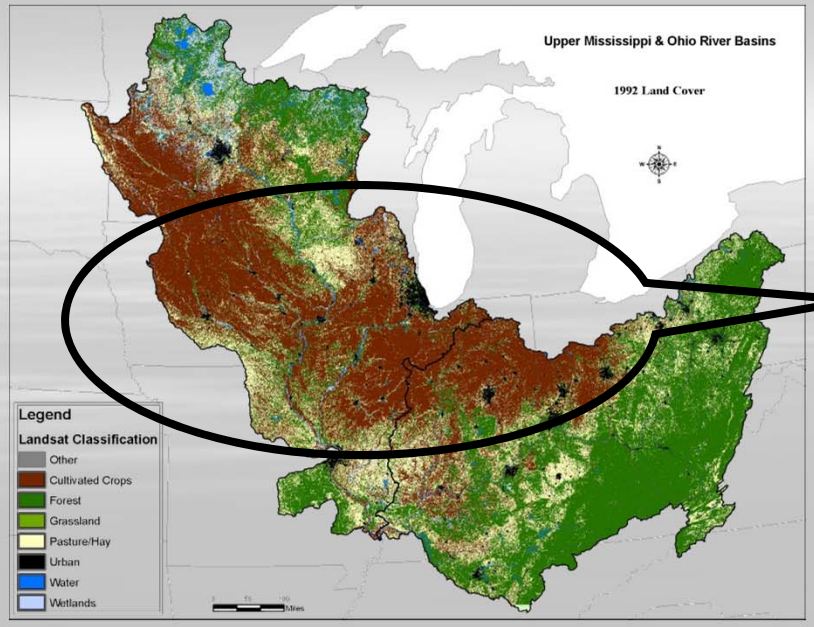
Water Quality Performance of Wetlands Receiving NPS Loads:

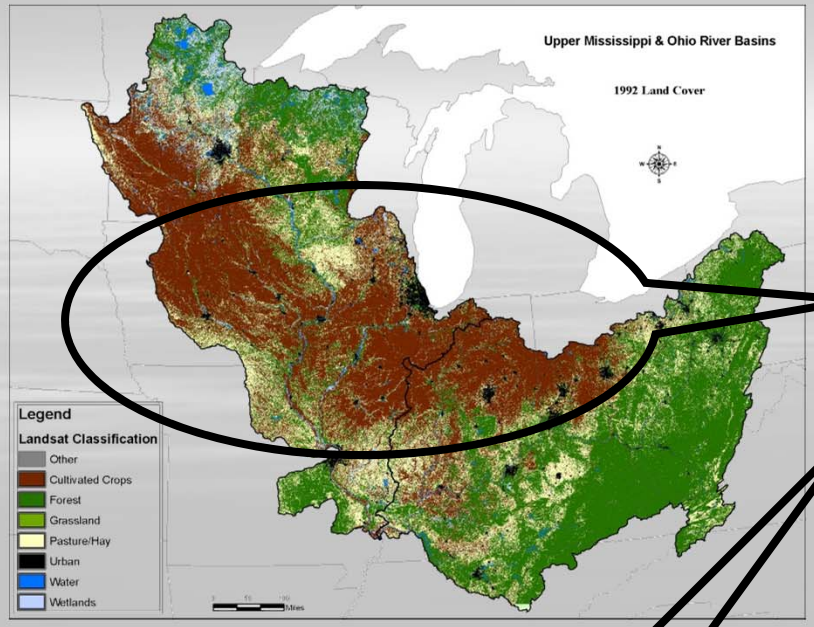
Case Studies of N Removal Efficiency and Load Reductions of Wetlands in the Western Corn Belt

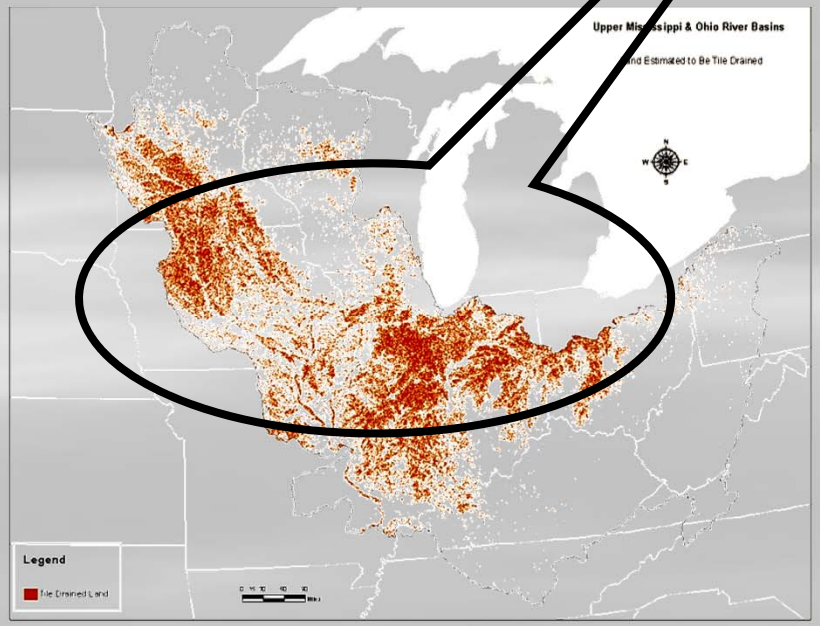
William G. Crumpton, Iowa State University
Department of Ecology, Evolution, and Organismal Biology



Upper Mississippi Basin is characterized by:

- extensive cultivated cropland





Upper Mississippi Basin is characterized by:

- extensive cultivated cropland
- extensive agricultural drainage

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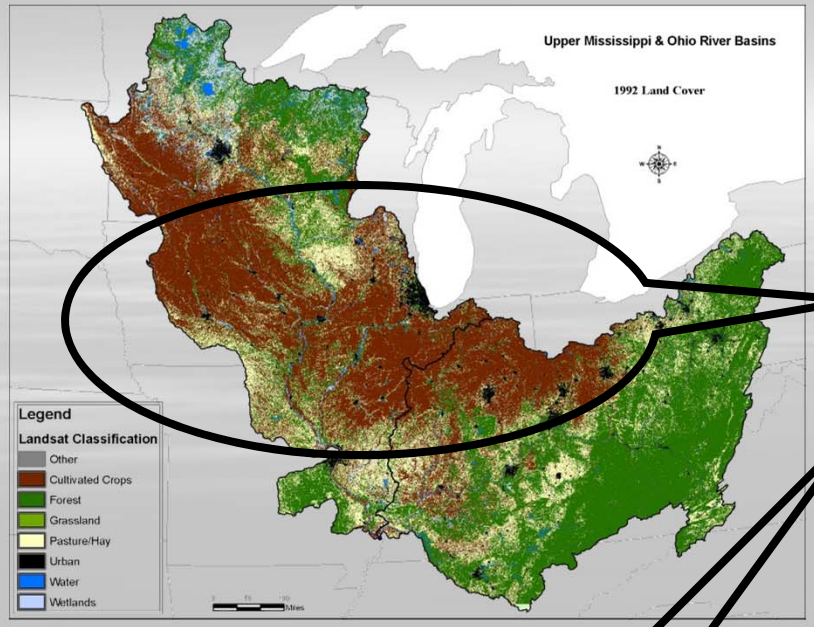
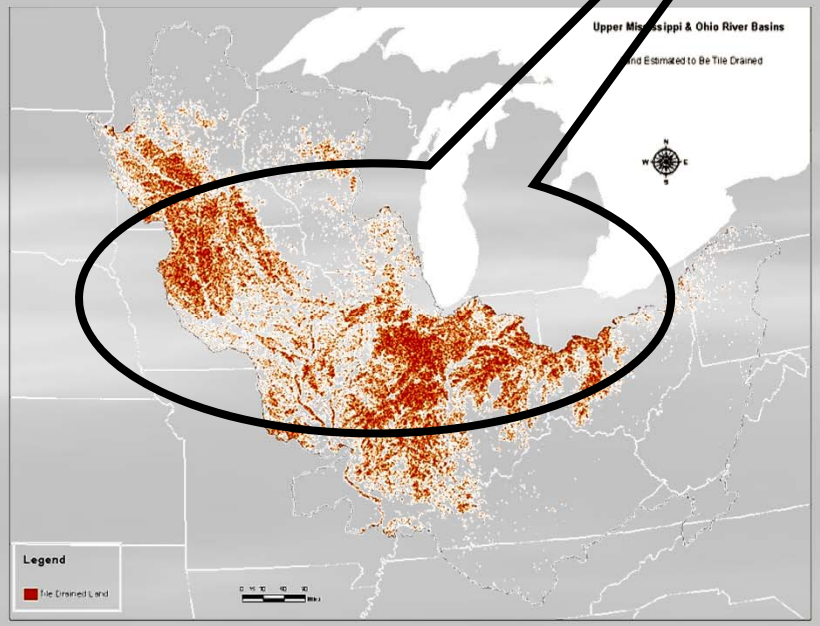
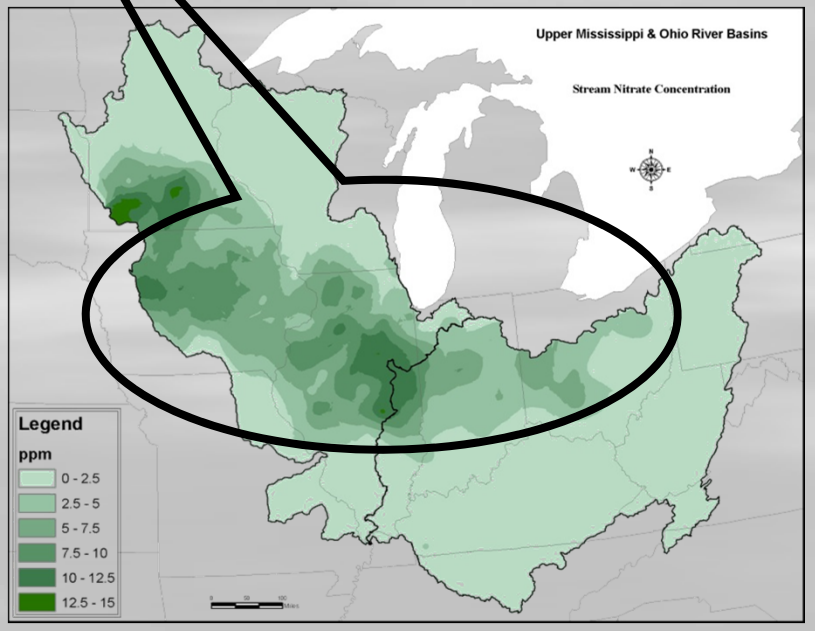
Upper Mississippi Basin is characterized by:

- extensive cultivated cropland
- extensive agricultural drainage
- elevated nitrate concentrations in surface waters







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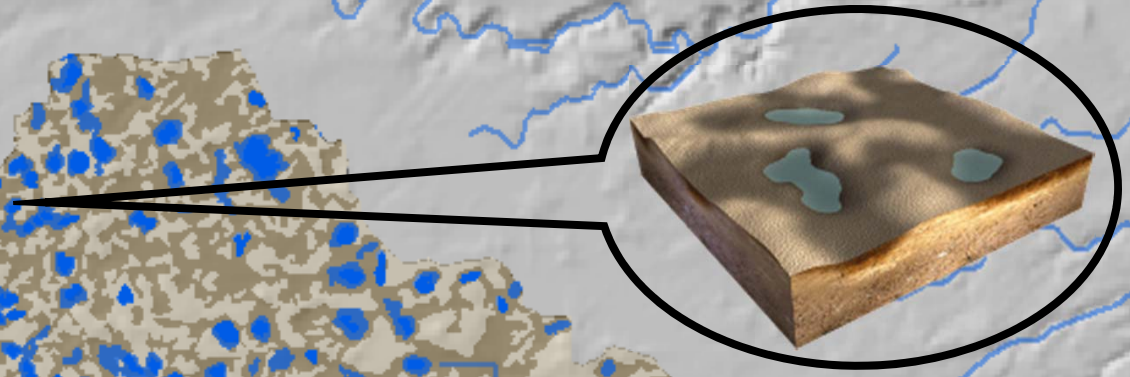
These landscapes were once characterized by extensive wetland systems



Legend

Soils by Landscape Position

- Upland Non-hydric
- Upland Depression
- Upland Swale
- Lowland Drainageway

0 0.5 1 Miles

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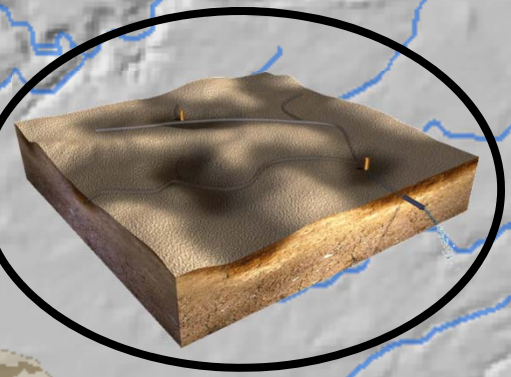
Today these landscapes are characterized by extensive subsurface tile drainage



Legend

Soils by Landscape Position

- Upland Non-hydric
- Upland Depression
- Upland Swale
- Lowland Drainageway
- Tile

0 0.5 1 Miles

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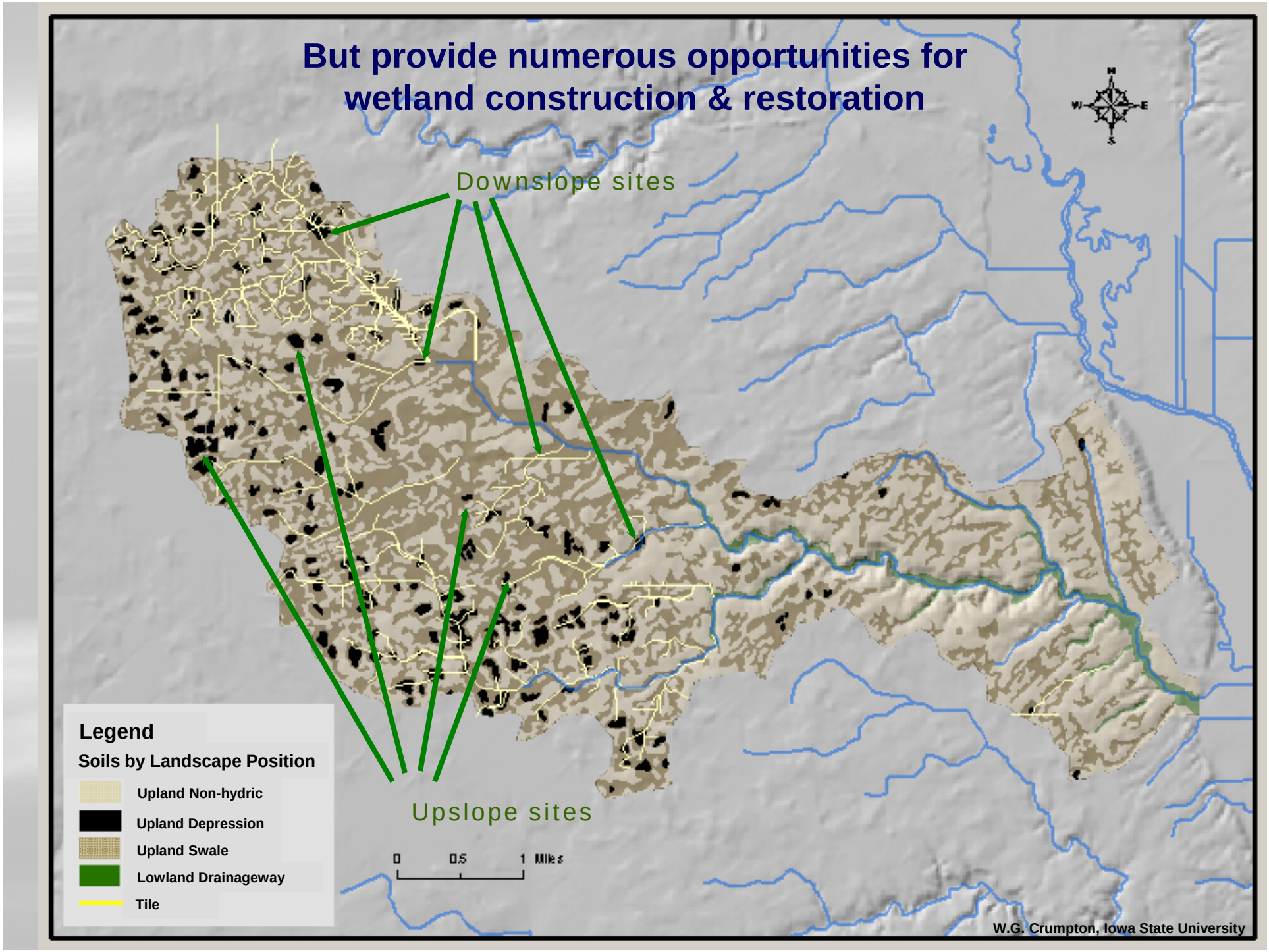
But provide numerous opportunities for wetland construction & restoration
Downslope sites
Upslope sites
Legend
Soils by Landscape Position
Upland Non-hydric
Upland Depression
Upland Swale
Lowland Drainageway
Tile
0
0.5
1 Miles
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Restoring Wetlands as N Sinks in Agricultural Watersheds

- N transformation and transport in agricultural landscapes
- N transformation in wetlands
- Mass balance analysis and modeling of wetland performance
- Watershed scale considerations

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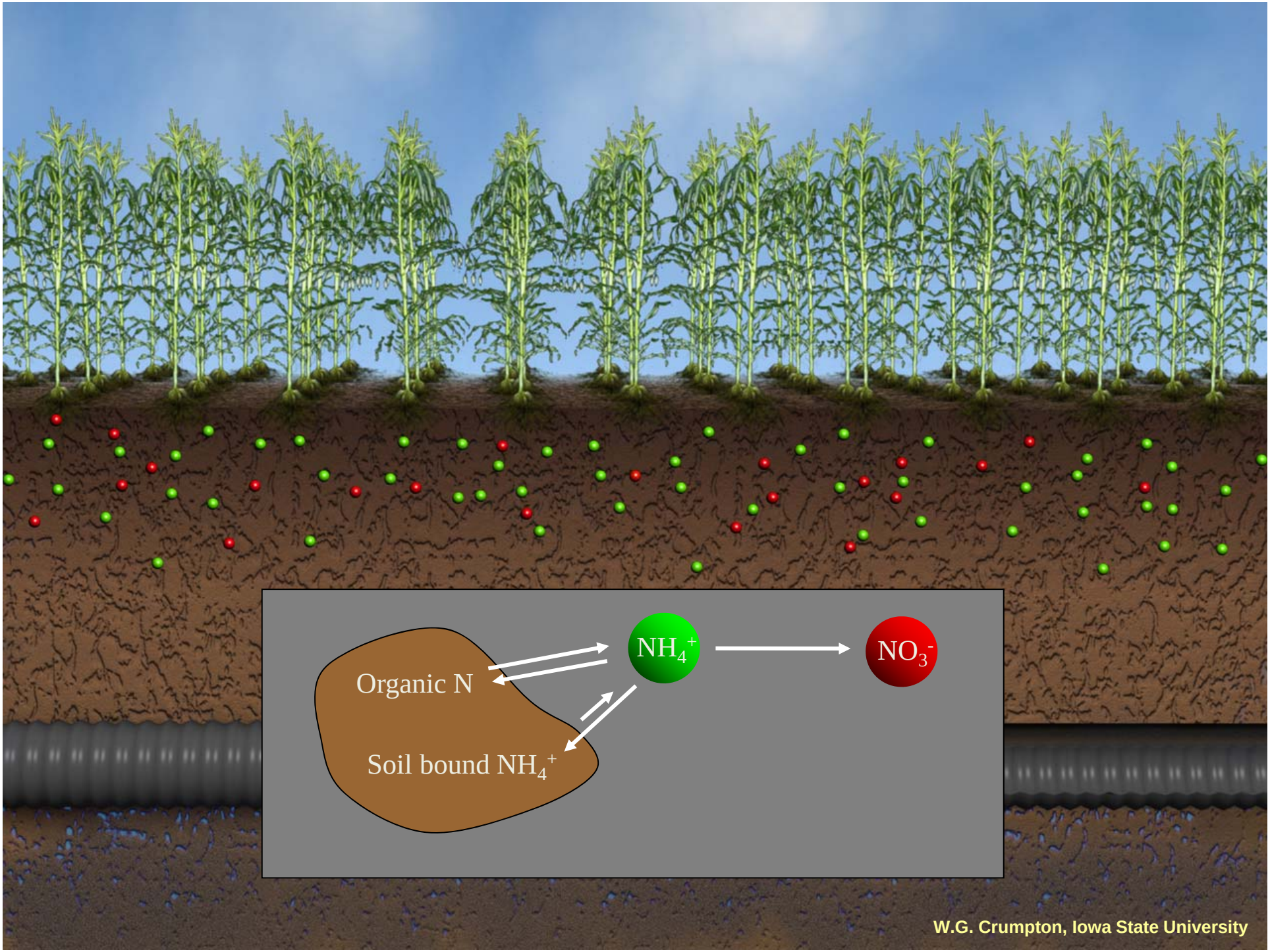
Organic N
NH_4^+
NO_3^-
Soil bound NH_4^+
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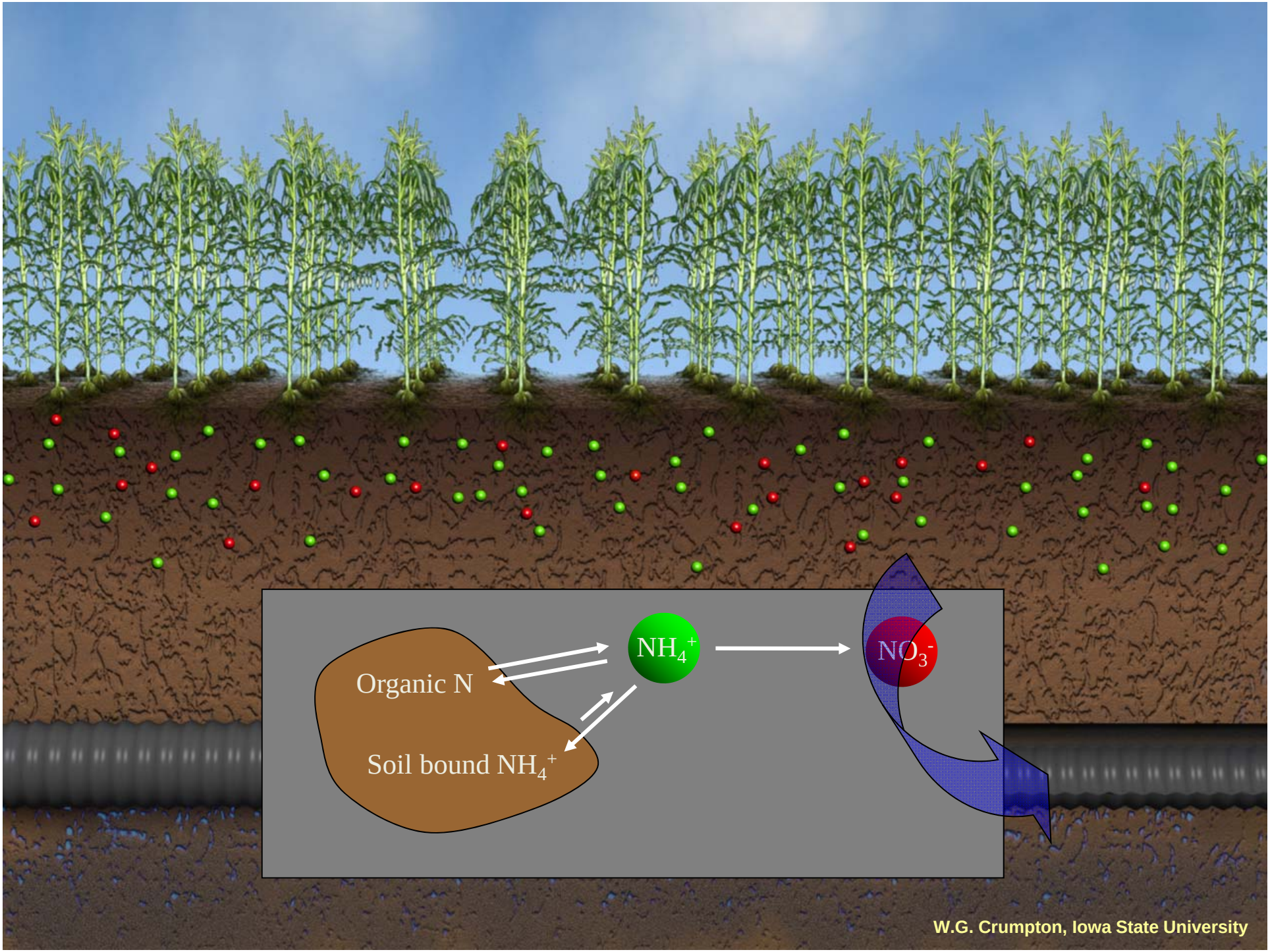
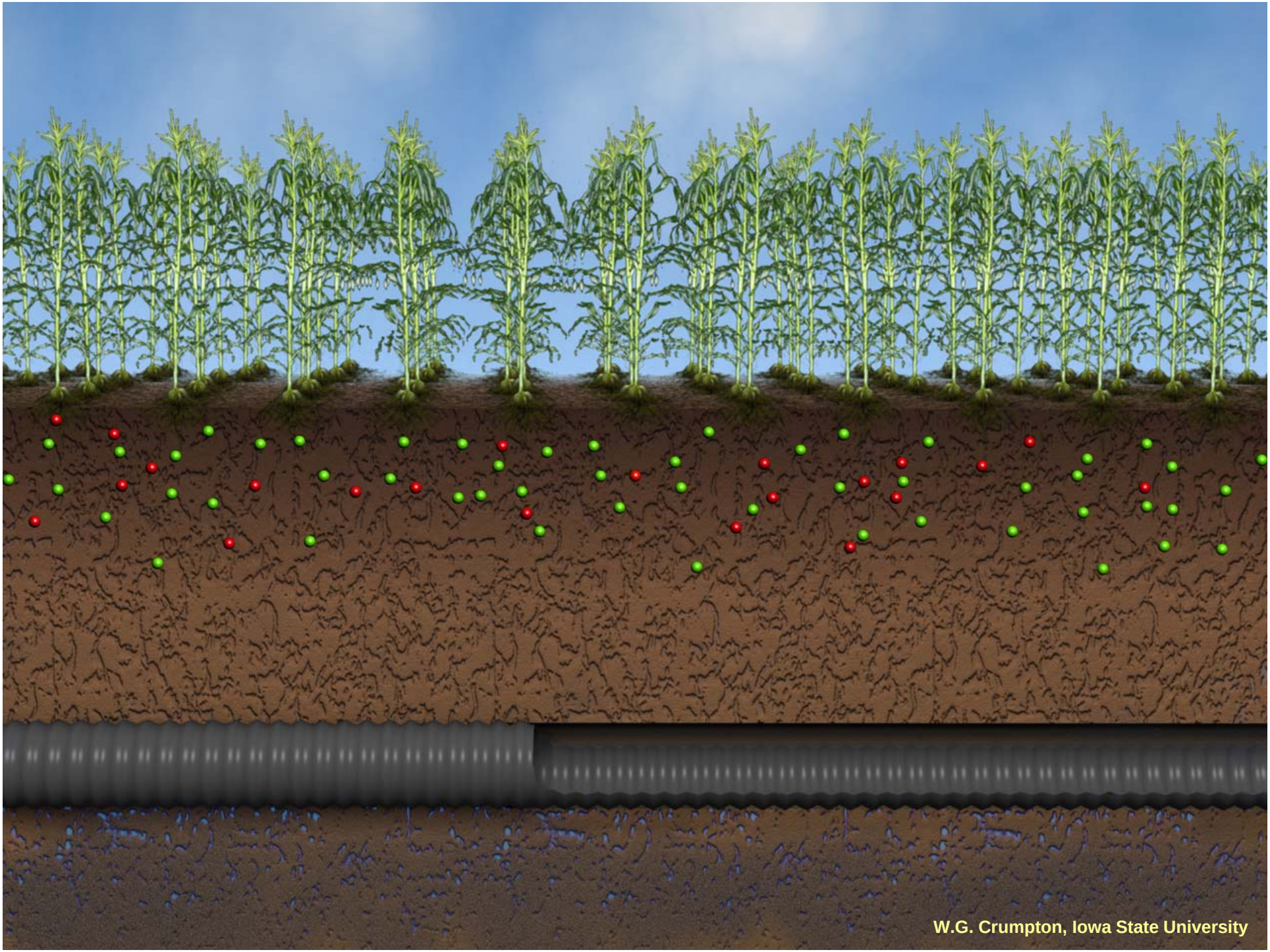

Organic N
Soil bound NH_4^+
NH_4^+
NO_3^-
W.G. Crumpton, Iowa State University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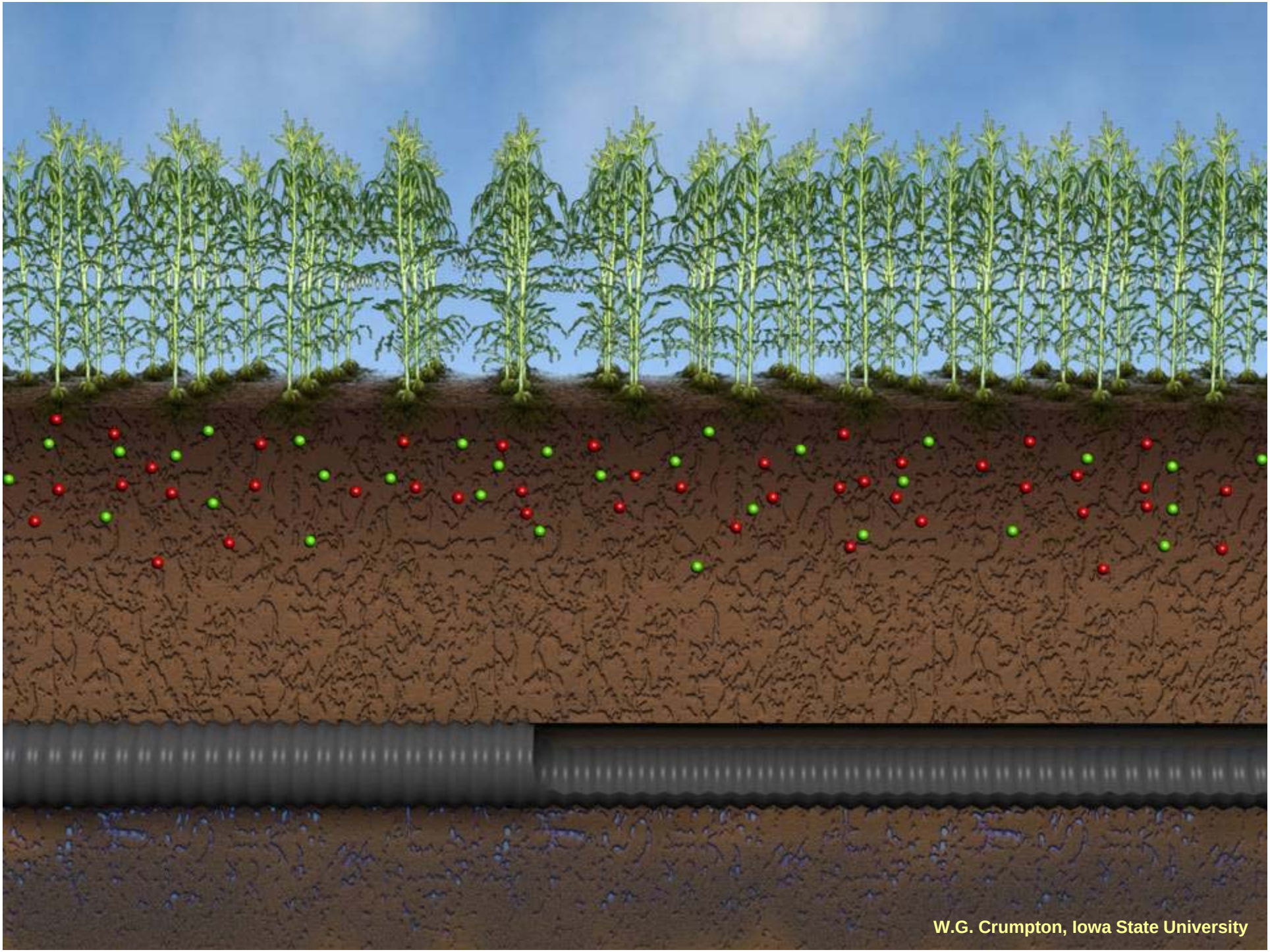
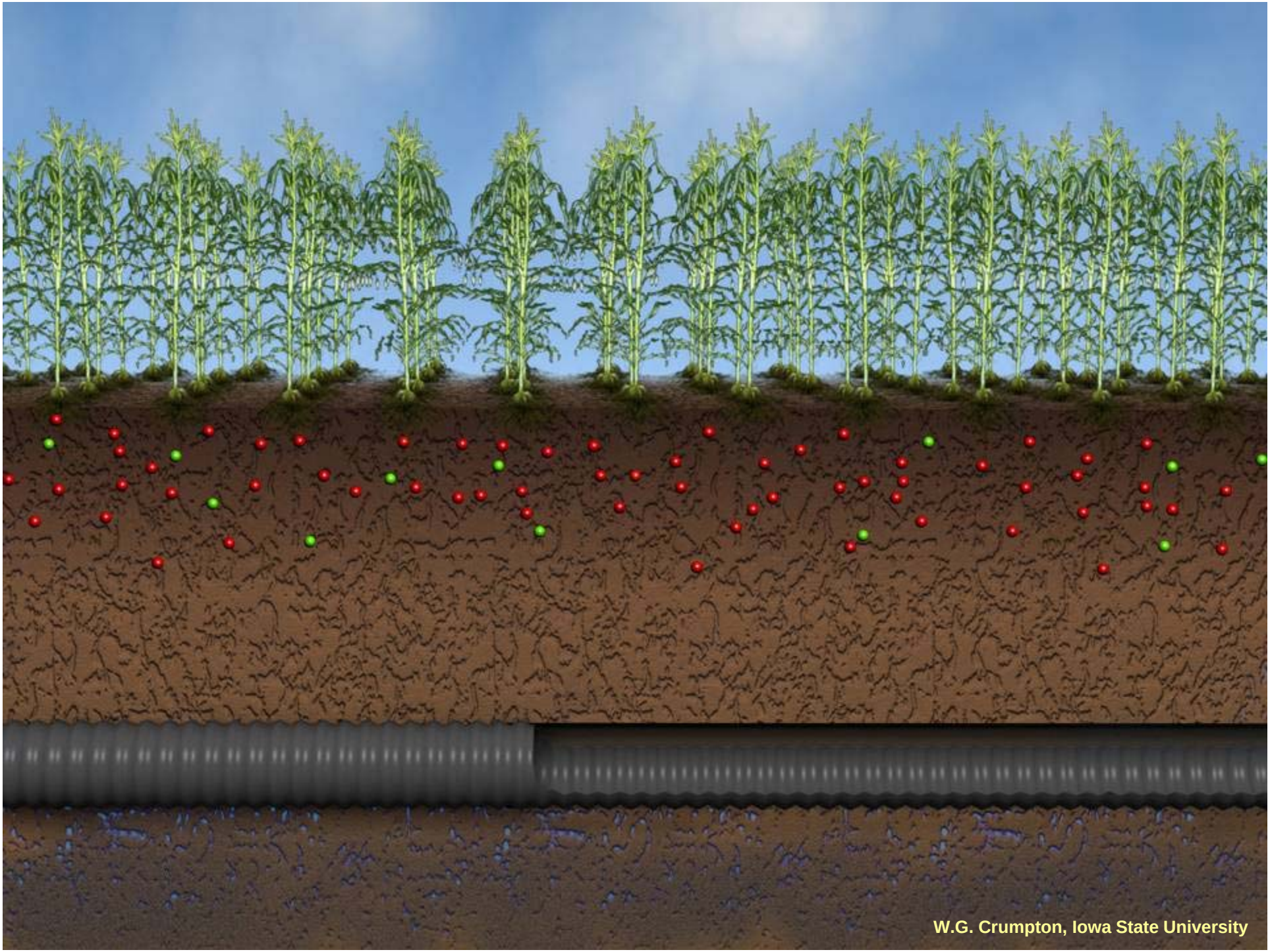
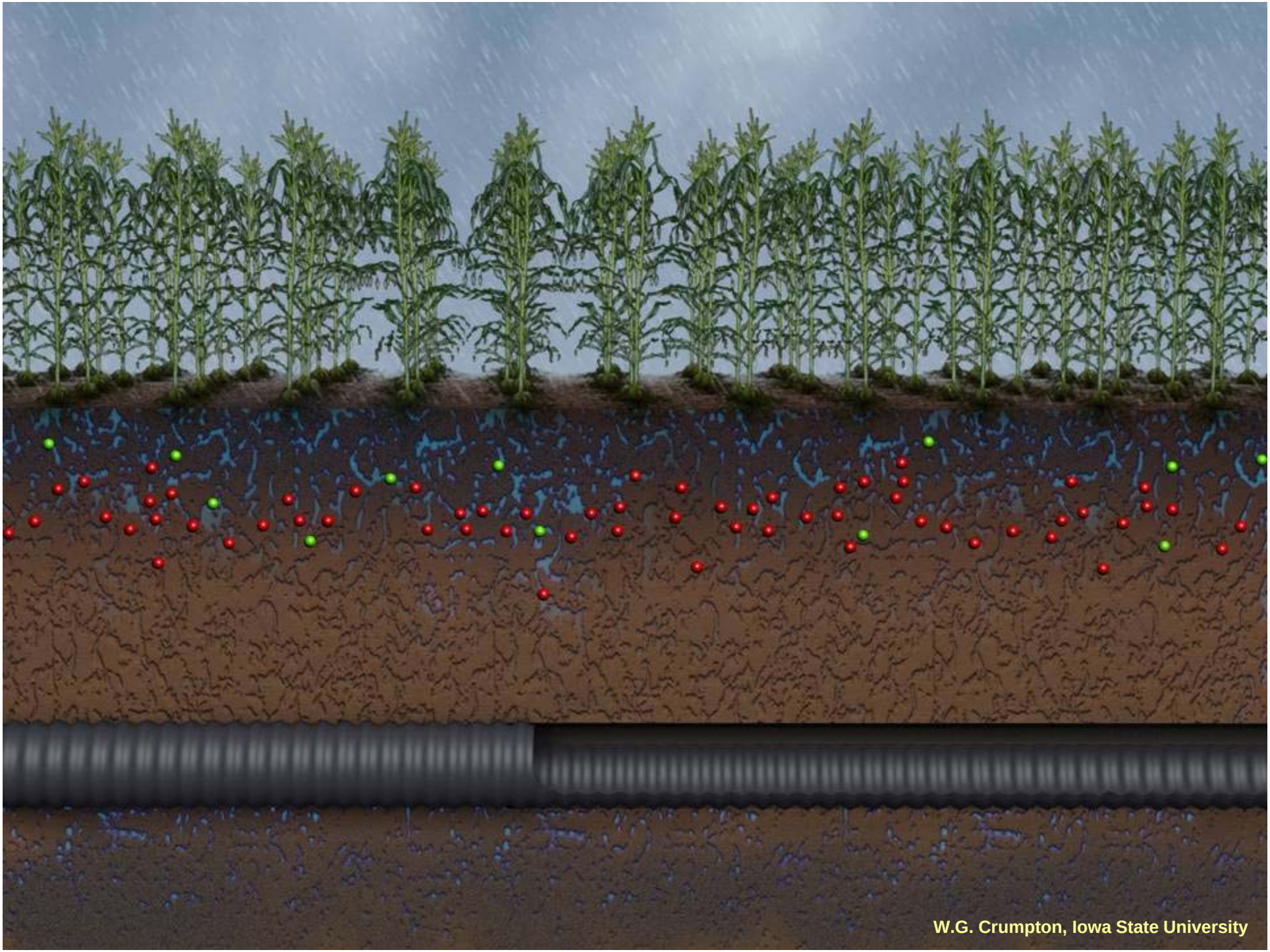

W.G. Crumpton, Iowa State University


W.G. Crumpton, Iowa State University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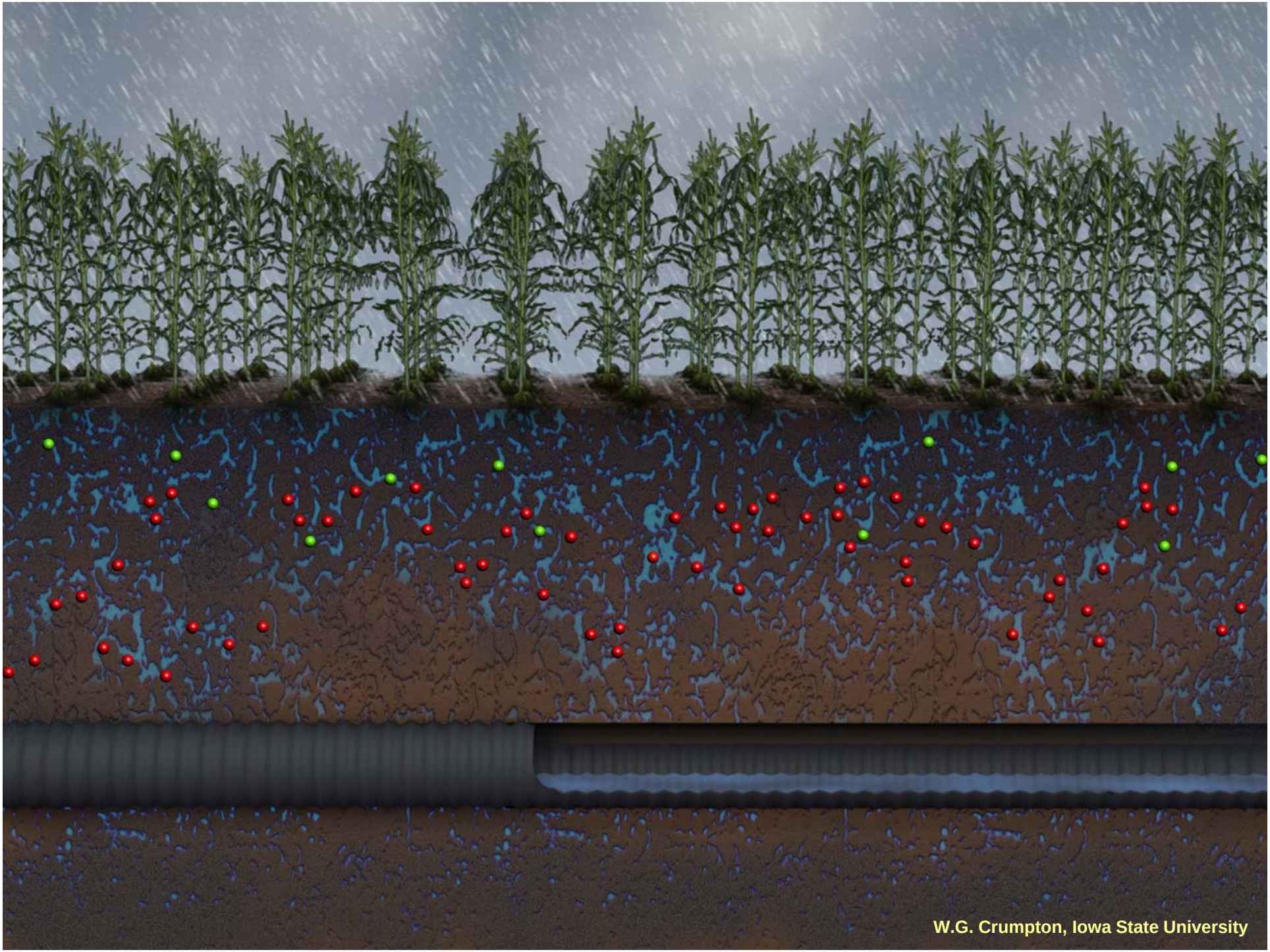
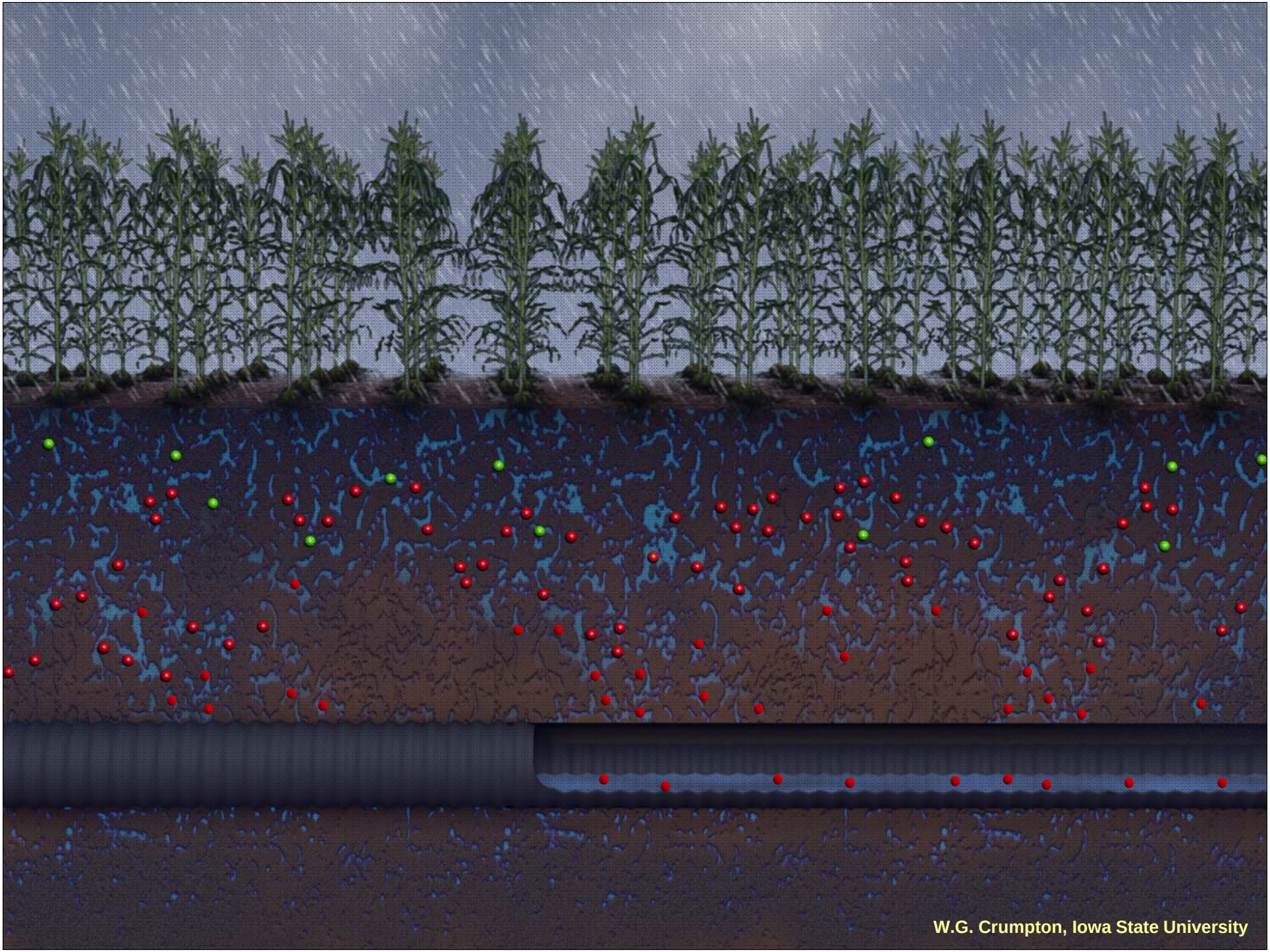

W.G. Crumpton, Iowa State University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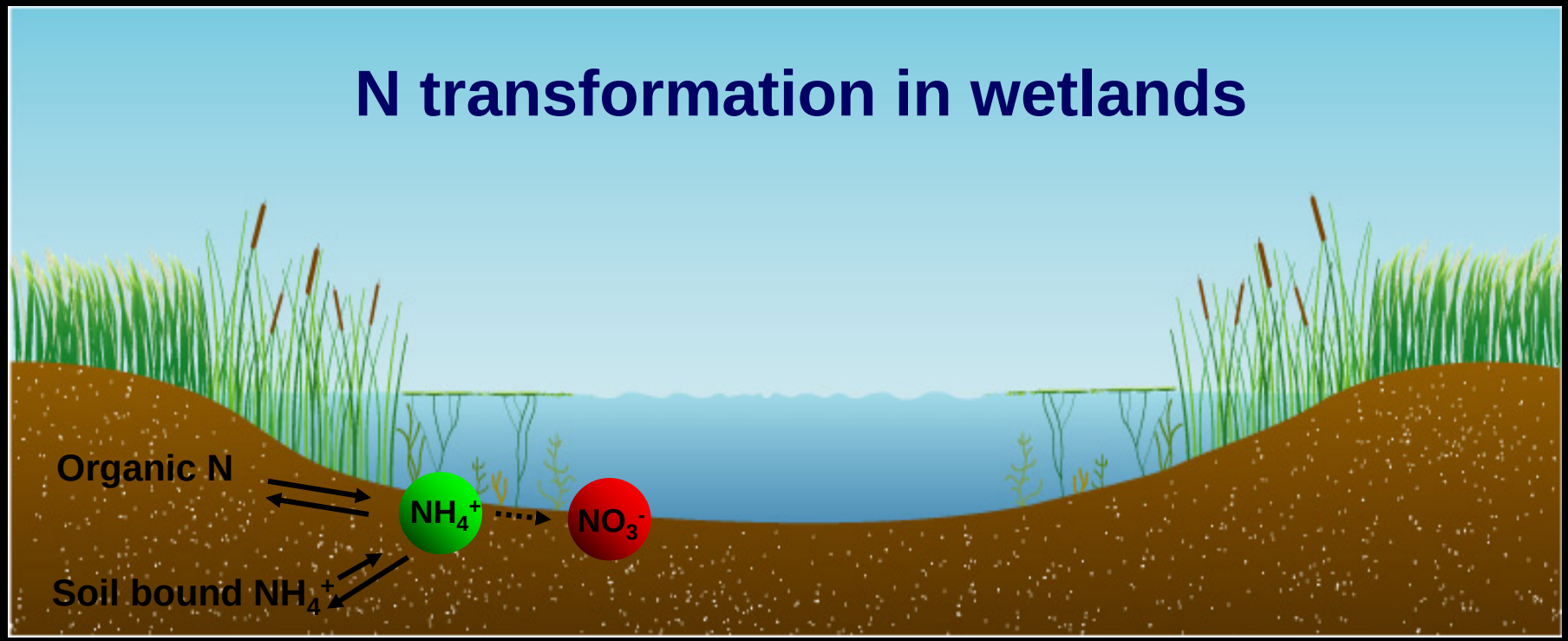
N transformation in wetlands



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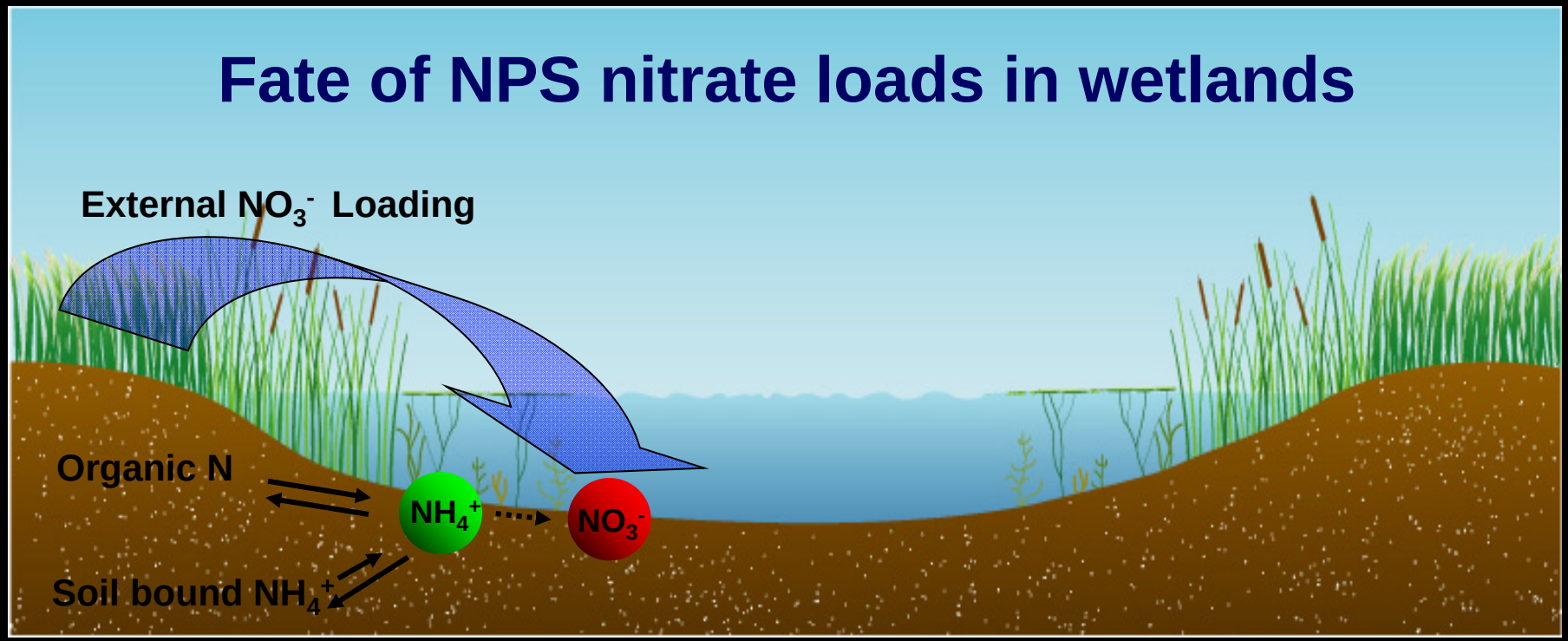
Fate of NPS nitrate loads in wetlands



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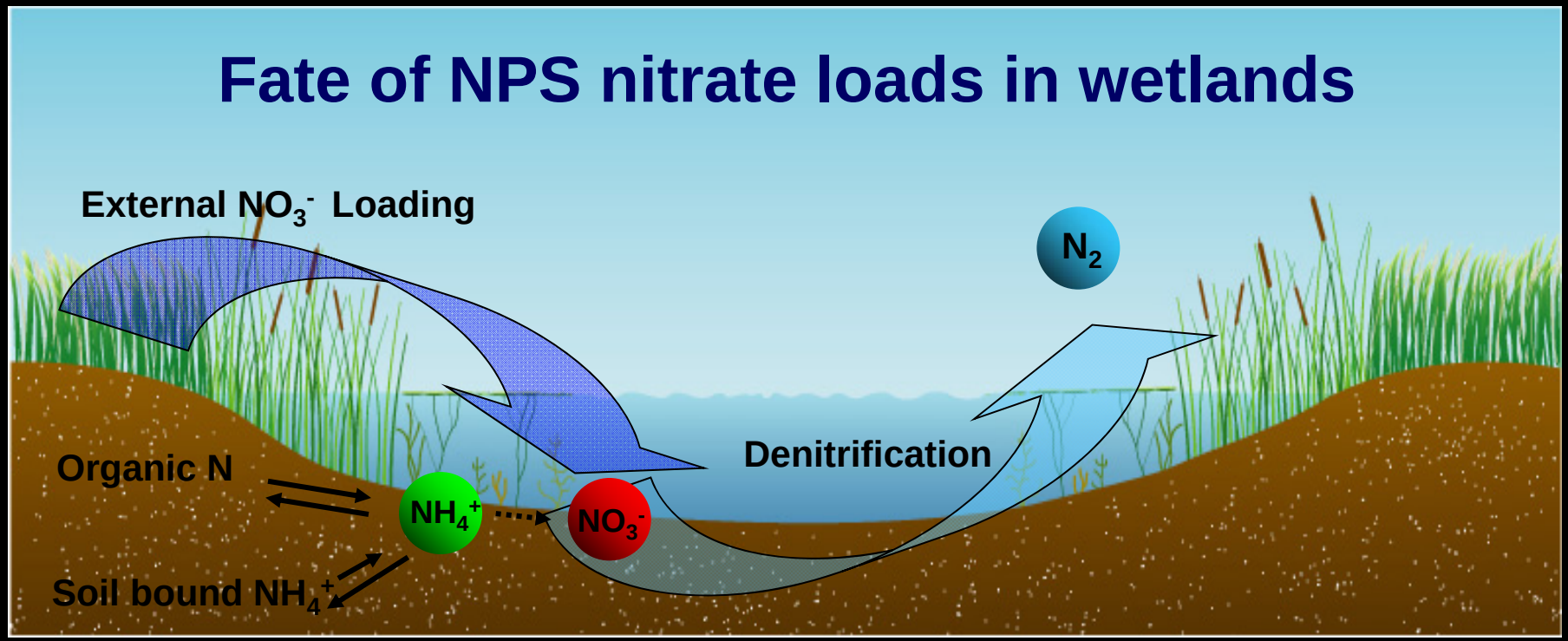
Fate of NPS nitrate loads in wetlands



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Primary Factors controlling NPS nitrate loss in wetlands

- Bioactive surface area
- Organic carbon supply
- Nitrate transport rate
- Temperature
- Dissolved oxygen
- Nitrate concentration and residence time

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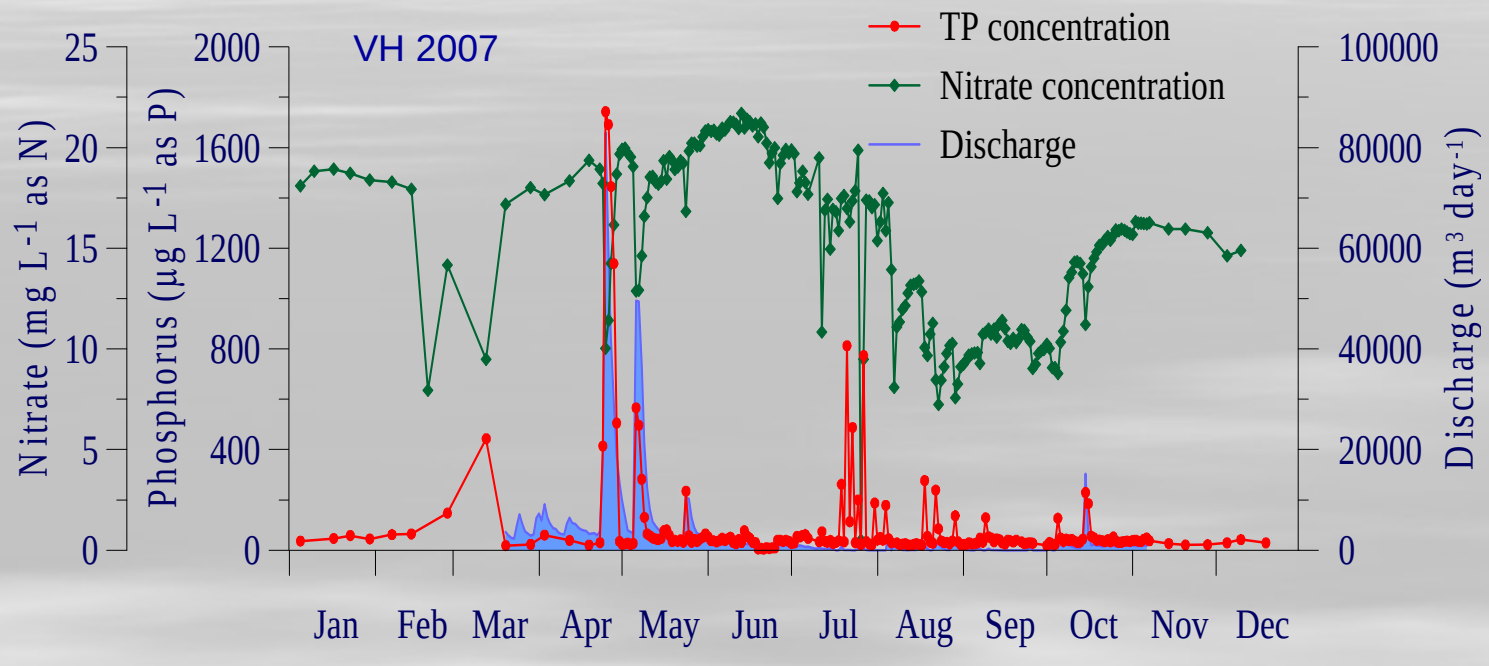
Influence of Vegetation Dynamics

Primary Factors controlling NPS nitrate loss in wetlands

- Bioactive surface area
- Organic carbon supply
- Nitrate transport rate
- Temperature
- Dissolved oxygen
- Nitrate concentration and residence time

Influence of hydraulic and nitrate loading rates



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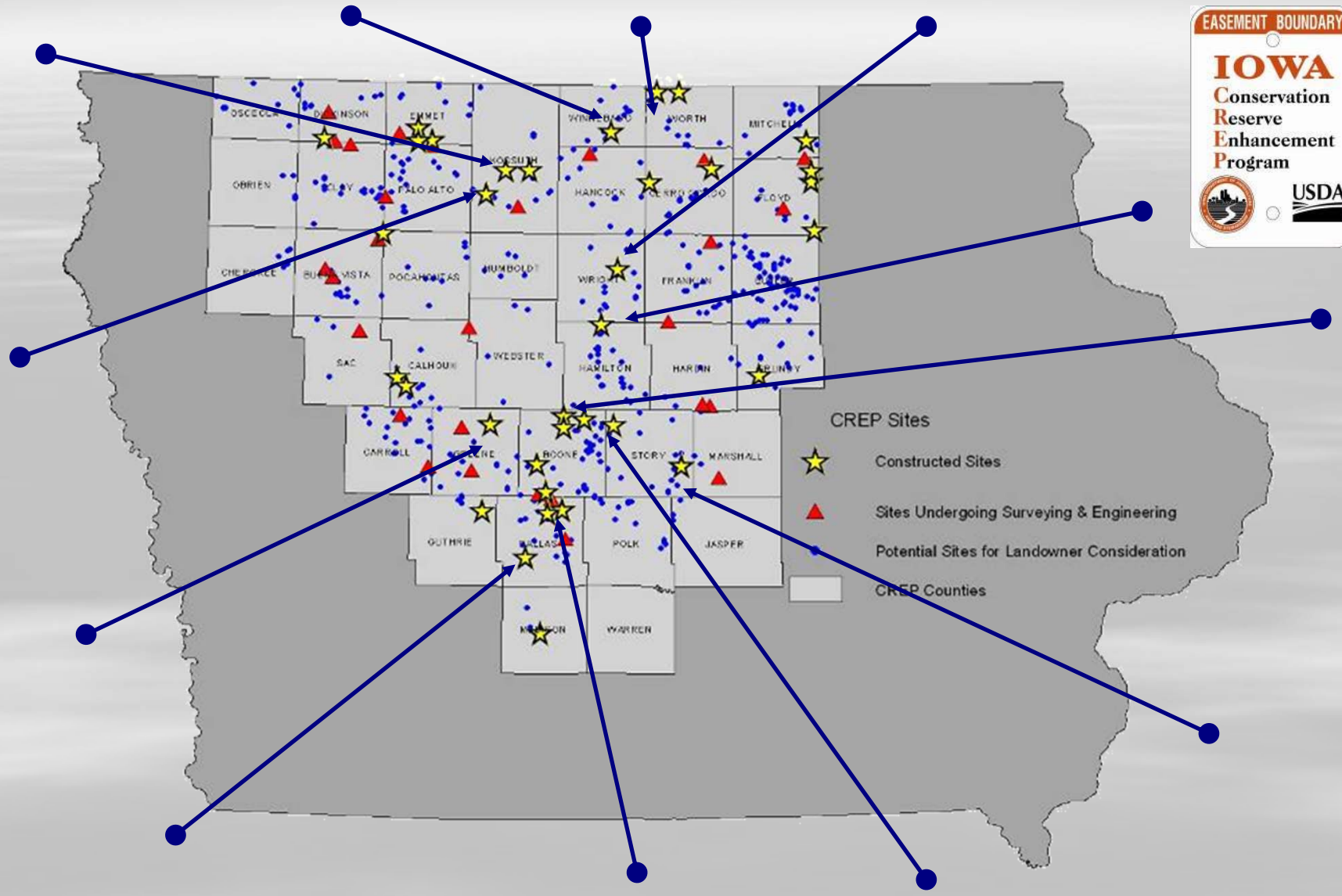
Monitoring Sites for Wetland Performance



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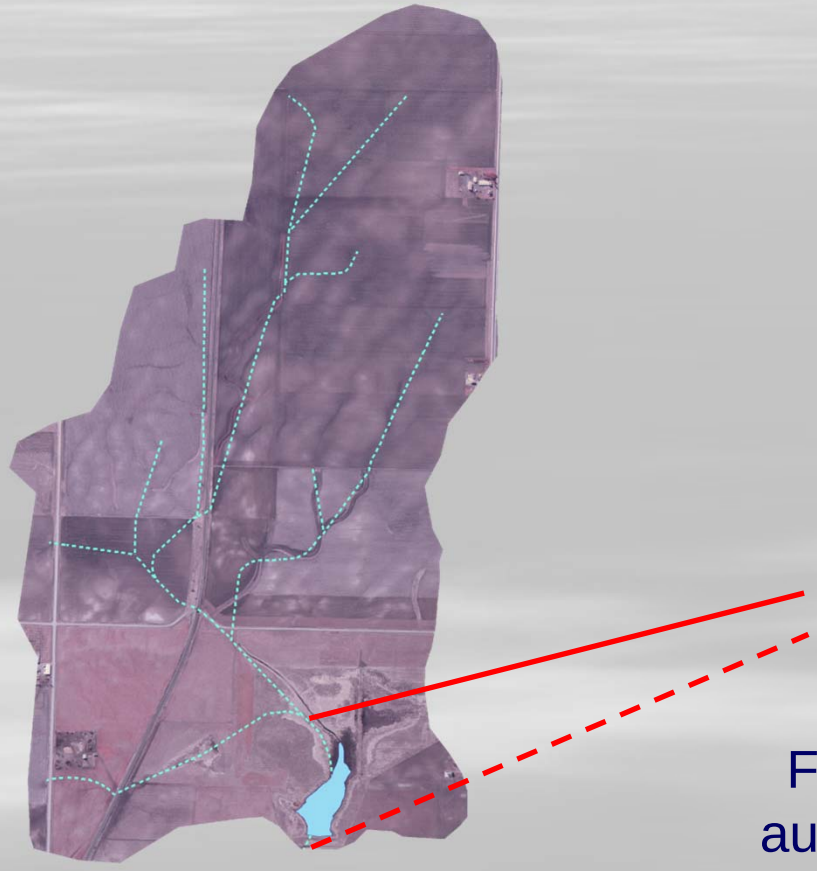
Monitoring of Wetland Performance

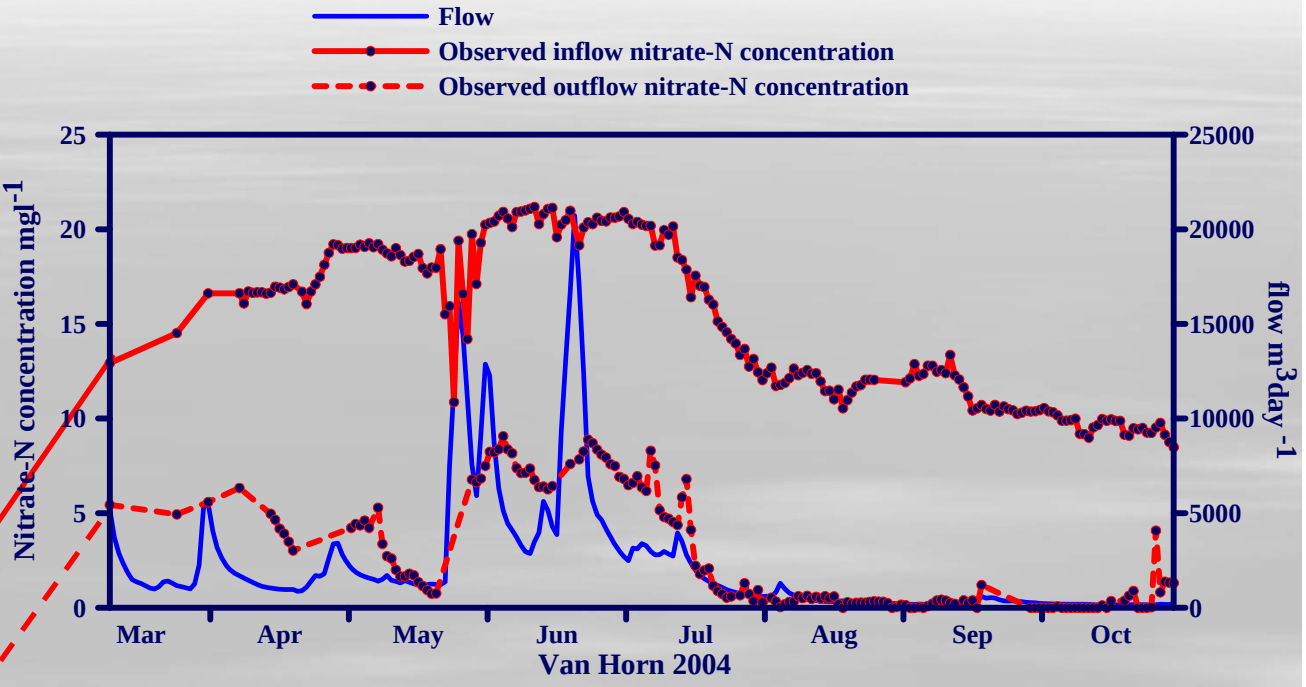
Van Horn Wetland



Field sites instrumented for automated sampling and flow measurement

Monitoring of Wetland Performance

Van Horn Wetland



Observed Nitrate concentrations and flow rates for Van Horn Wetland in 2004

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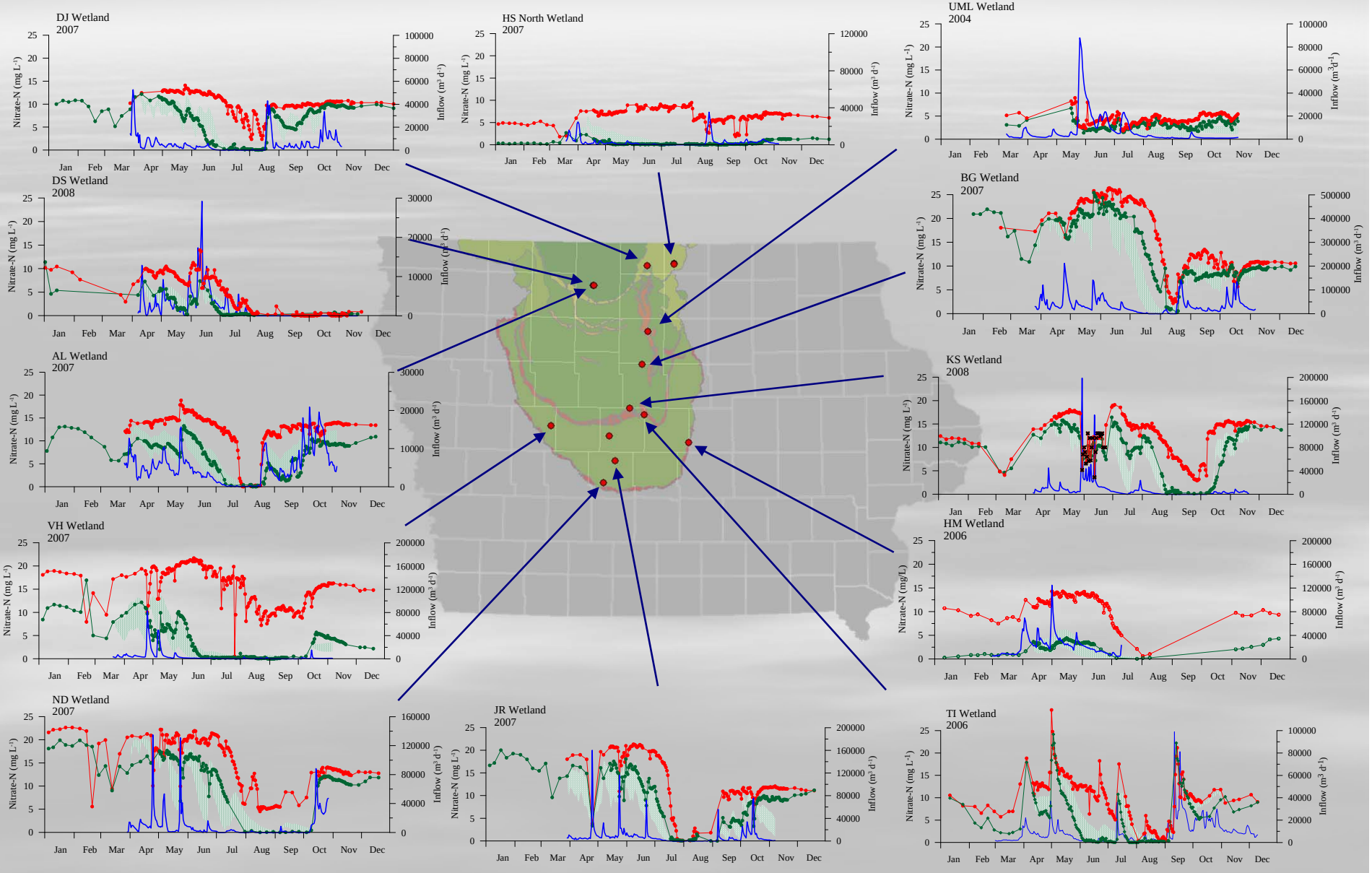
Examples from 2007 to 2009 monitoring



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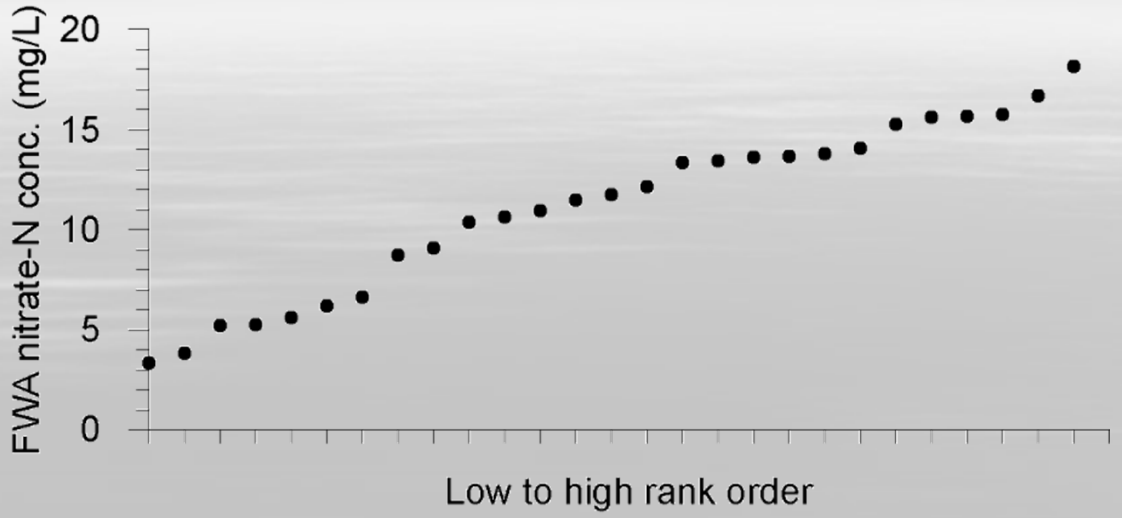

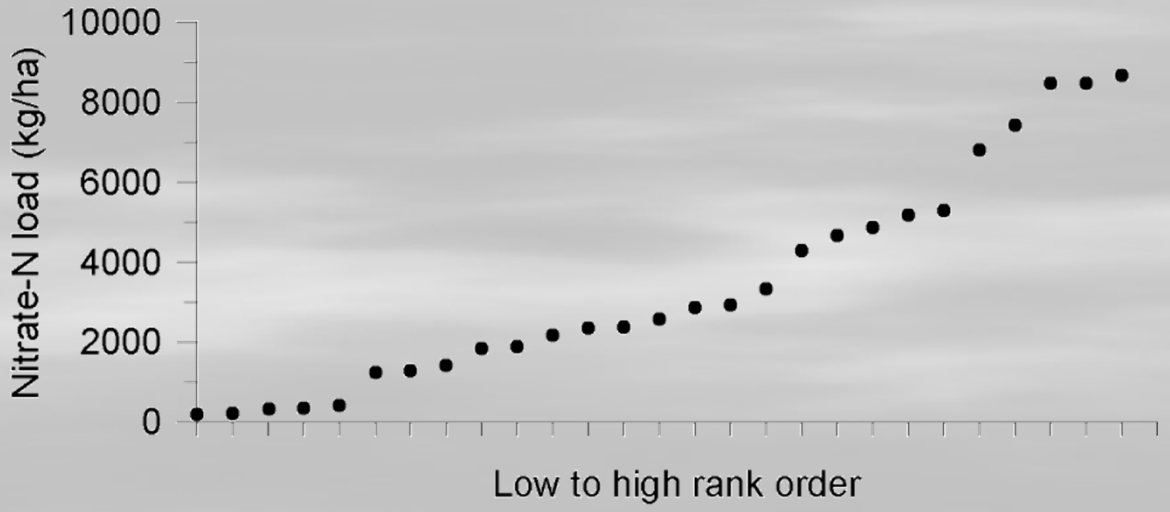

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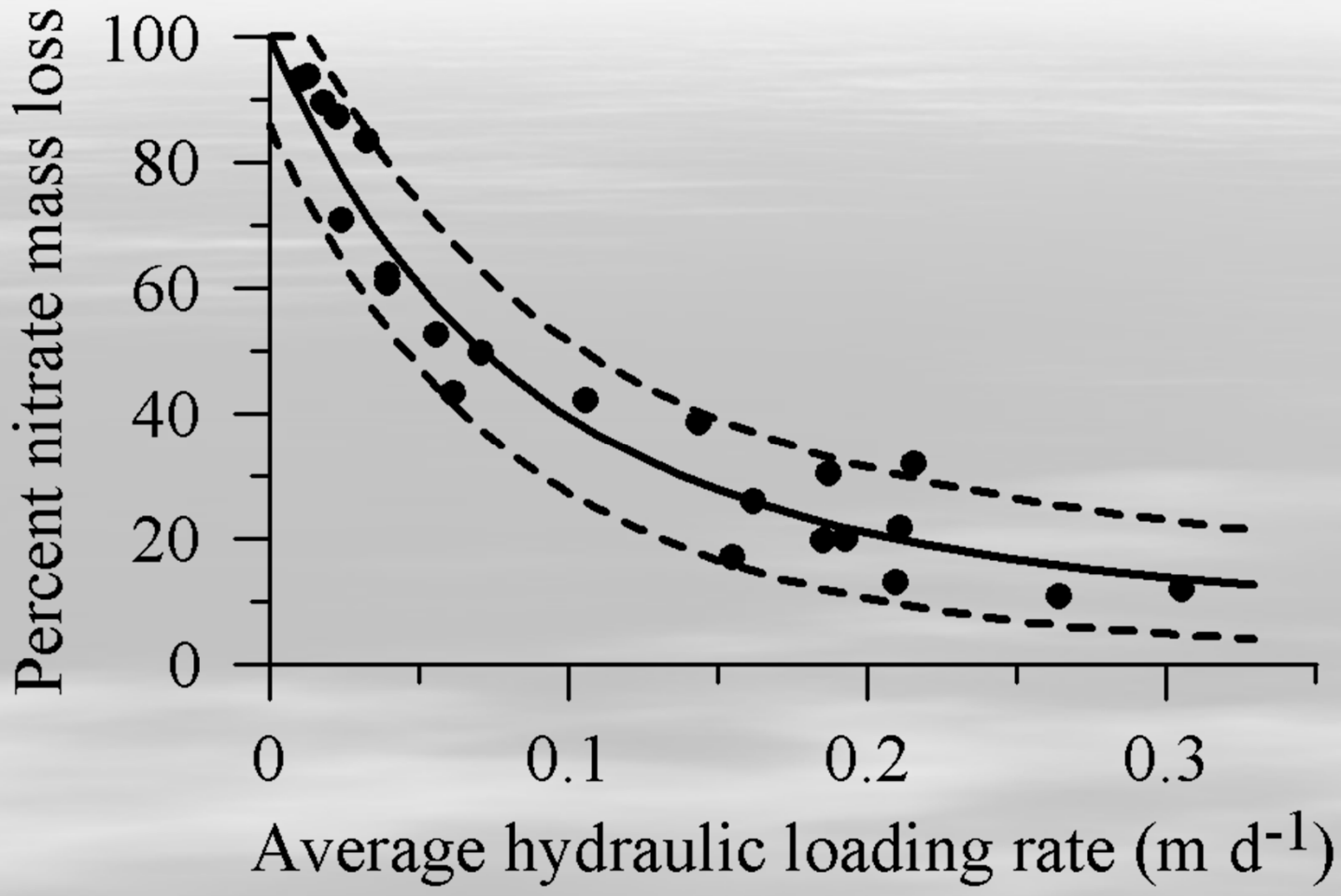

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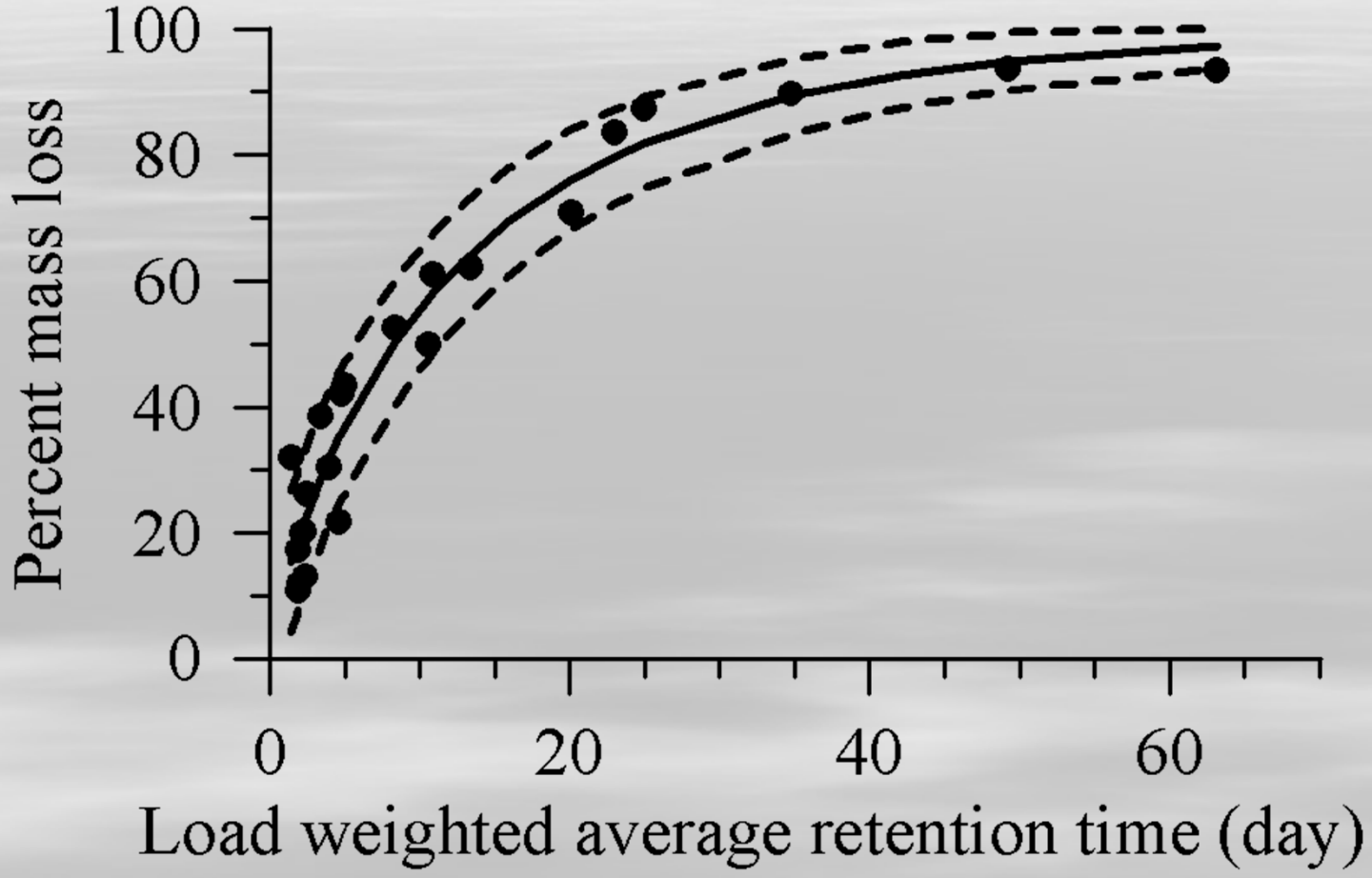

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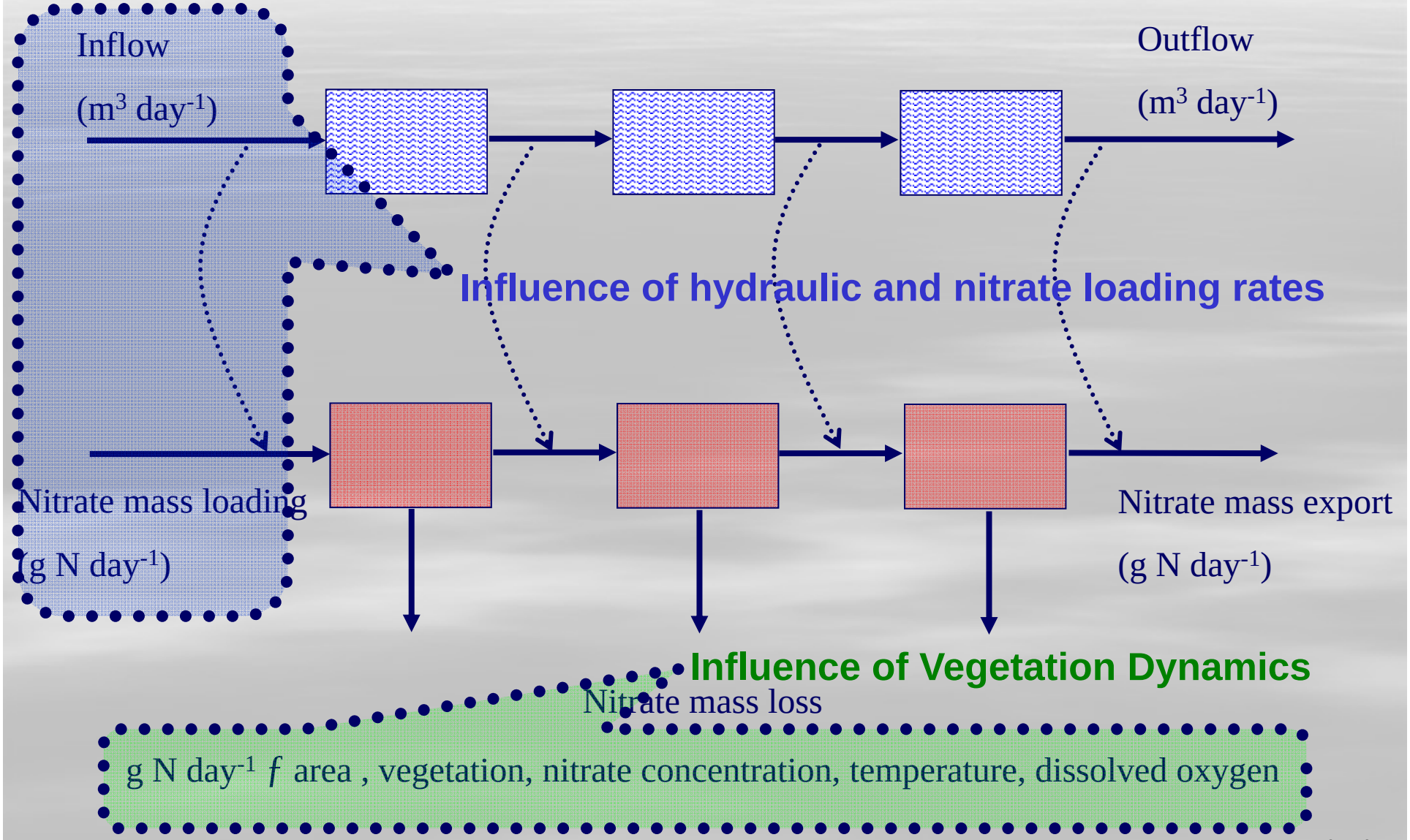
Mass Balance Analysis and Modeling of Wetland Performance



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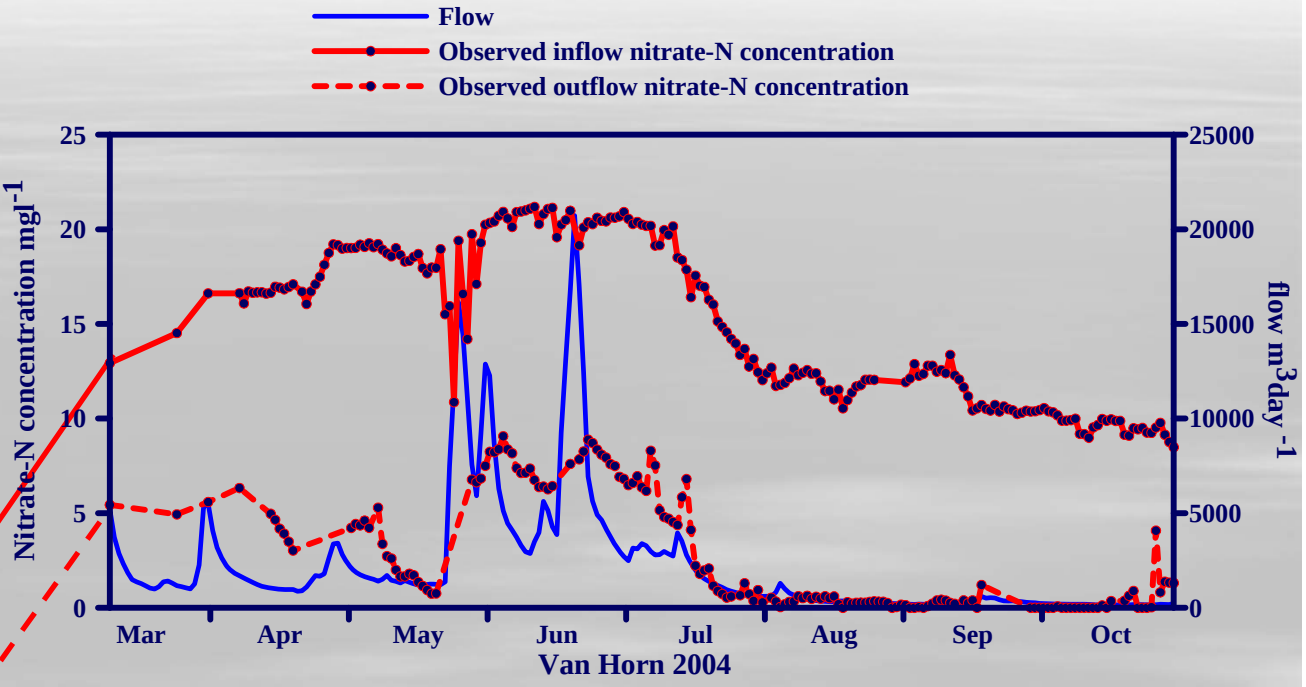
Monitoring of Wetland Performance

Van Horn Wetland



Observed Nitrate concentrations and flow rates for Van Horn Wetland in 2004

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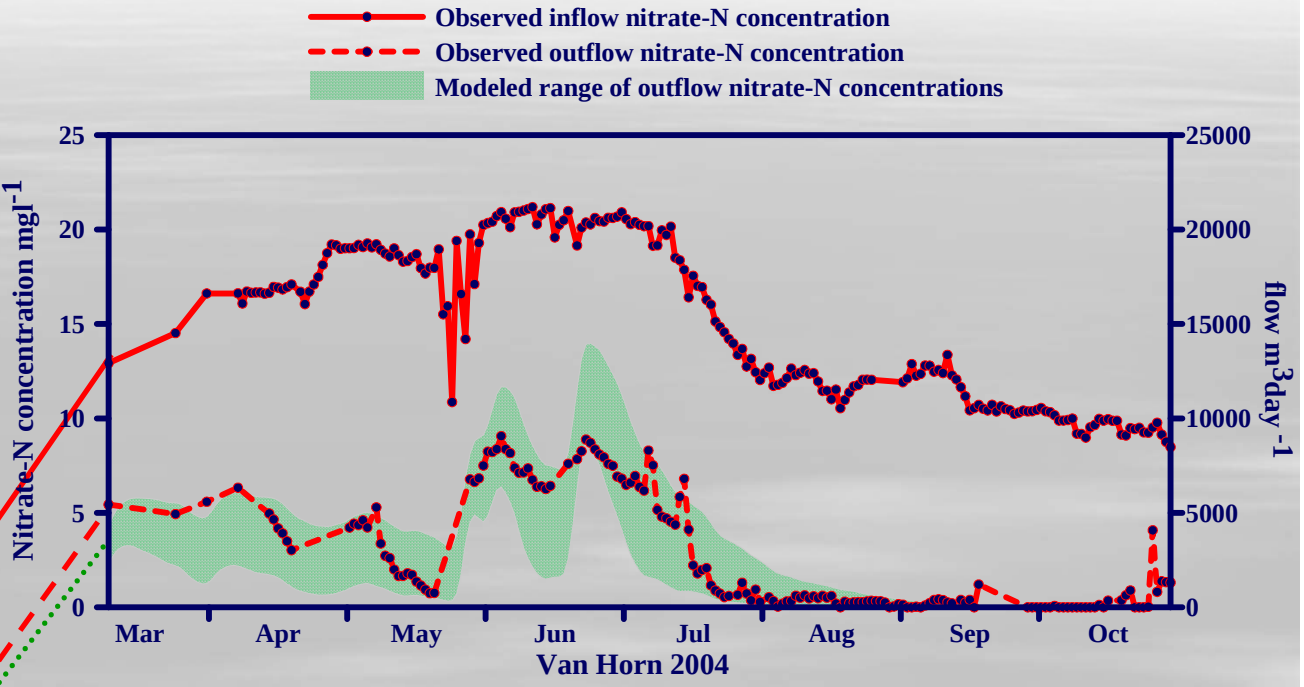
Mass Balance Analysis and Modeling of Wetland Performance

Van Horn Wetland



Measured and modeled nitrate concentrations for Van Horn Wetland in 2004.

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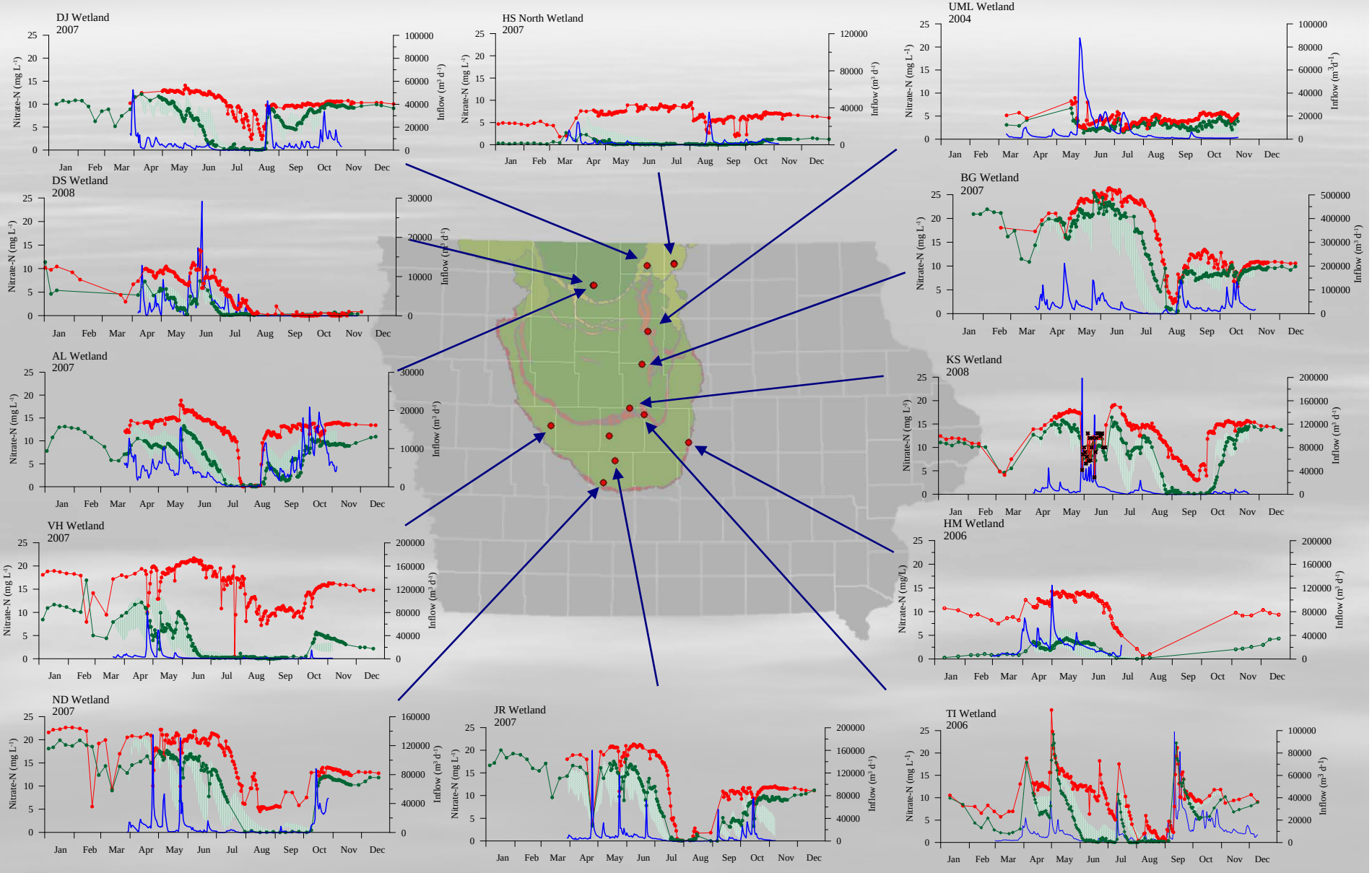
Examples from 2007 to 2009 monitoring



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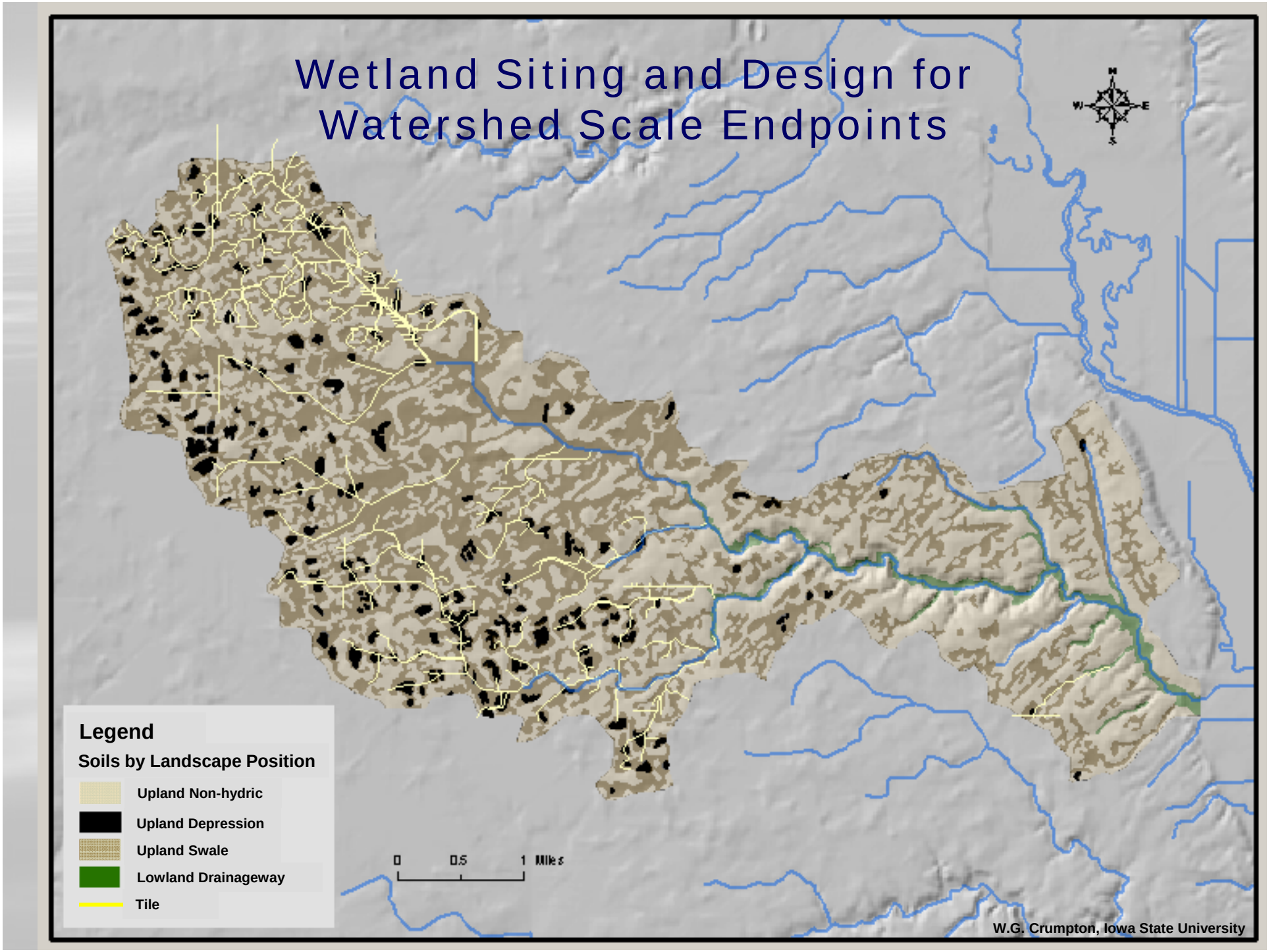
Wetland Siting and Design for Watershed Scale Endpoints
Legend
Soils by Landscape Position
Upland Non-hydric
Upland Depression
Upland Swale
Lowland Drainageway
Tile
0
0.5
1 Miles
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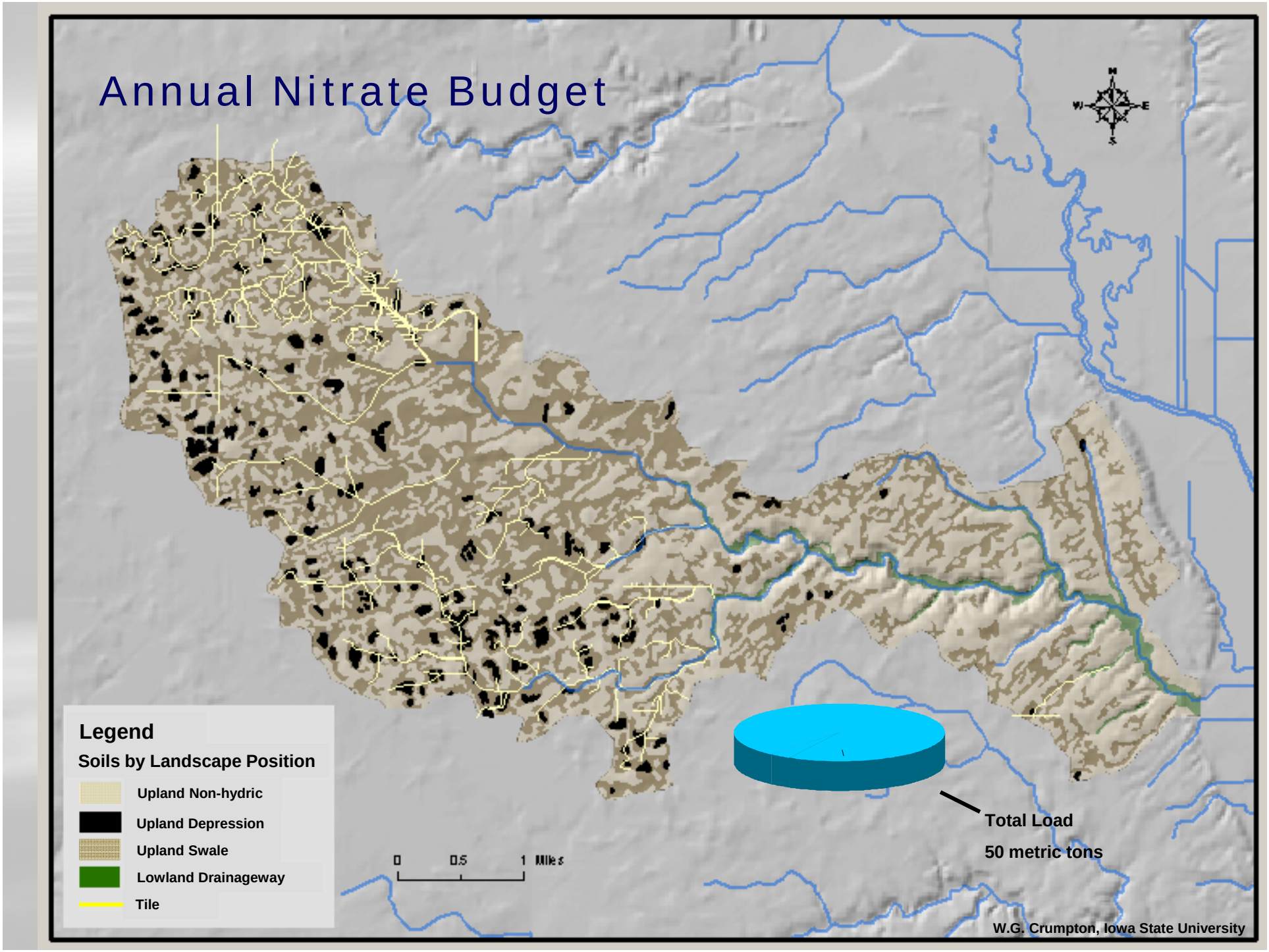
Annual Nitrate Budget
Legend
Soils by Landscape Position
Upland Non-hydric
Upland Depression
Upland Swale
Lowland Drainageway
Tile
0
0.5
1 Miles
Total Load
50 metric tons
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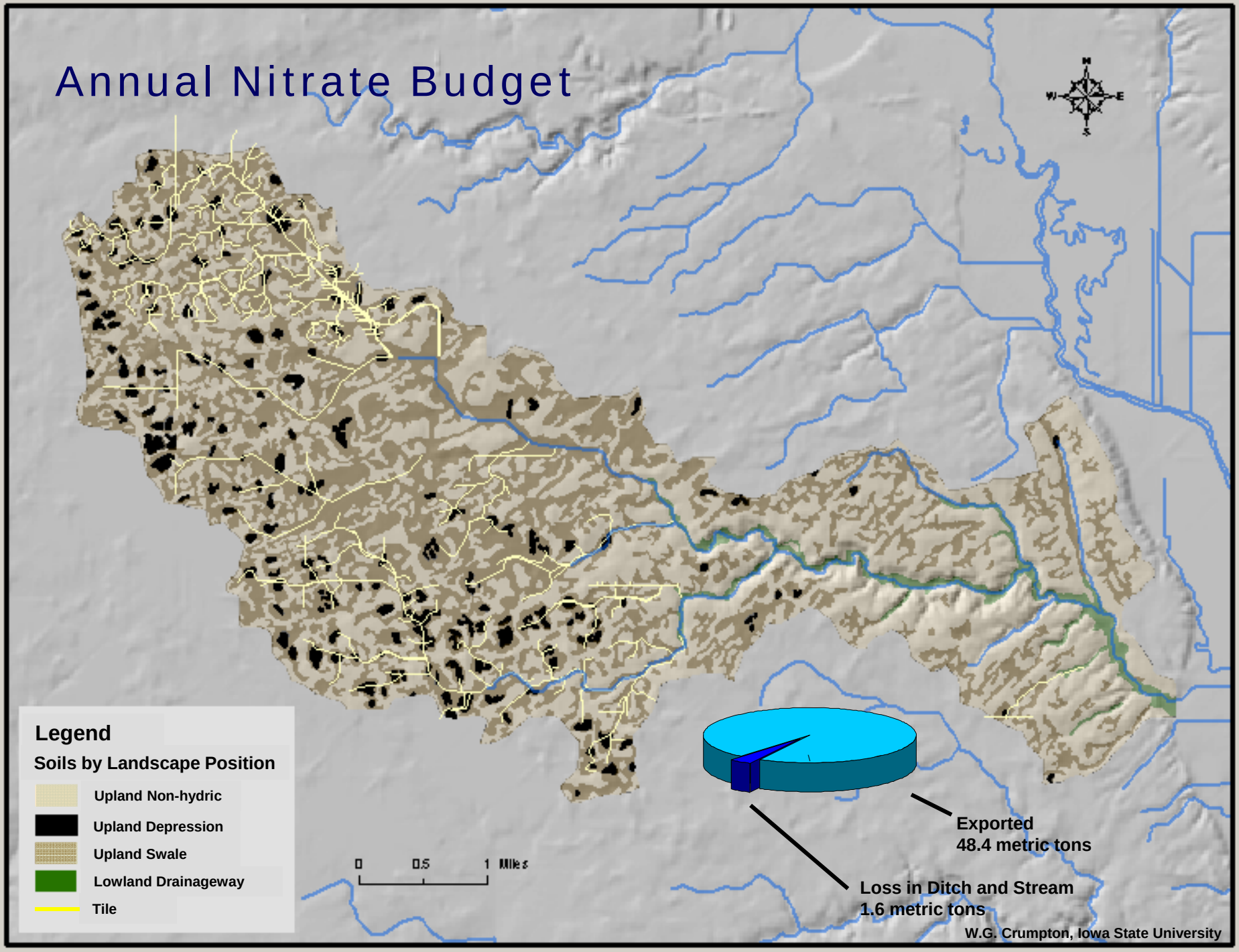
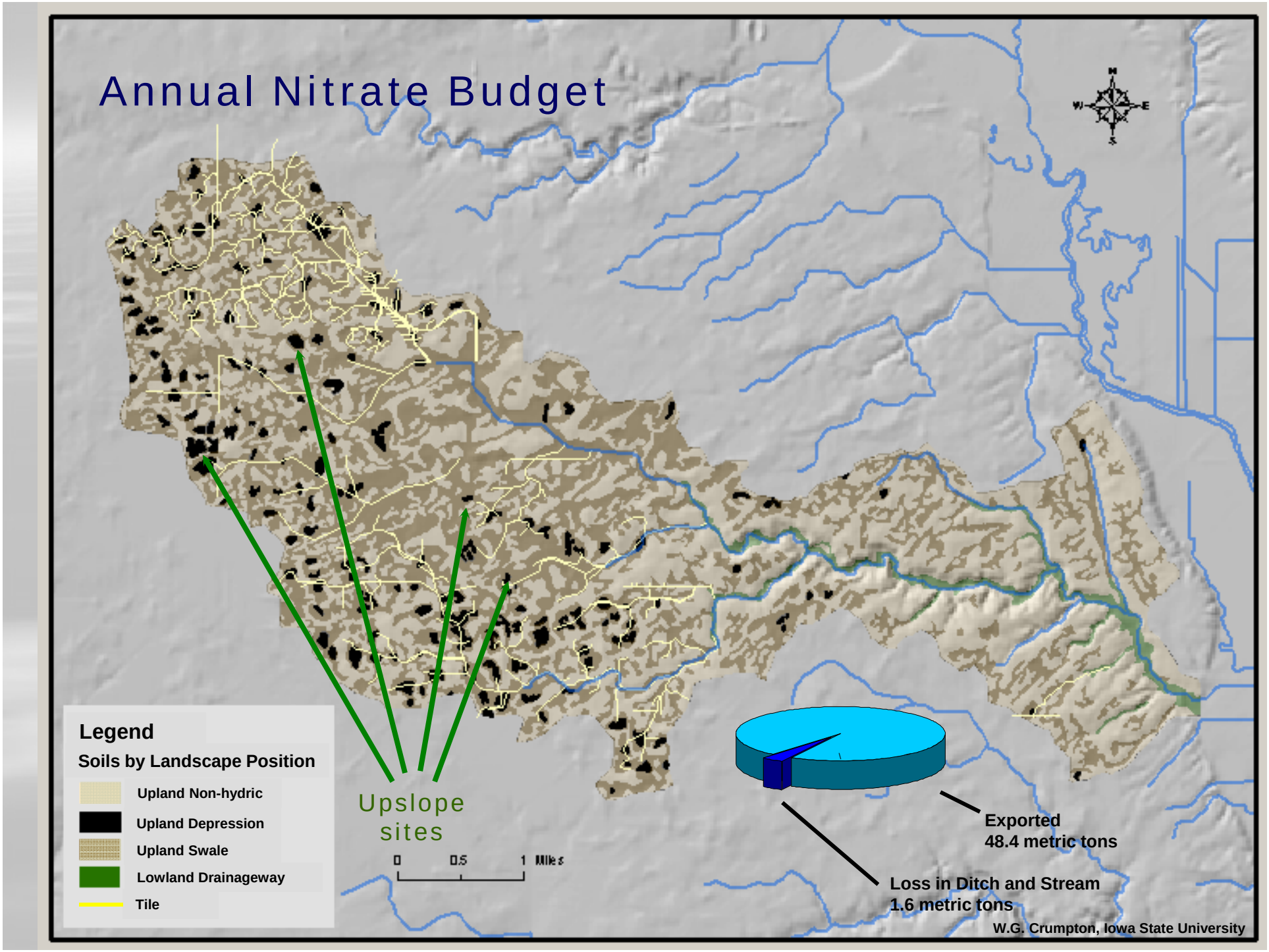
Annual Nitrate Budget




Annual Nitrate Budget
Legend
Soils by Landscape Position
Upland Non-hydric
Upland Depression
Upland Swale
Lowland Drainageway
Tile
Upslope sites
0
0.5
1 Miles
Exported
48.4 metric tons
Loss in Ditch and Stream
1.6 metric tons
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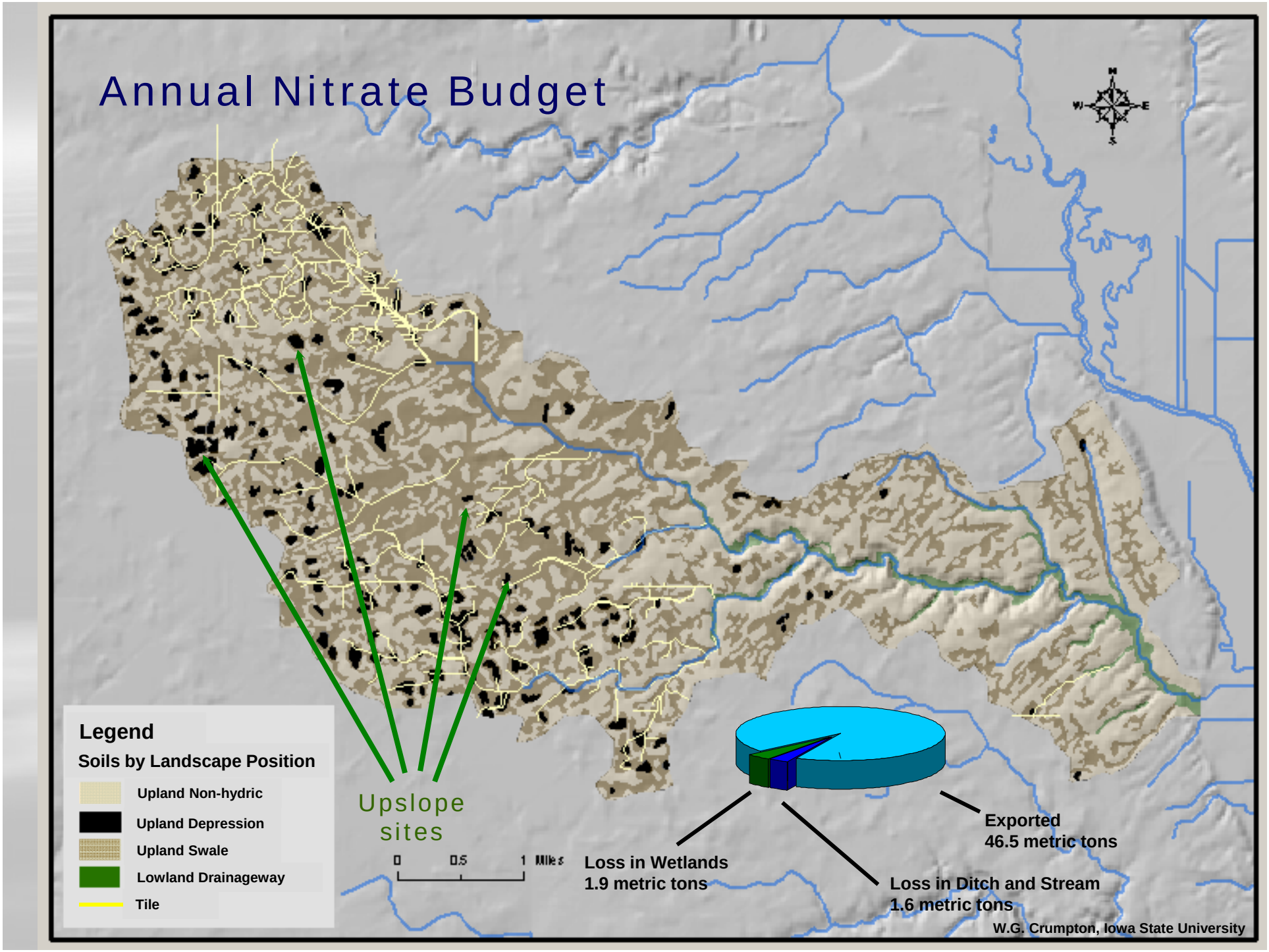
Annual Nitrate Budget
Legend
Soils by Landscape Position
Upland Non-hydric
Upland Depression
Upland Swale
Lowland Drainageway
Tile
Upslope sites
0
0.5
1 Miles
Loss in Wetlands
1.9 metric tons
Loss in Ditch and Stream
1.6 metric tons
Exported
46.5 metric tons
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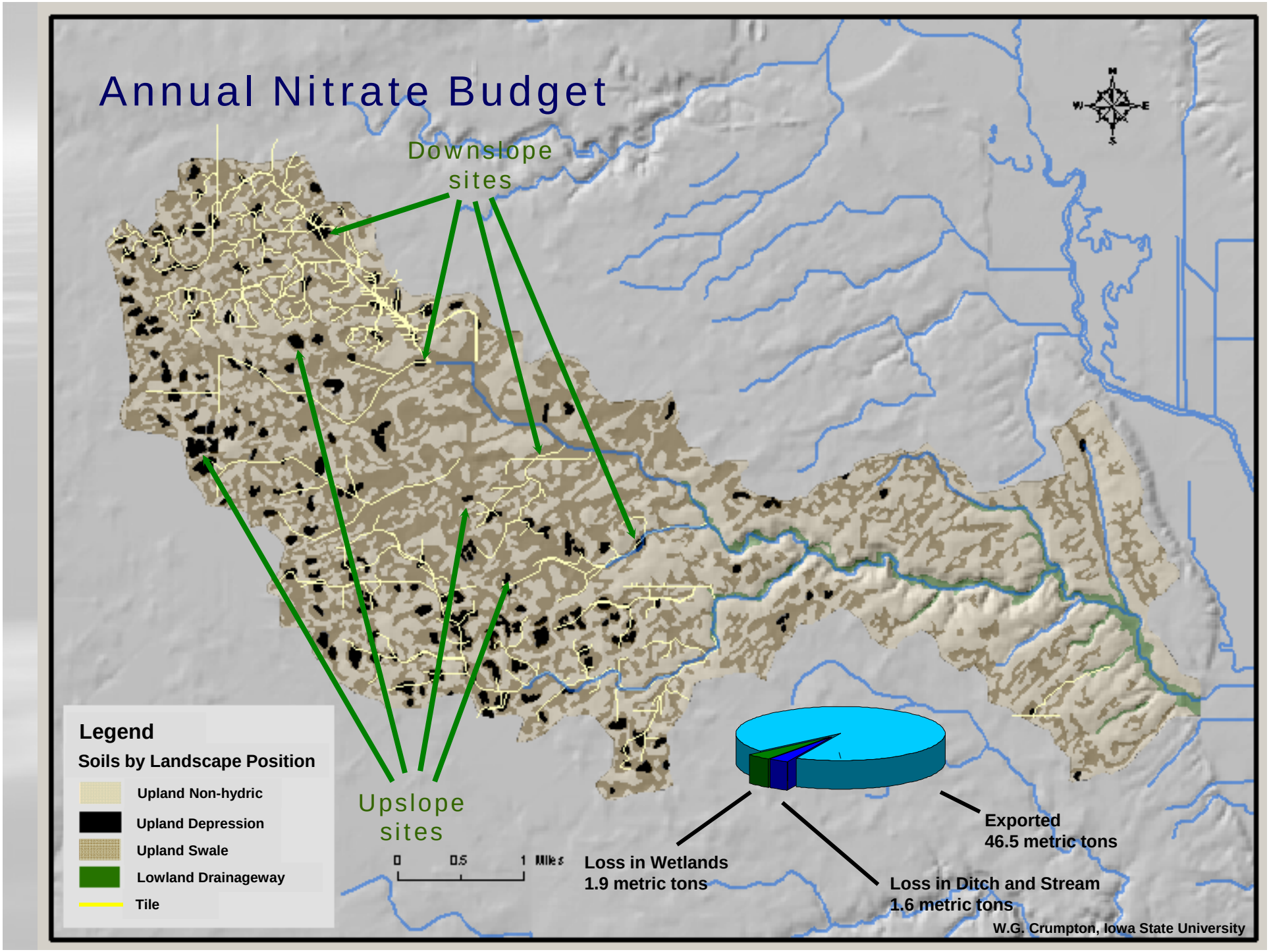
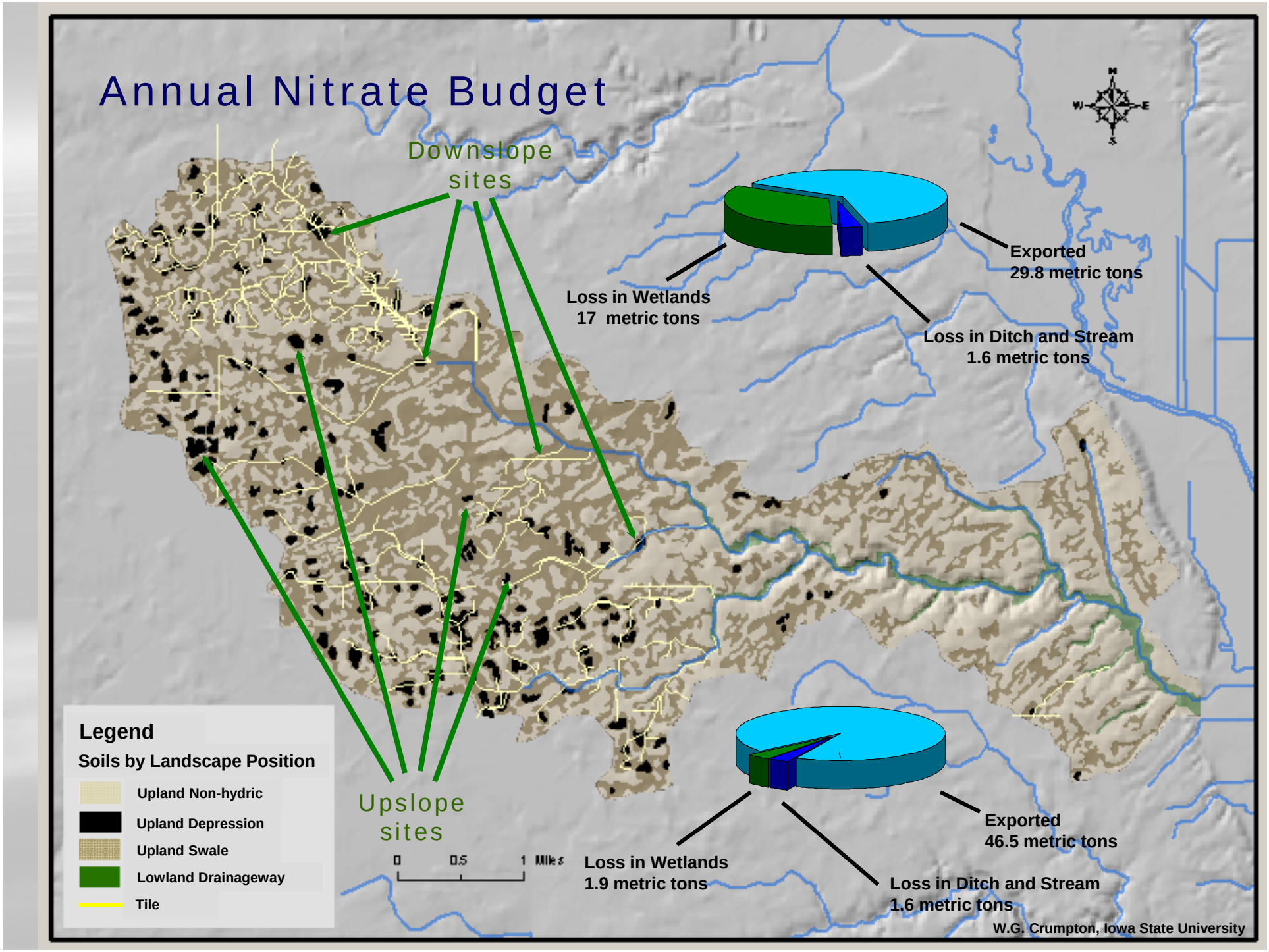

Annual Nitrate Budget
Downslope sites
Upslope sites
Legend
Soils by Landscape Position
Upland Non-hydric
Upland Depression
Upland Swale
Lowland Drainageway
Tile
0 0.5 1 Miles
Loss in Wetlands
1.9 metric tons
Loss in Ditch and Stream
1.6 metric tons
Exported
46.5 metric tons
W.G. Crumpton, Iowa State University


Annual Nitrate Budget
Downslope sites
Upslope sites
Exported
29.8 metric tons
Loss in Wetlands
17 metric tons
Loss in Ditch and Stream
1.6 metric tons
Exported
46.5 metric tons
Loss in Wetlands
1.9 metric tons
Loss in Ditch and Stream
1.6 metric tons
Legend
Soils by Landscape Position
Upland Non-hydric
Upland Depression
Upland Swale
Lowland Drainageway
Tile
0 0.5 1 Miles
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