



TETRA TECH

Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
FPL Response to NRC RAI No. WR-12
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Variable Density Ground Water Flow and Salinity Transport Model Analysis

Attribution Analysis Results

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Tetra Tech

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Executive Summary

- FPL used existing Groundwater Model with additional modifications to conduct the attribution analysis
- 8 regional and environmental factors were considered and individually modeled to assess their independent effects
- Each model result was compared to the base case
- The analysis indicated that the most influential factors were:
 - CCS salinity > seawater
 - Climate,
 - WMD canal operations
- The least influential factors were:
 - Local canals
 - Seasonal canals
 - Sea level rise*

* Sea level rise over the past 9 years of most significant change may not have reached an equilibrium at the current comparison time. Its effect may therefore be underestimated.

Outline

- Background
- Attribution analysis
 - Factors considered
 - Analysis and reporting methodology
- Results
 - Scenario development
 - Metric (depth-averaged change in area > 1000 mg/L chlorides west of CCS)
 - Visual
- Conclusion

Background

- DEP Consent Order #16-0241 (CO) was entered into between DEP and Florida Power & Light Company (FPL) on June 20, 2016
- Third Objective of CO:
 - FPL to provide mitigation for impacts related to the historic operation of the Cooling Canal System (CCS), including but not limited to the hypersaline plume and its influence on the saltwater interface (SWI)
- To achieve this third objective (in part), paragraph 23(a) of the CO requires FPL to:
 - “**Complete an analysis, within 2 years** from the effective date of this Order, with input from the Department and other agencies as selected by the Department, using the variable density three-dimensional groundwater model developed under the Miami-Dade County Consent Agreement, **that seeks to allocate relative contributions of other entities or factors to the movement of the SWI.**”

Factors Considered in Attribution Analysis (8)

1. Operation of the FPL Cooling Canal System (CCS);
2. Sea level rise;
3. Changes in land use;
4. Decadal-scale changes in precipitation recharge;
5. Construction of drainage structures and changes to drainage practices;
6. Construction and operation of controlled freshwater canals;
7. Changes to groundwater use (changes to the operation and capacity of nearby wellfields); and
8. Management and operation of mining practices west of the CCS.

Analysis and Reporting Methodology

- Description of specific factor to be assessed
 - Base case (calibrated model) condition
 - Scenario modifications
- Metric: Average change in area (from base case) of salinity > 0.05 (1000 mg/L Cl) west of the CCS over thickness of aquifer
- Visual: Areal view of saltwater interface line
 - Model layer 8, lower high flow zone
 - Simulated interface should not be compared to Prinos (2016) because of differing monitoring elevations and intervals

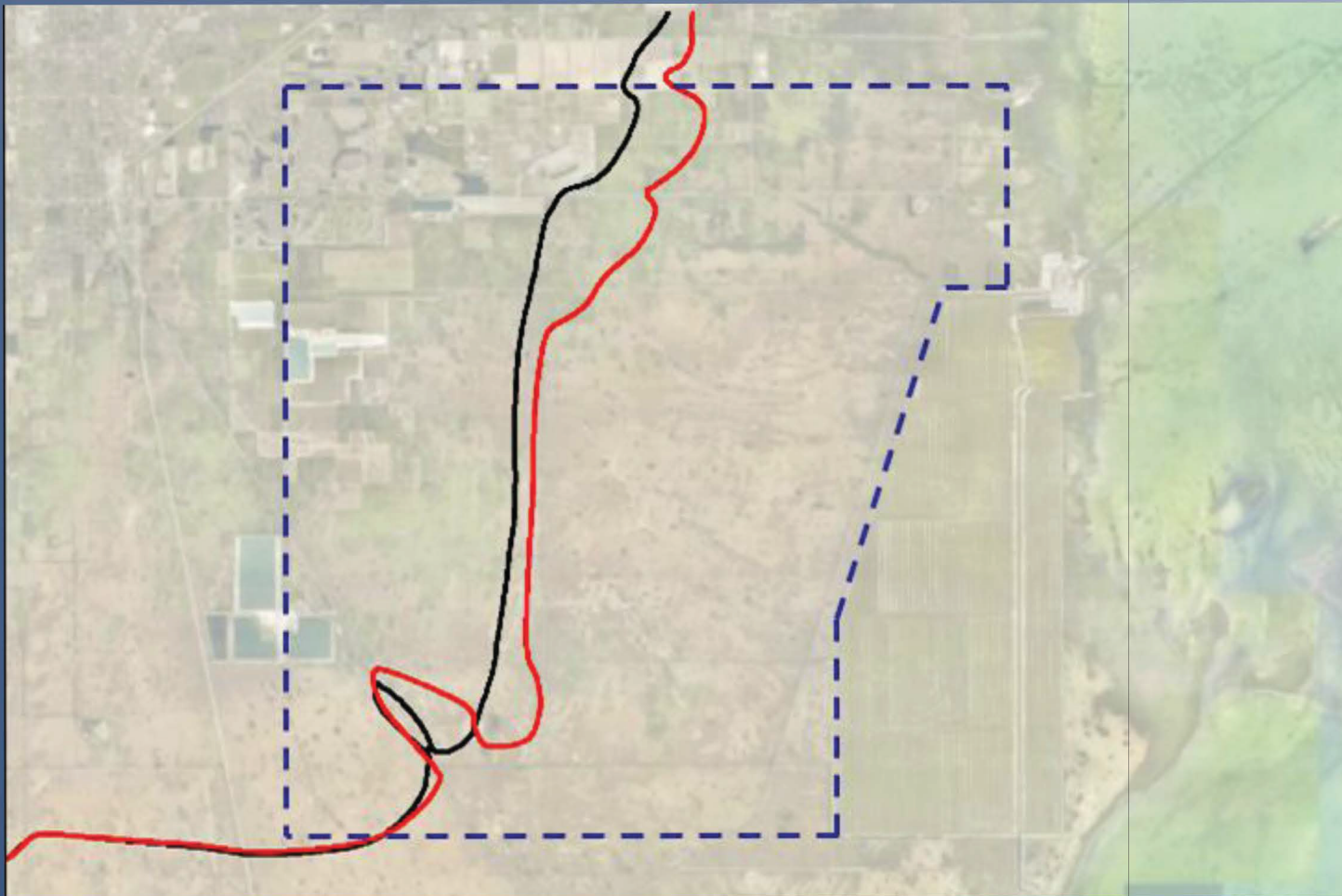
1. Operation of the FPL Cooling Canal System (CCS)

- Scenario 1: CCS operated at seawater salinity for its period of use
 - Replace CCS cells of greater than 35 PSU with 35 PSU
 - Run model, process results
 - Assesses position and orientation of saltwater interface if CCS salinity remained at 35 PSU

1. Operation of the FPL Cooling Canal System (CCS)

Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.10		
1	Limit CCS salinity to 35 PSU	21.45	2.65	11.01%

1. Operation of the FPL Cooling Canal System (CCS)



2. Sea Level Rise

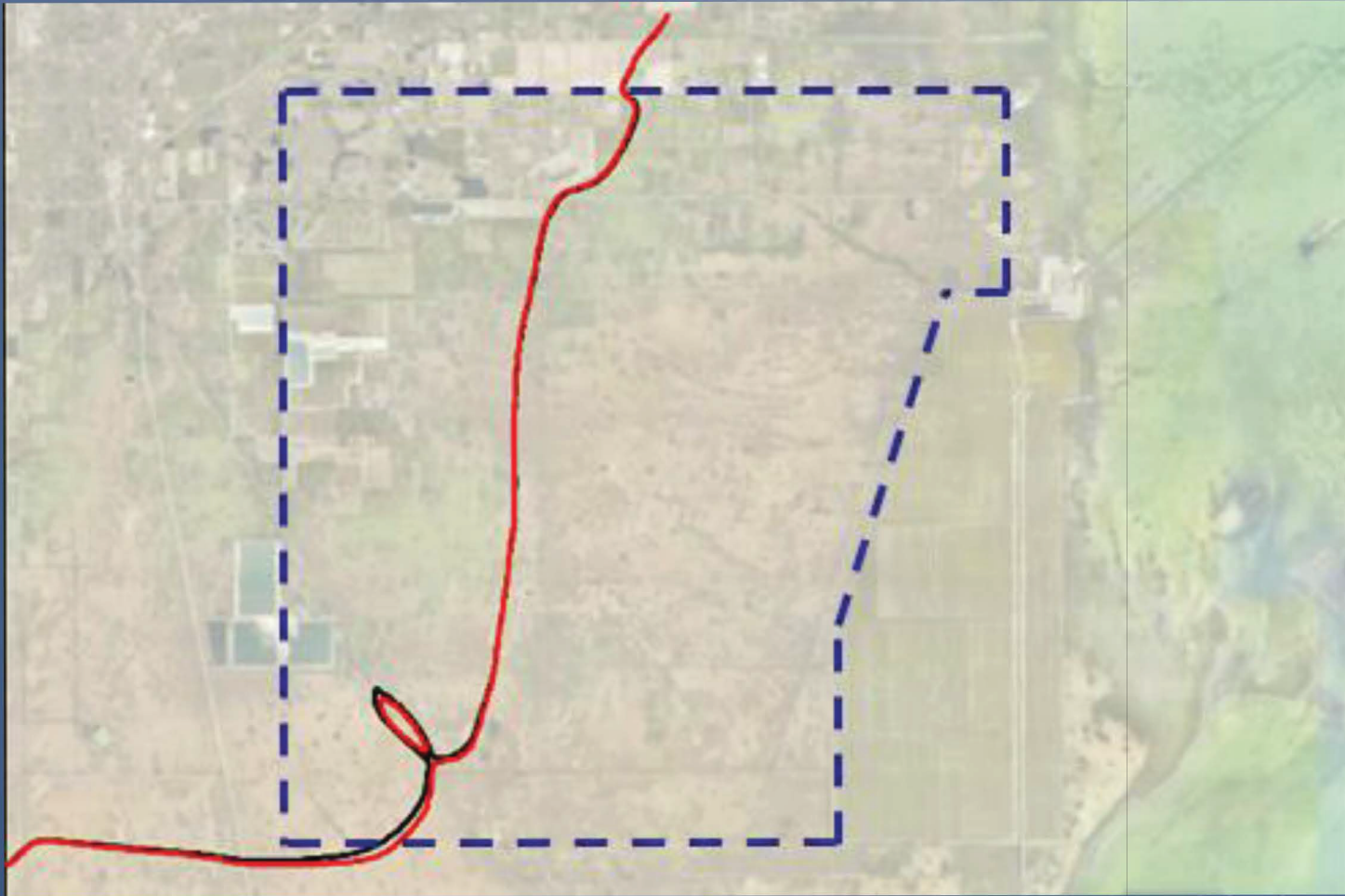
- Sea-level rise is included in base model:
 - Biscayne Bay boundary
 - Canal and inland boundary adjustments
 - 2.74 inches 1973-2010
 - 2.79 inches 2010-2018
- Scenario 2: No sea-level rise
 - Detrend Biscayne Bay boundary heads to account for no rise, but apply same seasonal and monthly variability
 - Adjust CCS stages by same amount to maintain same head differences with Biscayne Bay as base model
 - Run model, process results
 - Assess influence of sea-level rise

2. Sea Level Rise

Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.10		
2	No Sea Level Rise	23.99	0.11	0.45%

2. Sea Level Rise

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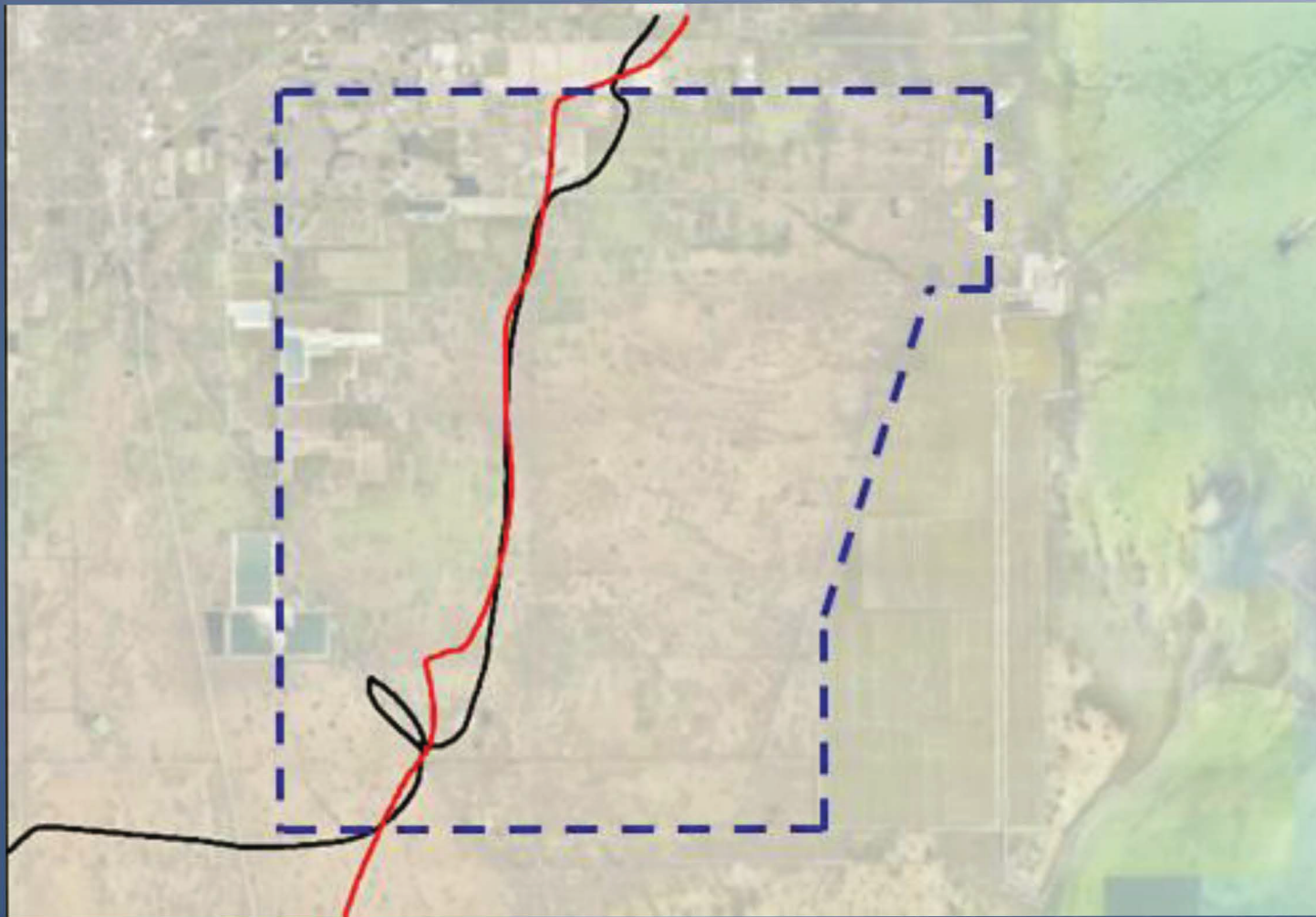
3. Changes in Land Use

- Land use change is included in base model:
 - Recharge (precipitation, agricultural irrigation)
 - Runoff (urbanization)
 - Drainage canals
- Scenario 3: No change in land use
 - Recharge distribution as in 1960's
 - Runoff distribution as in 1960's
 - Drainage canals as in 1960's

3. Changes in Land Use

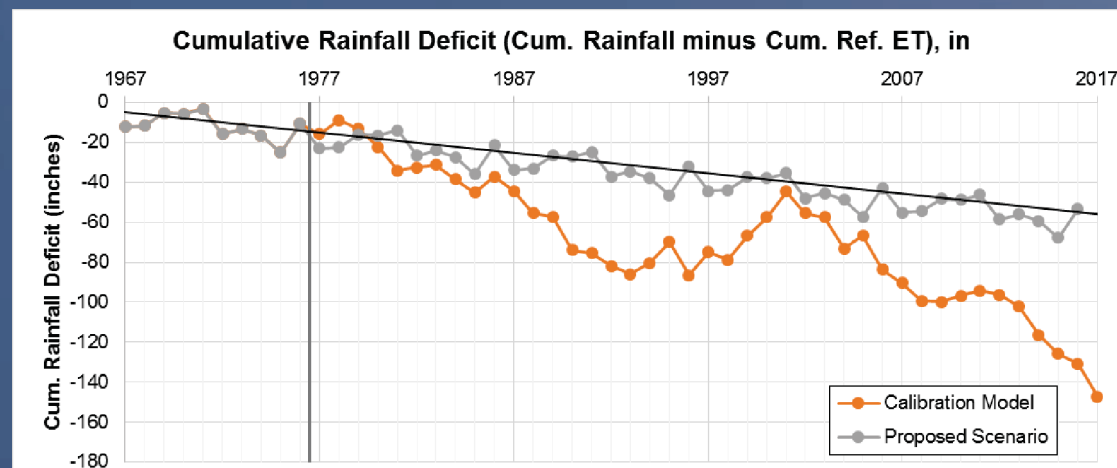
Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.10		
3	No Land Use Changes	23.97	0.13	0.55%

3. Changes in Land Use



4. Decadal-Scale Changes in Climate

- Actual climatic variability is included in base model
 - Precipitation / ET as measured/estimated from 1968-2015
- Scenario 4: Alternative decadal-scale change in recharge
 - Repeat 1967-1976 precipitation and ET through present
 - Determine effects of recent (drier) climate

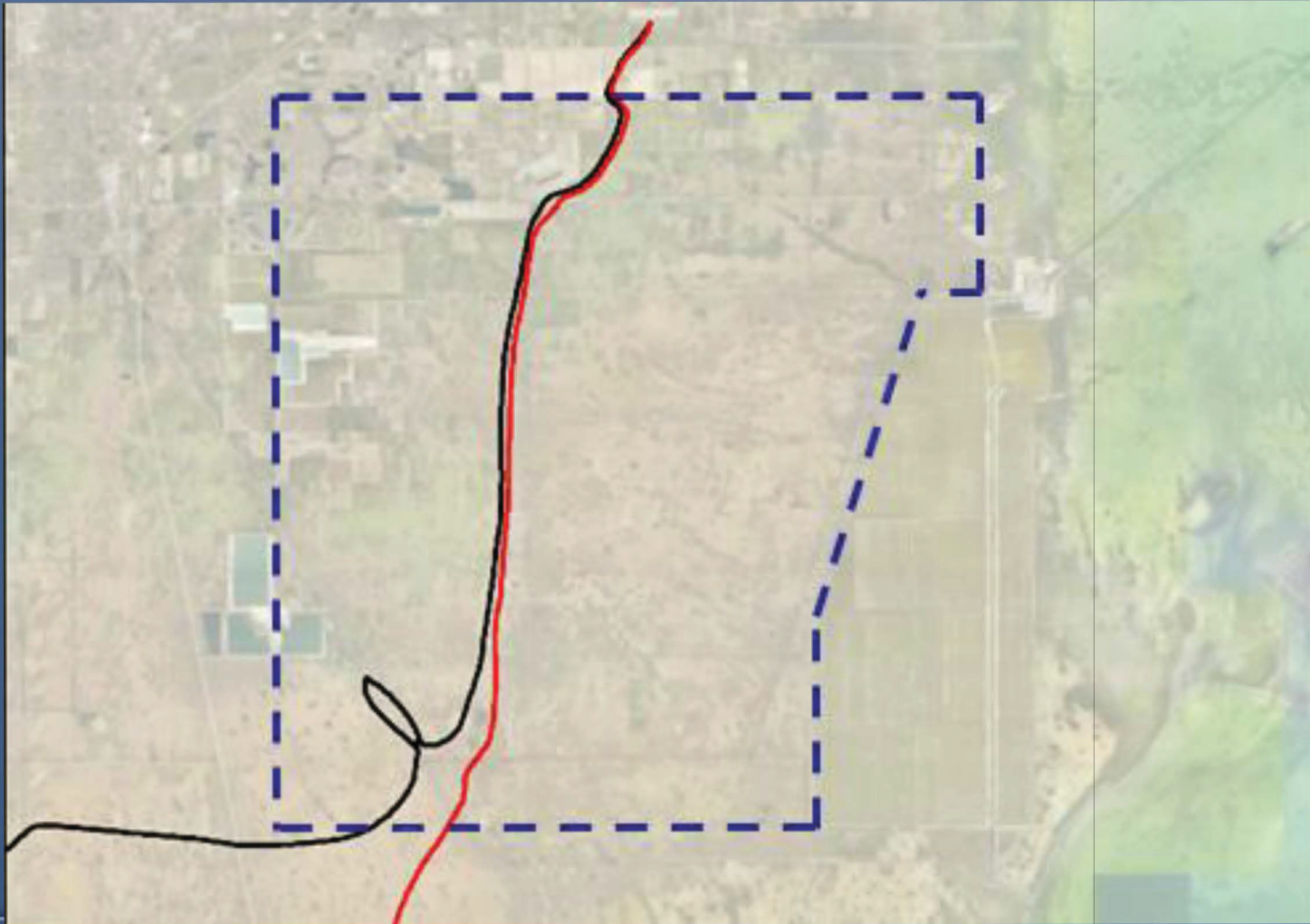


4. Decadal-Scale Changes in Climate

Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.10		
4	Decadal-Scale Change in Climate	22.81	1.29	5.38%

4. Decadal-Scale Changes in Climate

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5. Construction of Drainage Structures and Changes to Drainage Practices

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- Controlled freshwater canals are included in base model:
 - Progressive addition of canals with time
- Scenario 5a: Localized alternate management of drainage structures
 - Higher dry season heads in canals northwest of CCS
 - North, Florida City, and C-103 heads assumed equal to L31-E
- Scenario 5b: Widespread alternate management of drainage structures
 - Set observed maximum seasonal heads in all controlled canals

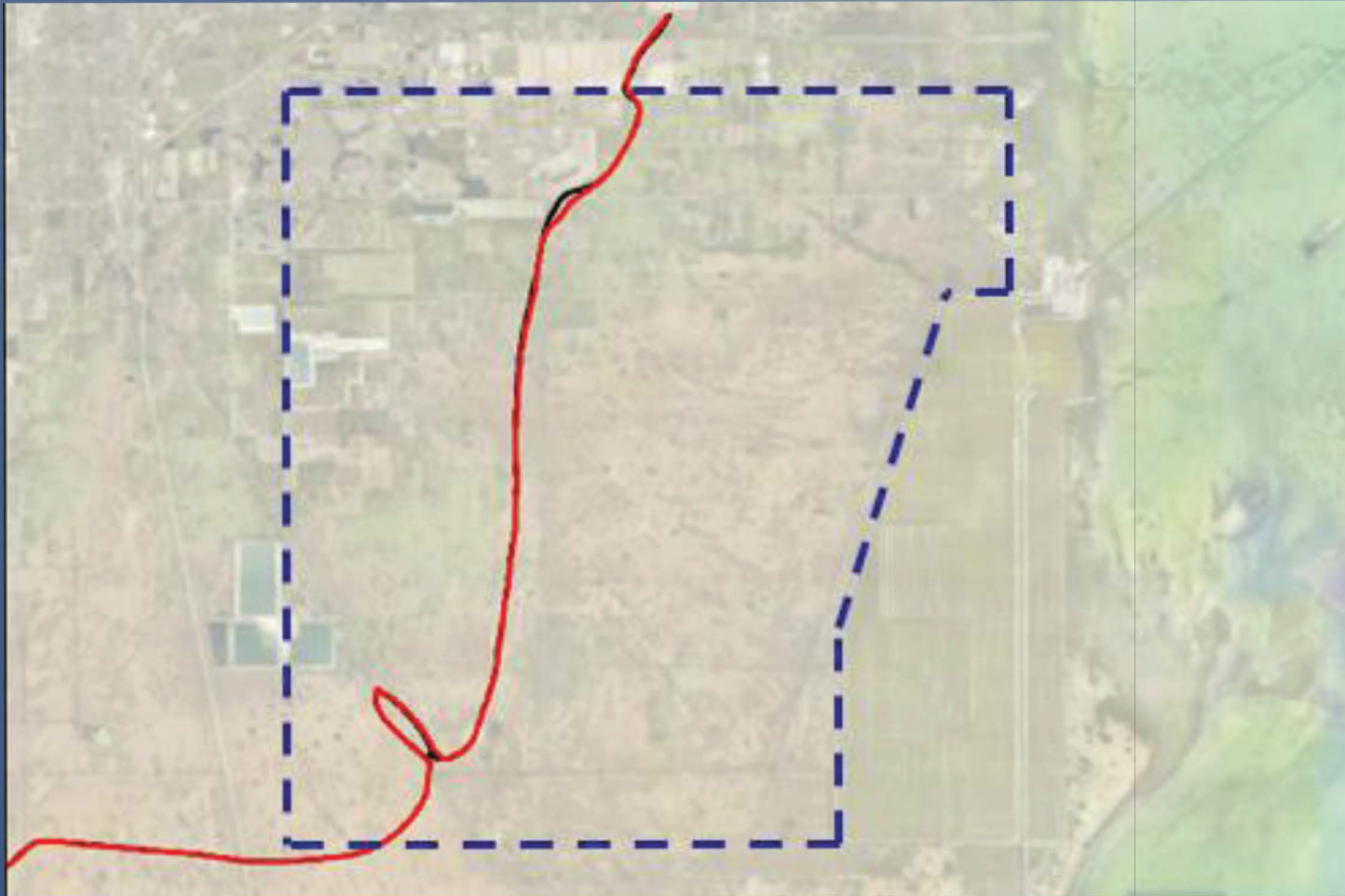
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Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.10		
5A	Local canals to L-31E	24.09	0.01	0.06%
5B	High seasonal canal stages	24.05	0.05	0.20%

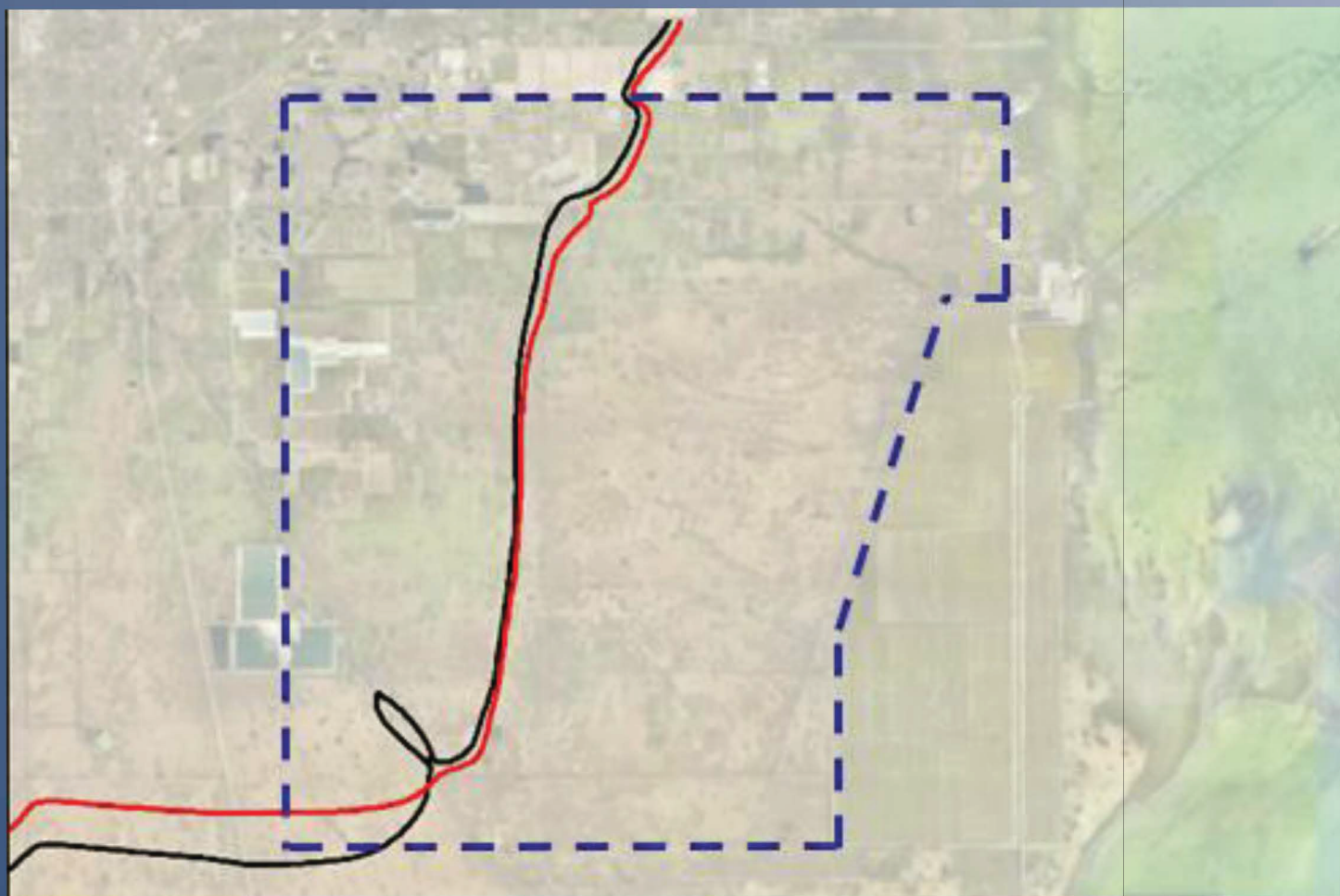
5a: Localized alternate management of drainage structures

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5b: Widespread alternate management of drainage structures

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6. Construction and Operation of Controlled Freshwater Canals

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- Controlled freshwater canals are included in base model:
 - Progressive addition of canals with time
 - Management practices represented as they occurred
- Scenario 6: 1960's canal distribution present through 2017
 - L31-E and other freshwater canals (built in late 1960's and early 1970's) not included in scenario
 - Assesses influence of freshwater canal construction

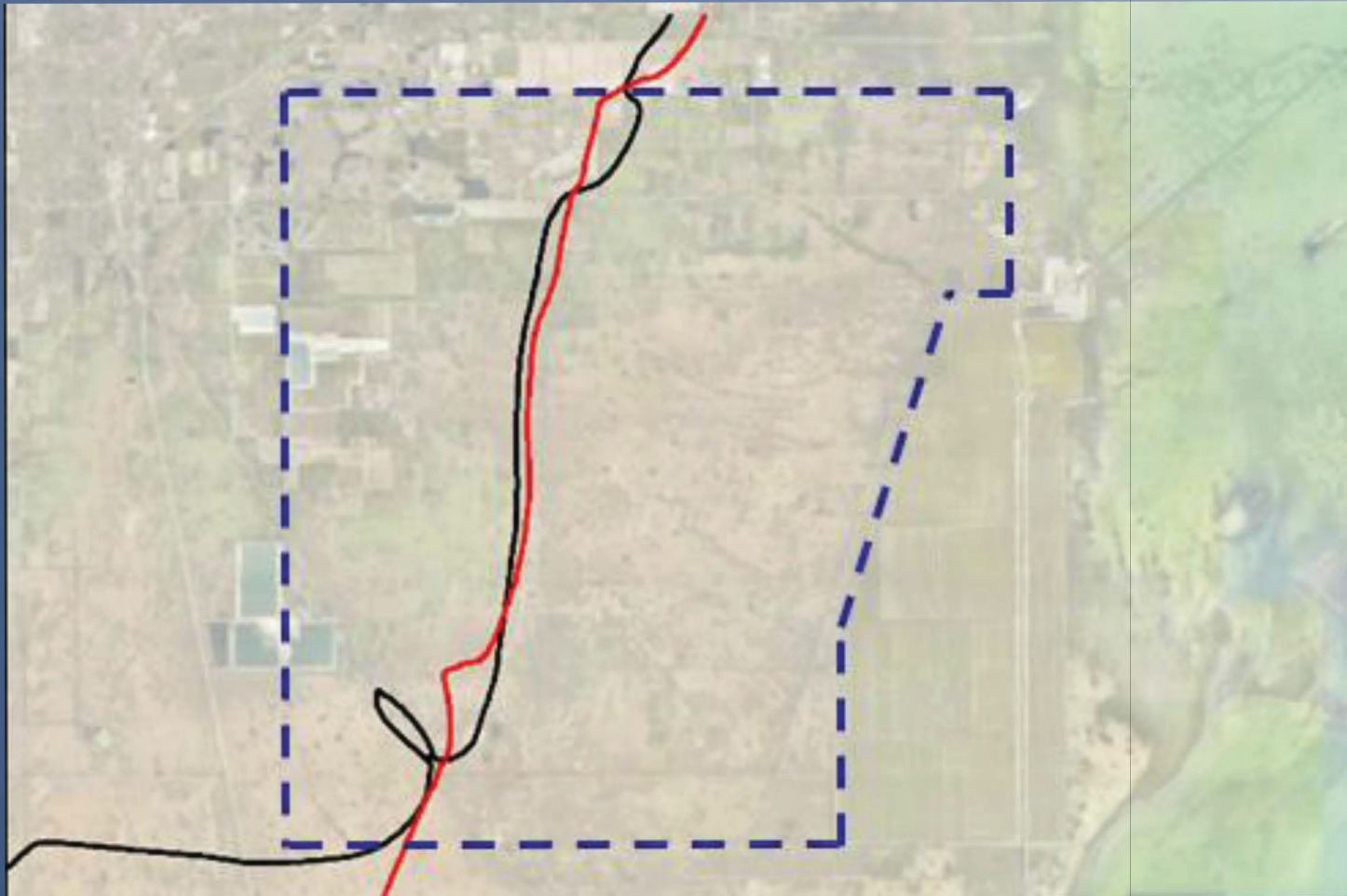
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Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.10		
6	No WMD canals	23.34	0.76	3.15%

6. Construction and Operation of Controlled Freshwater Canals

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7. Changes to Groundwater Use

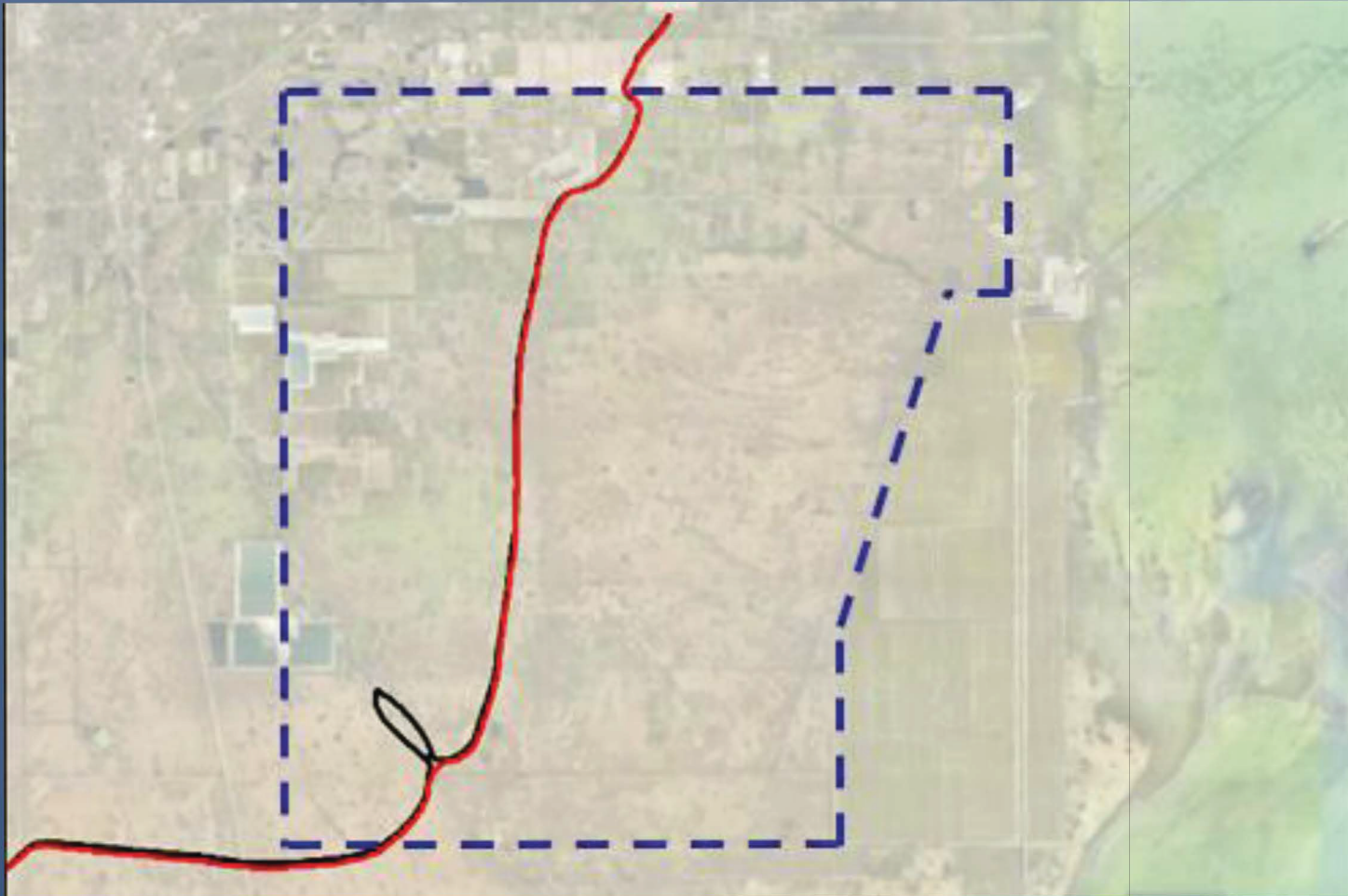
- Changes to the operation and capacity of nearby wellfields are included in base model
- Scenario 7a: Municipal Pumping
 - Eliminate municipal pumping from model
 - Run model, process results
- Scenario 7b: Agricultural Pumping
 - Eliminate agricultural pumping from model
 - Run model, process results

7. Changes to Groundwater Use

Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.10		
7A	No municipal pumping	23.94	0.16	0.66%
7B	No ag pumping	23.93	0.17	0.71%

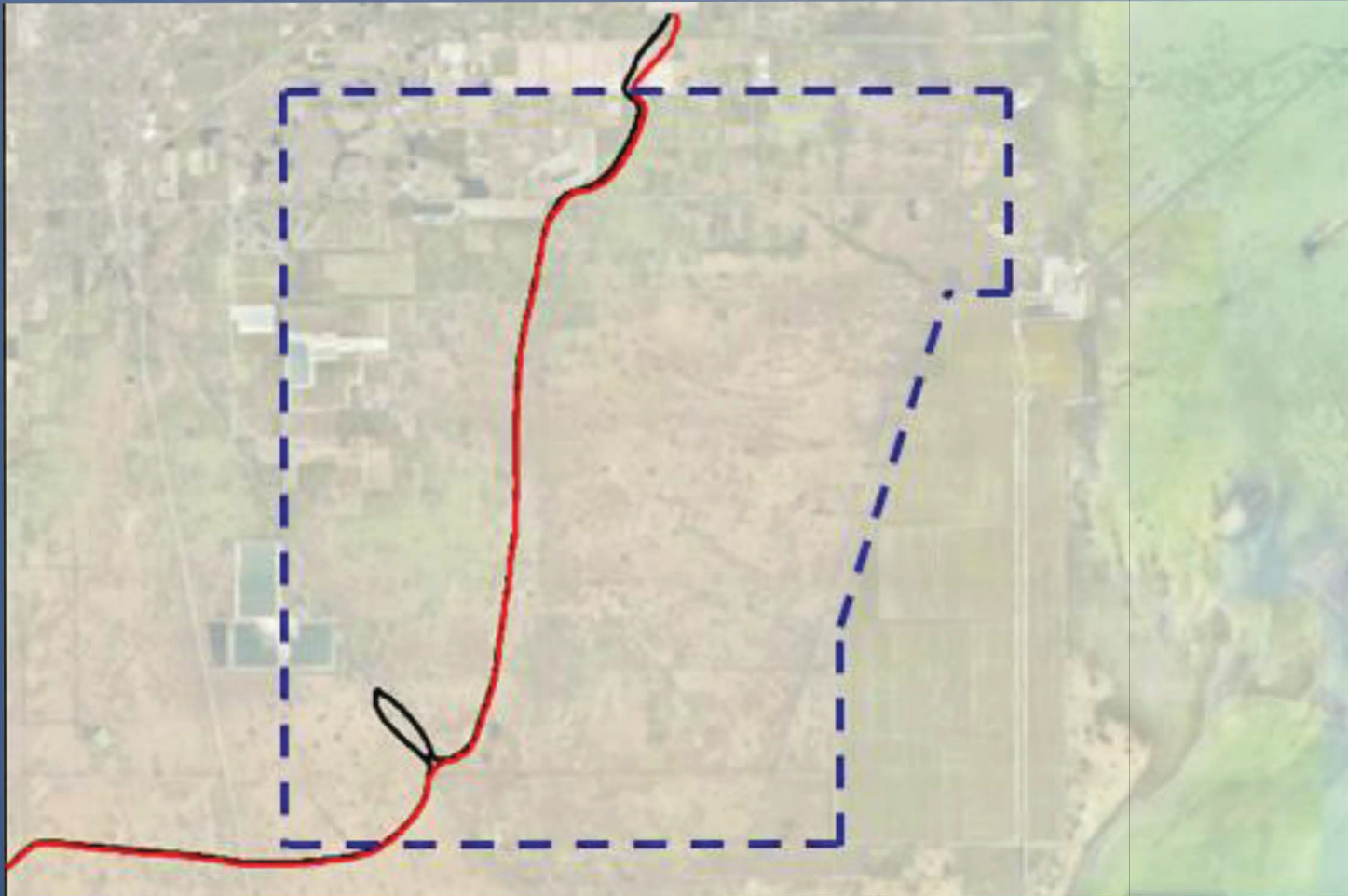
7a: Municipal Pumping

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7b: Agricultural Pumping

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8. Management and Operation of Mining Practices West of the CCS

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- Progressive addition of mining is included in base model:
 - 3 mines/quarries
 - Water balance based on recharge / evapotranspiration differences (generally an ET draft)
- Scenario 8:
 - Eliminate mines: assume natural conditions present in mine footprints
 - Run model, process results
 - Assesses influence of mine presence and water use

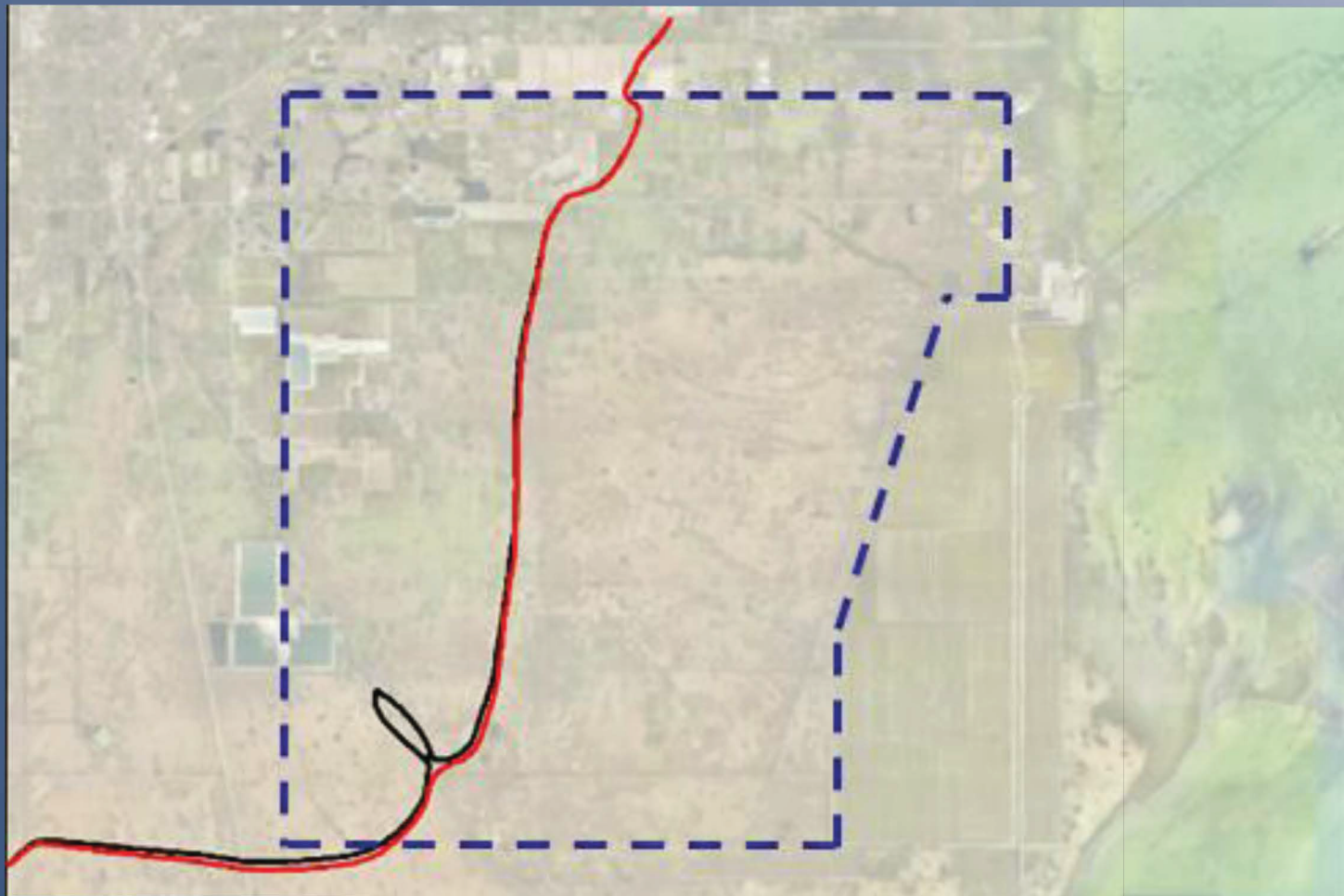
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Number	Description	Average areal extent of saltwater (mi ²)	Reduction from Base (mi ²)	% Reduction from Base
0	Base	24.1		
8	No mining	23.73	0.37	1.54%

8. Management and Operation of Mining Practices West of the CCS

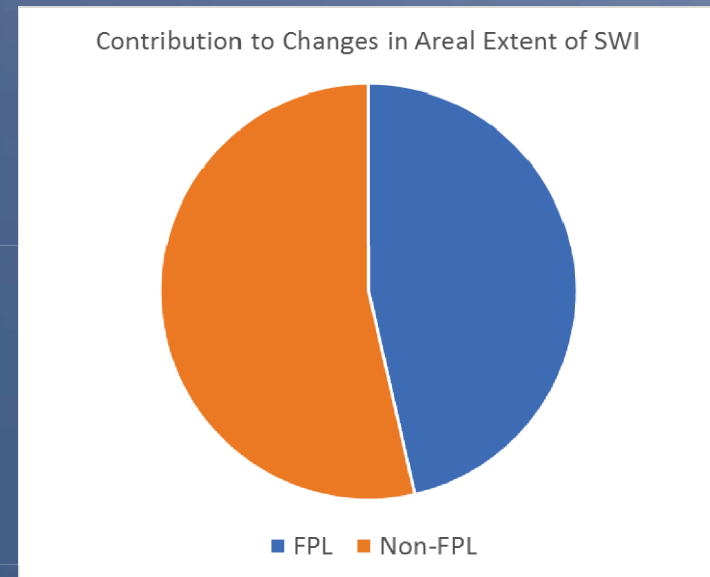
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Summary

- Attribution analysis has been performed in accordance with FDEP requirements
- Model was updated to be better suited for this type of analysis
- Changes to areal extent of SWI:

Attribution Scenario	Change in Areal Extent (sq mi)
CCS hypersalinity	2.65
Climate	1.30
WMD canals	0.76
Mining	0.37
Agricultural pumping	0.17
Municipal pumping	0.16
Land use	0.13
Sea-level rise	0.11
Seasonal canals	0.05
Local canals	0.01
TOTAL	5.72



Conclusions

- The analysis indicated that the most influential factors were:
 - CCS salinity > seawater
 - Climate,
 - WMD canal construction and operations
- The least influential factors were:
 - Local canals
 - Seasonal canals
 - Sea level rise*

Sea level rise over the past 9 years of most significant change may not have reached an equilibrium at the current comparison time. Its effect may therefore be underestimated.