | $27.67 | 0.015 | 344,984 | $505.82 | $202.91 |

* 50-year removal calculated based on 457 cfs operation for 187 days each year.

**Note that project total cost was updated after the Final Conceptual Design Report submittal due to a mathematical error, the ranking order does not change.

# 3.0 Development of the Refined Alternatives Summary Matrix

To create the refined alternatives summary matrix, J-Tech combined previously developed summary tables, pros and cons tables, and matrices from the WQFS, WQC Siting Evaluation, and Conceptual Design Reports. The factors evaluated in these previous reports were developed based on feedback from the Working Group, SFWMD staff, and the public. A review of this cumulative list of criteria included as part of previous evaluations, J-Tech identified and removed from the final matrix those criteria with identical scores, non-defining scores, and criteria with minimal distinguishable value for the final 5 options (see Table 3-3). Therefore, the key factors that were still applicable to the options were carried forward in the **refined** alternatives summary matrix.

## 3.1 Factors Evaluated

The factors evaluated in the refined alternatives summary matrix include:

- **NPV** – The NPV combines the capital and construction cost for each alternative with 50 years of operations and maintenance (O&M) costs to account for the total cost over the WQC life cycle. The alternatives are ranked with the lowest costs receiving the higher ranks.
- **Confidence in performance estimates** – This attribute evaluates whether reliable and reasonable performance data are available for nutrient and TSS removal efficiencies. Alternatives with greater confidence are scored higher. For instance, based on the findings of the SFWMD pilot study, there are concerns about the ability of Bold and Gold® to treat Caloosahatchee River water so alternatives using this technology were scored lower.
- **Reservoir cell discharges treated** – Most of the conveyance alternatives are only able to deliver water from Cell 2 to the WQC. Due to the location of the westernmost parcel (S-5), it is able to treat both Cell 1 and Cell 2 flows, which is considered a benefit and is scored higher.
- **Habitat value** – This attribute evaluates the benefits and potential harm to fish and wildlife as a result of the technology. Alternatives that provide habitat for fish and wildlife receive a higher score than technologies that do not provide habitat benefits.
- **Ecosystem services** – This attribute assesses ecosystem services, which are the benefits that ecosystems provide to people (e.g., water storage, carbon capture, habitat creation, etc.). Alternatives that provide ecosystem services receive a higher score than technologies that do not provide these services.
- **Operational complexity** – This attribute assesses the day-to-day complexity of operations and staff involvement needed to keep the technology functioning properly. Higher scores were assigned to technologies with less complexity and human resource needs.
- **Energy efficiency** – This attribute focuses on the energy requirements. Predominantly passive treatment technologies that do not require chemicals for treatment or maximize gravity flow with a lower carbon footprint are preferred, and therefore ranked higher, than more energy intensive technologies.

## 3.2 Scoring and Ranking of Alternatives

Each of these factors was scored for each alternative. As shown in Table 3-1, alternatives were assigned scores of 0, 1, or 2, with a higher score being more desirable. For the NPV factor, scores were assigned as 1, 2, 3, 4, or 5, with a higher score being superior. The scores were assigned consistently with scoring in previous reports.

**Table 3-1. Scoring for Each Factor**

| Alternative Scoring | Confidence in Performance Estimates | Reservoir Flows Treated | Habitat Value | Ecosystem Services | Operational Complexity | Energy Efficiency |
|---|---|---|---|---|---|---|
| 2 | High | Both Cells | High | High | Low | High |
| 1 | Moderate | 1 Cell | Moderate | Moderate | Moderate | Moderate |
| 0 | Low | Not applicable | Low | Low | Intensive | Low |

The scores for each factor were added together to determine a total score for each alternative. The technologies were then ranked from 1 to 5 with 1 assigned to the highest (best) score and 5 assigned to the lowest (worst) score. The scoring and rank for each alternative are shown in Table 3-2. Following this approach, Option 5, sand filter, ranked the highest followed by Option 3, HWTT; Option 1, post-storage alum treatment, and Option 4, STA and Bold and Gold®; and Option 2, sand filter and Bold and Gold®.

**Table 3-2. Refined Alternatives Summary Matrix, Score, and Final Ranking**

| Option/ Alternative | NPV 50-year ($ millions) | NPV Rank | Confidence in Performance Estimates | Confidence in Performance Estimates Score | Reservoir Flows Treated | Reservoir Flows Treated Score | Habitat Value | Habitat Value Score | Ecosystem Services | Ecosystem Services Score | Operational Complexity | Operational Complexity Score | Energy Efficiency | Energy Efficiency Score | Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/Post-storage Alum | $259 | 3 | High | 2 | Cells 1 and 2 | 2 | Low | 0 | Low | 0 | Moderate | 1 | Moderate | 1 | **9** | **3** |
| 2/Sand Filter with Bold and Gold® | $460 | 2 | Low | 0 | Cell 2 | 1 | Moderate | 1 | Low | 0 | Low | 2 | Moderate | 1 | **7** | **5** |
| 3/HWTT | $213 | 4 | High | 2 | Cell 2 | 1 | Moderate | 1 | High | 2 | Moderate | 1 | Moderate | 1 | **12** | **2** |
| 4/STA with Bold and Gold® | $460 | 1 | Low | 0 | Cell 2 | 1 | High | 2 | High | 2 | Low | 2 | Moderate | 1 | **9** | **3** |
| 5/Sand Filter | $175 | 5 | High | 2 | Cells 1 and 2 | 2 | Moderate | 1 | Low | 0 | Low | 2 | High | 2 | **14** | **1** |

## 3.3 Other Factors

Additional factors that should be considered significant in the final selection of the WQC, but are not listed or scored in the matrix are (1) meeting the MFL and considerations of the water reservation, and (2) the project's ability to provide flexibility in the form of future expansion or modifications to better improve water quality (increase performance). During the review of the conceptual designs for the final options, concerns were raised about water loss from the operation of the selected WQC and ensuring that water stored within the C-43 WBSR would be delivered to the C-43 Canal and the Caloosahatchee Estuary to meet the prescribed MFLs. Seepage estimates should be considered during final selection, understanding that designs which include liners or soil cement surfaces will minimize water loss concerns. Additionally, options which allow for expansion to other SFWMD-owned parcels, or where modifications to the existing design can be easily implemented (e.g. changing out of media as new technologies are developed or improved) should be considered in final selection. As discussed above, the factors that were excluded from the refined alternatives summary matrix and the justification for not including them are summarized in Table 3-3.

**Table 3-3. Factors Not Included in the Refined Alternatives Matrix**

| Factor | Reason for Not Including in Matrix |
|---|---|
| Use of SFWMD Lands | All alternatives were designed to fit within SFWMD-owned lands |
| Redundant Chemical Treatment | Only differentiates the two options that use alum |
| Natural Treatment Components | All alternatives, except for the post-storage alum treatment, have some natural treatment |
| Topographic Constraints | All alternatives fit within SFWMD-owned lands and topography is no longer an issue |
| WQC Size (Footprint) | All alternatives were designed to fit within SFWMD-owned lands |
| Wetland Impacts | Impacts to wetlands will need to be evaluated for any alternative selected |
| Protected Species | Impacts to protected species will need to be evaluated for any alternative selected |
| Cultural/Historical Resources Impacts | Impacts to cultural and historical resources will need to be evaluated for any alternative selected |
| Associated Infrastructure | Associated infrastructure is similar for all alternatives since they use the same SFWMD-owned parcels |
| Planning/Zoning Constraints | The same planning and zoning criteria apply to all alternatives |
| Remediation | Only minimal remediation would be required for any alternative |
| Gravity Discharge | All alternatives were designed with the option for gravity discharge |
| Discharges Need to be Sequenced with Water Supply | WQC discharge timing will need be evaluated for all alternatives |
| Significant Upgrades for Conveyance | Significant conveyance upgrades are only required if the WQC discharges to the Banana Branch Canal and all alternatives have been designed to discharge back to the Townsend Canal |
| Residuals Management | Residuals management has been addressed in design and the O&M costs |

# 4.0 Summary of Results

Based on the refined alternatives summary matrix, Option 5, sand filter, ranked the highest followed by Option 3, HWTT; Option 1, post-storage alum treatment, and Option 4, STA and Bold and Gold®; and Option 2, sand filter and Bold and Gold® (see Figure 4-1). As noted in the Final Conceptual Design Report, costs and benefits for the two options that include Bold and Gold® (Option 2 and Option 4) are based on nutrient removal performance estimates from the vendor, which are not consistent with the results from the SFWMD pilot study using C-43 basin water (Armstrong, 2021). Based on the findings of the pilot study, it does not appear that Bold and Gold® is an appropriate technology to treat Caloosahatchee River water, and SFWMD has recommended that this technology not be used in the WQC.

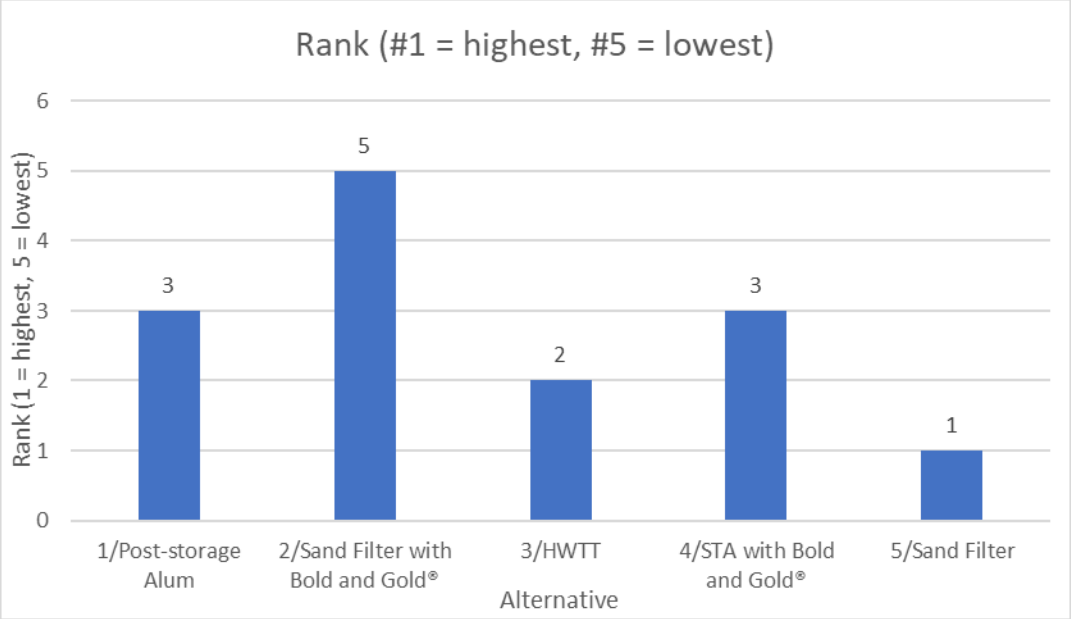


**Figure 4-1. Alternatives Final Ranking**

When comparing the NPVs of the alternatives, Option 5, sand filter, has the lowest life cycle cost at $175 million (Figure 4-2). This is followed by Option 3, HWTT, at a cost of $213 million then Option 1, post-storage alum treatment, at a cost of $259 million and finally Option 2, sand filter and Bold and Gold®, and Option 4, and STA and Bold and Gold®, both at a cost of $460 million.

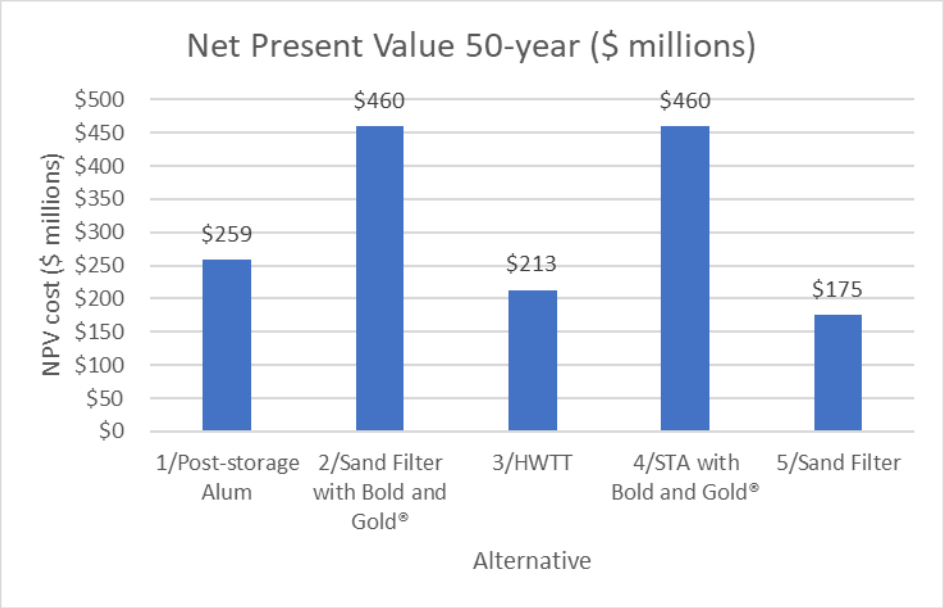


**Figure 4-2. NPV Comparison by Alternative**

# 5.0 Water Quality Component Selection

Through extensive evaluation of the innovative and conventional water treatment technologies, the final five alternatives include a range of possible technologies with varying costs and nutrient removal rates. As discussed above, the costs and benefits for the two options that include Bold and Gold® (Option 2 and Option 4) are based on nutrient removal performance estimates from the vendor, which are not consistent with the results from the SFWMD pilot study using C-43 basin water (Armstrong, 2021). Based on the findings of the pilot study, it does not appear that Bold and Gold® is an appropriate technology to treat Caloosahatchee River water, and SFWMD has recommended that this technology not be used in the WQC.

The remaining three technologies, which are also the highest ranked alternatives, include (1) sand filter, (2) HWTT, and (3) post-storage alum treatment. The post-storage alum treatment option is 25-30% more expensive than the HWTT or sand filter options, would result in double application of alum (with the in-reservoir alum treatment project currently in design), relies on sedimentation ponds to retain alum floc, and may not remove all micro-floc particles leaving the system. During the review process for the WQC project, a chemical-only treatment was not highly supported by the public, and is more operationally intensive than other technologies, including the need for annual pond dredging and mechanical centrifugation and drying of alum residuals. Despite the relatively low cost of this option, for these reasons post-storage alum treatment system was removed from consideration for selection.

In review of the HWTT option, this technology had lower construction costs and relatively lower annual O&M costs than the post-storage alum option, but would also result in double application of alum (with in-reservoir alum treatment project) and management of residuals. The HWTT technology is a patented technology with operation required by an outside vendor. This technology also is not completely lined, with only the settling basins lined, so an evaluation would be needed on any impacts to the minimum flow and level (MFL) or water reservation. For these reasons, this option was also removed from consideration.

The 150-acre sand filter option was ranked highest (#1) and also had the lowest NPV costs for 50 years of operation. In addition to the positive results of the ranking and NPV evaluations, the sand filter meets all the overarching goals of the project: lowest cost, ability to treat both reservoir cells, does not include additional chemical treatment, uses a more natural system, and is able to accept all flows leaving the reservoir (average of 457 cfs). Compared to other technologies, operations of the sand filter are relatively simple, and primarily related to the maintenance of the hydraulic conductivity of the sand surface through periodic scarification by discing or harrowing and replacement. The sand filter is lined so the system will not affect the MFL or water reservations through seepage to groundwater. The sand filter option, in conjunction with the in-reservoir alum treatment system, meets the project goal of adding water quality treatment to the C-43 WBSR to provide additional treatment and improve the quality of water leaving the reservoir (State of Florida Executive Order 19-12, 2019) using the simplest technology available, while achieving the target water quality concentrations identified during the study.

A meeting was held on July 28, 2021 with staff at the SFWMD to discuss the results of the refined alternatives summary matrix. At the conclusion of the meeting, consensus was achieved to move forward with the post-storage sand filter alternative to compliment the in-reservoir alum treatment project already in design. On July 29, 2021 a meeting was held with the Working Group that has been an integral part of identifying and developing the WQC Plan. The Working Group supported the results of the final assessment and the selection of the sand filter alternative as the post-storage WQC Plan. There were some concerns expressed related to the O&M of the sand filter and providing a setback from the nearby development, which were discussed and addressed in more detail during the meeting. In addition, concerns were expressed about the potential for treated water leaving the WQC to be inadvertently used by legal permitted consumptive water users along the Townsend Canal during water supply conditions in the basin. As all options discharge treated water to the river upstream of these consumptive users, this concern is being evaluated by SFWMD staff to determine the effect of this constraint on the operations of the reservoir.

The sand filter alternative, combined with the in-reservoir alum treatment, is expected to achieve the objectives identified in Executive Order 19-12 to provide additional treatment and improve water quality leaving the reservoir.

As design of the in-reservoir alum treatment system progressed from intermediate to final design, the model used to evaluate nutrient reduction effectiveness, the Sumo model, was updated to include an algae analysis. Additional modeling runs were performed with increases in alum doses, up to three times the original (0.6 mg/L) dose, to evaluate if the targets could be met solely with the implementation of the in-reservoir alum treatment system. From this evaluation, the model results identified that the original alum dose (0.6 mg/L) was able to meet the water quality targets identified in the siting analysis report. Additionally, evaluation revealed that an increase in alum dosage did not affect corrosion effects, did not significantly increase sedimentation and residuals, did not result in alum concentrations above U.S. Environmental Protection Agency standards, and did not significantly increase the nutrient removal.

SFWMD staff reviewed the selected WQC Plan and updated in-reservoir alum treatment model results with SFWMD management. As the in-reservoir alum treatment system is the most cost-effective technology and, based on the updated modeling, can achieve the project water quality targets without the need for the sand filter, SFWMD will proceed with the in-reservoir alum treatment component as the WQC Plan.

# 6.0 References

Armstrong, C. 2021. Water Quality Alternative Treatment Technology Pilot Study for the C-43 West Basin Storage Reservoir Water Quality Component. Memorandum dated June 16, 2021.

J-Tech. 2021a. C-43 West Basin Storage Reservoir Water Quality Component. Deliverable 7.2.2: Final Water Quality Component Siting Evaluation. Prepared for the South Florida Water Management District.

J-Tech. 2021b. C-43 West Basin Storage Reservoir Water Quality Component. Deliverable 9.1.6: Final Conceptual Design Report. Prepared for the South Florida Water Management District.

J-Tech. 2021c. C-43 West Basin Storage Reservoir Water Quality Component. Deliverable 9.1.1.2: Final Inline Alum Technical Memorandum. Prepared for the South Florida Water Management District.

J-Tech. 2020. C-43 West Basin Storage Reservoir Water Quality Feasibility Study. Deliverable 4.3.1: Final Feasibility Study Update. Prepared for the South Florida Water Management District.