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MEMORANDUM

Review Comments on Draft Alternative Plan Evaluation Criteria Document for the Everglades Agricultural Area Storage Reservoirs – Phase 1

TO: Angela Prymas/SFWMD

COPIES: File

FROM: Bob Knight/WSI

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Introduction

As part of the Comprehensive Everglades Restoration Plan (CERP), the Everglades Agricultural Area Storage Reservoir (EAASR) Phase 1 project is expected to consist of an earthen storage reservoir with a capacity of about 360,000 acre-feet of water that will be pumped from the EAA canal system and Lake Okeechobee. The proposed EAASR project will serve multiple purposes, including minimizing agricultural return pumping to Lake Okeechobee, flood and water supply storage, and flow and load equalization for downstream stormwater treatment areas (STAs). A requirement of the CERP planning process is the formulation of a Project Implementation Report (PIR) which contains a series of evaluation criteria and performance measures that are used to screen alternative project conceptual designs. The outcome of the PIR analysis is the recommendation of the most cost-effective design that meets the project objectives.

Wetland Solutions, Inc. (WSI) was tasked to review the draft evaluation criteria and performance measures that relate to water quality functions and habitat value of the EAASR Phase 1. The most recent compilation of these proposed metrics is found in the *Draft Alternative Plan Evaluation Criteria Document, Everglades Agricultural Area Storage Reservoirs – Phase 1* (Kimley-Horn and Associates, Inc. [KHA], 2003). In this memorandum WSI proposes a number of revisions to the evaluation criteria and performance measures to allow defensible analysis of potential alternatives.

Unfortunately, this task was not completed due to notification from the District requesting that WSI finalize work on this activity on or about October 24, 2003. This memo provides an abbreviated version of the document originally intended in the scope of services.

Review of Water Quality and Habitat Metrics

The KHA (2003) document (referred to in this memorandum as the "Plan") identified a complete Evaluation Criteria Hierarchy for EAASR planning. Levels 1 and 2 of this hierarchy include the following components:

- EAA Storage Reservoirs Project
  - Enhance Ecologic Values
  - Enhance Economic Values and Social Well Being
  - Cost, Risk, and Uncertainty
- EAA Storage Reservoirs System-Wide RECOVER
  - Lake Okeechobee
  - Everglades Protection Area
  - Water Availability within EAA

This memo only addresses evaluation criteria and performance measures under the first two bullets above: EAA Storage Reservoirs Project – Enhance Ecologic Values. Only one Level 3 criterion under Enhance Ecologic Values is discussed in this memorandum: Water Quality.

Under Water Quality there are four Level 4 criteria and 10 specific water quality-related evaluation criteria:

- Reservoirs/Impoundments
    - Phosphorus
    - Mercury/Sulfates
    - Other Water Quality Parameters
    - Minimize Frequncy of Dry-Out
    - Minimize Duration of Dry-Out
- STA's
    - Minimize Frequency of Dry-Out
    - Minimize Duration of Dry-Out
    - Minimze Bypass Frequncy and Volume
    - Optimize Retention Time
    - Phosphorus
- Reduce Phosphorus Loads to Lake Okeechobee
- Soil Contaminants

The first 11 of the 12 water quality-related Evaluation Criteria listed above are discussed in this memorandum. Due to the work stoppage on this task, Soil Contaminants is not discussed in this memo.

In addition to the Water Quality criteria it was originally intended that this memorandum would discuss the following three Habitat Availability criteria:

- Habitat Availability
    - Terrestrial levees
    - Aquatic Deep Water Refugia
    - Effects on Wetlands

Due to the stop work order, these habitat availability criteria are not discussed in this memo.

Fact sheets were previously prepared by KHA (2003) describing each item (**Description:** *What is being measured and why*); providing the technical basis for inclusion of the evaluation criteria/performance measure (**Rationale:** *Technical basis for why the performance measure is being utilized*); describing how each will be measured or otherwise quantified (**Target:** *Specific description of how success or failure will be measured*); and identifying what model or analytical tool will be used to compare performance against the target (**Evaluation Method:** *Description of what model or analytical method will be utilized*). This memorandum addresses all of these items for each of the 11 water quality-related evaluation criteria and recommends revisions where needed.

The Description, Rationale, Target, and Evaluation Method for each of the 11 water quality evaluation criteria from the Plan are restated below, and are followed by WSI's comments and where appropriate, recommended revisions. These suggested revisions are not complete due to the requirement to stop work early. Specific literature citations and references were omitted due to this time limitation. It is recommended that all of these evaluation criteria be enhanced further and supported by the literature during future revisions.

EC 1.1.1.1: Enhance Ecologic Values – Water Quality – Reservoirs/Impoundments – Phosphorus

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:

Reservoir discharge concentration of phosphorus. Phosphorus concentration of water discharged from the reservoirs to the STAs and the EAA Canals will be evaluated. High concentrations of phosphorus will directly impact the ability of the STAs to meet or exceed their performance requirement to meet the goals for discharges to the EPA. Reservoir discharges to the EAA Canals must meet State water quality standards, i.e., no degradation.

Rationale:

The fate of phosphorus in the reservoirs needs to be characterized for the following reasons:

1. *Need to be able to evaluate whether or not alternatives will meet State water quality standards for reservoir discharges to the EAA canals.*
2. *Need to be able to characterize the phosphorus concentrations in reservoir discharges to the STAs to evaluate the impact of each alternative on STA water quality performance.*
3. *Reservoir outflow concentrations will be evaluated for use in estimating STA inflows and for use in determining compliance with State water quality standards.*
4. *Need to be able to evaluate the effectiveness of the reservoir on reduction of phosphorus concentration from stormwater.*

Target:

1. *The reservoir should maximize the reduction of phosphorus load and concentration, i.e., outflow TP concentration less than inflow TP concentration.*
2. *The reservoir should not cause or contribute to violation of State water quality standards for phosphorus.*
3. *The reservoir(s) should not cause the STA discharges to be in non-compliance with State water quality standards for phosphorus.*

Evaluation Method:

For each alternative, simulate the fate of phosphorus in the reservoir, then enter this information into an STA water quality model (DMSTA) to evaluate the effect of the reservoir discharges on STA performance. For comparing alternatives, use the STA outflow concentrations for each of the alternatives. A model is needed to simulate phosphorus removal in the reservoir to provide inputs to the STA model (i.e., DMSTA) to simulate phosphorus removal in the STAs.

WSI Comments

The draft description above does not adequately present the background related to this issue. The draft rationale and targets are redundant. The draft evaluation method is incomplete. The following revisions are suggested for this Evaluation Criteria (EC 1.1.1.1) fact sheet:

Description:

~~*Reservoir discharge concentration of phosphorus. Phosphorus concentration of water discharged from the reservoirs to the STAs and the EAA Canals will be evaluated. High concentrations of phosphorus will directly impact the ability of the STAs to meet or exceed their performance requirement to meet the goals for discharges to the EPA. Reservoir discharges to the EAA Canals must meet State water quality standards, i.e., no degradation.*~~

Phosphorus (P) is a relatively conservative element. The major forms of P that are found in surface waters can be categorized as dissolved and particulate P. Each of these fractions can be further divided into organic and inorganic forms. The combined total of all forms of P is called total P (TP). In reservoirs and aquatic environments the primary processes that remove P from the water column are chemical precipitation and biological fixation in particulate forms and subsequent sedimentation. Phosphorus undergoes biogeochemical cycles in reservoirs and aquatic environments. Some of the P that is removed from the water column to the sediments is recycled back to the water column due to natural processes such as seasonal changes in dissolved oxygen concentrations overlying the sediments. Some is recycled by fish and other aquatic organisms. Some P enters the reservoir water column via precipitation, dryfall from atmospheric dust and ash, and biological activities such as excreta from migrating waterfowl. Some P leaves reservoirs in exported biological forms. However, the primary long-term sink for P in reservoirs and lakes is permanent storage in the sediments.

The process of P removal in reservoirs and other aquatic environments can be modeled and resulting water column concentrations can be predicted with varying accuracy. Models range in complexity from simple first-order processes with a single rate constant termed a "settling rate" to very complex models requiring dozens of parameters and intensive data collection for calibration. Most reservoir and lake water quality models predict that the concentration and load of P entering the aquatic system will be reduced by the processes described above. The amount of reduction is dependent upon the actual hydrodynamics of the water body, the forms of P in the inflows, the regional and local climatic conditions, and the biological conditions actually present in the reservoir. The single most important factors for predicting P removal in reservoirs are typically the hydraulic residence time (reservoir volume divided by inflow rate), the P inflow concentration and mass loading rate (inflow rate times concentration), and the fractionation of the P into organic and inorganic dissolved and particulate forms.

Phosphorus concentrations and loads of water discharged from the proposed EAASRs will be estimated using available models during alternative analysis. Excessively high P loads from the reservoirs will possibly affect water quality in conveyance canals and in Lake Okeechobee areas receiving agricultural backpumping. Reservoir outflow P concentrations will affect STA performance downstream. Reservoir discharges of P must meet all state water quality standards in the canals as well as in the Everglades Protection Area (EPA).

Rationale

~~*The fate of phosphorus in the reservoirs needs to be characterized for the following reasons:*~~

1. ~~*Need to be able to evaluate whether or not alternatives will meet State water quality standards for reservoir discharges to the EAA canals.*~~
2. ~~*Need to be able to characterize the phosphorus concentrations in reservoir discharges to the STAs to evaluate the impact of each alternative on STA water quality performance.*~~
3. ~~*Reservoir outflow concentrations will be evaluated for use in estimating STA inflows and for use in determining compliance with State water quality standards.*~~
4. ~~*Need to be able to evaluate the effectiveness of the reservoir on reduction of phosphorus concentration from stormwater.*~~

An important secondary objective of the proposed water storage reservoirs is to provide benefits for long-term P removal. Under no circumstances should the long-term downstream average P load be increased as a result of storage reservoirs. Maximizing P removal in reservoirs should be a goal whenever that function is not in conflict with other primary water storage goals. Reservoir outflow concentrations will be evaluated for use in estimating STA inflows and for use in determining compliance with State water quality standards in conveyance canals.

Target:

1. ~~*The reservoir should maximize the reduction of phosphorus load and concentration, i.e., outflow TP concentration less than inflow TP concentration.*~~
2. ~~*The reservoir should not cause or contribute to violation of State water quality standards for phosphorus.*~~
3. ~~*The reservoir(s) should not cause the STA discharges to be in non-compliance with State water quality standards for phosphorus.*~~

1. *The proposed EAASRs should maximize the reduction of phosphorus load and concentration to the extent possible without significantly compromising the primary project goal of water storage.*
2. *Alternative reservoir design criteria/methods should be considered that increase P removal capacity.*
3. *The proposed EAASRs should not cause or contribute to violation of State water quality standards for phosphorus in downstream conveyance canals or other regulated waters of the State.*

Evaluation Method:

~~*For each alternative, simulate the fate of phosphorus in the reservoir, then enter this information into an STA water quality model (DMSTA) to evaluate the effect of the reservoir discharges on STA performance. For comparing alternatives, use the STA outflow concentrations for each of the alternatives. A model is needed to simulate phosphorus removal in the reservoir to provide inputs to the STA model (i.e., DMSTA) to simulate phosphorus removal in the STAs.*~~

P removal in the proposed EAASRs will be assessed using the best available model. The best available model will be the most accurate analytical procedure, regression, spreadsheet, dynamic model, etc. for estimating P concentration and load reduction in the proposed EAASRs that is supported by existing data. Existing data on reservoir and lake P removal dynamics for Florida systems will be summarized by the District. These data will be used to calibrate the appropriate EAASR water quality model.

For each reservoir alternative it will be necessary to estimate inflow rates and P concentrations as well as other inputs to the selected reservoir P removal performance model. These simulated input data sets will be used in concert with the selected model to estimate a time-series of outflow P concentrations and loads for each reservoir alternative considered. These estimated data will be compared to ambient water quality criteria for downstream water bodies to demonstrate compliance with state water quality standards. These data will also be used in concert with any available algorithms predicting P removal in the canals to serve as the input to the STA performance models.

EC 1.1.1.2: Enhance Ecologic Values – Water Quality – Reservoirs/Impoundments – Mercury/Sulfur Species in Water, Fish, and Soils

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:

Concentration of total mercury and methylmercury and sulfate in dry soil leachate or surface water; total mercury, methylmercury, total sulfur, and acid volatile sulfide in soils; and total mercury in mosquito fish, sunfish, and largemouth bass. Widespread elevated mercury concentrations were first discovered in freshwater fish from the Everglades in 1989, which resulted in the issuance of fish consumption advisories for selected species and locations. Mercury is a persistent, bioaccumulative toxicant (PBT), which can build up in the food chain to levels that are harmful to human and ecosystem health. Elevated mercury levels had subsequently been found in predators like raccoons, alligators, wading birds, and Florida panthers. Methylmercury is the most toxic and bioaccumulative form of mercury.

Methylmercury is produced from inorganic mercury in runoff, atmospheric deposition, and sediment by natural processes occurring in all aquatic ecosystems. Methylation of a fraction of the newly deposited and soil-bound inorganic mercury occurs primarily in surficial sediments and primarily as a byproduct of the life processes of sulfate-reducing bacteria. This occurs in the absence of oxygen (anoxic or anaerobic conditions) but in the presence of organic carbon and sulfate. Sulfide is an end product of bacterial sulfate reduction. The addition of sulfate stimulates the metabolic activity of sulfate-reducing bacteria and the inadvertent methylation of inorganic mercury up to the point that something else becomes limiting, but sulfide may stimulate or inhibit methylmercury production, depending on its *concentration and the surrounding sediment biogeochemistry. The surface water sulfate concentrations causing stimulation or inhibition of mercury methylation vary across the Everglades. Methylmercury in soil and mosquitofish are strongly inversely correlated with pore water sulfide, but acid volatile sulfide in soil is an acceptable surrogate.*

Evidence suggests that sulfur species originating in the EAA have contaminated surface water and soils of the EPA (Bates et.al. 2002). Sulfate concentrations in EAA runoff and Lake Okeechobee releases average more than 50 times background concentrations in the pristine Everglades, which is less than 1 mg/L. Minimally impacted areas targeted for hydropattern restoration may be especially vulnerable to stimulation of methylation if sulfate-laden water is used for this purpose. Moreover, sulfide is toxic to aquatic invertebrates and fish and rooted plants. USEPA recommends that surface water contain no more than 2 ug/L sulfide on average to protect aquatic animals (USEPA Gold Book, 1987). A criterion to protect rooted plants has not been developed for sawgrass, but the 2 ug/L value protective of aquatic animals should be protective of rooted aquatic plants, as well.

Further, drying and rewetting of Everglades sediments greatly increases methylmercury production rates for short periods of time, but in some systems, such as STA-2 Cell 1, "first-flush" excess methylmercury production can persist for many months. This first-flush pulse of excess methylmercury then builds up in the aquatic food chain to levels that could place some fish-eating species or their predators at an unacceptable risk of toxic effects from methylmercury exposure. Moreover, in systems where the first-flush methylmercury pulse is efficiently recycled, the contamination of the food web can persist for decades, giving rise to the "reservoir effect."

Rationale:

The EAA storage reservoirs are expected to alter the timing, extent, magnitude and duration of flow and hydroperiods to the EPA, Holey Land WMA, and Rotenberger WMA. Dry downs of STAs and reservoirs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA storage reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in south Florida. USEPA has produced wildlife criteria which are protective of fish-eating predators and which are protective of human health.

Drydowns of reservoirs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida. The receiving areas of STA discharge water (i.e., EPA) are negatively affected by increased phosphorus and methylmercury levels in inflow water.

EAA storage reservoirs should not cause or contribute to sulfate contamination in the EPA. Waters discharged from the EAA storage reservoirs to the STAs should be protective of the downstream areas targeted for restoration.

Target:

It is necessary to monitor inflow, interior, and outflow water for total mercury, methylmercury, and sulfate; interior soils for total mercury, methylmercury, total sulfur, and acid volatile sulfide; and mosquitofish, sunfish, and largemouth bass for total mercury. For *pre-start systems, if soil leachate exceeds the Class III numerical Water Quality Standard (WQS) of 12 ng/L unfiltered total mercury or if the average soil total mercury or methylmercury concentration or the average mosquitofish concentration in a soil bioconcentration study exceeds the 90th percentile upper bound concentration for that waterbody type and basin, then additional monitoring should be triggered. For operational systems, the former test is applied to the outflow and the latter test to interior mosquitofish, sunfish, and largemouth bass. If a "Tier 1" trigger exceedance is verified, more intensive and extensive "Tier 2" studies should be initiated. This adaptive screening strategy is intended to focus limited monitoring, special studies, and modeling resources only on CERP projects that will behave or are behaving atypically relative to the basin and waterbody category to which they belong. The recommended Tier 1 and Tier 2 mercury monitoring protocols and action triggers are outlined in the attached draft CERP Guidance Memorandum.*

Evaluation Method:

Unfiltered samples of surface water will be collected using ultra-clean technique and analyzed for total mercury and methylmercury using ultra-trace methods approved by USEPA or equivalent. Soils will be digested using standard methods for ultra-trace total mercury analysis and distillation-extracted for ultra-trace methylmercury analysis. Mosquitofish will be digested following standard methods and analyzed for total mercury using ultra-trace methods, while sunfish and largemouth bass will be digested in the same manner but analyzed using trace and standard methods, respectively. Surface water sulfate and soil total sulfur and acid volatile sulfide will be analyzed by standard methods or equivalent.

If Tier 2 mercury modeling becomes necessary, the Dynamic Mercury Cycling Model (DMCM) is recommended for lakes and deep reservoirs, while the Everglades Mercury Cycling Model (E-MCM(II)) is recommended for STAs and shallow reservoirs with emergent vegetation. The special studies outlined above (e.g., soil leaching; mosquitofish bioconcentration) are necessary but not sufficient for model parameterization, while the monitoring program outlined above is necessary but not sufficient for model calibration and validation.

WSI Comments

The existing language in this draft fact sheet is somewhat speculative concerning the effects of reservoir drawdown and dryout on increasing mercury and sulfide pollution and should be reworded to reflect a more neutral outcome. In addition, this existing draft evaluation criterion requires research-level efforts that are not realistic within the timeframe and budget of a CERP planning project. The following changes are recommended for this evaluation criterion fact sheet (EC 1.1.1.2).

Description:

Concentration of total ~~mercury~~ and methylmercury and sulfate in ~~dry soil leachate or~~ surface water; total mercury, methylmercury, total sulfur, and acid volatile sulfide in soils; and total mercury in mosquito fish, sunfish, and largemouth bass. Widespread elevated mercury concentrations were first discovered in freshwater fish from the Everglades in 1989, which resulted in the issuance of fish consumption advisories for selected species and locations. Mercury is a persistent, bioaccumulative toxicant (PBT), which can build up in the food chain to levels that are harmful to human and ecosystem health. Elevated mercury levels had subsequently been found in predators like raccoons, alligators, wading birds, and Florida panthers. Methylmercury is the most toxic and bioaccumulative form of mercury.

Methylmercury is produced from inorganic mercury in runoff, atmospheric deposition, and sediment by natural processes occurring in all aquatic ecosystems. Methylation of a fraction of the newly deposited and soil-bound inorganic mercury occurs primarily in surficial sediments and primarily as a byproduct of the life processes of sulfate-reducing bacteria. This occurs in the absence of oxygen (anoxic or anaerobic conditions) but in the presence of organic carbon and sulfate. Sulfide is an end product of bacterial sulfate reduction. The addition of sulfate stimulates the metabolic activity of sulfate-reducing bacteria and the inadvertent methylation of inorganic mercury up to the point that something else becomes limiting, but sulfide may stimulate or inhibit methylmercury production, depending on its concentration and the surrounding sediment biogeochemistry. The surface water sulfate concentrations causing stimulation or inhibition of mercury methylation vary across the Everglades. Methylmercury in soil and mosquitofish are strongly inversely correlated with pore water sulfide, but acid volatile sulfide in soil is an acceptable surrogate.

Evidence suggests that sulfur species originating in the EAA have contaminated surface water and soils of the EPA (Bates et.al. 2002). Sulfate concentrations in EAA runoff and Lake Okeechobee releases average more than 50 times background concentrations in the pristine Everglades, which is less than 1 mg/L. Minimally impacted areas targeted for hydropattern restoration may be especially vulnerable to stimulation of methylation if sulfate-laden water is used for this purpose. Moreover, sulfide is toxic to aquatic invertebrates and fish and rooted plants. USEPA recommends that surface water contain no more than 2 ug/L sulfide on average to protect aquatic animals (USEPA Gold Book, 1987). A criterion to protect rooted plants has not been developed for sawgrass, but the 2 ug/L value protective of aquatic animals should be protective of rooted aquatic plants, as well.

Further, drying and rewetting of Everglades sediments greatly increases methylmercury production rates for short periods of time, but in some systems, such as STA-2 Cell 1, "first-flush" excess methylmercury production can persist for many months. This first-flush pulse of excess methylmercury then builds up in the aquatic food chain to levels that could place some fish-eating species or their predators at an unacceptable risk of toxic effects from methylmercury exposure. Moreover, in systems where the first-flush methylmercury pulse is efficiently recycled, the contamination of the food web can persist for decades, giving rise to the "reservoir effect."

Rationale:

The EAA storage reservoirs are expected to alter the timing, extent, magnitude and duration of flow and hydroperiods to the EPA, Holey Land WMA, and Rotenberger WMA. ~~Dry downs of STAs and reservoirs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects.~~ EAA storage reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in south Florida. ~~USEPA has produced wildlife criteria which are protective of fish-eating predators and which are protective of human health.~~

~~Drydowns of reservoirs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing~~

~~*mercury contamination in South Florida. The receiving areas of STA discharge water (i.e., EPA) are negatively affected by increased phosphorus and methylmercury levels in inflow water.*~~

EAA storage reservoirs should not cause or contribute to sulfate contamination in the EPA. Waters discharged from the EAA storage reservoirs to the STAs should be protective of the downstream areas targeted for restoration.

Target:

The proposed EAASRs should not cause or contribute to violations of the Class III water quality standards for total mercury in downstream surface waters. To the greatest extent practicable the EAASRs should not result in measurable increases in downstream levels of methylmercury in surface water and biota. The EAASRs also should not cause an increase in the average downstream surface water concentrations of sulfate.

~~*It is necessary to monitor inflow, interior, and outflow water for total mercury, methylmercury, and sulfate; interior soils for total mercury, methylmercury, total sulfur, and acid volatile sulfide; and mosquitofish, sunfish, and largemouth bass for total mercury. For pre-start systems, if soil leachate exceeds the Class III numerical Water Quality Standard (WQS) of 12 ng/L unfiltered total mercury or if the average soil total mercury or methylmercury concentration or the average mosquitofish concentration in a soil bioconcentration study exceeds the 90th percentile upper bound concentration for that waterbody type and basin, then additional monitoring should be triggered. For operational systems, the former test is applied to the outflow and the latter test to interior mosquitofish, sunfish, and largemouth bass. If a "Tier 1" trigger exceedance is verified, more intensive and extensive "Tier 2" studies should be initiated. This adaptive screening strategy is intended to focus limited monitoring, special studies, and modeling resources only on CERP projects that will behave or are behaving atypically relative to the basin and waterbody category to which they belong. The recommended Tier 1 and Tier 2 mercury monitoring protocols and action triggers are outlined in the attached draft CERP Guidance Memorandum.*~~

Evaluation Method:

Total mercury removal, methylmercury generation, and fish bioconcentration in the proposed EAASRs will be assessed using the best available models. The best available models will be the most accurate analytical procedure, regression, spreadsheet, dynamic model, etc. that is supported by existing data.

For each reservoir alternative it will be necessary to estimate inflow rates and total mercury concentrations as well as other inputs to the selected reservoir total mercury removal performance model such as total sulfate. These simulated input data sets will be used in concert with the selected mercury dynamics model to estimate a time-series of outflow total mercury concentrations and loads for each reservoir alternative considered. These estimated data will be compared to ambient water quality criteria for downstream water bodies to demonstrate compliance with state water quality standards. These data will also be used in concert with any available algorithms predicting mercury methylation, bioaccumulation, and total mercury removal in the canals to serve as the input to STA mercury dynamics models.

~~*Unfiltered samples of surface water will be collected using ultra-clean technique and analyzed for total mercury and methylmercury using ultra-trace methods approved by USEPA or equivalent. Soils will be digested using standard methods for ultra-trace total mercury analysis and distillation-extracted for ultra-trace methylmercury analysis. Mosquitofish will be digested following standard methods and analyzed for total mercury using ultra-trace*~~

~~*methods, while sunfish and largemouth bass will be digested in the same manner but analyzed using trace and standard methods, respectively. Surface water sulfate and soil total sulfur and acid volatile sulfide will be analyzed by standard methods or equivalent.*~~

~~*If Tier 2 mercury modeling becomes necessary, the Dynamic Mercury Cycling Model (DMCM) is recommended for lakes and deep reservoirs, while the Everglades Mercury Cycling Model (E-MCM(II)) is recommended for STAs and shallow reservoirs with emergent vegetation. The special studies outlined above (e.g., soil leaching; mosquitofish bioconcentration) are necessary but not sufficient for model parameterization, while the monitoring program outlined above is necessary but not sufficient for model calibration and validation.*~~

EC 1.1.1.3: Enhance Ecologic Values – Water Quality – Reservoirs/Impoundments – Other Water Quality Parameters

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:
This criterion addresses the fate of other water quality parameters in the reservoirs, i.e., the reservoirs should not cause or contribute to violation of State water quality standards (Rule 62-302).

Draft CERP Guidance Memorandum (CGM) dated March 25, 2003 identifies the EAA Storage Reservoirs project as category "B" project. Category B projects are described in the CGM as those for which water quality improvement is not a project purpose, but is to be addressed during design..

Rationale:
The fate of the water quality parameters in the reservoirs needs to be evaluated to provide assurances that the project will not cause or contribute to violation of State water quality standards.

The following list of parameters, compiled using Class III water quality criteria (as specified in Section 62-302.530, Florida Administrative Code), is the recommended list of water quality parameters by FDEP for baseline water quality characterization.

1. *Dissolved Oxygen (DO)*
2. *Conductivity*
3. *PH*
4. *Turbidity*
5. *Total nitrogen*
6. *Alkalinity*
7. *Iron*
8. *Total Phosphorus (will be a separate Evaluation Criteria see 1.1.1.1)*
9. *Calcium*

10. *Sulfate (will be a separate Evaluation Criteria see 1.1.1.2)*
11. *Sodium*
12. *Chloride*
13. *Mercury (will be a separate Evaluation Criteria see 1.1.1.2)*
14. *Pesticide/Herbicide*
15. *Total Suspended Solids (TSS)*

Target:
Do not cause or contribute to water quality degradation.

Evaluation Method:
For these water quality parameters, we need to demonstrate, using a narrative based on literature review and/or analysis of existing data, that the project won't cause or contribute to water quality degradation.

WSI Comments

Additional clarification of the description, rationale, target, and evaluation method are recommended for this fact sheet (EC 1.1.1.3) as follows.

Description:
This criterion addresses the fate of ~~other~~ water quality parameters other than phosphorus, mercury, and sulfur compounds in the proposed EAASRs. ~~reservoirs, i.e., the reservoirs should not cause or contribute to violation of State water quality standards (Rule 62-302).~~

Draft CERP Guidance Memorandum (CGM) dated March 25, 2003 identifies the EAA Storage Reservoirs project as a category "B" project. Category B projects are described in the CGM as those for which water quality improvement is not a project purpose, but is to be addressed during design. The water quality parameters of interest in this evaluation criterion are those that are regulated by the Florida Department of Environmental protection (FDEP) and are considered to be the most likely to show degradation in surface waters downstream from the proposed EAASRs.

The following list of parameters, compiled using Class III water quality criteria (as specified in Section 62-302.530, Florida Administrative Code), is the recommended list of water quality parameters by FDEP for baseline water quality characterization:

1. *Dissolved Oxygen (DO)*
2. *Conductivity*
3. *pH*
4. *Turbidity*
5. *Total nitrogen*
6. *Alkalinity*
7. *Iron*

8. *Total Phosphorus (covered under Evaluation Criterion 1.1.1.1)*
9. *Calcium*
10. *Sulfate (covered under Evaluation Criterion 1.1.1.2)*
11. *Sodium*
12. *Chloride*
13. *Mercury (covered under Evaluation Criterion 1.1.1.2)*
14. *Pesticide/Herbicide*
15. *Total Suspended Solids (TSS)*

Rationale:

The fate of the water quality parameters in the proposed EAASRs ~~reservoirs~~ needs to be evaluated to provide assurances that the project will not cause or contribute to violation of State water quality standards in downstream regulated surface waters. Storage of water in the proposed EAASRs is likely to have variable effects on the parameters of interest listed above. If the reservoir outlet is designed near the water surface, concentrations of DO may be increased due to primary production by filamentous or planktonic algae or by submerged aquatic vegetation that colonize the reservoirs. If the reservoir outlet pulls water off the bottom of the reservoir, then DO concentrations in the discharge may be seasonally low due to anaerobic conditions near the sediment/water interface. Conductivity and chloride concentrations may be slightly raised or lowered in water stored within the proposed reservoirs due to the effects of evaporation or precipitation. Hydrogen ion concentration (pH) may also be influenced by algal and SAV productivity. Turbidity and total suspended solids concentrations may be increased by internal production of suspended solids or may be decreased by sedimentation of suspended matter and reduction in color. Total nitrogen concentrations will generally decline in reservoirs. Alkalinity may increase or decrease based on the source of the surface water and interactions with groundwater and soils. Iron, calcium, and sodium concentrations may increase or decrease due to the same factors. Concentrations of pesticides and herbicides will generally decrease in reservoirs unless there are internal sources due to mosquito or aquatic weed control.

~~The following list of parameters, compiled using Class III water quality criteria (as specified in Section 62-302.530, Florida Administrative Code), is the recommended list of water quality parameters by FDEP for baseline water quality characterization.~~

1. *~~Dissolved Oxygen (DO)~~*
2. *~~Conductivity~~*
3. *~~PH~~*
4. *~~Turbidity~~*
5. *~~Total nitrogen~~*
6. *~~Alkalinity~~*
7. *~~Iron~~*

8. ~~*Total Phosphorus (will be a separate Evaluation Criteria see 1.1.1.1)*~~
9. ~~*Calcium*~~
10. ~~*Sulfate (will be a separate Evaluation Criteria see 1.1.1.2)*~~
11. ~~*Sodium*~~
12. ~~*Chloride*~~
13. ~~*Mercury (will be a separate Evaluation Criteria see 1.1.1.2)*~~
14. ~~*Pesticide/Herbicide*~~
15. ~~*Total Suspended Solids (TSS)*~~

Target:

The basic measure of success for any reservoir alternative that is considered is that the option will ~~Do~~ not cause or contribute to water quality degradation in downstream surface waters. More specifically, each parameter or group of parameters in the FDEP list has a different indicator of success or failure as indicated below:

1. *Conservative parameters such as conductivity and chloride – no statistically significant change outside of normal increases or decreases due to natural climatic conditions such as precipitation and evaporation*
2. *Biologically active parameters such as DO, pH, nitrogen, turbidity, and total suspended solids – no violation of Class III water quality standards at the reservoir outfall*
3. *Salts, metals, cations, and anions such as iron, calcium, sodium, and anthropogenic trace organic pesticides and herbicides that may be released from antecedent soils within the footprint of the reservoirs or by operation of the reservoirs - no violation of Class III water quality standards at the reservoir outfall*

Evaluation Method:

Water quality in the proposed EAASRs will be assessed using the best available model for each parameter of interest. The best available model will be the most accurate analytical procedure, regression, spreadsheet, dynamic model, etc. for estimating the water quality constituent concentration and load reduction in the proposed EAASRs that is supported by existing data.

For each reservoir alternative it will be necessary to estimate inflow rates and water quality constituent concentrations as well as other inputs needed for the selected reservoir water quality model. These simulated input data sets will be used in concert with the selected model to estimate a time-series of outflow water quality constituent concentrations and loads for each reservoir alternative considered. These estimated data will be compared to ambient water quality criteria for downstream water bodies to demonstrate compliance with State water quality standards. These data will also be used in concert with any available algorithms predicting water quality changes in the canals to serve as the input to the STA performance models.

~~For these water quality parameters, we need to demonstrate, using a narrative based on literature review and/or analysis of existing data, that the project won't cause or contribute to water quality degradation.~~

EC 1.1.1.4: Enhance Ecologic Values – Water Quality – Reservoirs/Impoundments – Minimize Frequency of Dry-out

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

> ***Description:***
> *The frequency of reservoir dry out events. Dryout may cause water quality concerns.*
>
> ***Rationale:***
> *When a reservoir dries out, the phosphorus enriched soil in the reservoir potentially releases phosphorus. When the reservoir is re-wetted, there is a potential flush of phosphorus into the water column that can cause increased phosphorus levels in discharge water. In addition, the production of methylmercury is increased with frequent drying and re-wetting events. Drydowns of the reservoir may produce pulses of methylmercury production; stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida.*
>
> ***Target:***
> *Minimize the frequency of dry-out events in reservoirs, with the ultimate target of zero dry-out events. A dry-out event is defined as an event where water level within a reservoir is equal to or less than the average ground surface elevation.*
>
> ***Evaluation Method:***
> *Estimate the frequency of dry-out events in reservoirs using subregional and/or 2x2 model output.*

WSI Comments

A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.1.4).

> ***Description:***
> *The frequency of reservoir dry out events should be minimized through reservoir design and operation. Reservoir ~~D~~dryout may ~~cause~~ in some cases deteriorate water quality ~~concerns~~ for some parameters in the reservoir outflow. For example, dryout followed by reflooding may result in the release of minimally sequestered compounds such as organic P, soluble reactive P (SRP), organic and ammonium nitrogen, cations and anions such as calcium, iron, sodium, and sulfate, methylated mercury compounds, and trace organics such as pesticides and herbicides into the reflooded water column. Upon discharge, some of these resuspended and dissolved constituents may be released to downstream waters.*
>
> ***Rationale:***
> *The frequency of reservoir dryout can be altered through reservoir siting and design. For some water quality parameters it is currently suspected that dryout will potentially result in*

degradation of water quality and the possible release of degraded water compared to the inflow water quality. The extent and actual importance of this potential water quality degradation is not well understood at this time but can be suspected to be highly dependent upon the actual circumstances of the dryout, including its duration and frequency, the season when it occurs, the pre-existing ecological status of the reservoir prior to the dryout (plant community, water depth, populations of fish or other wildlife, etc.), management of the reservoir during the dryout by fire, tilling, or other plant control activities, and by stochastic variation.

When a reservoir dries out, ~~the phosphorus~~ P-enriched soil in the reservoir may potentially release phosphorus. When the reservoir is re-wetted, there is a potential flush of phosphorus into the water column that can cause increased phosphorus levels in discharge water. In addition, the production of methylmercury is increased with frequent drying and re-wetting events. Drydowns of the reservoir may produce pulses of methylmercury production; stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida.

For some water quality constituents and reservoir management goals, dryout may be beneficial. For example, it has been hypothesized that periodic dryouts help sequester P in shallow algal-dominated waters through co-precipitation with calcium. Dryout is also intentionally used in many lakes and man-made reservoirs for sediment consolidation (increasing water storage volume) and for control of aquatic weeds.

The effects of dryout, if any, may also be mitigated by reservoir design and by operation. For example, inclusion of perennially wet "deep zones" within the footprint of the reservoir that extend below the lowest surface elevation of the local water table may mitigate some water quality changes in drier areas. Holding water after reservoir dryout before eventual release downstream may allow re-adsorption of some dissolved contaminants such as phosphorus, nitrogen, and methylated mercury.

For the reasons described above, it is important to assess both the potential negative and positive effects of dryout when considering a range of alternative design options and locations for the proposed EAASRs.

Target:
Minimize the frequency of undesirable or unplanned dry-out events in reservoirs, with the ~~ultimate~~ target of zero unplanned dry-out events. A dry-out event is defined as an event where water level within a reservoir is equal to or less than the average ground surface elevation for one day (50% of the ground surface is not covered by water but may be saturated while 50% is covered by surface water).

Evaluation Method:
Estimate the frequency of dry-out events in reservoirs using estimated inflow hydraulic loads based on watershed models and preparation of a daily water balance for each reservoir option using subregional and/or 2x2 model output. Prepare a semi-quantitative matrix of anticipated dryout effects ranging from positive (+5 to +1), no effects (0), to increasingly negative (-1 to -5) for each of the following target criteria:

- *Downstream P loads*

- *Mercury methylation and bioaccumulation*
- *Effects on other water quality parameters at the reservoir outflow*
- *Sediment consolidation*
- *Plant communities*
- *Fish and wildlife habitat*

EC 1.1.1.5: Enhance Ecologic Values – Water Quality – Reservoirs/Impoundments – Minimize Duration of Dry-out

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

> ***Description:***
> *The duration of reservoir dry out events. Dryout may cause water quality concerns.*
>
> ***Rationale:***
> *When a reservoir dries out, the phosphorus enriched soil in the reservoir potentially releases phosphorus. When the reservoir is re-wetted, there is a potential flush of phosphorus into the water column that can cause increased phosphorus levels in discharge water. In addition, the production of methylmercury is increased with frequent drying and re-wetting events. Drydowns of the reservoir may produce pulses of methylmercury production; stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida*
>
> ***Target:***
> *Minimize the duration of dry-out events in reservoirs, with the ultimate target of minimizing the number of consecutive days of dry-out event. A dry-out event is defined as an event where water level within a reservoir is equal to or less than the average ground surface elevation for one day. Consecutive day events could be defined as "greater than 2 consecutive days."*
>
> ***Evaluation Method:***
> *Estimate the duration of dry-out events in reservoirs using subregional and/or 2x2 model output.*

WSI Comments

A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.1.5).

> ***Description:***
> *The duration of reservoir dry out events should be minimized through reservoir design and operation. Reservoir ~~D~~dryout may ~~cause water quality concerns~~ in some cases deteriorate water quality for some parameters in the reservoir outflow. For example, dryout followed by reflooding may result in the release of minimally sequestered compounds such as organic P, soluble reactive P (SRP), organic and ammonium nitrogen, cations and anions such as*

calcium, iron, sodium, and sulfate, methylated mercury compounds, and trace organics such as pesticides and herbicides into the reflooded water column. Upon discharge, some of these resuspended and dissolved constituents may be released to downstream waters.

Rationale:

The duration and spatial extent of reservoir dryout can be altered through reservoir siting and design. For some water quality parameters it is currently suspected that dryout will potentially result in degradation of water quality and the possible release of degraded water compared to the inflow water quality. The extent and actual importance of this potential water quality degradation is not well understood at this time but can be suspected to be highly dependent upon the actual circumstances of the dryout, including its duration and frequency, the season when it occurs, the pre-existing ecological status of the reservoir prior to the dryout (plant community, water depth, populations of fish or other wildlife, etc.), management of the reservoir during the dryout by fire, tilling, or other plant control activities, and by stochastic variation.

When a reservoir dries out, ~~the phosphorus~~ P-enriched soil in the reservoir may potentially release phosphorus. When the reservoir is re-wetted, there is a potential flush of phosphorus into the water column that can cause increased phosphorus levels in discharge water. In addition, the production of methylmercury is increased with frequent drying and re-wetting events. Drydowns of the reservoir may produce pulses of methylmercury production; stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida.

For some water quality constituents and reservoir management goals, dryout may be beneficial. For example, it has been hypothesized that periodic dryouts help sequester P in shallow algal-dominated waters through co-precipitation with calcium. Dryout is also intentionally used in many lakes and man-made reservoirs for sediment consolidation (increasing water storage volume) and for control of aquatic weeds.

The effects of dryout, if any, may also be mitigated by reservoir design and by operation. For example, inclusion of perennially wet "deep zones" within the footprint of the reservoir that extend below the lowest surface elevation of the local water table may mitigate some water quality changes in drier areas. Holding water after reservoir dryout before eventual release downstream may allow re-adsorption of some dissolved contaminants such as phosphorus, nitrogen, and methylated mercury.

For the reasons described above, it is important to assess both the potential negative and positive effects of dryout when considering a range of alternative design options and locations for the proposed EAASRs.

Target:

Minimize the duration of undesirable or unplanned dry-out events in reservoirs, with the ~~ultimate~~ target of minimizing the number of consecutive days of unplanned dry-out events. A dry-out event is defined as an event where water level within a reservoir is equal to or less than the average ground surface elevation for one day (50% of the ground surface is not covered by water but may be saturated while 50% is covered by surface water).

Evaluation Method:

Estimate the duration of dry-out events in reservoirs using estimated inflow hydraulic loads based on watershed models and preparation of a daily water balance for each reservoir option using subregional and/or 2x2 model output. Prepare a semi-quantitative matrix of anticipated dryout effects ranging from positive (+5 to +1), no effects (0), to increasingly negative (-1 to -5) for each of the following target criteria:

- *Downstream P loads*
- *Mercury methylation and bioaccumulation*
- *Effects on other water quality parameters at the reservoir outflow*
- *Sediment consolidation*
- *Plant communities*
- *Fish and wildlife habitat*

EC 1.1.2.1: Enhance Ecologic Values – Water Quality – STAs – Minimize Frequency of Dry-out

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:
The frequency of STA dry-out for the STAs that will receive water from the EAA reservoirs. Currently the STAs receive supplemental water from Lake Okeechobee to avoid dry-out. Once on line, the reservoirs should be able to provide the supplemental water to the STAs to avoid dry-out.

Rationale:
When an STA dries out, the phosphorus enriched soil in the STA could potentially release phosphorus. When the STA is re-wetted, there is potentially a flush of phosphorus into the water column that could cause increased phosphorus levels in discharge water. In addition, the production of methylmercury is potentially increased with frequent drying and re-wetting events. Drydowns of STAs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida. The receiving areas of STA discharge water (i.e., EPA) are negatively affected by increased phosphorus and methylmercury levels in inflow water.

Dry-out is a major concern for the STA treatment cells dominated by submerged aquatic vegetation (SAV). Plant morbidity during prolonged periods of dry-out can result in a delay in treatment capability following re-wetting.

Target:
Minimize the frequency of dry-out events in STAs, with the ultimate target of zero dry-out events. A dry-out event is defined as an event where water level within an STA is below 6"above the average ground surface elevation.

Evaluation Method:

Estimate the frequency of dry-out events in STAs that will receive water from the reservoirs. The 2x2 model simulates sending supplemental water to the STAs on a daily as-needed basis (if source water is available). The number of days that supplemental water is provided to the STAs would be totaled over the 36-year period of simulation to define the frequency of dry-out for each alternative.

WSI Comments

A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.2.1).

Description:

The frequency of ~~STA~~ dry-out for the STAs that will receive water from the EAA reservoirs. Currently the STAs receive supplemental water from Lake Okeechobee to avoid dry-out. Once on line, the reservoirs should be able to provide the supplemental water to the STAs to avoid dry-out.

Rationale:

For some water quality parameters in STAs it is currently suspected that dryout will potentially result in degradation of water quality and the possible release of degraded water compared to the inflow water quality. The extent and actual importance of this potential water quality degradation is not well understood at this time but can be suspected to be highly dependent upon the actual circumstances of the dryout, including its duration and frequency, the season when it occurs, the pre-existing ecological status of the reservoir prior to the dryout (plant community, water depth, populations of fish or other wildlife, etc.), management of the reservoir during the dryout by fire, tilling, or other plant control activities, and by stochastic variation.

When an STA dries out, the phosphorus enriched soil in the STA ~~could~~ may potentially release phosphorus. When the STA is re-wetted, there is potentially a flush of phosphorus into the water column that could cause increased phosphorus levels in discharge water. In addition, the production of methylmercury is potentially increased with frequent drying and re-wetting events. Drydowns of STAs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida. The receiving areas of STA discharge water (i.e., EPA) are negatively affected by increased phosphorus and methylmercury levels in inflow water.

For some water quality constituents and STA management goals, dryout may be beneficial. For example, it has been hypothesized that periodic dryouts help sequester P in shallow algal-dominated waters through co-precipitation with calcium.

Dry-out is a major concern for the STA treatment cells dominated by submerged aquatic vegetation (SAV). Plant morbidity during prolonged periods of dry-out can result in a delay in treatment capability following re-wetting.

The effects of dryout, if any, may also be partially mitigated by STA design and operation. For example, inclusion of perennially wet "deep zones" within the footprint of the STA that *extend below the lowest surface elevation of the local water table may mitigate some water quality changes in drier areas. Holding water after STA dryout and reflooding before eventual release downstream may allow re-adsorption of some dissolved contaminants such as phosphorus, nitrogen, and methylated mercury.*

For the reasons described above, it is important to assess both the potential negative and positive effects of dryout when considering a range of alternative design options and locations for the proposed EAASRs.

Target:
Minimize the frequency of unplanned dry-out events in STAs, with the ultimate target of zero unplanned dry-out events. A dry-out event is defined as an event where water level within an STA is below 6"above the average ground surface elevation for one day.

Evaluation Method:
Estimate the frequency of dry-out events in STAs that will receive water from the reservoirs using estimated inflow hydraulic loads based on reservoir models and preparation of a daily STA water balance for each upstream reservoir option. The 2x2 model simulates sending supplemental water to the STAs on a daily as-needed basis (if source water is available). The number of days that supplemental water is provided to the STAs would be totaled over the 36-year period of simulation to define the frequency of dry-out for each alternative.

Prepare a semi-quantitative matrix of anticipated STA dryout effects ranging from positive (+5 to +1), no effects (0), to increasingly negative (-1 to -5) for each of the following target criteria:

- *Downstream P loads*
- *Mercury methylation and bioaccumulation*
- *Effects on other water quality parameters at the STA outflow*
- *Plant communities*
- *Fish and wildlife habitat*

EC 1.1.2.2: Enhance Ecologic Values – Water Quality – STAs – Minimize Duration of Dry-out

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:
The duration of STA dry-out for the STAs that will receive water from the EAA reservoirs. Currently the STAs receive supplemental water from Lake Okeechobee to avoid dry-out. Once on line, the reservoirs should be able to provide the supplemental water to the STA(s) to avoid dry-out.

Rationale:
When an STA dries out, the phosphorus enriched soil in the STA could potentially release phosphorus. When the STA is re-wetted, there is potentially a flush of phosphorus into the water column that could cause increased phosphorus levels in discharge water. In addition,

the production of methylmercury is potentially increased with frequent drying and re-wetting events. Drydowns of STAs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida. The receiving areas of STA discharge water (i.e., EPA) are negatively affected by increased phosphorus and methylmercury levels in inflow water.

Dry-out is a major concern for the STA treatment cells dominated by submerged aquatic vegetation (SAV). Plant morbidity during prolonged periods of dry-out can result in a delay in treatment capability following re-wetting.

Target:
Minimize the duration of dry-out events in STAs, with the ultimate target of minimizing the number of consecutive days of dry-out events. A dry-out event is defined as an event where water level within an STA is below 6" above the average ground surface elevation for one day. Consecutive day events could be defined as "greater than 2 consecutive days."

Evaluation Method:
Estimate the duration of dry-out events in STAs that will receive water from the reservoirs. The 2x2 model simulates sending supplemental water to the STAs on a daily as-needed basis (if source water is available). The number of consecutive day events that supplemental water is provided to the STA(s) would be summarized over the 36-year period of simulation to evaluate the duration of dryout for each alternative.

WSI Comments

A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.2.2).

Description:
The duration of ~~STA~~ dry-out for the STAs that will receive water from the EAA reservoirs. Currently the STAs receive supplemental water from Lake Okeechobee to avoid dry-out. Once on line, the reservoirs should be able to provide the supplemental water to the STAs to avoid dry-out.

Rationale:
For some water quality parameters in STAs it is currently suspected that dryout will potentially result in degradation of water quality and the possible release of degraded water compared to the inflow water quality. The extent and actual importance of this potential water quality degradation is not well understood at this time but can be suspected to be highly dependent upon the actual circumstances of the dryout, including its duration and frequency, the season when it occurs, the pre-existing ecological status of the reservoir prior to the dryout (plant community, water depth, populations of fish or other wildlife, etc.), management of the reservoir during the dryout by fire, tilling, or other plant control activities, and by stochastic variation.

When an STA dries out, the phosphorus enriched soil in the STA ~~could~~ may potentially release phosphorus. When the STA is re-wetted, there is potentially a flush of phosphorus into the water column that could cause increased phosphorus levels in discharge water. In *addition, the production of methylmercury is potentially increased with frequent drying and re-wetting events. Drydowns of STAs may produce pulses of methylmercury production, stimulate corresponding bioaccumulation in wildlife, increase exposure, and risks of toxic effects. EAA reservoirs may either directly or indirectly influence the sedimentary release, downstream loading, net methylation, or bioaccumulation of mercury, thus inadvertently contributing to the existing mercury contamination in South Florida. The receiving areas of STA discharge water (i.e., EPA) are negatively affected by increased phosphorus and methylmercury levels in inflow water.*

For some water quality constituents and STA management goals, dryout may be beneficial. For example, it has been hypothesized that periodic dryouts help sequester P in shallow algal-dominated waters through co-precipitation with calcium.

Dry-out is a major concern for the STA treatment cells dominated by submerged aquatic vegetation (SAV). Plant morbidity during prolonged periods of dry-out can result in a delay in treatment capability following re-wetting.

The effects of dryout, if any, may also be partially mitigated by STA design and operation. For example, inclusion of perennially wet "deep zones" within the footprint of the STA that extend below the lowest surface elevation of the local water table may mitigate some water quality changes in drier areas. Holding water after STA dryout and reflooding before eventual release downstream may allow re-adsorption of some dissolved contaminants such as phosphorus, nitrogen, and methylated mercury.

For the reasons described above, it is important to assess both the potential negative and positive effects of dryout when considering a range of alternative design options and locations for the proposed EAASRs.

Target:

Minimize the duration of unplanned dry-out events in STAs, with the ultimate target of minimizing the number of consecutive days of unplanned dry-out events. A dry-out event is defined as an event where water level within an STA is below 6"above the average ground surface elevation for one day. Consecutive day events are ~~could~~ be defined as "greater than 2 consecutive days."

Evaluation Method:

Estimate the duration of dry-out events in STAs that will receive water from the reservoirs using estimated inflow hydraulic loads based on reservoir models and preparation of a daily STA water balance for each upstream reservoir option. The 2x2 model simulates sending supplemental water to the STAs on a daily as-needed basis (if source water is available). The number of consecutive day events that supplemental water is provided to the STA(s) would be totaled over the 36-year period of simulation to define the frequency of dry-out for each alternative.

Prepare a semi-quantitative matrix of anticipated STA dryout effects ranging from positive (+5 to +1), no effects (0), to increasingly negative (-1 to -5) for each of the following target criteria:

- *Downstream P loads*
- *Mercury methylation and bioaccumulation*

- o *Effects on other water quality parameters at the STA outflow*
- o *Plant communities*
- o *Fish and wildlife habitat*

EC 1.1.2.3: Enhance Ecologic Values – Water Quality – STAs – Minimize Bypass Frequency and Volume

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

> **_Description:_**
> *The frequency and volume of events where water is released to the EPA without first passing through an STA for treatment. The reservoirs should have the capacity to store enough water so that large storm events can be captured and released to the STAs such that the hydraulic and water treatment capacity of the STAs are not exceeded.*
>
> **_Rationale:_**
> *Water that does not pass through an STA has a higher phosphorus load than water that has passed through an STA. Phosphorus-enriched water negatively impacts the natural system.*
>
> *Water quality in the Everglades has experienced substantial degradation over the last century. Anthropogenic inputs associated with the EAA have resulted in the nutrient enrichment of the EPA. Therefore, reversing the historic trend of water quality degradation and nutrient enrichment will: 1) improve ecological health by increasing native wildlife diversity and abundance; 2) decrease occurrences of cattail stands 3) decrease nutrient tolerant organisms; 4) reverse impairments in designated uses; and 5) promote the growth of native periphyton communities. Reduction in phosphorus load will provide water quality improvements to support the ecological restoration of the Everglades.*
>
> **_Target:_**
> *Minimize the frequency of bypass events, with an ultimate target of zero events, and to minimize the total volume of bypasses that occur.*
>
> **_Evaluation Method:_**
> *The 2x2 model simulates STA bypass water on a daily as-needed basis (if STA hydraulic capacity/maximum depth is exceeded).*
>
> a. *Frequency: The number of STA bypass events (in days) would be summarized over the 36-year period of simulation to evaluate the frequency of bypass for each alternative.*
>
> b. *Volume: For each alternative, the total volume of bypass (in acre-feet) over the 36 year period of simulation would be calculated.*

WSI Comments

A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.2.3).

Description:
The frequency and volume of events where water is released to the EPA without first passing through an STA for treatment. The reservoirs should have the capacity to store enough water so that large storm events can be captured and released to the STAs such that the hydraulic and water treatment capacity of the STAs are not exceeded.

Rationale:
Water that does not pass through an STA typically has a higher phosphorus load than water that has passed through an STA. Phosphorus-enriched water that bypasses the STAs has the potential to negatively impact~~s~~ the downstream natural system.

Water quality in the Everglades has experienced substantial degradation over the last century. Anthropogenic inputs associated with the EAA have resulted in the nutrient enrichment of some portions of the EPA. One of the principal goals of the EFA is to reverse ~~Therefore, reversing~~ the historic trend of water quality degradation and nutrient enrichment and to ~~will~~: 1) improve ecological health by increasing native wildlife diversity and abundance; 2) decrease occurrences of cattail stands 3) decrease dominance by nutrient tolerant organisms; 4) reverse impairments in designated uses; and 5) promote the growth of native periphyton communities. Reduction in phosphorus load is an important goal for ~~will provide water quality improvements to support the~~ ecological restoration of the Everglades.

Target:
Minimize the frequency of STA bypass events by adding upstream flow equalization in the proposed EAASRs, with an ultimate target of zero bypass events, and to minimize the total volume of bypasses that occur.

Evaluation Method:
The 2x2 model simulates STA bypass water on a daily as-needed basis (if STA hydraulic capacity/maximum depth is exceeded).

a. *Frequency: The number of STA bypass events (in days) would be summarized over the 36-year period of simulation to evaluate the frequency of bypass for each alternative.*

b. *Volume: For each alternative, the total volume of bypass (in acre-feet) over the 36 year period of simulation would be calculated.*

EC 1.1.2.4: Enhance Ecologic Values – Water Quality – STAs – Optimize Retention Time

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:
Hydraulic retention times in the STAs. Longer retention times are expected to result in improved efficiency of water quality treatment. The reservoirs should have the capacity to store enough water so that large storm events can be captured and released so as to optimize the hydraulic retention time in the STAs.

Rationale:

Longer retention times are anticipated to result in increased phosphorus removal in the STAs.

Target:
Optimize the hydraulic retention time of the STAs.

Evaluation Method:
Estimate the hydraulic retention time in the STAs for each of the alternatives. (select a predictive tool).

WSI Comments

A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.2.4).

Description:
Hydraulic retention times in the STAs. Phosphorus removal in STAs is directly related to hydraulic retention time. Longer retention times in the STAs are expected to result in improved efficiency of water quality treatment. Flow-equalization capacity in the proposed EAASRs ~~The reservoirs~~ should ~~have the capacity to~~ store enough water so that large storm events can be captured and released at lower, more constant flow rates ~~so as~~ to better optimize the hydraulic retention time in the STAs.

Rationale:
Constant flows and stable hydraulic retention times ~~Longer retention times~~ are anticipated to result in increased phosphorus removal in the STAs.

Target:
Optimize the inflow to and hydraulic retention time of the STAs.

Evaluation Method:
The 2x2 model will be used in concert with the DMSTA model to estimate the effects of flow equalization in the proposed EAASRs on STA performance. Various reservoir alternatives will be evaluated based on their contribution to maximizing P removal in the downstream STAs based on the model predictions. ~~Estimate the hydraulic retention time in the STAs for each of the alternatives. (select a predictive tool).~~

EC 1.1.2.5: Enhance Ecologic Values – Water Quality – STAs – Phosphorus

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:
STA discharge phosphorus concentration. The Restudy document (Yellow Book) describes the EAA project as including water storage features that might assist the ECP in removing phosphorus such that the EPA do not receive water with phosphorus concentrations that will impact the Everglades ecosystem. The storage compartments might also be designed to provide a water quality treatment function, augmenting the performance of the ECP and ensuring protection of water quality in the EPA. Design of this feature for water quality performance will be based on water quality targets for the ECP and other water quality targets developed to protect designated uses in EAA waters.

Rationale:
Water quality in the Everglades has experienced substantial degradation over the last century. Anthropogenic inputs associated with runoff have resulted in the nutrient enrichment of the EPA.

Target:
Minimize phosphorus load and concentrations discharged from the STAs.

Evaluation Method:
DMSTA developed by Dr. Bill Walker.

WSI Comments

This performance measure is redundant with EC 1.1.1.1: Water Quality, Reservoirs/Impoundments/Phosphorus. It deals with measures during design and operation of the proposed EAASRs that might reduce the load of phosphorus traveling downstream to the existing STAs. It is recommended that either the proposed revised wording listed above for EC 1.1.1.1 may be used to replace this fact sheet or the performance measure may be dropped. A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.2.5).

Description:
STA discharge phosphorus concentration. The Restudy document (Yellow Book) describes the EAA project as including water storage features that might assist the ECP in removing phosphorus such that the EPA do not receive water with phosphorus concentrations that will impact the Everglades ecosystem. The storage compartments might also be designed to provide a water quality treatment function, augmenting the performance of the ECP and ensuring protection of water quality in the EPA. Design of this feature for water quality performance will be based on water quality targets for the ECP and other water quality targets developed to protect designated uses in EAA waters. See EC 1.1.1.1 for a more complete description of this proposed performance measure.

Rationale:
Water quality in the Everglades has experienced substantial degradation over the last century. Anthropogenic inputs associated with runoff have resulted in the nutrient enrichment of the EPA. An important secondary objective of the proposed water storage reservoirs is to provide benefits for long-term P removal. Under no circumstances should the long-term downstream average P load be increased as a result of storage reservoirs. Maximizing P removal in reservoirs should be a goal whenever that function is not in conflict with other primary water storage goals. Reservoir outflow concentrations will be evaluated for use in estimating STA inflows and for use in determining compliance with State water quality standards in conveyance canals.

Target:
~~*Minimize phosphorus load and concentrations discharged from the STAs.*~~

1. *The proposed EAASRs should maximize the reduction of phosphorus load and concentration to the extent possible without significantly compromising the primary project goal of water storage.*

2. *Alternative reservoir design criteria/methods should be considered that increase P removal capacity.*
3. *The proposed EAASRs should not cause or contribute to violation of State water quality standards for phosphorus in downstream conveyance canals or other regulated waters of the State.*

Evaluation Method:

~~*DMSTA developed by Dr. Bill Walker.*~~

P removal in the proposed EAASRs will be assessed using the best available model. The best available model will be the most accurate analytical procedure, regression, spreadsheet, dynamic model, etc. for estimating P concentration and load reduction in the proposed EAASRs that is supported by existing data. Existing data on reservoir and lake P removal dynamics for Florida systems will be summarized by the District. These data will be used to calibrate the appropriate EAASR water quality model.

For each reservoir alternative it will be necessary to estimate inflow rates and P concentrations as well as other inputs to the selected reservoir P removal performance model. These simulated input data sets will be used in concert with the selected model to estimate a time-series of outflow P concentrations and loads for each reservoir alternative considered. These estimated data will be compared to ambient water quality criteria for downstream water bodies to demonstrate compliance with state water quality standards. These data will also be used in concert with any available algorithms predicting P removal in the canals to serve as the input to the STA performance models.

EC 1.1.3: Enhance Ecologic Values – Water Quality – Reduce Phosphorus Loads to Lake Okeechobee

Draft Language

The following text is reproduced from the draft planning document (KHA, 2003):

Description:

Phosphorus loads to Lake Okeechobee. These phosphorus loads contribute to current exceedances of the Lake Okeechobee TMDL.

Rationale:

The reservoir set aside for agriculture should receive the majority, if not all, of the excess water from the EAA. Lake Okeechobee is considered eutrophic as a result of anthropogenic loading of excess phosphorus. The historic concentration of phosphorus in Lake Okeechobee has been determined to be 40 ug/L. To achieve this concentration in the pelagic zones of the Lake, a TMDL of phosphorus to Lake Okeechobee has been established at 140 tons, of which 35 tons is attributed to rainfall. To achieve this TMDL and the associated target phosphorus concentration, phosphorus loads to the Lake must be reduced in each of the contributing basins.

Water that is pumped into the Lake may affect the ecology of the lake. The pumped water may contain pesticides, herbicides, and other harmful substances that negatively affect the lake. The pumping events are especially deleterious after long periods of nutrient accumulation (after dry season) which may cause super-elevated levels of nutrient releases to the Lake.

Phosphorus loads to the Lake in addition to the adopted TMDL, 140 tons, will not be allowed without mitigation. Phosphorus load reductions will be required from all inflows to Lake Okeechobee.

Reductions in phosphorus loads will assist in the overall effort to restore Lake Okeechobee.

Target:

Minimize pumping events into Lake Okeechobee through S-2 and S-3, with the ultimate target of zero back-pumping events.

Evaluation Method:

Estimate the frequency and volume of pumping events into Lake Okeechobee through S-2 and S-3. The regional or sub-regional models could provide these estimates.

WSI Comments

A number of revisions are suggested to improve the evaluation criteria fact sheet for this performance measure (PM 1.1.3).

Description:

Phosphorus loads to Lake Okeechobee. ~~These~~ Current phosphorus loads from the EAA contribute to ~~current~~ exceedances of the Lake Okeechobee TMDL. One of the goals of the proposed EAASR project is to reduce the loads of phosphorus that enter the lake from the south.

Rationale:

The proposed EAASRs will serve multiple purposes, including water storage during rainy periods for subsequent uses in the EAA during dry periods. The reservoir volume set aside for agriculture should receive the majority, if not all, of the excess water from the EAA. Reductions in the quantity of backpumped water to the lake will be likely to reduce the pollutant loads of phosphorus, other nutrients, trace metals, and pesticides. These reductions in pollutant loads to the lake as a result of the proposed EAASR project will help with the overall restoration of Lake Okeechobee.

~~Lake Okeechobee is considered eutrophic as a result of anthropogenic loading of excess phosphorus. The historic concentration of phosphorus in Lake Okeechobee has been determined to be 40 ug/L. To achieve this concentration in the pelagic zones of the Lake, a TMDL of phosphorus to Lake Okeechobee has been established at 140 tons, of which 35 tons is attributed to rainfall. To achieve this TMDL and the associated target phosphorus concentration, phosphorus loads to the Lake must be reduced in each of the contributing basins.~~

~~Water that is pumped into the Lake may affect the ecology of the lake. The pumped water may contain pesticides, herbicides, and other harmful substances that negatively affect the lake. The pumping events are especially deleterious after long periods of nutrient accumulation (after dry season) which may cause super-elevated levels of nutrient releases to the Lake.~~

~~Phosphorus loads to the Lake in addition to the adopted TMDL, 140 tons, will not be allowed without mitigation. Phosphorus load reductions will be required from all inflows to Lake Okeechobee.~~

~~Reductions in phosphorus loads will assist in the overall effort to restore Lake Okeechobee.~~

Target:

Minimize phosphorus loads ~~pumping events~~ into Lake Okeechobee from the EAA and 298 Districts through S-2 and S-3, with the ultimate target of zero back-pumping events.

Evaluation Method:

Estimate the frequency and volume of pumping events and the phosphorus load into Lake Okeechobee through S-2 and S-3 based on historic records. The regional or sub-regional models ~~could~~ will be used to provide ~~these~~ estimates of flows and phosphorus loads for the various reservoir alternatives considered.

References

Kimley-Horn and Associates, Inc. (KHA) 2003. Draft Alternative Plan Evaluation Criteria Document, Everglades Agricultural Area Storage Reservoirs – Phase 1. Prepared for the U.S. Army Corps of Engineers and South Florida Water Management District.