Applying knowledge to improve water quality

National Water Program

A Partnership of USDA CSREES & Land Grant Colleges and Universities

Assessing Tillage Induced Ephemeral Gully Erosion in the Cheney Lake Watershed Using GIS, TIEGEM and the AnnAGNPS Model

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Special "Thank You" to Ming-chieh Lee – Ks State Univ.

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San Antonio Marriott Rivercenter
San Antonio, TX

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Ephemeral Gully Equation

$$\frac{(A+B) \times D \times L \times W}{2 \times 2000 \times Y} = T$$

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Ephemeral Gully vs. S&R (from USDA-NRCS. 1997)

STATE	SHEET & RILL (S&R) [Kg/m^2/y]	EPHEMERAL GULLY (EG) [Kg/m^2/y]	EG / (S&R+EG) [%]
Alabama	0.573	0.342	37.4
Delaware	0.038	0.093	71.0
Illinois	0.261	0.191	42.2
Iowa	0.353	0.110	23.8
Kansas	0.807	0.294	26.7
Louisiana	0.654	0.222	25.3
Maine	0.412	0.189	31.4
Maryland	0.195	0.147	43.0
Michigan	0.172	0.045	20.7
Mississippi	0.646	0.275	29.9

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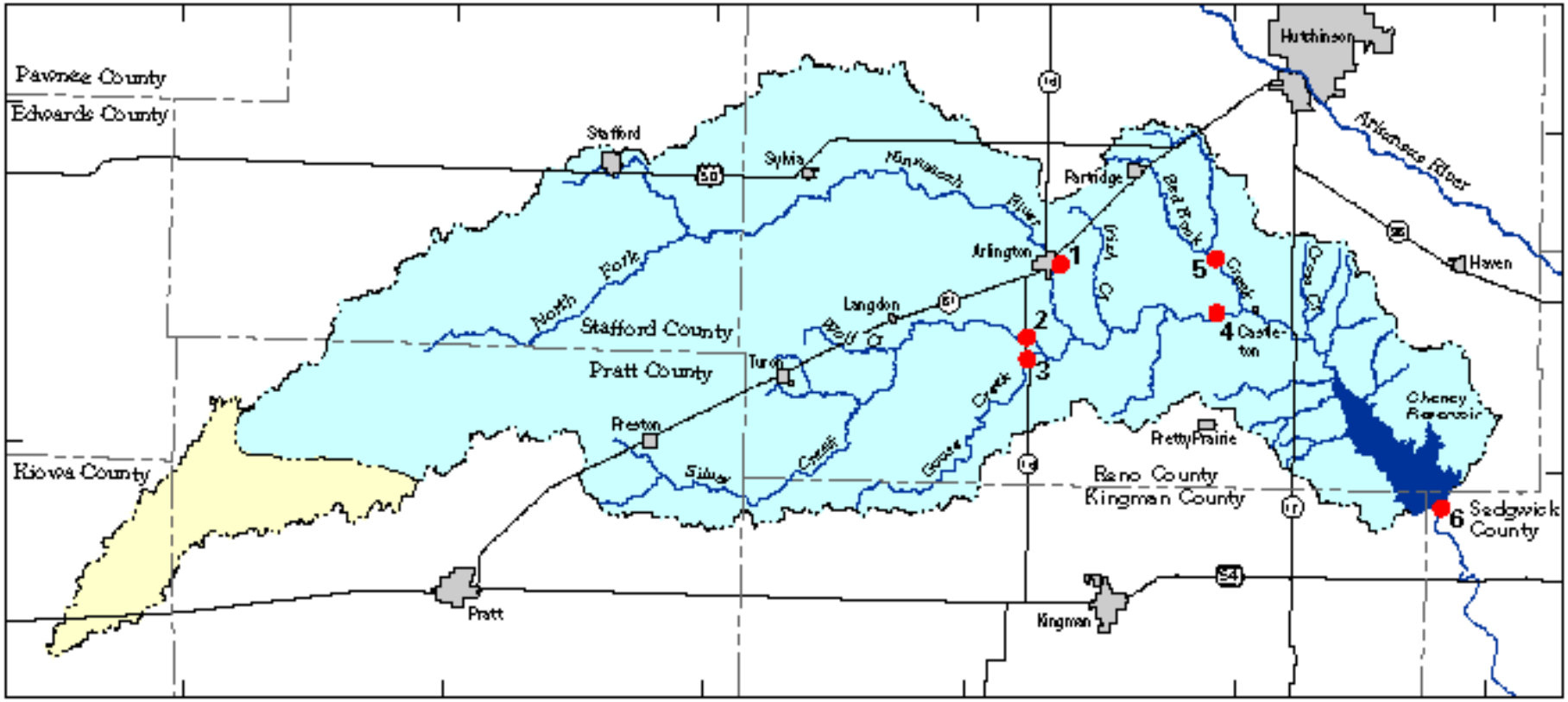
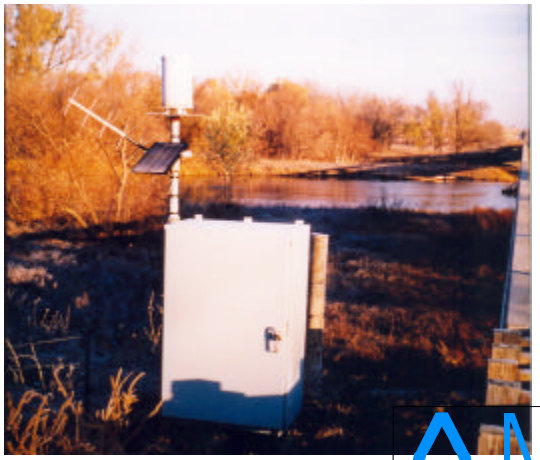


Site #1 – West Ninnescah
Site #2 – Silver Creek
Site #3 – Goose Creek
Site #4 – USGS Gage Site
Site #5 – Red Rock Creek



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Sediment Load, 1997-99

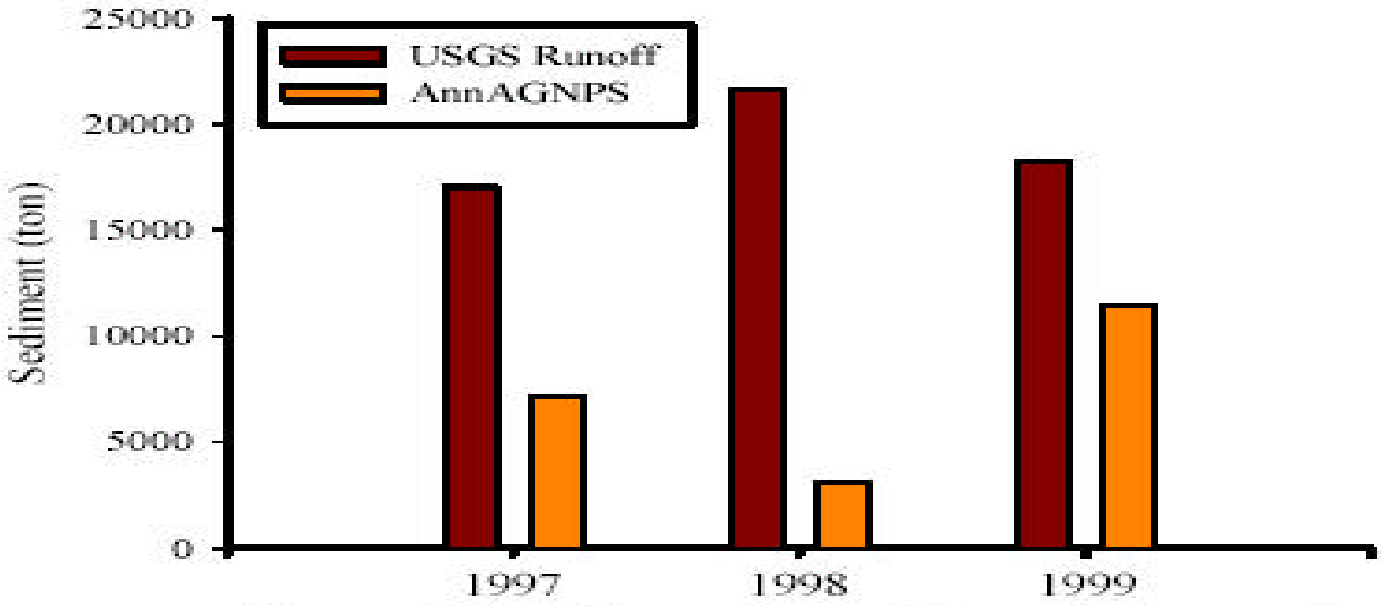

Figure 12. Comparison plots of observed and predicted sediment yield at the USGS gaging station (07144780) on the North Fork Ninnescah River above Cheney Reservoir during 1997-1999.

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Rill Erosion

- Persistence in Time: Erased by tillage, usually do not reform in the same place
- Size: Smaller than Ephemerals
- Cross Sectional Area: Less than 1 ft ^{2} , narrow relative to depth
- Flow Pattern; Small disconnected parallel channels uniformly spaced and sized
- Topographic Location: On Smooth side slopes above drainageways
- Nature of Erosion: Soil is removed in shallow channels, annual tillage causes soil to become thinner over entire slope

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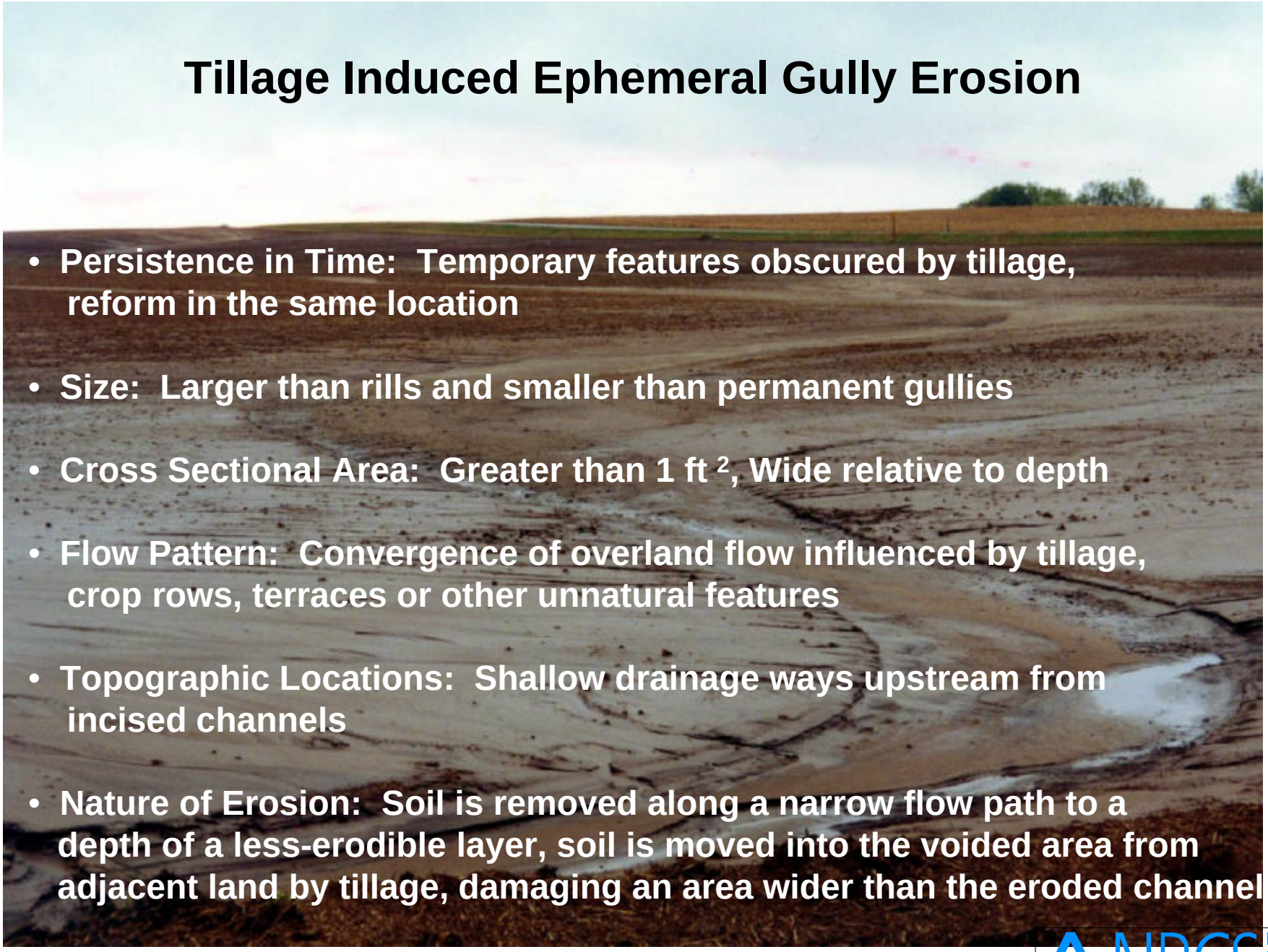
Tillage Induced Ephemeral Gully Erosion



- **Persistence in Time: Temporary features obscured by tillage, reform in the same location**
- **Size: Larger than rills and smaller than permanent gullies**
- **Cross Sectional Area: Greater than 1 ft ^{2}, Wide relative to depth**
- **Flow Pattern: Convergence of overland flow influenced by tillage, crop rows, terraces or other unnatural features**
- **Topographic Locations: Shallow drainage ways upstream from incised channels**
- **Nature of Erosion: Soil is removed along a narrow flow path to a depth of a less-erodible layer, soil is moved into the voided area from adjacent land by tillage, damaging an area wider than the eroded channel**

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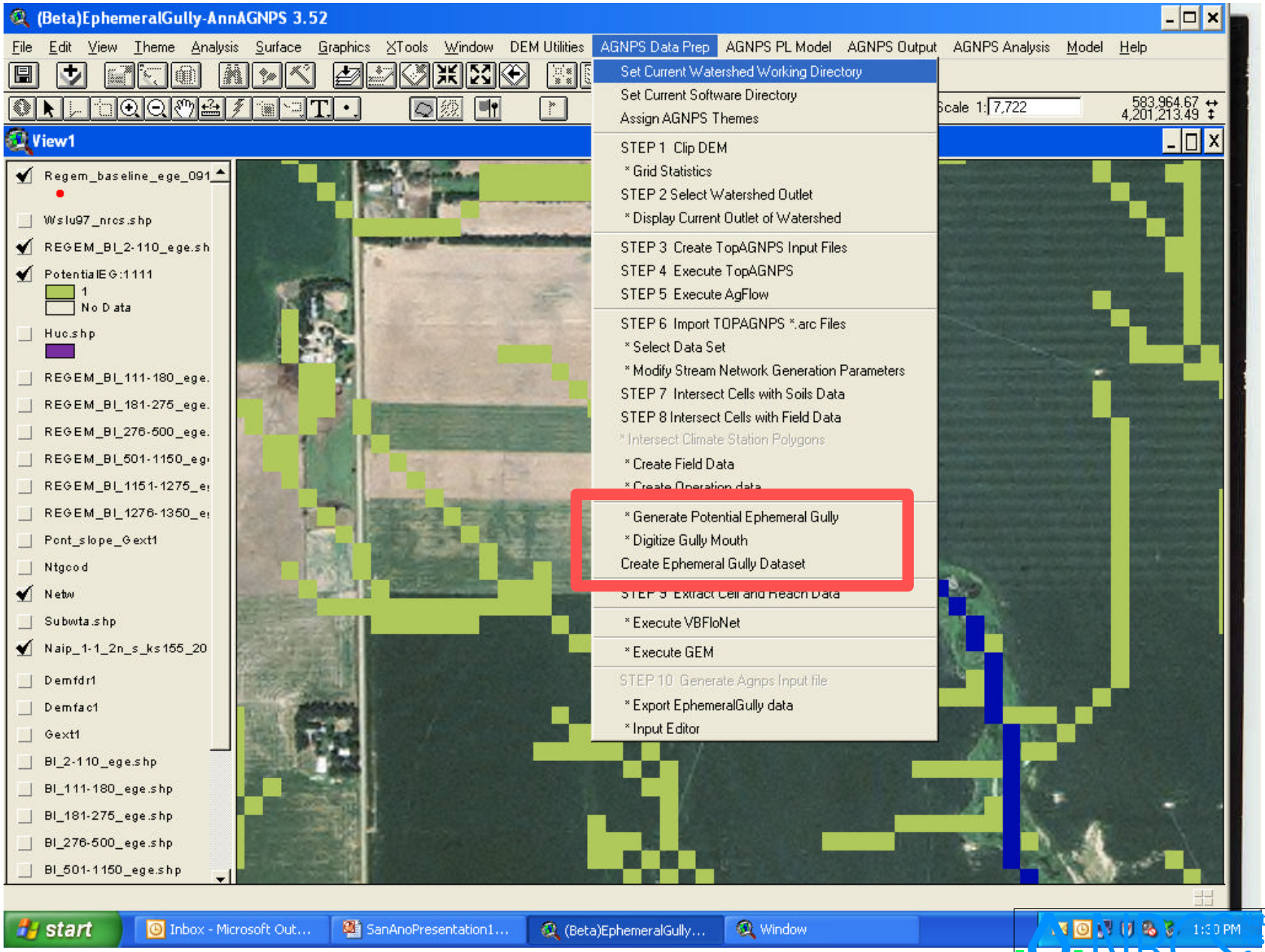
(Beta)EphemeralGully-AnnAGNPS 3.52
File Edit View Theme Analysis Surface Graphics XTools Window DEM Utilities AGNPS Data Prep AGNPS PL Model AGNPS Output AGNPS Analysis Model Help
Set Current Watershed Working Directory
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STEP 1 Clip DEM
* Grid Statistics
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* Execute VBFloNet
* Execute GEM
STEP 10 Generate Agnps Input file
* Export EphemeralGully data
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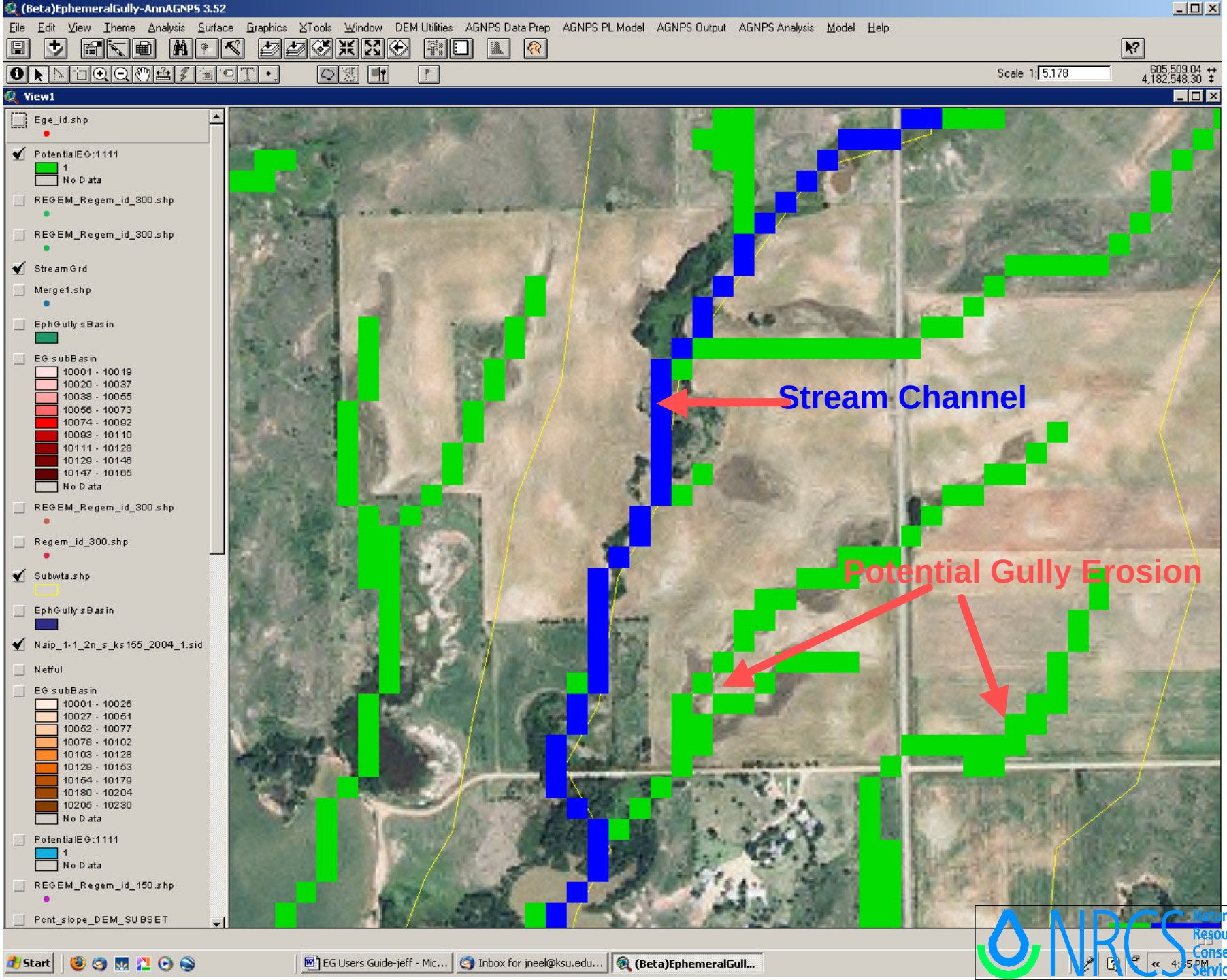
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August 26, 2005

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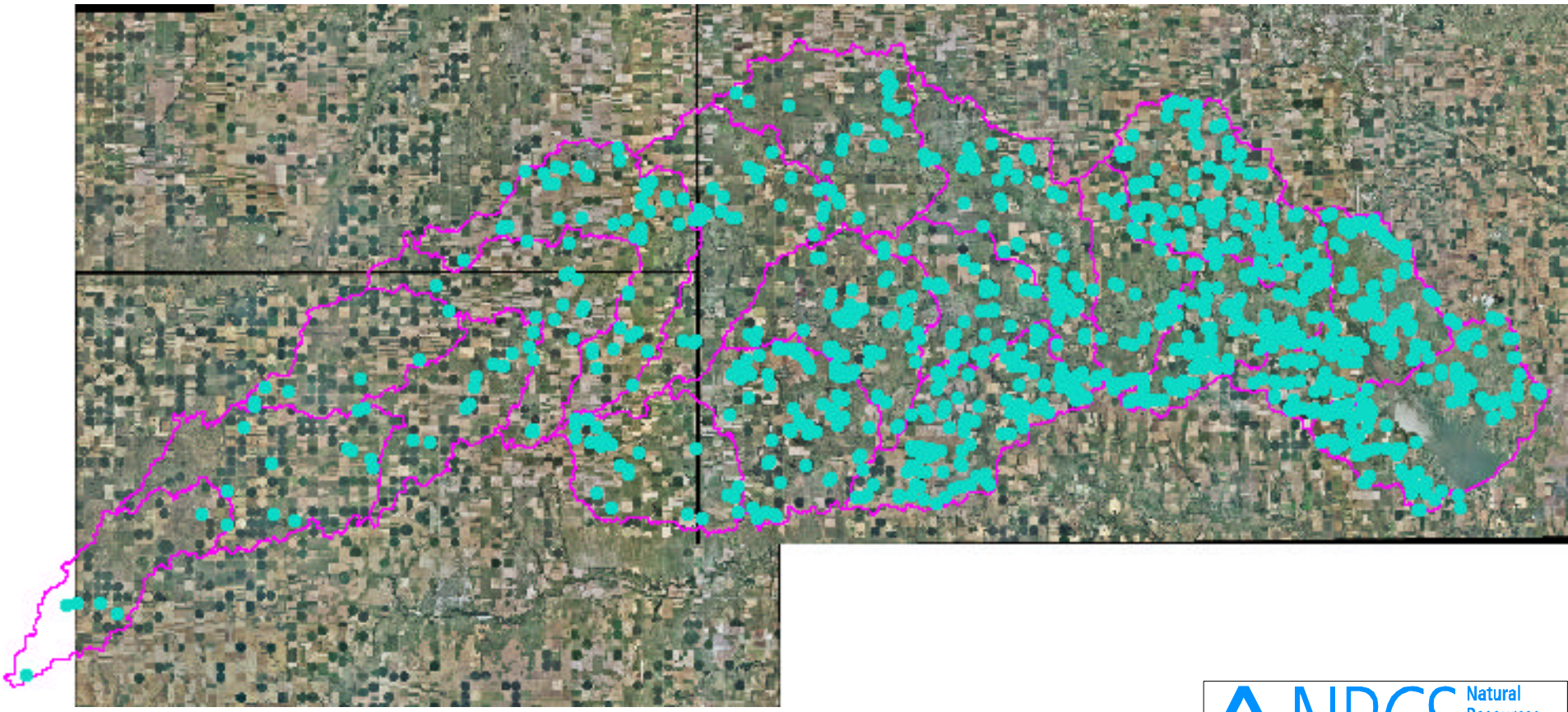
989 Tillage Induce Ephemeral Gully Erosion Locations in the Cheney Lake Watershed



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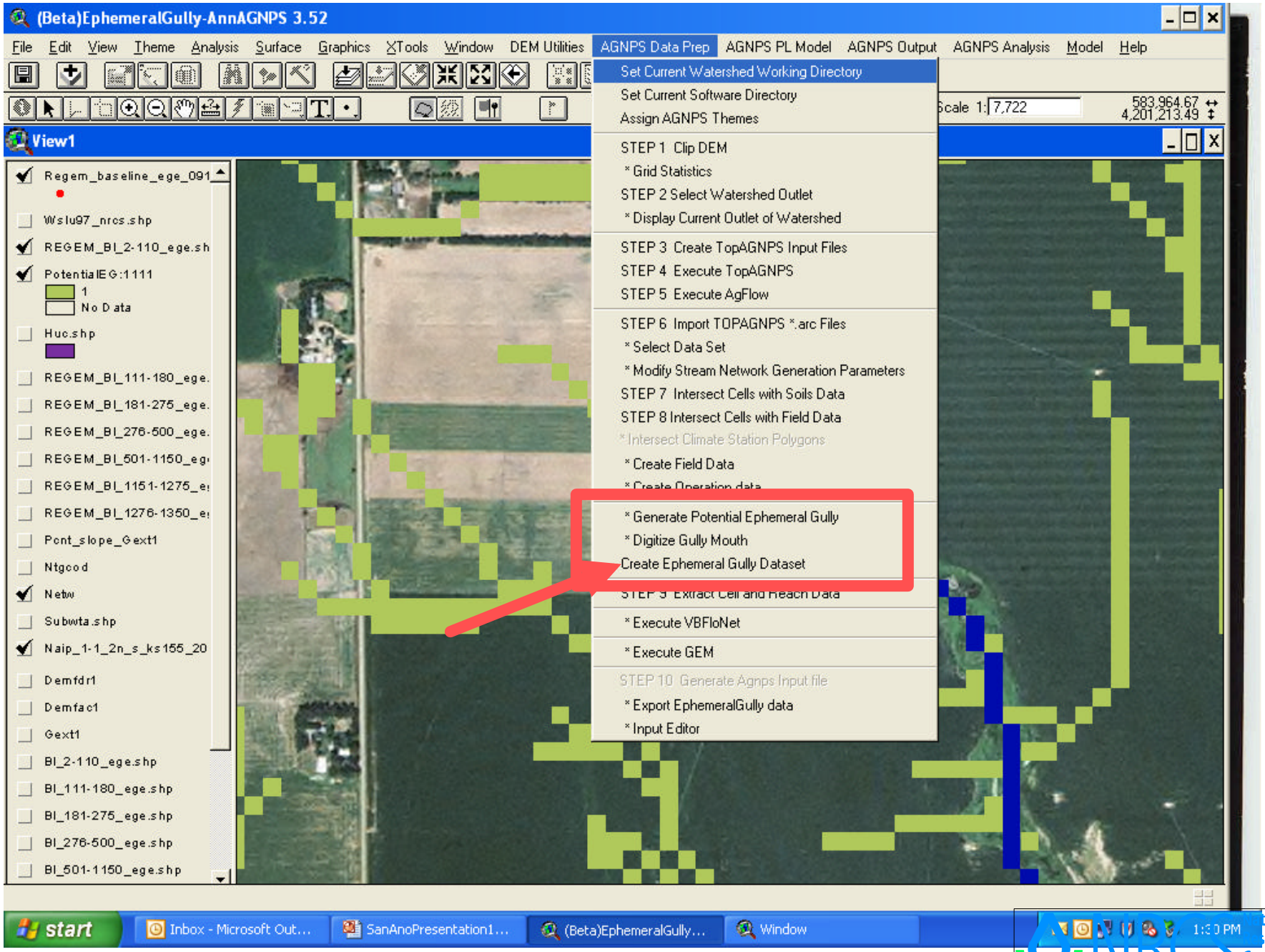
EG Identification and TIEGEM

TIEGEM Requirements:

- Gully Mouth ID
- EG drainage area
- Slope of concentrated flow zone
- Critical shear stress at which gully begins
- Erodibility rate (based on soil properties)
- Receiving reach drainage area
- Delivery ratio (HUSLE)
- Manning's "n"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REGEM_BI_1151-1275_e
REGEM_BI_1276-1350_e
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Ntgcod
Netw
Subwta.shp
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Demfac1
Gext1
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BI_501-1150_ege.shp
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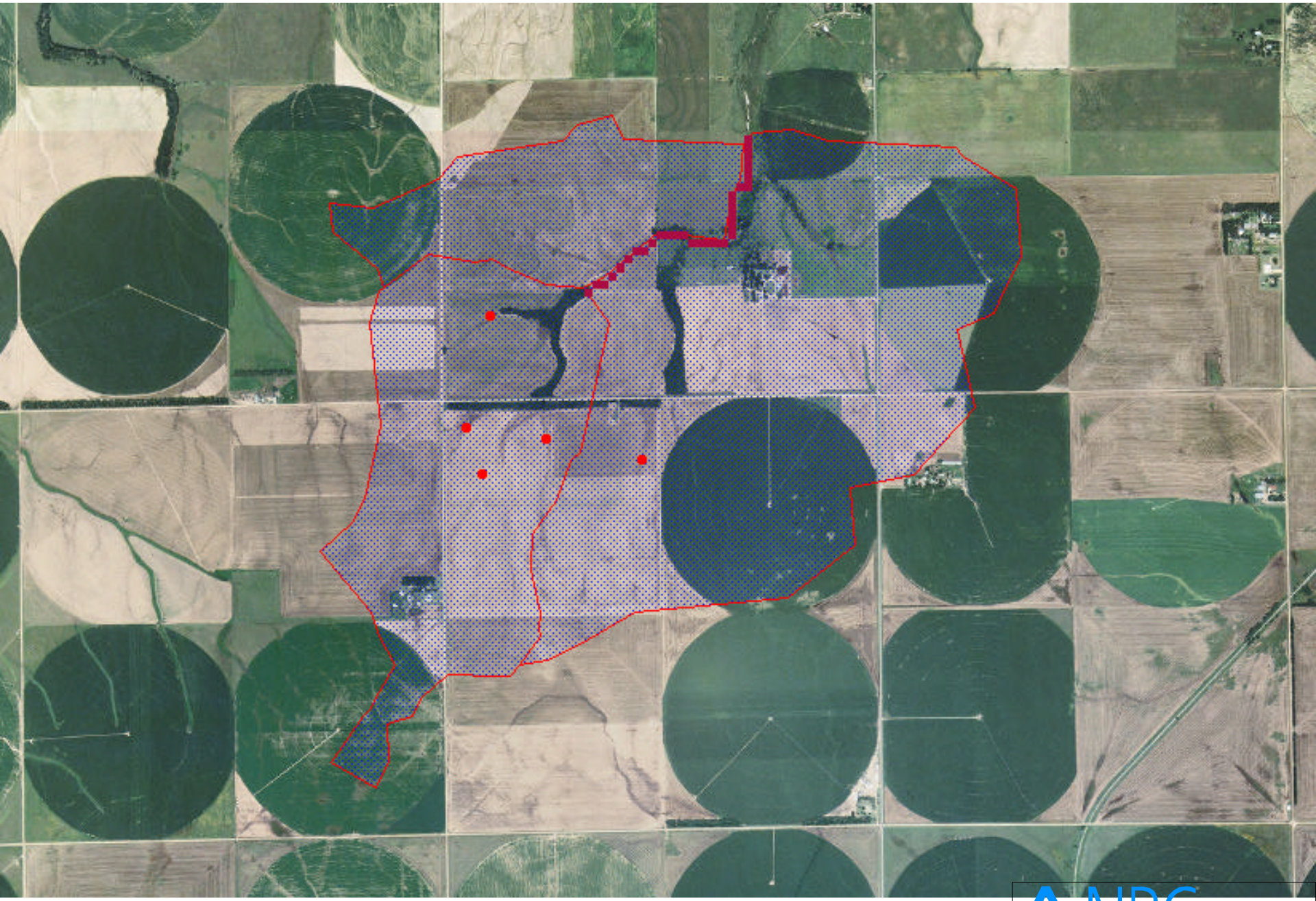

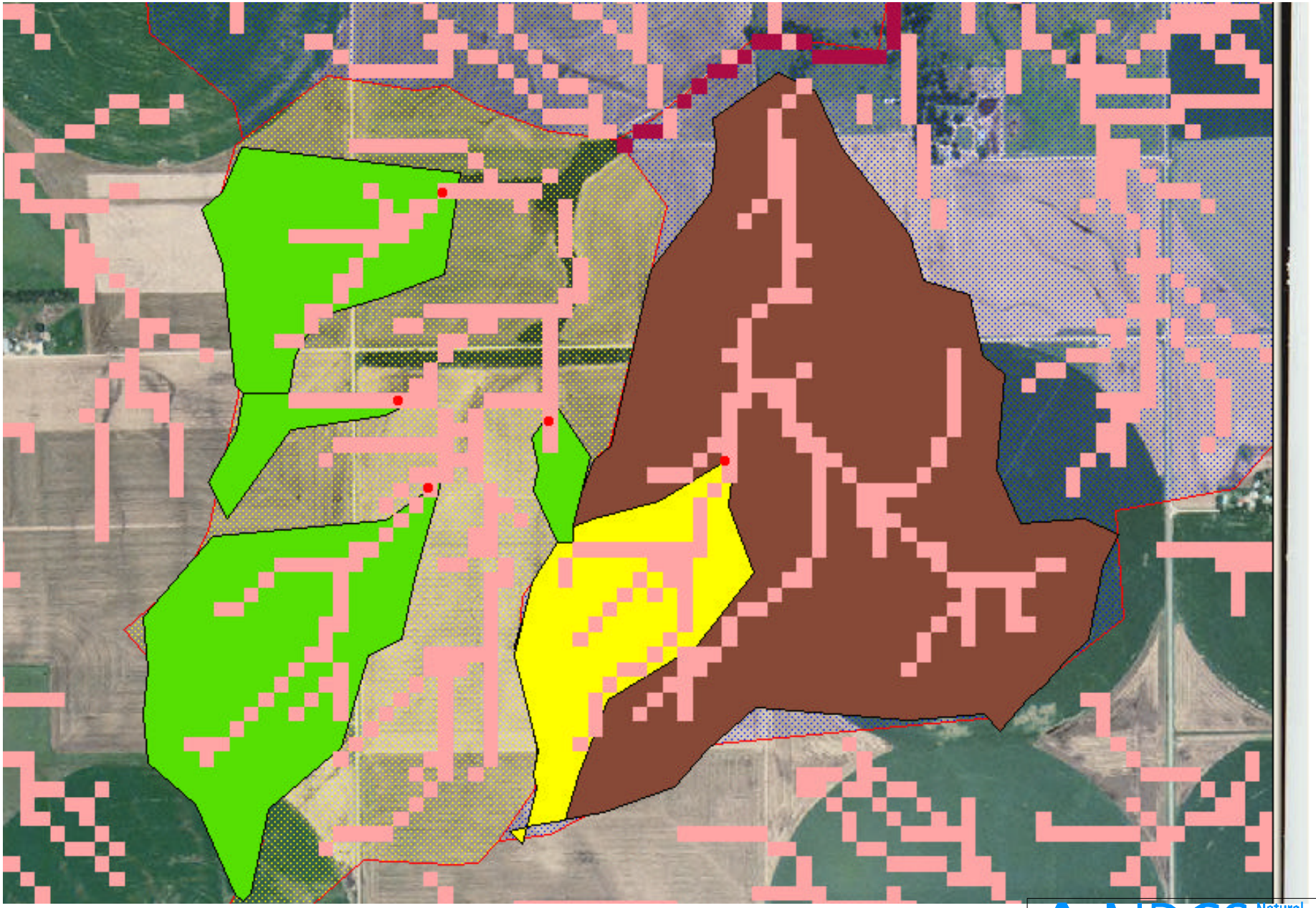
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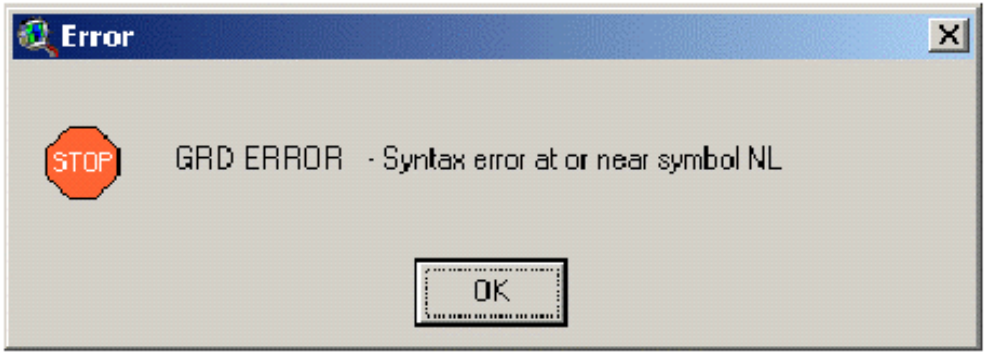
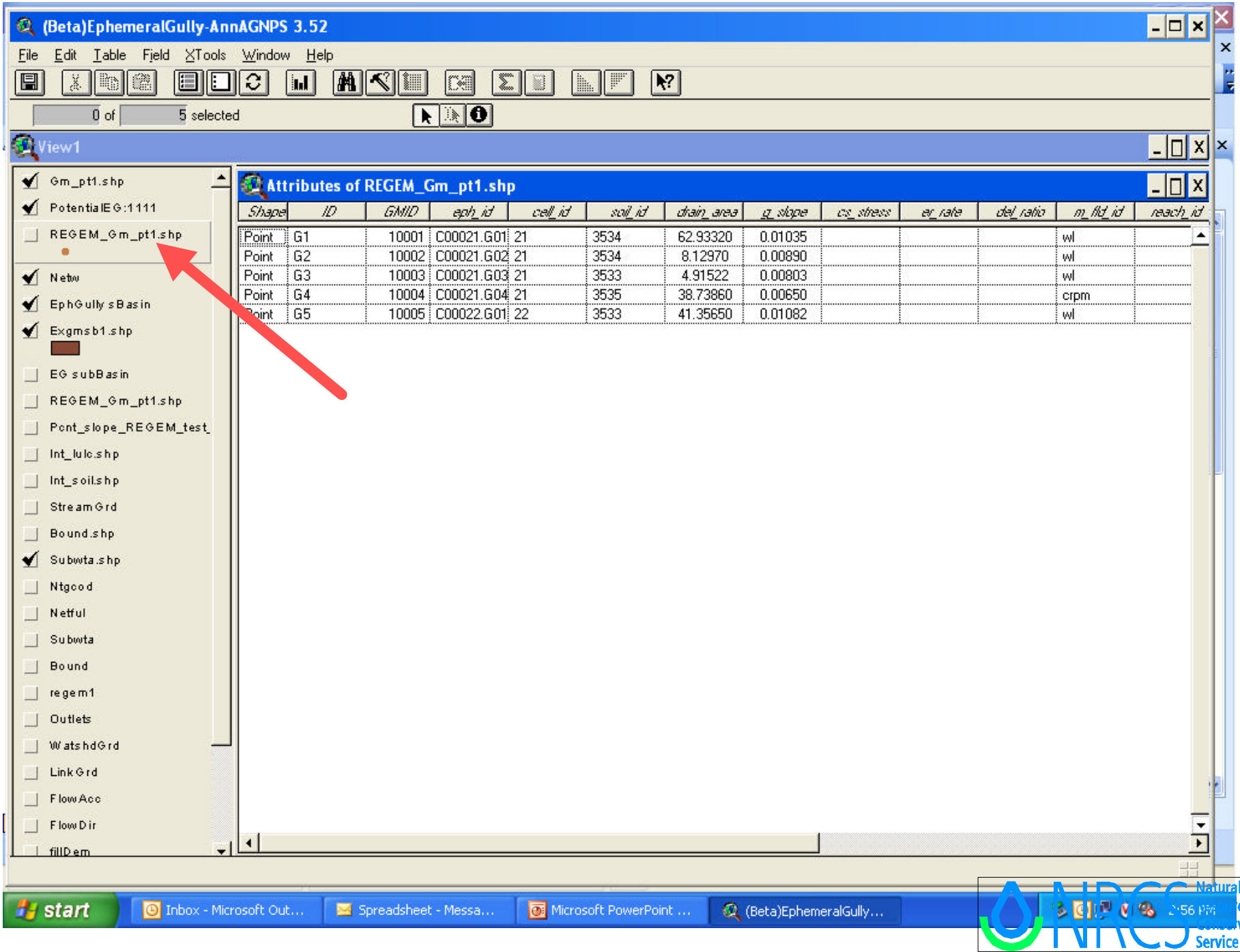
Problem: Extension crashes in mid-operation, producing an obscure message stating that there is a syntax error at or near symbol NL:



This is sometimes followed by the infamous Segmentation Violation message:

Sometimes ArcView crashes completely and vanishes without showing these messages; while other times it vanishes after showing these messages. Sometimes it keeps working in an unstable state.

Solution: There is no simple solution to this problem. It is due to a bug in Spatial Analyst which causes SA to crash after approximately 32,500 grid operations or if SA tries to hold > 50 grids in memory at one time. You can force the error to occur by writing a short script that checks the cell value at a particular point, then loops over 32,500 iterations. You can also trigger it by running the Zonal Statistics function on a point theme containing over 32,500 points or trying to do any grid operation that accesses > 50 grids.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File Edit Table Field XTools Window Help
0 of 5 selected
View1
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REGEM_Gm_pt1.shp
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Exgmsb1.shp
EG subBasin
REGEM_Gm_pt1.shp
Pont_slope_REGEM_test_
Int_lulc.shp
Int_soil.shp
StreamGrd
Bound.shp
Subwta.shp
Ntgcod
Netful
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LinkGrd
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Point G2 10002 C00021.G02 21 3534 8.12970 0.00890 wl
Point G3 10003 C00021.G03 21 3533 4.91522 0.00803 wl
Point G4 10004 C00021.G04 21 3535 38.73860 0.00650 crpm
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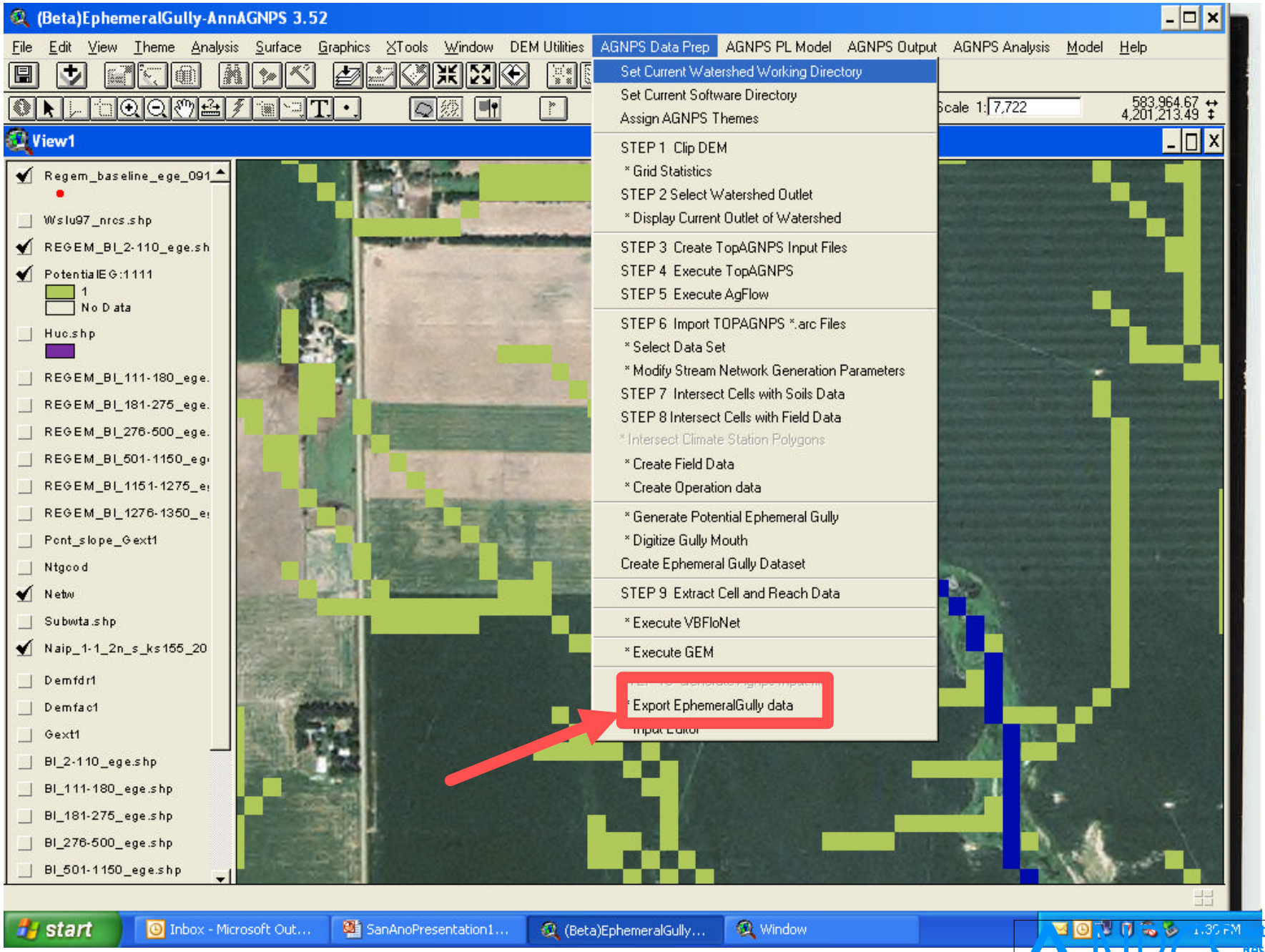
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* Create Operation data
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* Digitize Gully Mouth
Create Ephemeral Gully Dataset
STEP 9 Extract Cell and Reach Data
* Execute VBFloNet
* Execute GEM
* Export EphemeralGully data
View1
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Wslu97_nrcs.shp
REGEM_BI_2-110_ege.sh
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REGEM_BI_1276-1350_e
Pcnt_slope_Gext1
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Netw
Subwta.shp
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Demfac1
Gext1
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Natural Resources Conservation Service
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Watershed: 2KS_CEAP_0508_26

No. Gullies: 989

The following field set repeats for the number of gullies (specified above). Multiple gullies for a cell should be grouped consecutively.

Ephemeral Gully ID:	C00372.G02
1st Cell ID:	372
1st Cell Gully Drainage Area:	38.6258
2nd Cell ID:	
2nd Cell Gully Drainage Area:	
Reach ID:	
Soil ID:	3535
Slope:	0.00714
Management Field ID:	wm
Calibration Factor:	
Delivery Ratio:	

Gully Mannings 'n':	
Critical Shear Stress:	
Erodibility Rate:	
1st Cell Subcell Drainage Area:	173.99
Re-Plant Period:	
Erosion Depth:	

Current Gully: 41

Previous | Next

Insert | Replicate | Delete

Delete ALL | Forget | Accept

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KS Cheney Lake Conservation Effects Assessment Program (CEAP) Scenarios

1. **Baseline_No Conservation Treatment** - PreProgram – Existing landuse base; No Waterway; No terraces; No CRP; all cropland-conventional tillage; Range - 97 conditions
2. **No Ephemeral Gully Erosion Treatment** - Ephemeral gully's treated – 97 conditions with no EG's; all Eg's receive erosion treatment.
3. **Land Base all Cropland NoTill** - Conservation Tillage – 97 landuse base; No additional terraces; No additional EG treatment; all cropland with no-till treatment
4. **Land Base all Cropland MulchTill** - Conservation Tillage – 97 landuse base; No additional terraces; No additional EG treatment; all cropland with mulch till treatment
5. **Remove CRP** – Remove CRP from 97 landuse and replace with conventional tillage; add Ephemeral Gullies's in CRP
6. **All Native Grass** - All Cheney Lake Watershed to Native grass
7. **97 current condition 70% irrigation soil moisture** - trigger for irrigation application – 50% soil moisture trigger for irrigation application.

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Questions?

Severe sheet and rill erosion on highly erodible soils in northwest Iowa after heavy rains. The spring rains fell on soils that had no protection against soil erosion.