Spatially Explicit Modelling for Examining Water Quantity and Quality Effects of Individual Wetlands at Site, Field, Farm, and Watershed Scales

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Agricultural Conservation Practices

Conservation Tillage

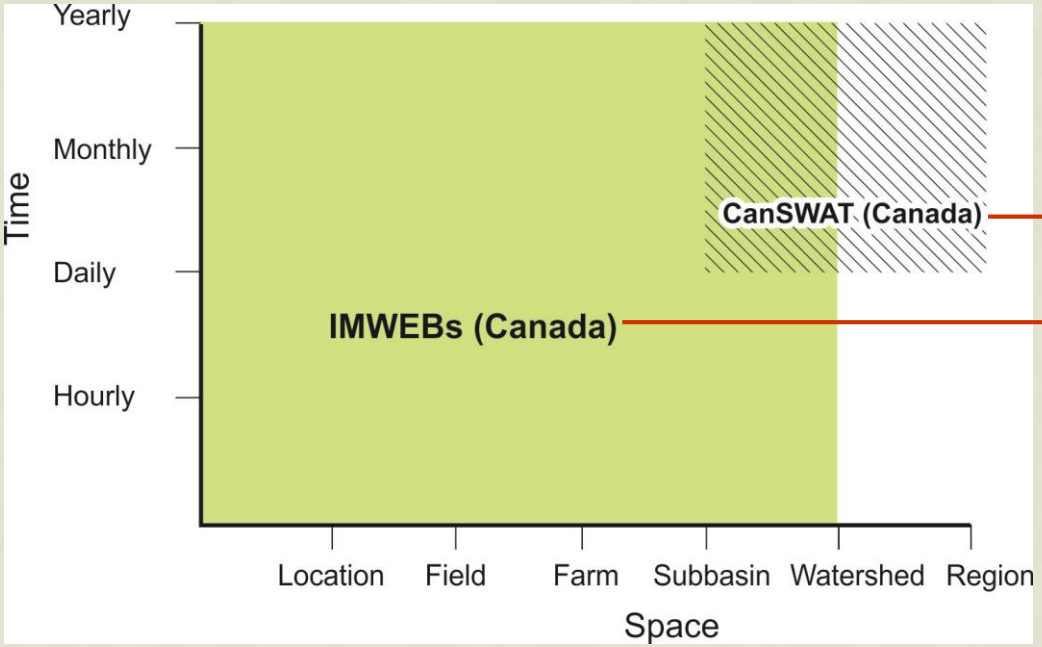
Cover Crop

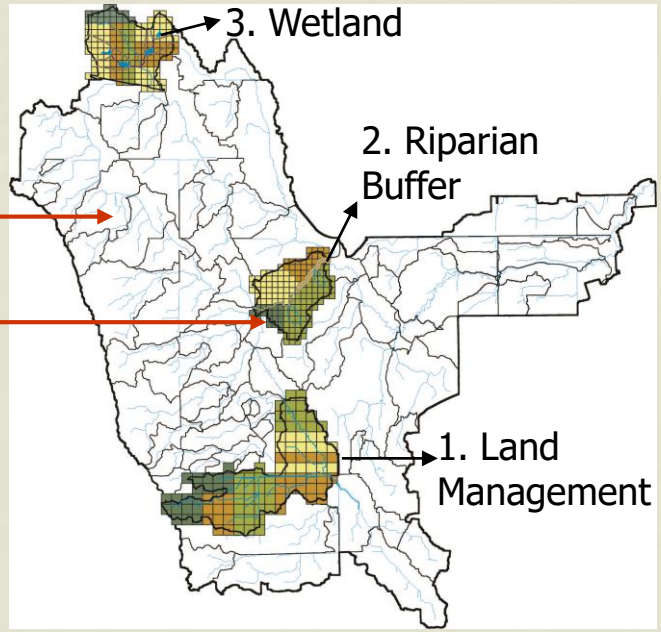
Nutrient Management

Water&Sediment Control Basin

http://www.mda.state.mn.us/protecting/conservation/practices/bufferforested.aspx

BMP Assessment in Space and Time

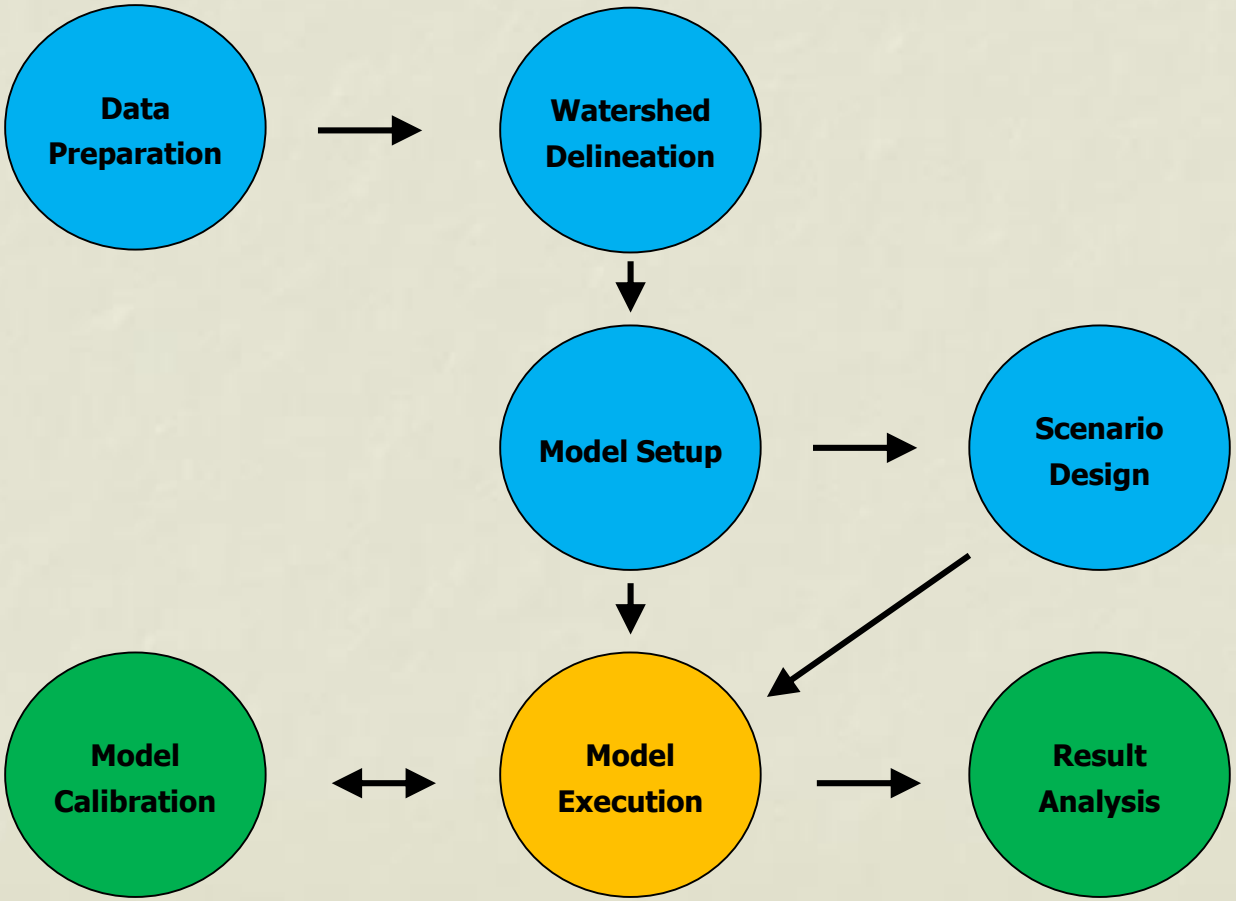




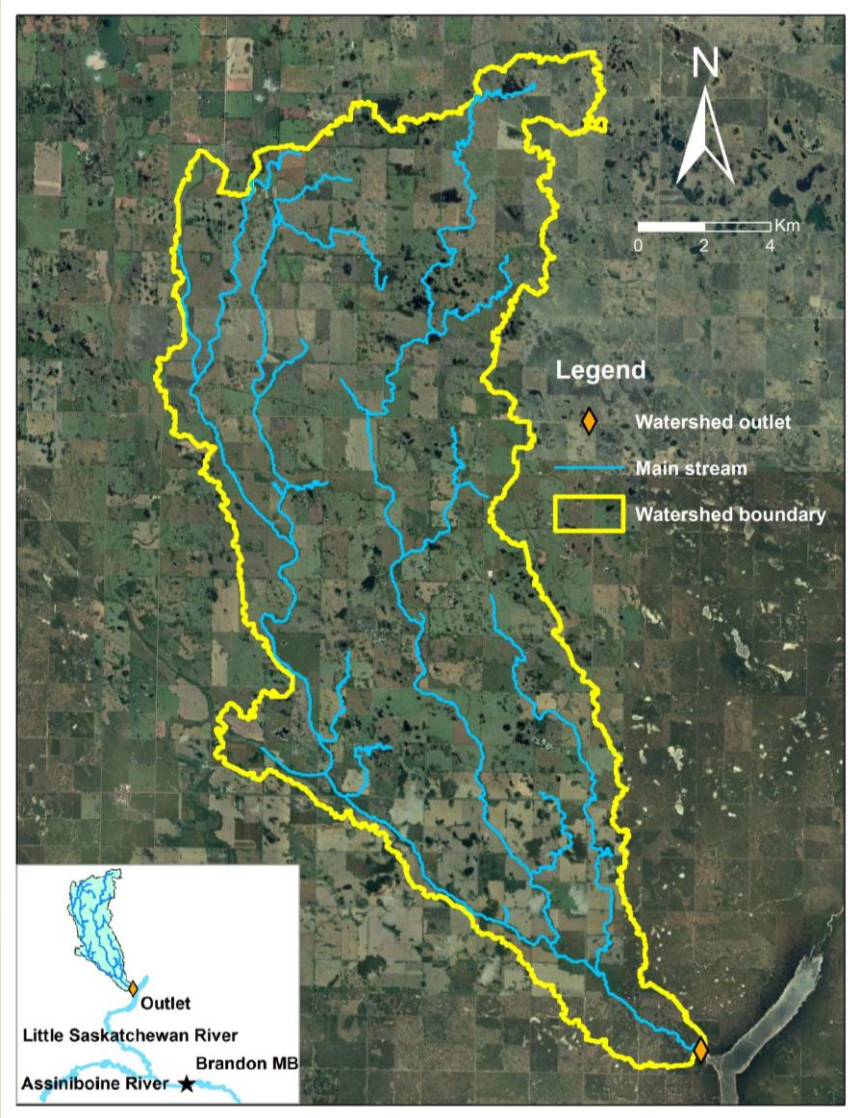
CanSWAT: Canadian Version of Soil and Water Assessment Tool – Adapted from U.S.

IMWEBs: Integrated Modelling for Watershed Evaluation of BMPs – Canada

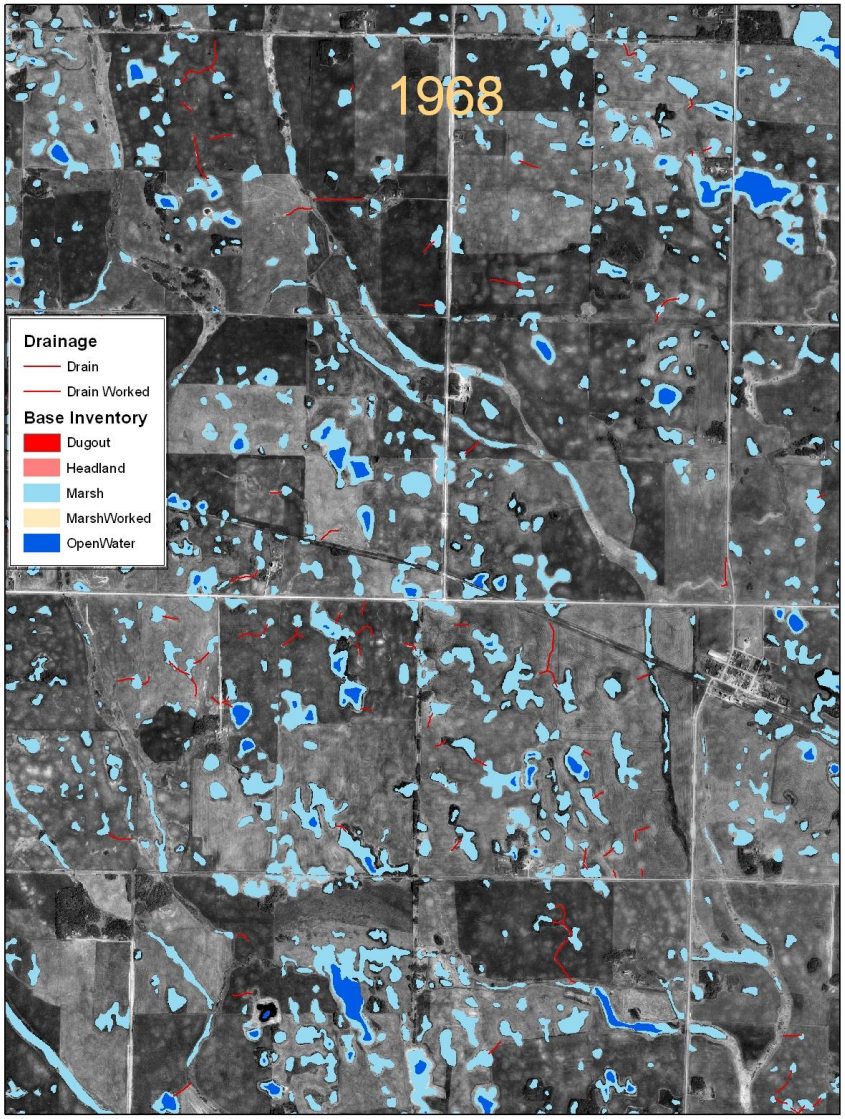
IMWEBs Model Workflow

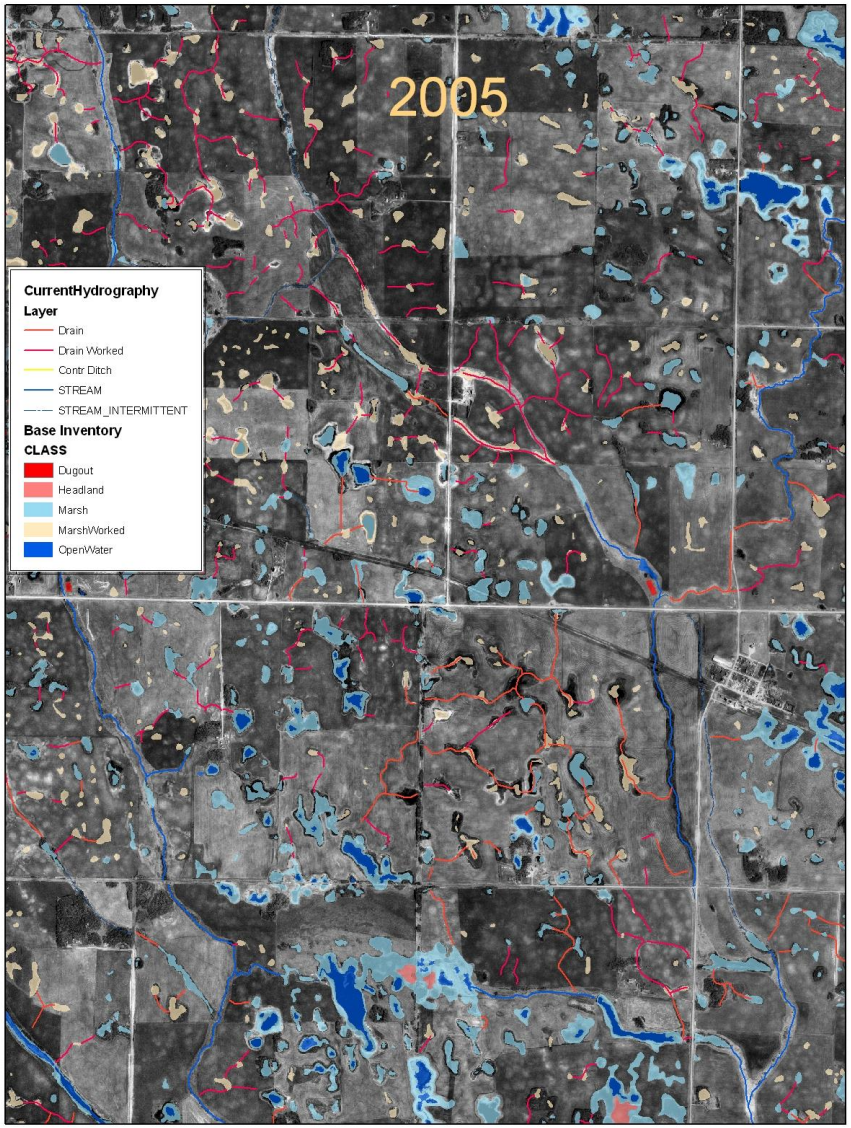


The Broughton's Creek Watershed



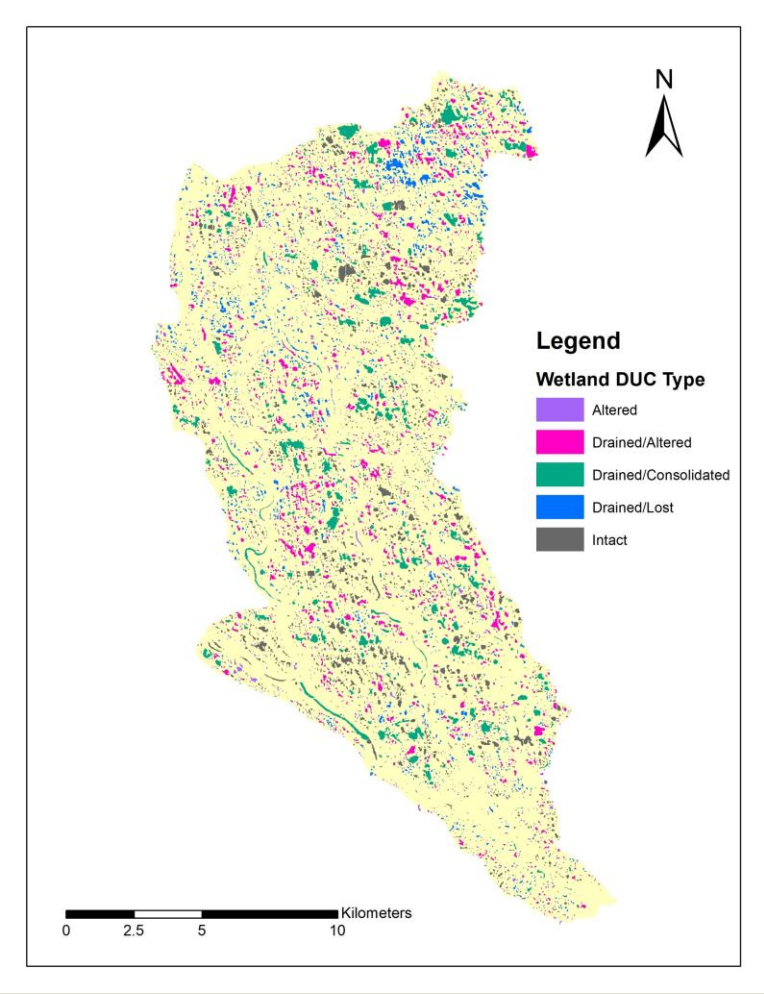
Wetland Drainage



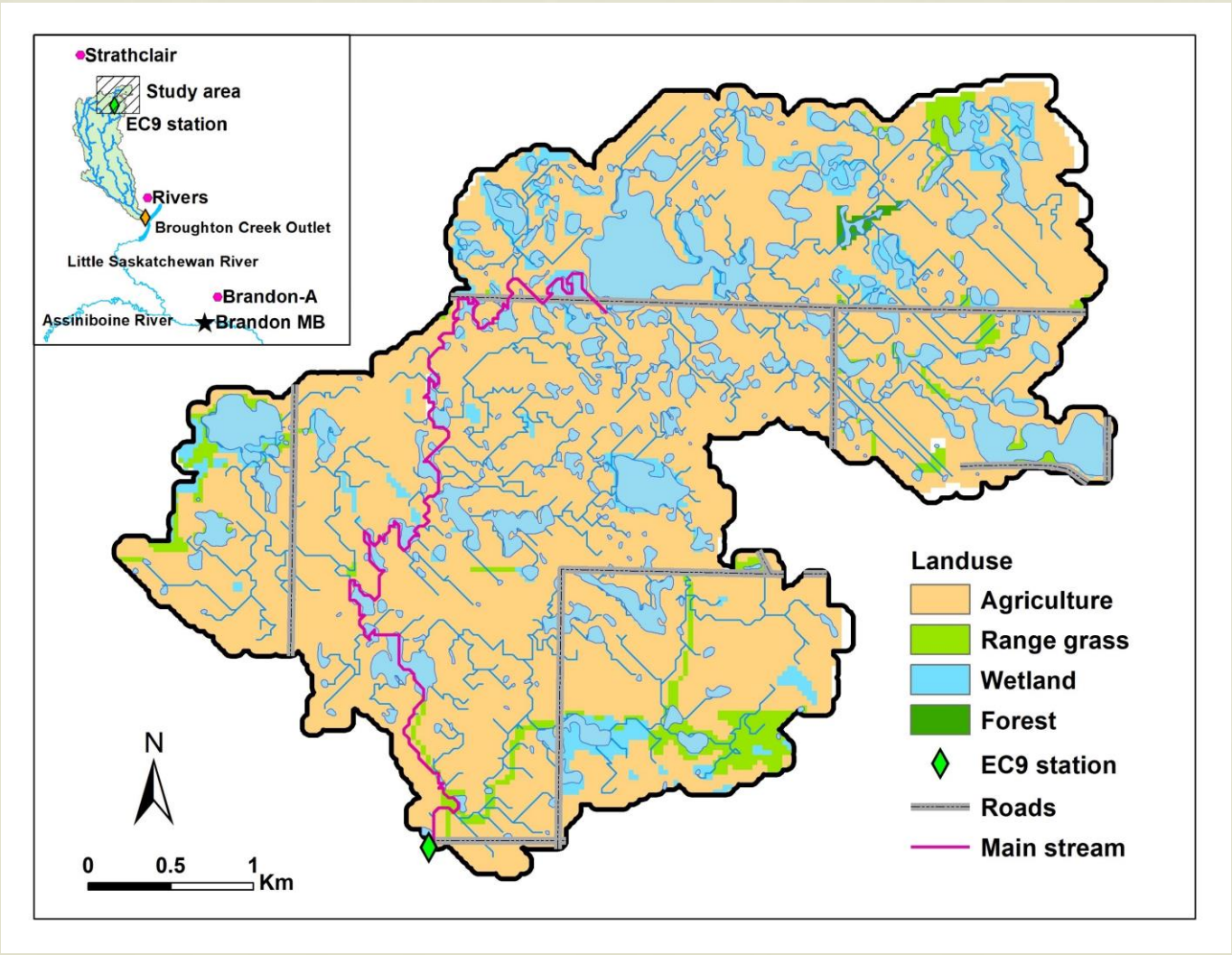


Wetlands in the Broughton's Creek Watershed

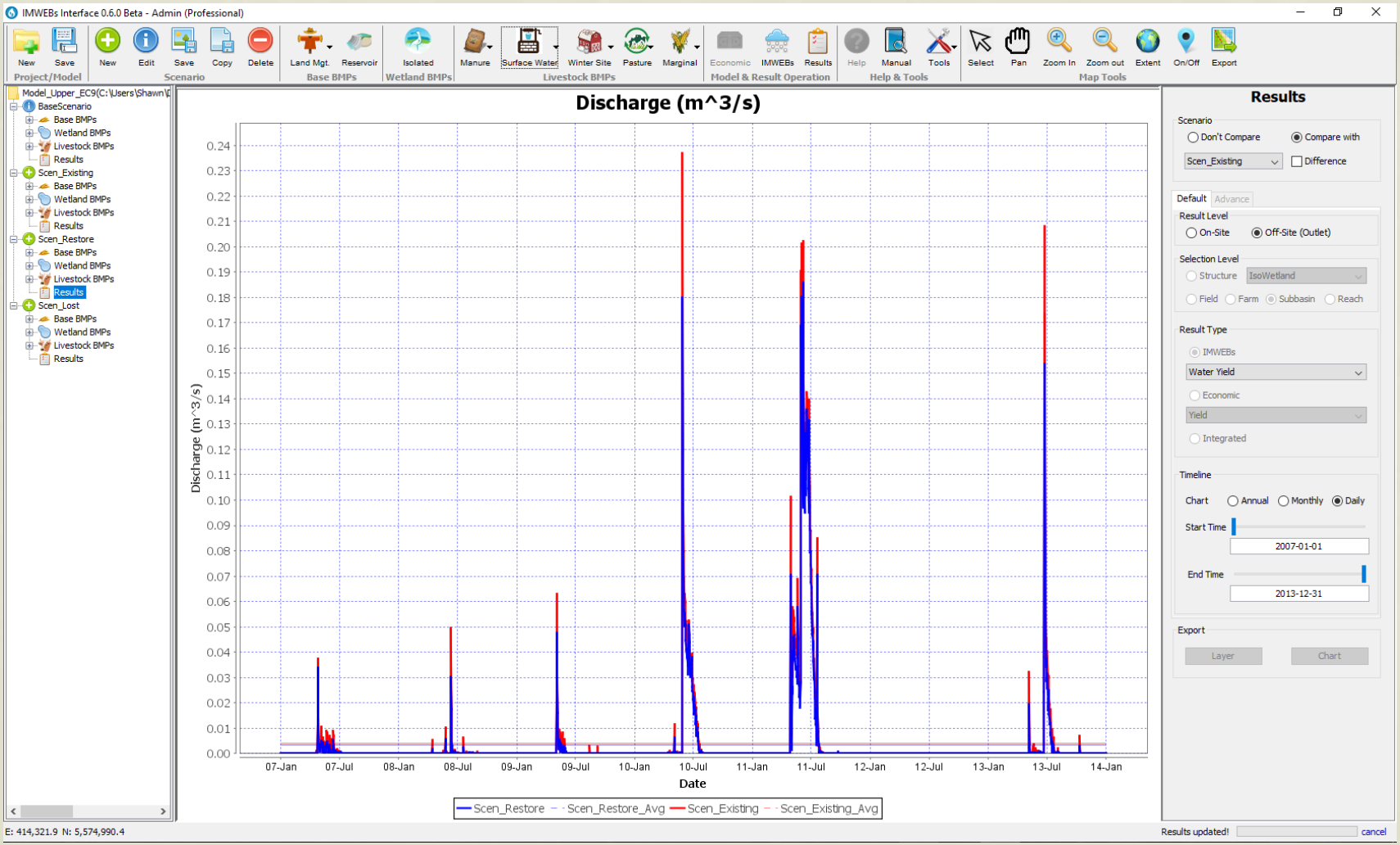
Type	Count	Area (ha)	Avg. area (ha)	% of wetland area	% of watershed area
Altered	2,656	370	0.139	9.24	1.48
Intact	2,238	974	0.435	24.33	3.91
Drained consolidated	308	960	3.12	23.98	3.85
Drained altered	1,297	1,059	0.816	26.46	4.25
Drained lost	1,968	640	0.325	15.99	2.57
Total	**8,467**	**4,003**	**0.473**	**100**	**16.06**



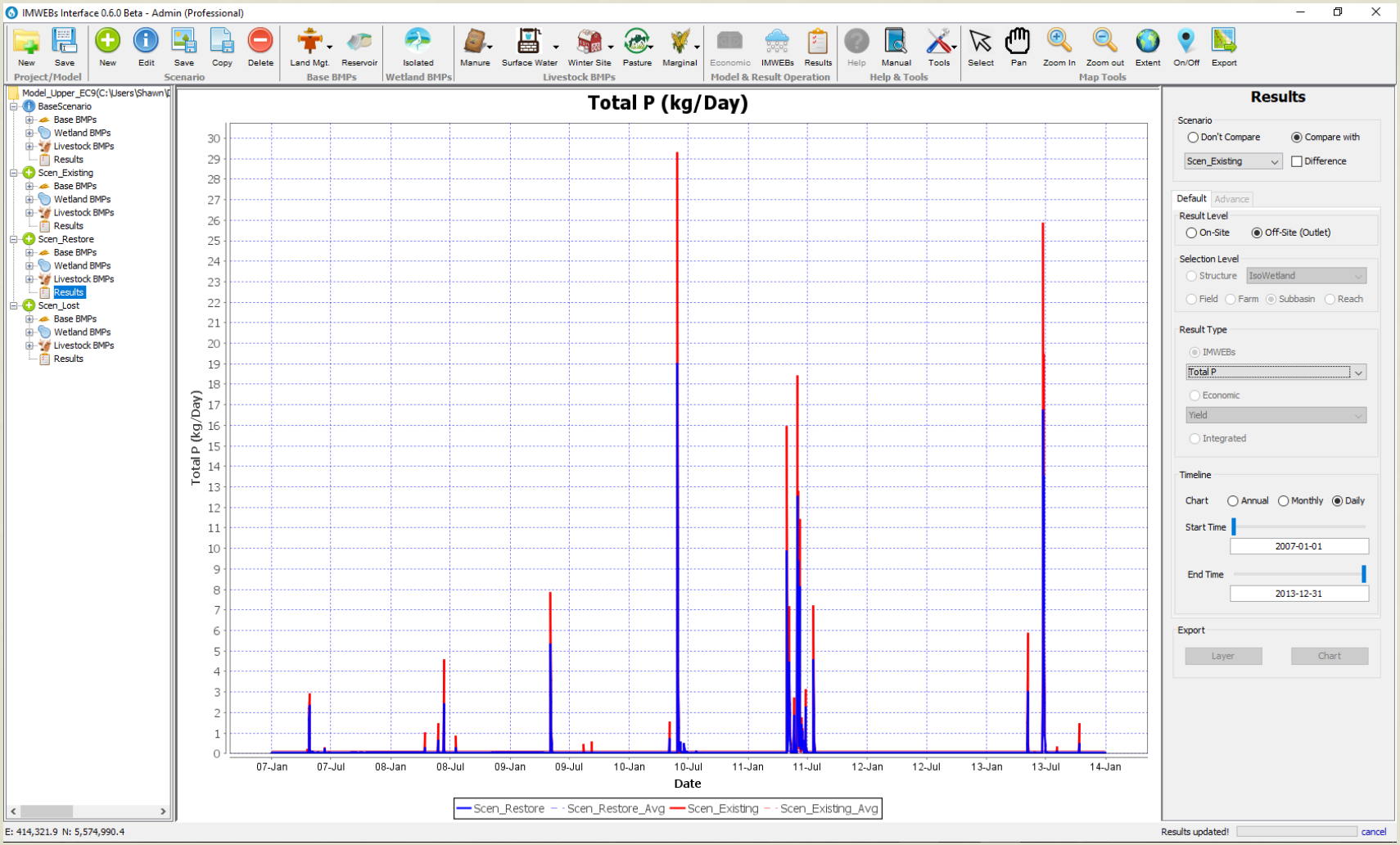
Zoom in – Upper EC-9 Station



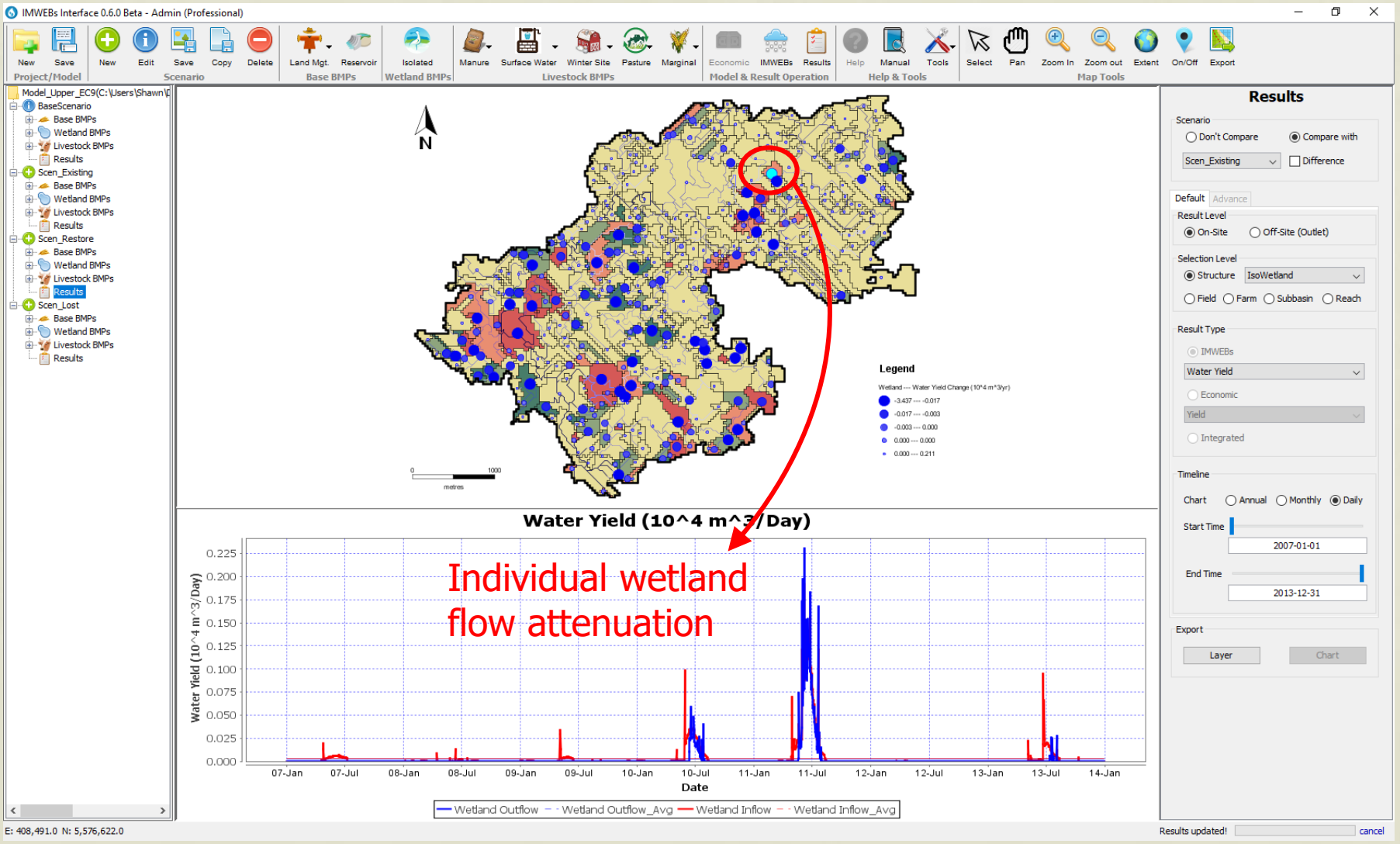
Flow Attenuation at EC9 Station for All Wetland Restoration



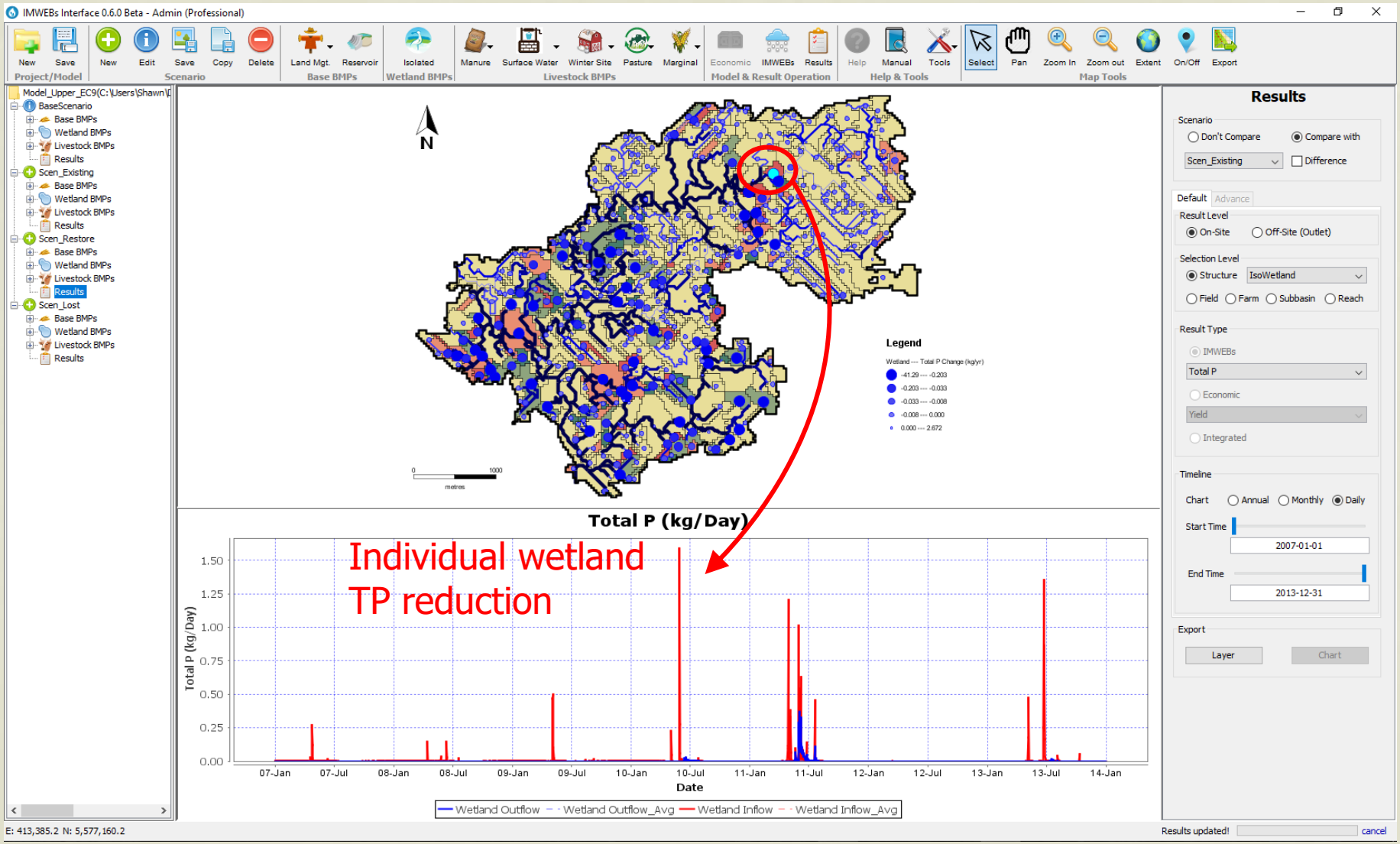
TP Reduction at EC9 Station for All Wetland Restoration



Flow Attenuation of Individual Wetlands



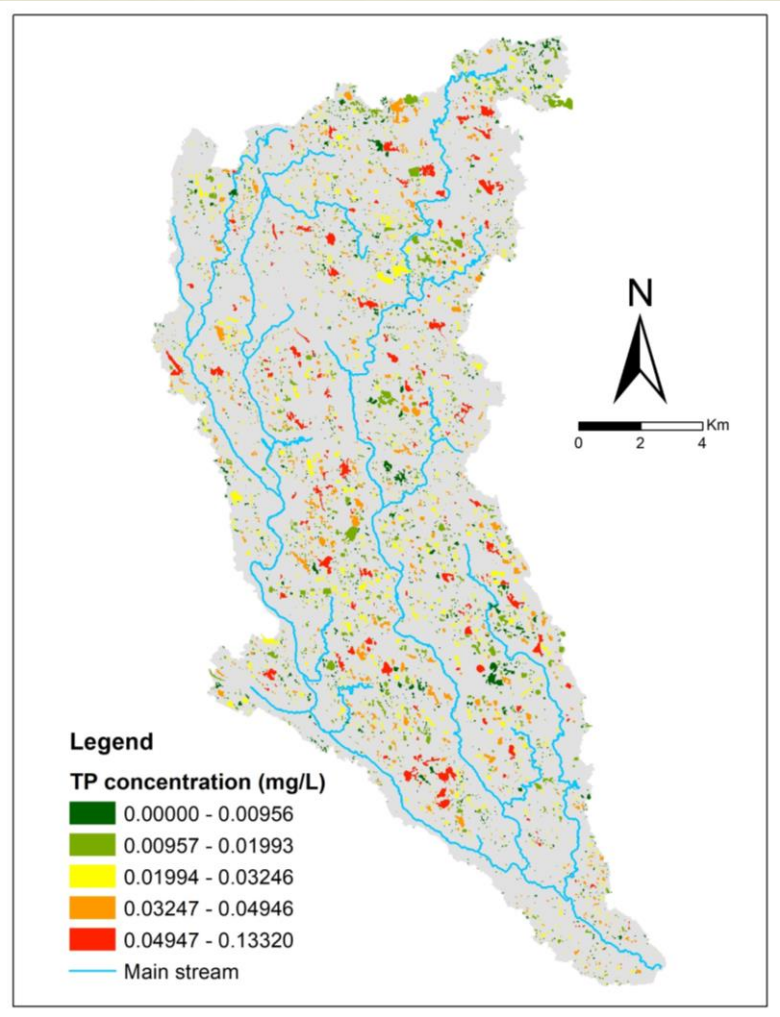
TP Reduction of Individual Wetlands



Wetland TP Analysis Based on Modelling Results

- Average isolated wetland TP concentration from 2008 to 2013 is 0.019 mg/L with standard deviation of 0.014 mg/L

- Existing wetlands have reduced 4,975 kg/yr of on-site TP loading or 3,447 kg/yr of TP at the watershed outlet



Wetland Ranking Based on TP Reduction Efficiency

TP reduction efficiency
(kg ΔTP per ha per year)

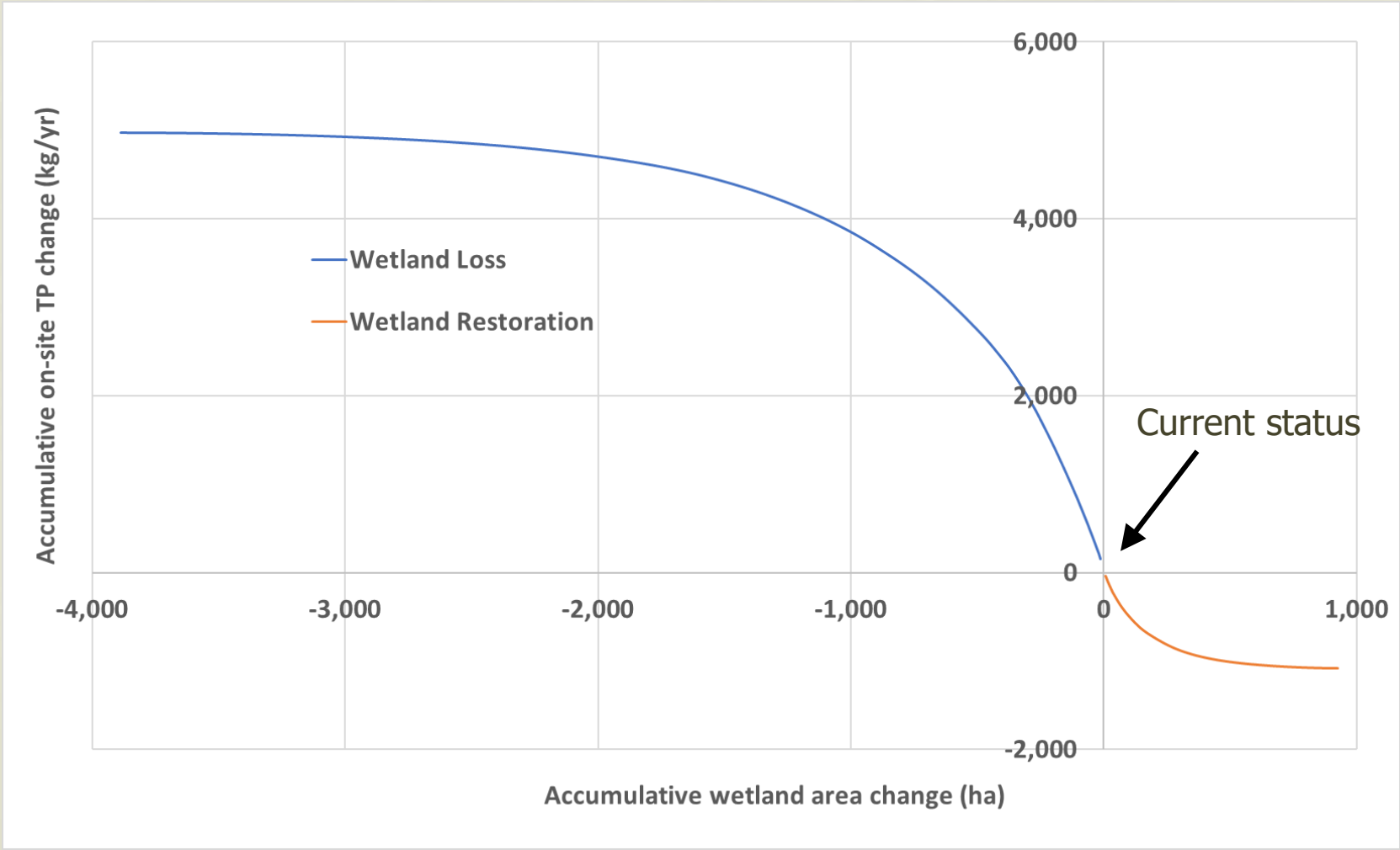
=

Annual wetland TP reduction (kg/yr)

/

Wetland area (ha)

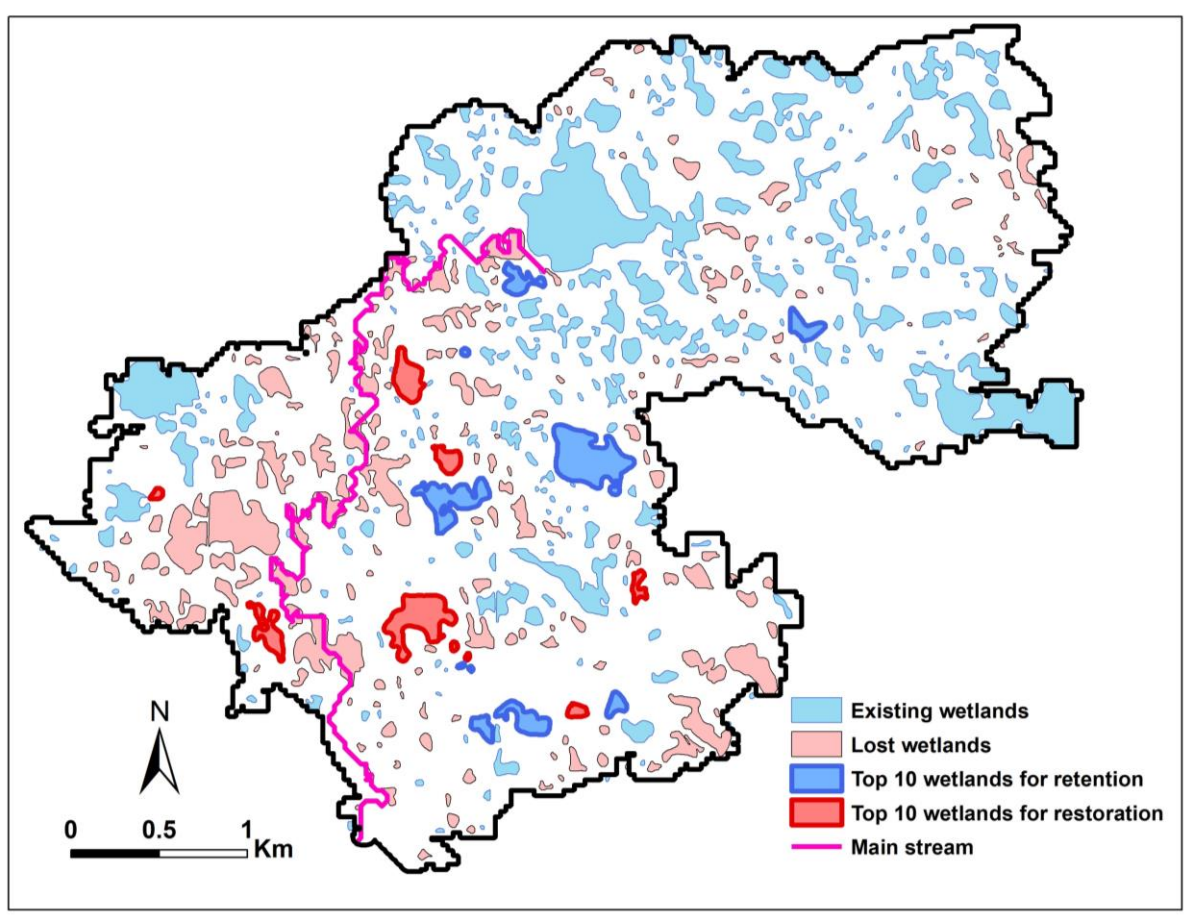
On-site TP Change in Response to Wetland Loss/Restoration



Spatial Targeting of Wetland Retention and Restoration

- Retention: Identify the top 10 wetlands with the highest TP increase if lost
- Restoration: Identify the top 10 wetlands with the highest TP reduction efficiency if restored

Top 10 Wetlands for Retention and Top 10 Wetlands for Restoration



- All 249 existing wetlands – Average TP reduction 1.1 kg/ha/yr
- Top 10 wetlands for retention – Average TP reduction 6.7 kg/ha/yr
- Top 10 wetlands for restoration – Average TP reduction 7.9 kg/ha/yr

Wetland Loss and Restoration Scenarios (Subbasin with Outlet at EC9 Station)

Wetland loss and restoration scenarios for the EC9 subbasin in the BRC watershed

Scenario	Wetland number	Wetland surface area (ha)	Storage ($10^4 m^3$)	Flow (mm/yr)	Sediment (t/yr)	TN (t/yr)	TP (t/yr)
Existing	249	266	94.8	275	9.4	5,806	1,268
Loss all	0	0	0	326	10.5	6,504	1,562
Restore all	456	515	192	258	4.07	4,424	1,101
Loss 10	239	233	81.0	279	9.57	6,017	1,312
Restore 10	259	298	108	271	6.31	4,555	1,187

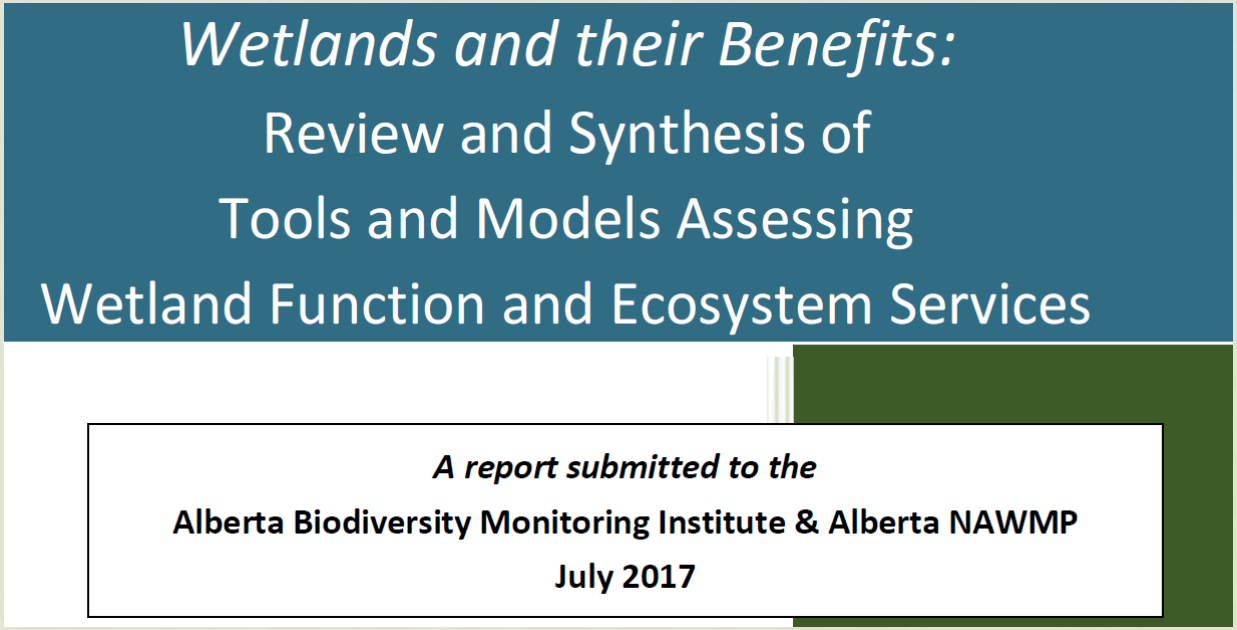
Evaluation results of wetland loss and restoration scenarios for the EC9 subbasin

Scenario	Flow		Sediment		TN		TP	
	(mm/yr)	(%)	(t/yr)	(%)	(kg/yr)	(%)	(kg/yr)	(%)
Loss all	51	18.5	1.13	12.0	697	12.0	294	23.2
Restore all	-17	-6.10	-5.33	-56.9	-1382	-23.8	-168	-13.2
Loss 10	4	1.35	0.17	1.86	211	3.63	44	3.44
Restore 10	-4	-1.51	-2.25	-23.9	-814	-14.0	-93	-7.33

Conclusions

- The cell-based IMWEBs model was developed and applied to a representative watershed to evaluate the water quantity and quality effects of wetland loss and restoration
- The IMWEBs is a unique watershed model that is capable of evaluating agricultural BMPs including wetlands at site, field, farm, and watershed scales
- The IMWEBs model can be further developed to support decision making in landscape conservation programs

Recognition of the IMWEBs Model



Although many tools and models were reviewed that have the potential to evaluate water purification as a wetland ecosystem service, limited options were available, with the model that has the most potential (i.e., IMWEBs) currently in development. With respect to climate regulation, there were limited options

http://ecosystemservices.abmi.ca/resources/publications/

IMWEBs Supported BMP List

General BMPs

- Crop management
- Tillage management
- Fertilizer management
- Grazing management
- Irrigation management
- Reservoir

Wetland restore BMPs

- Isolated wetland restoration

Livestock BMPs

Manure and nutrient management

- Manure incorporation
- Manure setback
- No application on snow
- Fall application
- Apply base on soil N level
- Apply base on soil P level
- Feedlot management
- Manure storage design
- Catch basin management
- Dugout

IMWEBs Supported BMP List

Livestock BMPs

Riparian and surface water management

- Manage access including fencing
- Vegetated filter strip
- Riparian buffer strip
- Grassed waterway

Wintering site management

- Changing location and area of wintering site
- Alternating wintering site annually
- Vegetation adjacent to wintering site

Pasture management

- Rotational grazing
- Timing and density of stocking
- Plant species in tame pasture
- Conservation and sustainable use of natural areas

Marginal crop land management

- Conservation to tame perennials
- Conservation to native perennials

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