Are nutrients contributing to impairment in Subembayment X?

What are the optimal management actions for preventing or mitigating impairment, if impairment is occurring?

What are potential impairment pathways or indicators?

(NNE Lit Review and Nutrient Strategy)

NO

Existing guidelines for assessing impairment due to nutrients?

YES

Impairment pathway A

Impairment pathway B

Impairment pathway C

Impairment pathway D

Impairment pathway E

Quantify nutrient loads, including relative importance of different sources and how this varies in time and space

Design/Implement

Control Strategies: Identify scenarios for load reduction and evaluate effectiveness through modeling

Model development and use. Evaluate ecosystem response to nutrients under current and future conditions. Determine load reductions, if necessary.

NOT SUBSTANTIAL

STOP

NOT LINKED

Synthesis of Science | **Science Plan** | Expert Review | Special Studies

Impairment assessment

YES

IMPAIRED?

NO

STOP

Assessment framework development

Monitoring Program Development, implementation and on-going monitoring

On-going evaluation of monitoring, modeling, and special studies results to determine if conditions are changing

NO

NO

NO

Sufficient new information to substantially change course?

YES

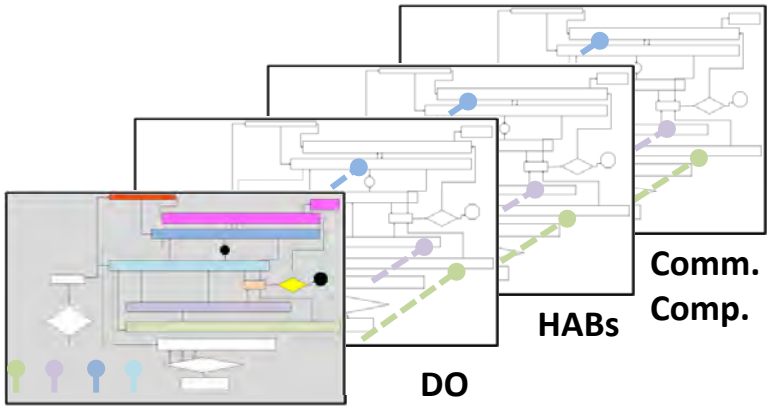
Modify Science Plan or Management and Regulatory Approach

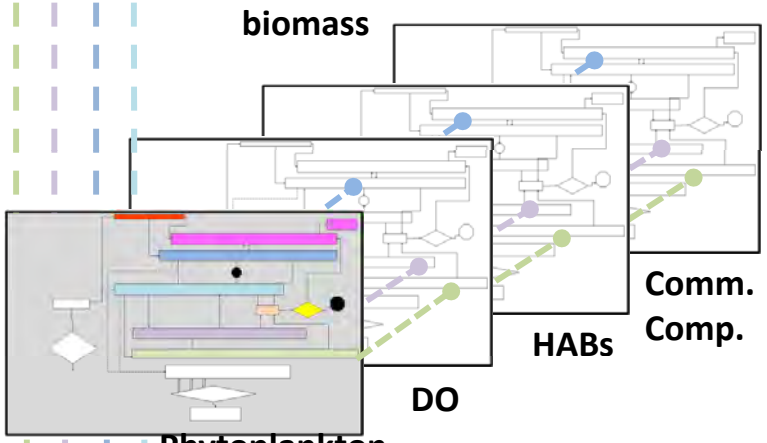
2011-2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019

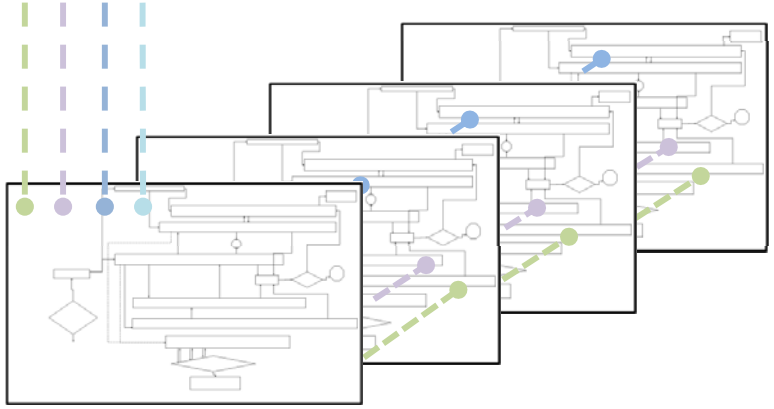
Suisun

Lower South

Other







2014 proposed workplan

- Modeling
- Synthesis/ Science Plan
- Assessment framework
- Monitoring
- Science Program Coordination

Are nutrients contributing to impairment of beneficial uses in Suisun Bay?

What are the optimal management actions for preventing or mitigating impairment, if impairment is occurring?

LEGEND

Red Text = Completed project, currently funded project, or future project with secured funding

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= Dashed line, information flow from one effort to another, but not main work flow

= Work that proceeds in parallel

= Grey arrow, assume this pathway is not relevant

= Prioritization of science and special studies

= Monitoring program dev./implementation

= Quantifying nutrient loads

= Program Management

= Assessment Framework development

= Model development/modeling

= Control strategy scenario identification/testing

= Impairment assessment

START: Existing guidelines for assessing impairment due to nutrients?

NO

YES[1] X

*We know there are no guidelines, so removed that path for clarity
[1] For clarity, assuming toxicity and indicators same across habitats.

What are potential impairment pathways?[2]

(NNE Lit Review and Nutrient Strategy)

Rank/prioritize based on linkage to management decisions, potential magnitude of problem, and potential for significant improvement in understanding through additional study, along with other criteria.

- Low phytoplankton production due to NH4 inhibition of primary production
- HABs, toxins
- Shifts in phyto comm comp
- Indirect tox to copepods: shifts in phyto cell
- Direct toxicity: copepod, other

Each pathway investigated separately, with some shared costs

**Quantify nutrient loads Current RMP Project

Explore approaches for Reducing Nutrient Loads.. Evaluate cost relative to multiple benefits of "straightforward" (individual POTWs) vs. coordinated and longer-term integrated options that address multiple wastewater-related issues

Revise and refine control strategy scenarios

Identify and test environmental effectiveness of control strategy scenarios for load reduction

**Refine Nutrient Loads Funded IEP project, loads from Delta to Suisun

Refine nutrient loads from Delta to Suisun. Current and Future conditions

Use Model to estimate necessary load reductions under different load reduction scenarios and environmental scenarios.

On-going modeling to interpret observed changes in monitoring data relative to changes in loads

Revise model structure and/or collect additional data to improve model calibration or parameterization

Impairment assessment: Is Suisun Bay impaired by this mechanism under current or future conditions?

YES

NO

END. Conditions in Suisun Bay do not meet impairment criteria for this mechanism. Return to other mechanisms

Sufficient understanding of or confidence in mechanism?

NO

Studies/ data available?

YES

NO

**Conceptual Model Current RMP project

**Synthesis, critical review of existing studies, field and experimental data.

Initial Recommendations
**Suisun Synthesis I

Is the mechanism ecologically-significant? Develop and apply **model** for Suisun Bay: Nutrients, grazing, light, hydrodynamics, phytoplankton response

Model Future conditions

Model Current conditions

Update model with input from on-going experiments

Additional effort to improve model justified and feasible in terms of cost and regulatory timeline?

NO

Use best available model

Sufficient confidence in available data, and metrics or thresholds for determining if impairmentis occurring?

YES

NO

Convene expert panel to evaluate state of science and Science Plan

Re-convene expert panel. Update state of science: recommendations Workshop and subsequent write-up/analysis

Ecologically-significant effect (under current or future conditions)?

YES/MAYBE

NO

Sufficient confidence in model and relative importance of process compared to other factors

NO

YES

Final model

Establish acceptable loads and optimal approach considering environmental effectiveness and cost

Develop Suisun Nutrient Science Plan: Management questions and Science questions

Synthesis of new study results. Evaluate results relative to Suisun Nutrient Science Plan goals

END. Suisun Not Impaired by this Mechanism. Return to other mechanisms

Agreement on Joint Fact Finding Process in Suisun Bay. Parties: Region 2, BACWA, SFCWA, Region 5 (?), SacRegional (?), IEP (?), others

Plausible Mechanism?

NO

Sufficient confidence in mechanism and what levels/thresholds lead to impairment (determined by assessment framework) to set regulations?

YES

Final thresholds

Begin implementing approach

Special Studies: Priority studies identified but not addressed by 2012/2013 IEP and other funding

Special Studies: Begin currently funded work (e.g., IEP, SFCWA, others) addressing each impairment pathway

NO

Additional study justified and feasible in terms of cost and regulatory timeline?

NO

Use best available data

YES

Assessment Framework – Part I

Conduct additional studies

Assessment Framework – Parts II and III

Monitoring Program Development – Part I

Monitoring Program Development – Part II

Monitoring Program Development

On-going Monitoring

On-going evaluation of monitoring, special studies, and modeling results to determine if determinations about impairment (yes/no) or actions can be made earlier than 2017/2018

Sufficient new information to substantially change course?

NO

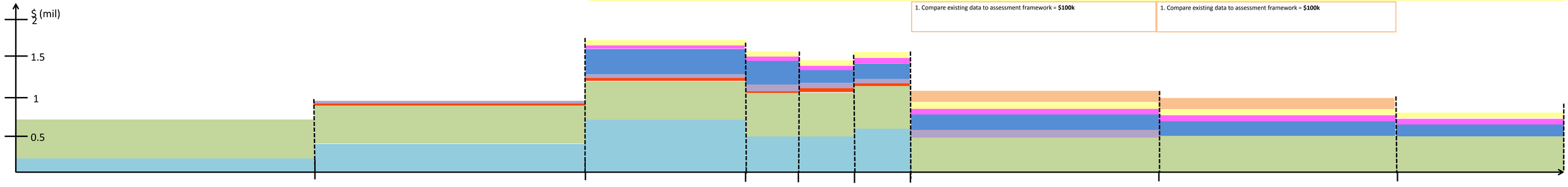
NO

NO

YES

Modify Science Plan and Management/Regulatory Approach

2011-2012	2013	2014	2015	2016	2017	2018	2019
1. NNE Document identifying potential indicators and data gaps = $**100k** 2. Nutrient Strategy Development = **$95k**	1. Nutrient Conceptual Model = **$50k** RMP 2. IEP and SFCWA funded field and lab studies = **$500k** 3. Suisun Science Plan Development + Expert Panel = **$50k** 4. Suisun Synthesis #2 = **$100k**	Special Studies: **$500k /yr for all nutrient Special Studies**		Synthesis of special studies = $**100k**			
1. Monitoring in Suisun Bay = **$500k** (USGS + IEP)	1. Monitoring in Suisun Bay = **$500k** USGS + IEP 2. Nutrient Monitoring Program Development = **$50k** SWRCB	1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program) 2. Monitoring program development = $**75k/yr**			1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program) 2. Monitoring Program implementation = **$75k**	1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program) 2. Monitoring Program implementation = **$75k**	1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program 2. Monitoring Program implementation = **$75k**
1. Nutrient Loading study (RMP) = **$20k RMP**	1. Nutrient Loading = **$30k** RMP	1. Refine nutrient loads from direct discharges = **$10k/yr**					
1. Assesment Framework I – short list of assessment framework options = **$30k** SWRCB	1 Assessment Framework I –Developing options, data analysis = **$50k** SWRCB	Assess.Frame SWRCB = **$30k** Additional = **$50k**	1. Assessment Framework = **$50k/yr** (Suisun portion across all pathways)		1. Assessment Framework II = $50k		
	1. Nutrient Modeling in the Delta = **$90k IEP** 2. Modeling plan development = **$50k RMP** 3. Develop model = **$50k** (RMP) +$**150k**	1. Modeling in Suisun Bay = **$200k/yr** 1. Nutrient Modeling in the Delta = **$90k IEP**			1. Modeling in Suisun Bay: current and future conditions = **$200k**	1. Modeling in Suisun Bay = **$200k**	1. Modeling in Suisun Bay = **$100k**
	1. Initial assessment of control strategy scenarios = **$25k**	1. Initial assessment of control strategy scenarios = **$50k/yr across al nutrients in Suisun**			1. Refine list of control strategy scenarios based on relative importance of sources time/locations of greatest impairment = **$50k**	1. Finalization of control strategy scenarios = **$50k**	1 Implementation of optimal load reductions = **$50k**
	1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**			1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**
					1. Compare existing data to assessment framework = **$100k**	1. Compare existing data to assessment framework = **$100k**	



Are nutrients contributing to impairment of beneficial uses in Suisun Bay?

What are the optimal management actions for preventing or mitigating impairment, if impairment is occurring?

LEGEND

Red Text = Completed project, currently funded project, or future project with secured funding

→ = Solid line, Main work flow direction

⇢ = Dashed line, information flow from one effort to another, but not main work flow

= Work that proceeds in parallel

= Grey arrow, assume this pathway is not relevant

= Prioritization of science and special studies

= Monitoring program dev./implementation

= Quantifying nutrient loads

= Program Management

= Assessment Framework development

= Model development/modeling

= Control strategy scenario identification/testing

= Impairment assessment

START: Existing guidelines for assessing impairment due to nutrients?

NO

YES[1] X

[*] We know there are no guidelines, so removed that path for clarity
[1] For clarity, assuming toxicity and indicators same across habitats.

What are potential impairment pathways?[2]

(NNE Lit Review and Nutrient Strategy)

Rank/prioritize based on linkage to management decisions, potential magnitude of problem, and potential for significant improvement in understanding through additional study, along with other criteria.

Low phytoplankton production due to NH4 inhibition of primary production

HABs, toxins

Shifts in phyto comm comp

Indirect tox to copepods: shifts in phyto cell

Direct toxicity: copepod, other

Will be developed separately.

**Quantify nutrient loads Current RMP Project

Explore approaches for Reducing Nutrient Loads. For this case it would be focused on NH4, but part of broader "Control Strategies" work element. Evaluate cost relative to multiple benefits of "straightforward" (individual POTWs) vs. coordinated and longer-term integrated options that address multiple wastewater-related issues

**Refine Nutrient Loads Funded IEP project, loads from Delta to Suisun

Refine nutrient loads from Delta to Suisun. Current and Future conditions

Revise and refine control strategy scenarios

Identify and test environmental effectiveness of control strategy scenarios for load reduction

Use Model to estimate necessary load reductions under different load reduction scenarios and environmental scenarios.

On-going modeling to interpret observed changes in monitoring data relative to changes in loads

Revise model structure and/or collect additional data to improve model calibration or parameterization

Impairment assessment: Is Suisun Bay impaired by this mechanism under current or future conditions?

YES

NO

END. Conditions in Suisun Bay do not meet impairment criteria for this mechanism. Return to other mechanisms

Additional effort to improve model justified and feasible in terms of cost and regulatory timeline?

NO

YES

Use best available model

Sufficient understanding of or confidence in mechanism?

NO

YES

Studies/ data available?

YES

NO

**Conceptual Model Current RMP project

**Synthesis, critical review of existing studies, field and experimental data.

Initial Recommendations
**Suisun Synthesis I

Is the mechanism ecologically-significant? Develop and apply **model** for Suisun Bay: Nutrients, grazing, light, hydrodynamics, phytoplankton response

Model Future conditions

Model Current conditions

Update model with input from on-going experiments

Sufficient confidence in available data, and metrics or thresholds for determining whether NH4-inhibition is occurring?

YES

NO

Convene expert panel to evaluate state of science and Science Plan

Develop Suisun Nutrient Science Plan: Management questions and Science questions

Agreement on Joint Fact Finding Process in Suisun Bay. Parties: Region 2, BACWA, SFCWA, Region 5 (?), SacRegional (?), IEP (?), others

Re-convene expert panel. Update state of science: recommendations Workshop and subsequent write-up/analysis

Synthesis of new study results. Evaluate results relative to Suisun Nutrient Science Plan goals

Ecologically-significant effect (under current or future conditions)?

YES/MAYBE

NO

END. Suisun Not Impaired by this Mechanism. Return to other mechanisms

Sufficient confidence in model and relative importance of process compared to other factors

NO

YES

Final model

Establish acceptable loads and optimal approach considering environmental effectiveness and cost

Begin implementing approach

Plausible Mechanism?

NO

Sufficient confidence in mechanism and what levels/thresholds lead to impairment (determined by assessment framework) to set regulations?

YES

Final thresholds

Special Studies: Priority studies identified but not addressed by 2012/2013 IEP and other funding

Special Studies: Begin currently funded work (e.g., IEP, SFCWA, others) focused on NH4-inhibition questions.

Additional study justified and feasible in terms of cost and regulatory timeline?

NO

YES

Use best available data

Assessment Framework – Part I

Conduct additional studies

Assessment Framework – Parts II and III

Monitoring Program Development – Part I

Monitoring Program Development – Part II

Monitoring Program Development

On-going Monitoring

On-going evaluation of monitoring, special studies, and modeling results to determine if determinations about impairment (yes/no) or actions can be made earlier than 2017/2018

Sufficient new information to substantially change course?

NO

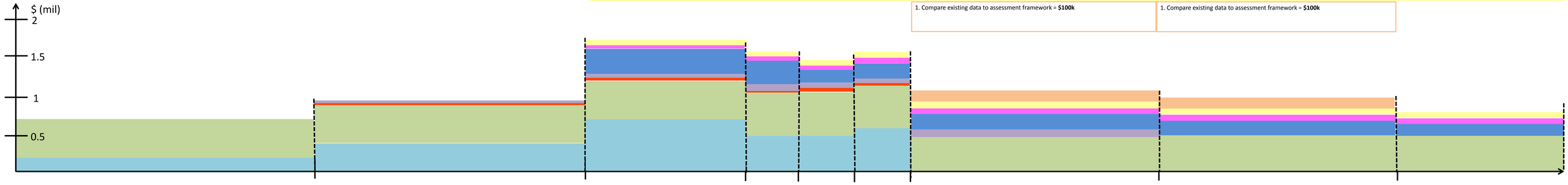
NO

NO

YES

Modify Science Plan and Management/Regulatory Approach

2011-2012	2013	2014	2015	2016	2017	2018	2019
1. NNE Document identifying potential indicators and data gaps = $**100k** 2. Nutrient Strategy Development = **$95k**	1. Nutrient Conceptual Model = **$50k** RMP 2. IEP and SFCWA funded field and lab studies = **$500k** 3. Suisun Science Plan Development + Expert Panel = **$50k** 4. Suisun Synthesis #2 = **$100k**	Special Studies: Lab and field Does elevated NH4reduce phytoplankton biomass by inhibiting primary production? Do other substances contribute to low biomass? =**$500k /yr for all nutrient Special Studies**		Synthesis of special studies = $**100k**			
1. Monitoring in Suisun Bay = **$500k** (USGS + IEP)	1. Monitoring in Suisun Bay = **$500k** USGS + IEP 2. Nutrient Monitoring Program Development = **$50k** SWRCB	1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program) 2. Monitoring program development = $**75k/yr**			1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program) 2. Monitoring Program implementation = **$75k**	1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program) 2. Monitoring Program implementation = **$75k**	1. Monitoring in Suisun Bay = $**500k/yr** (some covered by IEP's and DWR's on-going program 2. Monitoring Program implementation = **$75k**
	1. Nutrient Loading study (RMP) = **$20k RMP**	1. Nutrient Loading = **$30k** RMP			1. Refine nutrient loads from direct discharges = **$10k/yr**		
	1. Assesment Framework I – short list of assessment framework options = **$30k** SWRCB	1 Assessment Framework I –Developing options, data analysis = **$50k** SWRCB	Assess.Frame SWRCB = **$30k** Additional = **$50k**	1. Assessment Framework = **$50k/yr** (Suisun portion across all nutrient forms/pathways)	1. Assessment Framework II = $50k		
		1. Nutrient Modeling in the Delta = **$90k IEP** 2. Modeling plan development = **$50k RMP** 3. Develop model = **$50k** (RMP) +**$150k**	1. Modeling in Suisun Bay = **$200k/yr** 1. Nutrient Modeling in the Delta = **$90k IEP**		1. Modeling in Suisun Bay: current and future conditions = **$200k**	1. Modeling in Suisun Bay = **$200k**	1. Modeling in Suisun Bay = **$100k**
	1. Initial assessment of control strategy scenarios = **$25k**	1. Initial assessment of control strategy scenarios = **$50k/yr across al nutrients in Suisun**			1. Refine list of control strategy scenarios based on relative importance of sources time/locations of greatest impairment = **$50k**	1. Finalization of control strategy scenarios = **$50k**	1 Implementation of optimal load reductions = **$50k**
	1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**			1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**
					1. Compare existing data to assessment framework = **$100k**	1. Compare existing data to assessment framework = **$100k**	



Are nutrients contributing to impairment of beneficial uses in Lower South Bay?

What are the optimal management actions for preventing or mitigating impairment, if impairment is occurring?

LEGEND

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= Work that proceeds in parallel

= Grey arrow, assume this pathway is not relevant

= Prioritization of science and special studies

= Monitoring program dev./implementation

= Quantifying nutrient loads

= Program Management

= Assessment Framework development

= Model development/modeling

= Control strategy scenario identification/testing

= Impairment assessment

START: Existing guidelines for assessing impairment due to nutrients?

NO

YES[1] X

[1] We know there are no guidelines, so removed that path for clarity
[2] For clarity, assuming toxicity and indicators same across habitats.

What are potential impairment pathways?[2]

(NNE Lit Review and Nutrient Strategy)

Rank/prioritize based on linkage to management decisions, potential magnitude of problem, and potential for significant improvement in understanding through additional study, along with other criteria.

Shifts in phytoplankton community composition that results in suboptimal assemblage

- HABs, toxins
- High phytoplankton biomass
- Low DO due to high phytoplankton biomass
- Other food web effects: shifts in phyto cell N:P
- Direct toxicity: copepod, other

Each pathway will be evaluated by similar process.

**Quantify nutrient loads in South Bay
Previous RMP Project

**Quantify nutrient loads Baywide and refine estimates for Lower South Bay
Current RMP Project

Explore approaches for Reducing Nutrient Loads. For this case it would be focused on nutrient forms and ratios, but part of broader "Control Strategies" work element. Evaluate cost relative to multiple benefits of straightforward" (individual POTWs) vs. coordinated and longer-term integrated options that address multiple wastewater-related issues

Revise and refine control strategy scenarios

Identify and test environmental effectiveness of control strategy scenarios for load reduction

Use Model to estimate necessary load reductions under different load reduction scenarios and environmental scenarios.

On-going modeling to interpret observed changes in monitoring data relative to changes in loads

Impairment assessment: Is Lower South Bay impaired by this mechanism under current or future conditions?

YES

NO

END. Conditions in Lower South Bay do not meet impairment criteria for this mechanism. Return to other mechanisms

Revise model structure and/or collect additional data to improve model calibration or parameterization

Update model with input from on-going experiments

Sufficient understanding of or confidence in mechanism?

NO

YES

Studies/ data available?

YES

NO

**Conceptual Model
Current RMP project

Is the mechanism ecologically-significant? Develop and apply **model** : hydrodynamics, nutrient fate/transformations, phytoplankton response grazing, light,

Model Future conditions

Model Current conditions

Additional effort to improve model justified and feasible in terms of cost and regulatory timeline?

YES

NO

Use best available model

Sufficient confidence in available data, and metrics or thresholds for determining whether shift to suboptimal assemblage is occurring?

YES

NO

**Synthesis, critical review of existing studies, field and experimental data.

Initial Recommendations
**Lower South Bay Synthesis

Convene expert panel to evaluate state of science and Science Plan

Develop LSB Nutrient Science Plan: Management questions and Science questions

Agreement on Joint Fact Finding Process in LSB: Key partners, decision-making, funding,

Re-convene expert panel. Update state of science: recommendations Workshop and subsequent write-up/analysis

Synthesis of new study results. Evaluate results relative to LSB Nutrient Science Plan goals

Ecologically-significant effect (under current or future conditions)?

YES/MAYBE

NO

END. Lower South Bay not Impaired by this Mechanism. Return to other mechanisms

Sufficient confidence in model and relative importance of process compared to other factors

NO

YES

Final model

Establish acceptable loads and optimal approach considering environmental effectiveness and cost

Design and implement approach

Plausible Mechanism?

NO

Sufficient confidence in mechanism and what levels/thresholds lead to impairment (determined by assessment framework) to set regulations?

YES

Final thresholds

NO

Additional study justified and feasible in terms of cost and regulatory timeline?

NO

YES

Use best available data

Conduct additional studies

Special Studies: focused on role of nutrients in creating suboptimal phytoplankton community composition, and other relevant drivers.

Assessment Framework – Part I

Assessment Framework – Parts II and III

Monitoring Program Development – Part I

Monitoring Program Development – Part II

Monitoring Program Development

On-going Monitoring

On-going evaluation of monitoring and special studies data to determine whether conditions are changing

NO

NO

NO

Sufficient new information to substantially change course?

YES

Modify Science Plan or Management/Regulatory Approach

2011-2012	2013	2014	2015	2016	2017	2018	2019
1. NNE Document identifying potential indicators and data gaps = $**100k** 2. Nutrient Strategy Development = **$95k**							
	1. Nutrient Conceptual Model = **$80k**						
		1. Special studies: Lab and field studies **$300k/yr** across all pathways in LSB. Some potential overlap between LSB and Suisun…e.g, phytoplankton composition.		Synthesis of special studies = $**100k**			
	1. Nutrient Conceptual Model = **$50k** RMP 2. Lower South Bay Synthesis #1 = **$100k** 3. Science Plan development +expert panel = **$50k**						
1. Monitoring in Lower South Bay = **$300k** (USGS + POTWs)	1. Monitoring in Lower South Bay = **$300k** (USGS + POTWs)	1. Monitoring in LSB = **$500k/yr ship and moored sensors** 2. Monitoring program development = **$20k/yr LSB portion**			1. Monitoring in Lower South Bay = **$500k ship and moored sensors**	1. Monitoring in Lower South Bay = **$500k** ship and moored sensors	1. Monitoring in Lower South Bay = **$500k** ship and moored sensors
	1. Monitoring in LSB = **$300k** (USGS + POTWs) 2. Special studies: $**250k** RMP + USGS, Moored sensor deployment at Dumbarton & other locations 3. HAB toxin monitoring: **$15k** RMP (LSB share) 4. Monitor. Progr. Devel. = **$15k** SWRCB (LSB share)						
	1. Nutrient Loading study (RMP) = **$5k RMP**	1. Refine nutrient loads from direct discharges = **$10k/yr**					
	1. Nutrient Loading = $8k RMP						
1. Assesment Framework I – short list of assessment framework options = **$30k** SWRCB					1. Assessment Framework II = **$50k** (LSB portion)		
	1 Assessment Framework I –Developing options, data analysis = **$50k** SWRCB (LSB share)	Assess.Frame SWRCB = **$30k** Additional = **$50k**	1. Assessment Framework = **$50k/yr** (Lower South Bay portion across all nutrient forms/pathways)				
	1. Modeling plan development = **$10k** RMP 2. Develop model for LSB = **$50k** (RMP) +**$150k**	1. Modeling in LSB = **$150k/yr**			1. Modeling in Lower South Bay: current and future conditions = **$100k**	1. Modeling in Lower South Bay = **$100k**	1. Modeling in Lower South Bay = **$100k**
	1. Initial assessment of control strategy scenarios = **$25k** across al nutrients in LSB (LSB portion)	1. Assessment of control strategy scenarios = **$50k/yr across all nutrients in LSB (LSB portion)**			1. Refine list of control strategy scenarios based on relative importance of sources time/locations of greatest impairment = **$50k (LSB portion)**	1. Finalization of control strategy scenarios = **$50k**	1 Implementation of optimal load reductions = **$50k**
	1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**			1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**	1. Project management – contracts, tracking deliverables, fundraising = **$50k**
					1. Compare existing data to assessment framework = **$100k** (LSB portion across all impairment pathways)	1. Compare existing data to assessment framework = **$100k (LSB portion across all impairment pathways)**