



Turbidity Standards

Redwood – Cottonwood Rivers Control Area (RCRCA)

Classes (and descriptions) related to
303(d) list use support:

Turbidity (NTUs)

1B - (drinking water)	10
2A - (cold water fishery, all recreation)	10
2B - (cool & warm water fishery, all recreation)	25
2C - (indigenous fish, most recreation)	25



Turbidity and it's effects

Redwood – Cottonwood Rivers Control Area (RCRCA)

- Turbidity in water is caused by suspended soil particles, algae, etc., that scatter light in the water column making the water appear cloudy.
- Excess turbidity can significantly degrade the aesthetic qualities of water bodies.
- People are less likely to recreate in waters degraded by excess turbidity.
- Also, turbidity can make the water more expensive to treat for drinking or food processing uses.
- Turbidity values that exceed the standard can harm aquatic life.
- Aquatic organisms may have trouble finding food, gill function may be affected, and spawning beds may be covered.



What is Turbidity?

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Turbidity is an expression of the optical property of a sample of water which causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. It is caused by the presence of suspended matter such as clay, silt, finely divided organic matter, bacteria, plankton and other microscopic organisms. In the past, some publications used the terms “turbidity” and “suspended solids” almost synonymously. However, the degree of turbidity is not equal to the concentration of suspended solids, but is only an expression of one effect of suspended solids upon the character of the water.



What is Turbidity? - cont

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Measurement of turbidity is based upon a comparison of the amount of light passing through the given water sample with that passing through a standard sample.

Turbidity is measured in standard units, defined in terms of the depth of water to which a candle flame can be clearly distinguished (McKee and Wolf, 1971).

Turbidity is measured in nephelometric turbidity units (NTUs)



Factors Affecting Turbidity

Redwood – Cottonwood Rivers Control Area (RCRCA)

- The largest component of the particles creating turbidity in rivers is caused by the erosion of materials from the contributing watershed. These materials may be clay, silt, mineral particles from soils or organic matter.
- To understand the formation of turbidity, it is important to understand the hydrologic cycle.
- Watershed characteristics (size, slopes, soils, land use and cover, etc.) affect runoff patterns and stream flows which in turn affect the amount of suspended particles in the water which then creates turbidity.
- Precipitation events often provide for increased turbidity levels due to increased runoff and stream flows which can cause surface erosion and channel erosion.
- Turbidity in streams and rivers is a constantly changing phenomenon. During dry periods, when no precipitation occurs, turbidity levels usually drop to a somewhat stable value for the stream. A precipitation event in the watershed can then bring additional suspended material into the stream and greatly increase the turbidity. Generally, the more intense the precipitation event, the higher the turbidity values experienced in the stream.



Turbidity factors

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Water quality measurements that can help in the characterization of turbidity include total suspended solids, volatile suspended solids, total dissolved solids, suspended sediment concentration, chlorophyll a, and particle size analysis.



Turbidity surrogates

Redwood – Cottonwood Rivers Control Area (RCRCA)

T-tubes (transparency-tubes) and TSS readings can serve as surrogates for locations with insufficient numbers of turbidity (NTU) observations.

T-tube readings of less than 20 cm. represent an impairment to that waterway.

TSS readings of over 60 mg/L in our ecoregions (Western Corn Belt Plains & Northern Glaciated Plains) represent an impairment as well.



Redwood River Watershed Background

Redwood – Cottonwood Rivers Control Area (RCRCA)

People

- Population: Just over 27,000 people
- Rural area, 81% in towns and communities
- 66% of population resides in Marshall and Redwood Falls

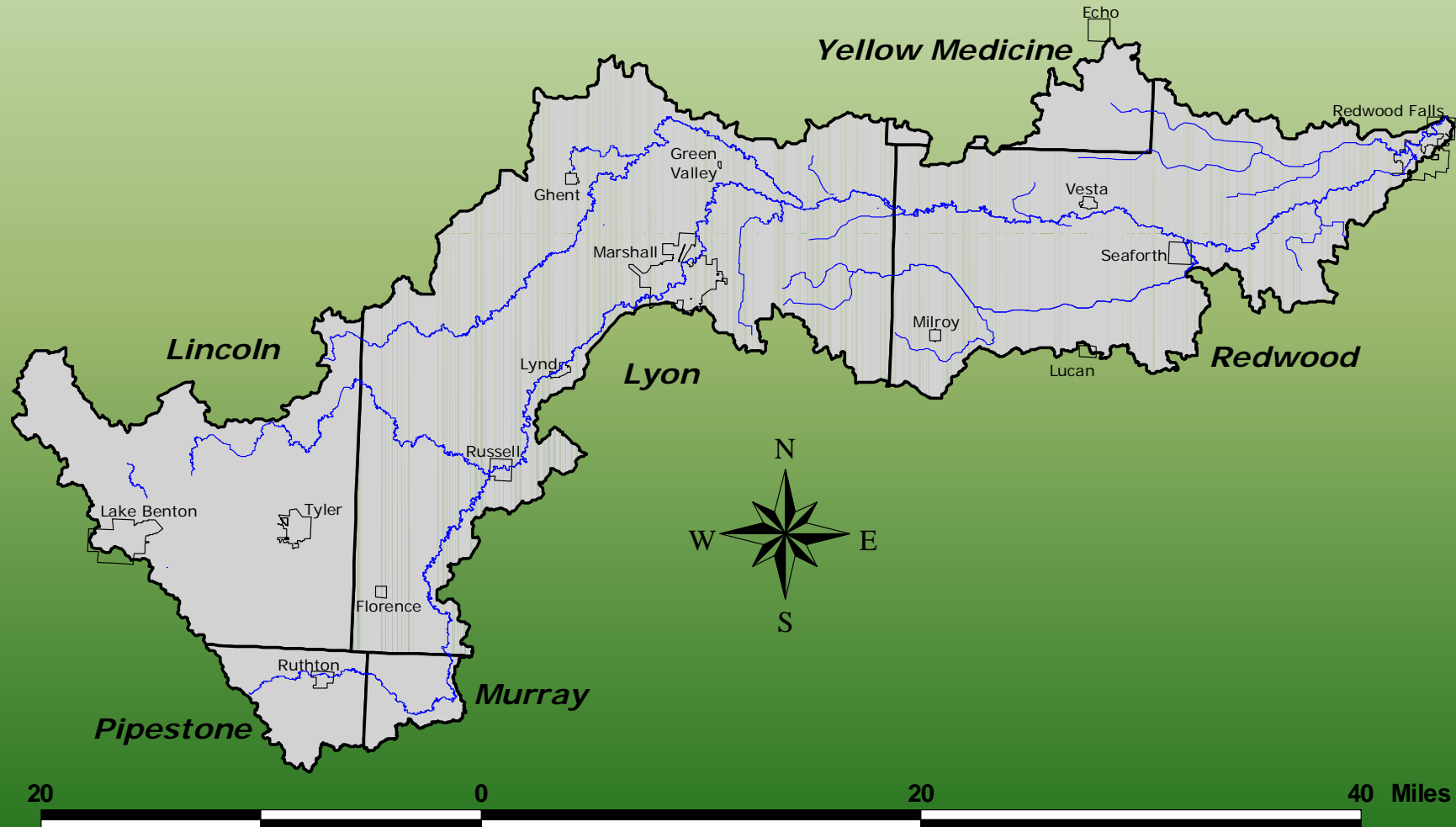
Native Landscape

- Prairie, scattered shrubs and trees w/small (pothole) lakes and seasonal wetlands
- Riparian woodlands/thicker on steep terrain



Redwood River Watershed

Redwood – Cottonwood Rivers Control Area (RCRCA)





Redwood River Watershed Overview

Redwood – Cottonwood Rivers Control Area (RCRCA)

Geography

- Smallest of the 12 Major contributing watersheds to the Minnesota River; 705 sq. miles
- Small portions of Murray, Pipestone and Yellow Medicine Counties
- Major portions of Lincoln, Lyon, and Redwood Counties



Redwood River Topology

Redwood – Cottonwood Rivers Control Area (RCRCA)

Coteau des Prairies (upland)

- Glacial drainage dictates surface water patterns
- Poor natural drainage/numerous ponds
- Rolling belts of end moraines parallel to ridge
- Elevation drops transitioning rivers through deep, narrow valleys into the lowland flats
- River Grade: 18 ft/mi Pipestone County to Marshall



Redwood River Topology

Redwood – Cottonwood Rivers Control Area (RCRCA)

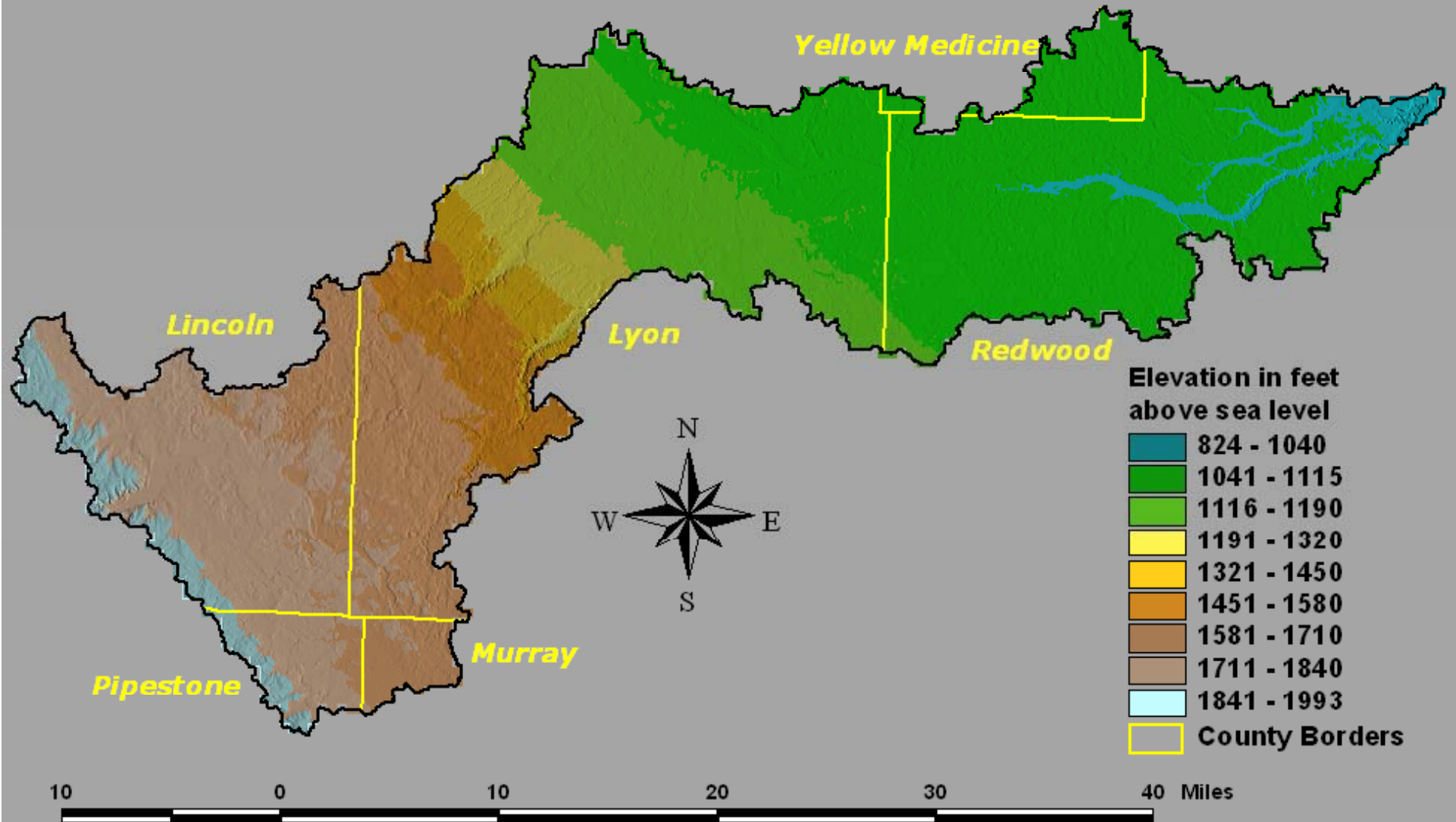
Lowland Plains

- Ground moraines overlying bedrock
- Gentle rolling to flat
- Mostly used for row-crop farming eased by extensive artificial drainage
- River straightened from MN-23 to Seaforth (designated JD 37)
- River grade: 4ft/mile from Marshall to RWF
- River falls 24 ft/mi from RWF to the Minn. R



Redwood Watershed Elevation

Redwood – Cottonwood Rivers Control Area (RCRCA)





Land Use in Redwood River Watershed

Redwood – Cottonwood Rivers Control Area (RCRCA)

Land Use	Redwood River Watershed	
	Acres	%
Coniferous Forest	1.78	0.00
Cultivated Land	385,663.30	85.47
Deciduous Forest	11,562.91	2.56
Exposed Soil, Sandbars, & Sand Dunes	38.06	0.01
Farmsteads & Rural Residences	5,550.21	1.23
Grassland	32,871.35	7.28
Grassland-Shrub-Tree (Deciduous)	392.17	0.09
Gravel Pits & Open Mines	260.94	0.06
Other Rural Developments	689.68	0.15
Rural Residential Development	155.76	0.03
Transitional Agricultural Land	394.50	0.09
Water	6,799.56	1.51
Wetlands	2,100.18	0.47
Other	4,769.10	1.06
Totals	451,249.49	100.00



Cottonwood River Watershed Background

Redwood – Cottonwood Rivers Control Area (RCRCA)

People

- Population: Just under 21,000 people
- Rural area, 55% in towns and communities
- Small portions of Marshall and New Ulm effect the watershed with storm water runoff

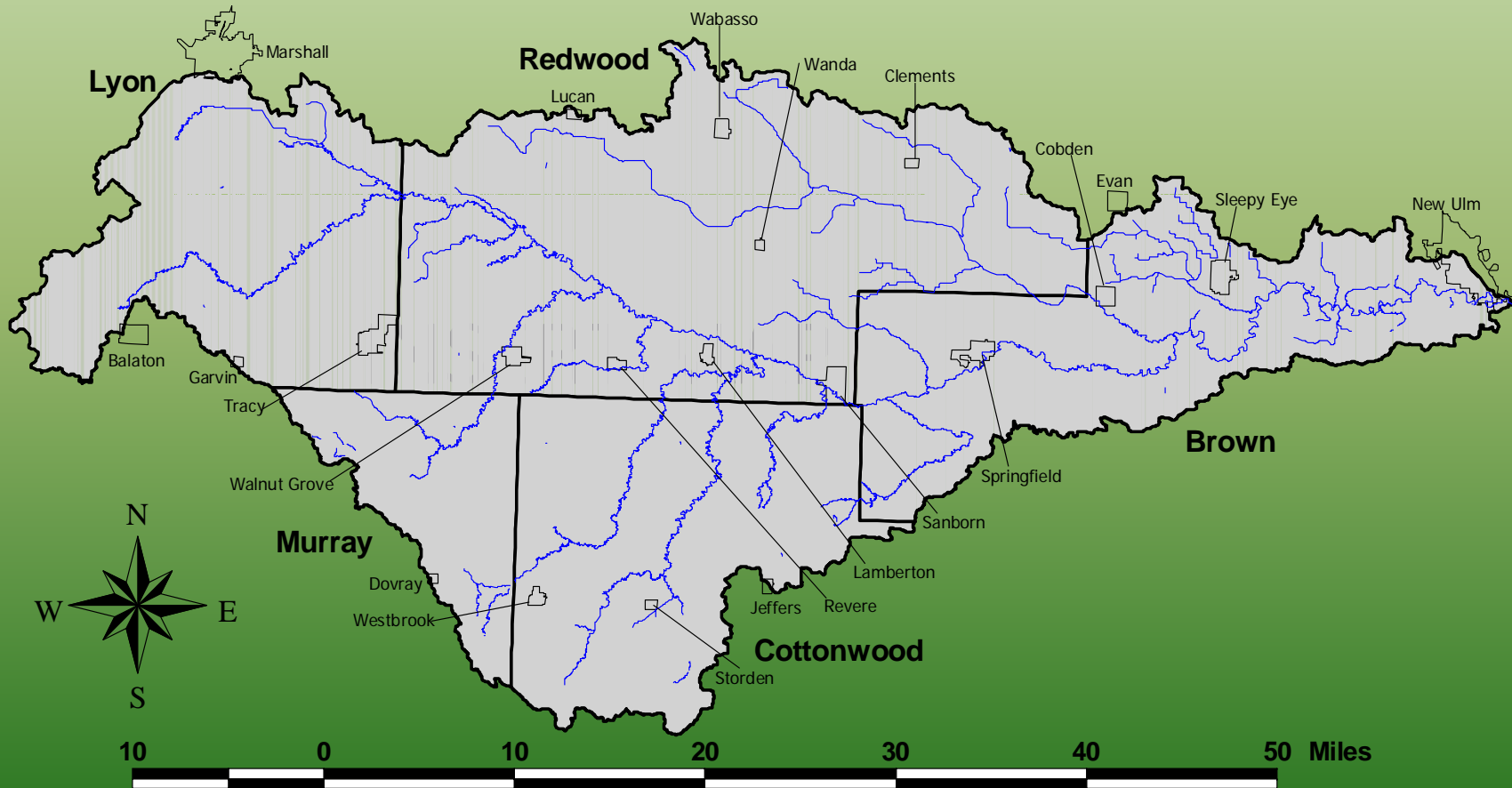
Native Landscape

- Prairie, scattered shrubs and trees w/small (pothole) lakes and seasonal wetlands
- Riparian woodlands/thicker on steep terrain



Cottonwood River Watershed

Redwood – Cottonwood Rivers Control Area (RCRCA)





Cottonwood River Watershed Overview

Redwood – Cottonwood Rivers Control Area (RCRCA)

Geography

- 7th largest of the 12 Major contributing watersheds to the Minnesota River; 1312 sq. miles
- Small portion of Murray County
- Major portions of Brown, Cottonwood, Lyon, and Redwood Counties



Cottonwood River Topology

Redwood – Cottonwood Rivers Control Area (RCRCA)

Coteau des Prairies (upland)

- Glacial drainage dictates surface water patterns
- Poor natural drainage/numerous ponds
- Rolling belts of end moraines parallel to ridge
- Elevation drops from SW to NE
- Cottonwood River flows generally east
- River Grade: 1650 ft elevation in southwest Lyon County to 790 ft elevation in New Ulm



Cottonwood River Topology

Redwood – Cottonwood Rivers Control Area (RCRCA)

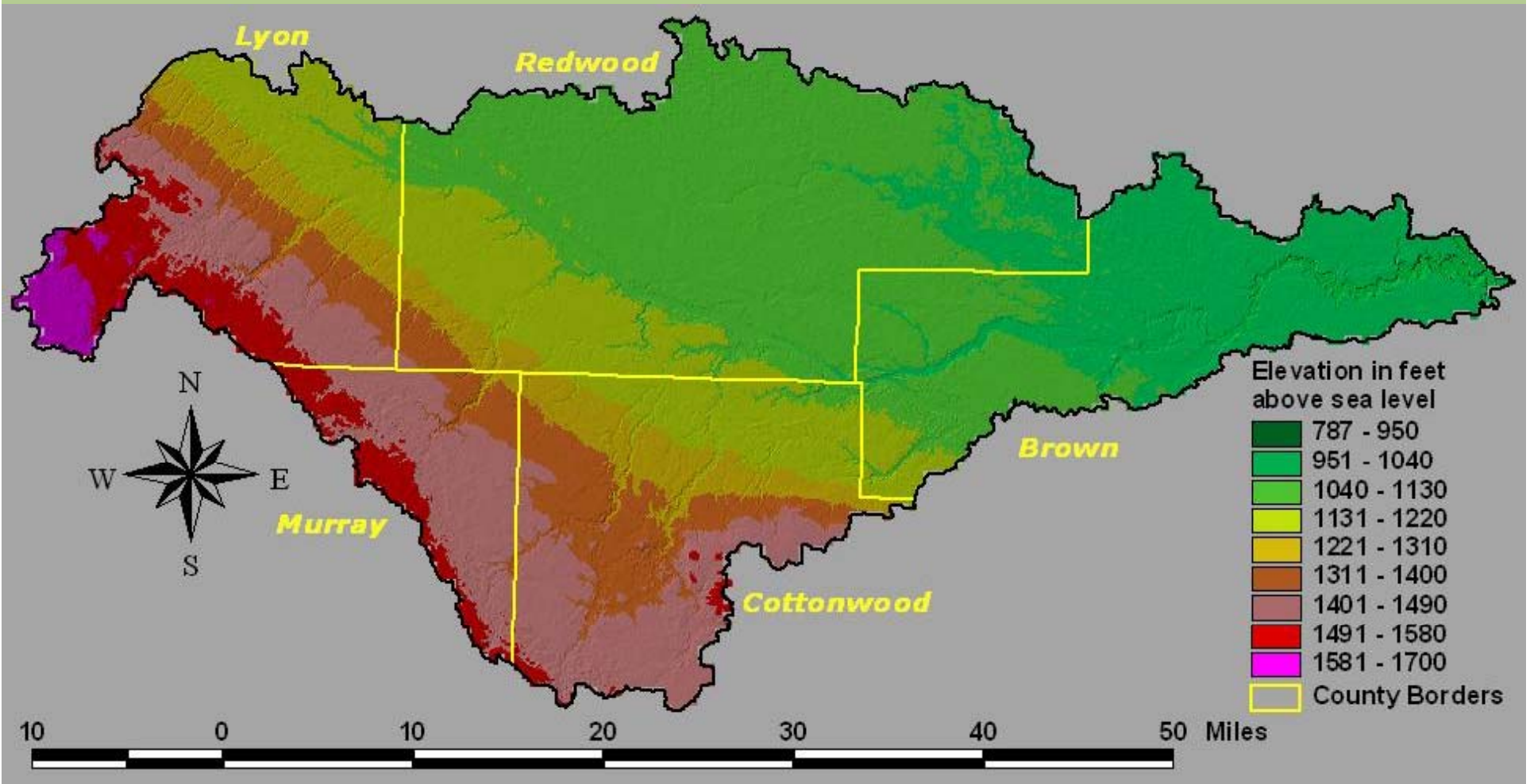
Lowland Plains

- Ground moraines overlying bedrock
- Gentle rolling to flat
- Mostly used for row-crop farming eased by extensive artificial drainage
- River grade: averages 7.5 ft/mile from headwaters to confluence w/ Minnesota R.
- River falls 20 ft/mi through New Ulm to the Minn. R



Cottonwood Watershed Elevation

Redwood – Cottonwood Rivers Control Area (RCRCA)





Land Use in Cottonwood River Watershed

Redwood – Cottonwood Rivers Control Area (RCRCA)

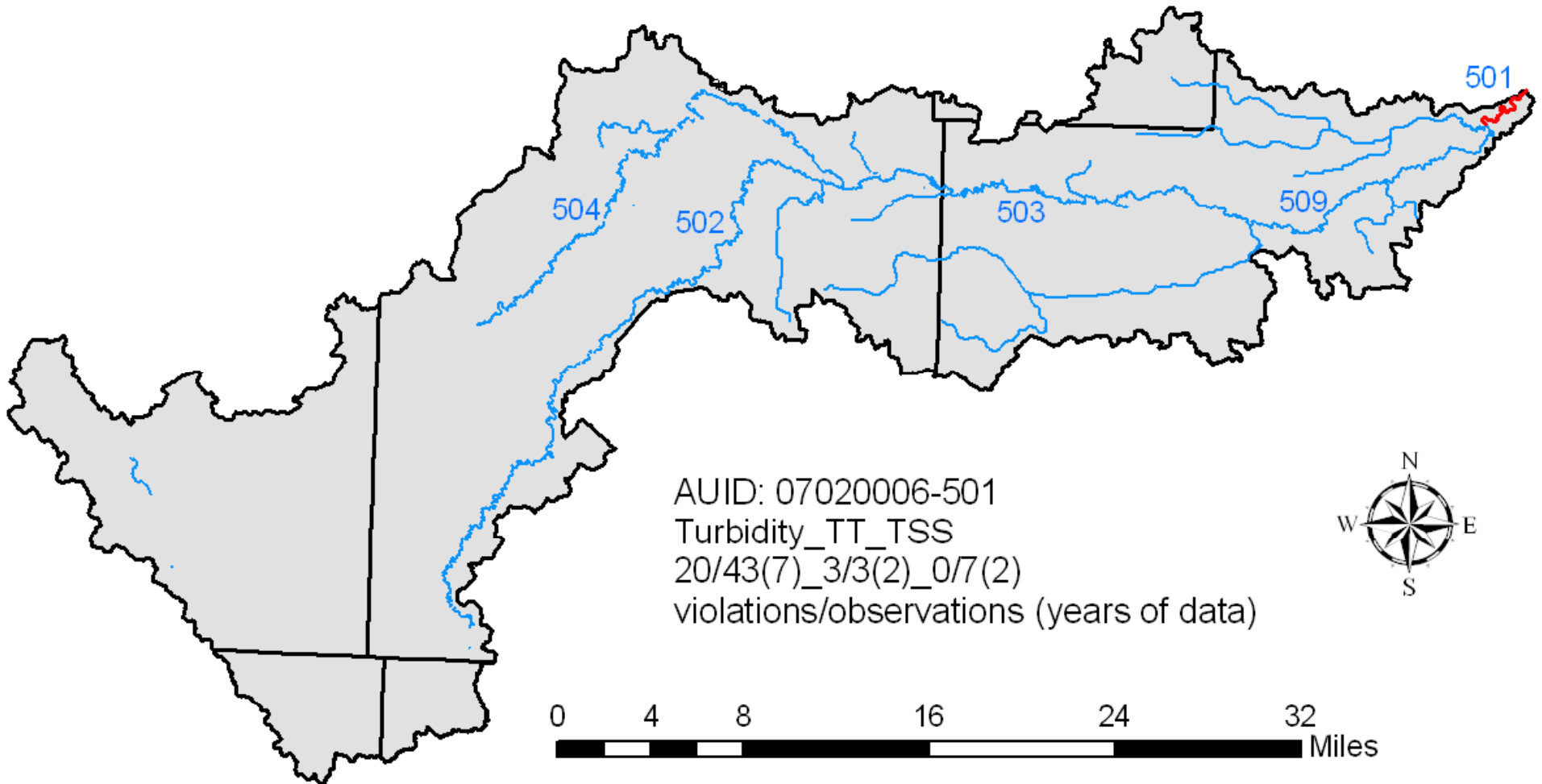
Cottonwood River Watershed

Land Use	Acres	%
Cultivated Land	738,911.72	87.95%
Deciduous Forest	24,935.13	2.97%
Exposed Soil, Sandbars, & Sand Dunes	90.55	0.01%
Farmsteads & Rural Residences	10,991.01	1.31%
Grassland	47,908.23	5.70%
Grassland-Shrub-Tree (Deciduous)	715.38	0.09%
Gravel Pits & Open Mines	247.32	0.03%
Other Rural Developments	1,256.71	0.15%
Rural Residential Development	168.70	0.02%
Transitional Agricultural Land	422.20	0.05%
Urban and Industrial	5,351.39	0.64%
Water	5,750.74	0.68%
Wetlands	3,443.78	0.41%
Totals	840,192.86	100.00%



Turbidity Impaired Reaches

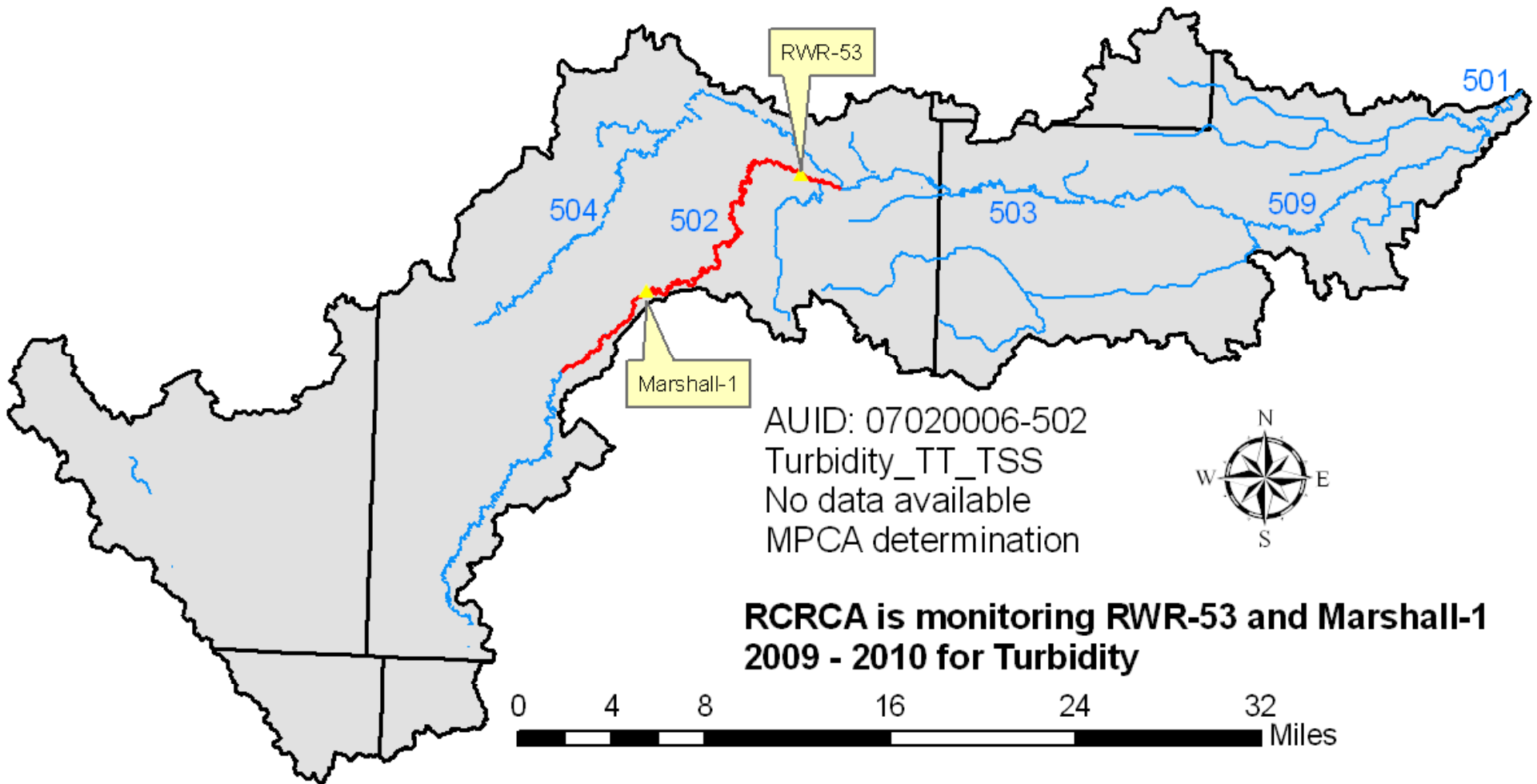
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Turbidity Impaired Reaches

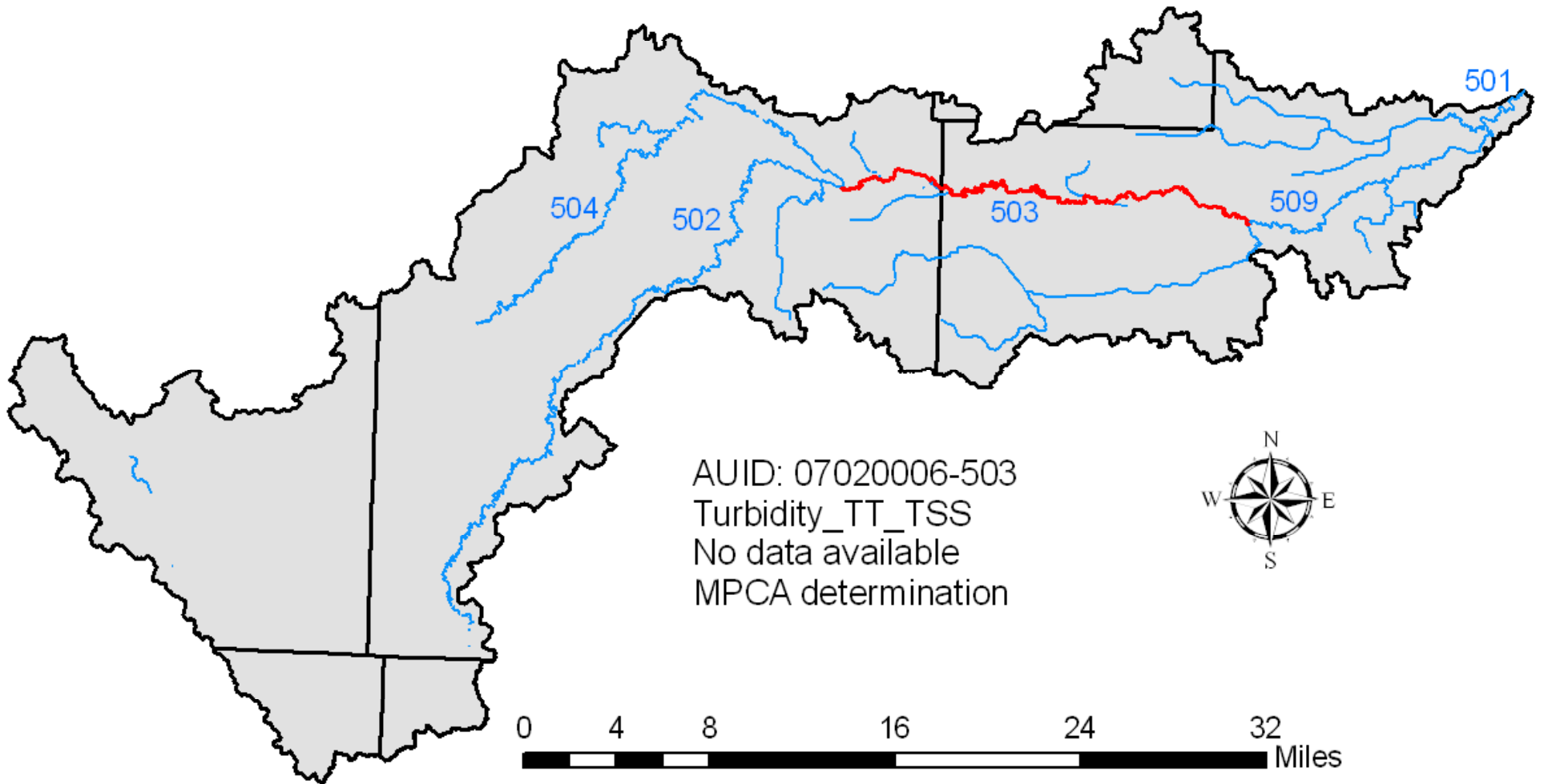
Redwood – Cottonwood Rivers Control Area (RCRCA)





Turbidity Impaired Reaches

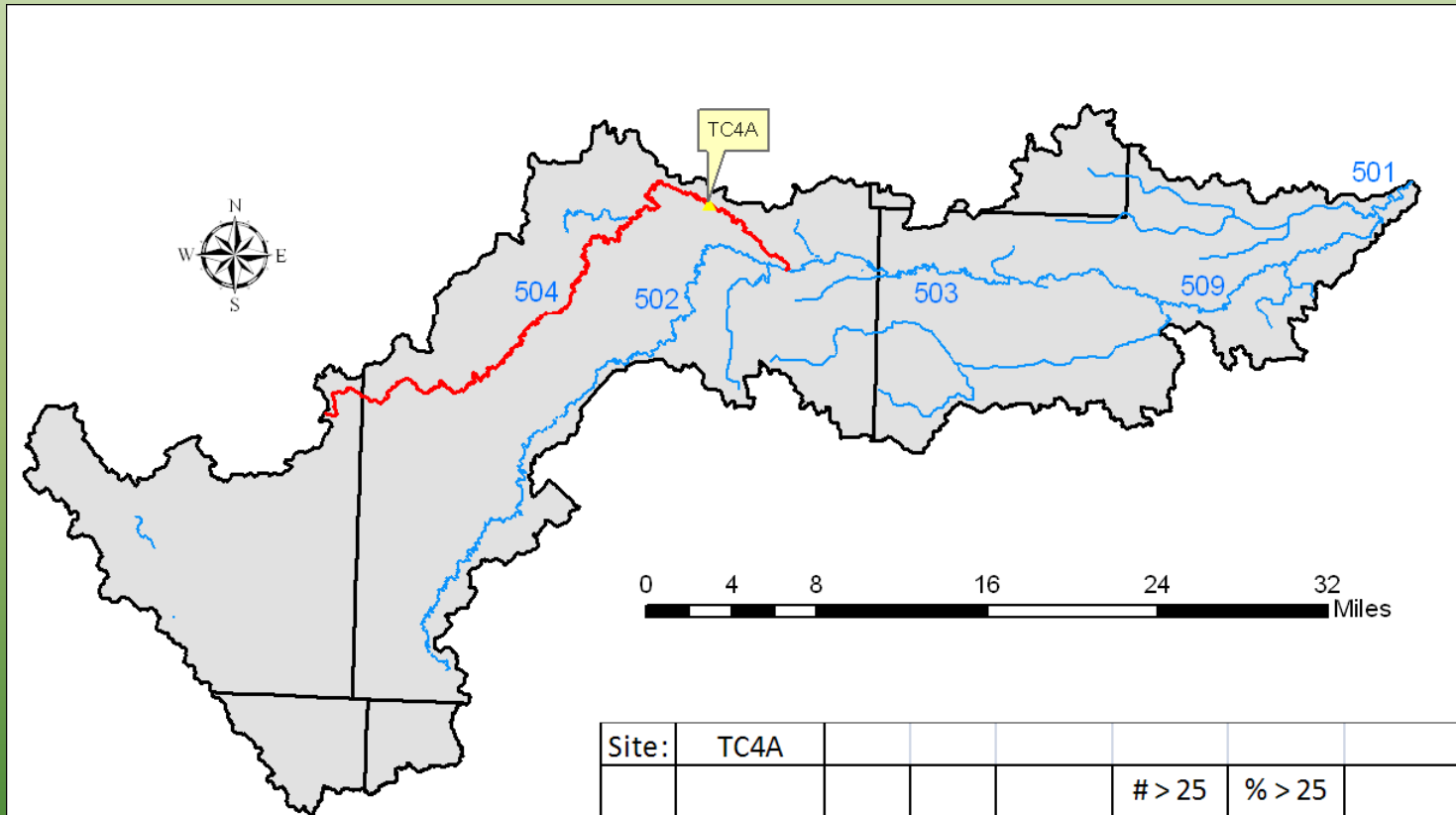
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Turbidity Impaired Reaches

Redwood – Cottonwood Rivers Control Area (RCRCA)



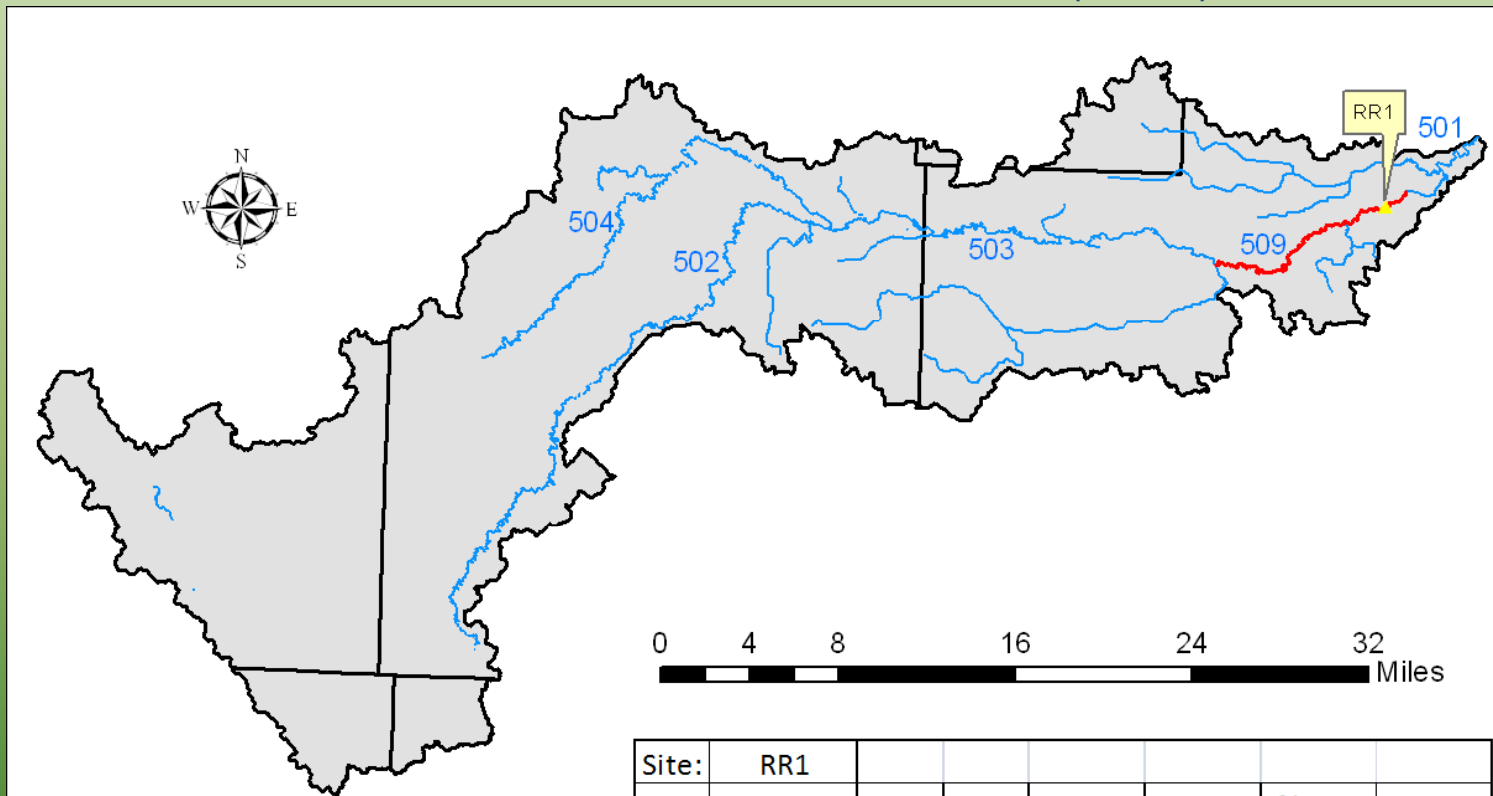
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 violations/observations (years of data)

Year	# Samples	Max	Min	Ave.	# > 25 NTU	% > 25 NTU	Median
2008	17	120	8	37.94	11	64.7%	37
2007	13	150	10	36.38	6	46.2%	25
2006	14	90	4	27.00	8	57.1%	27
2005	15	39	8	18.40	2	13.3%	16
2004	9	20	7	12.33	0	0.0%	11
2003	4	25	6	15.75	0	0.0%	16



Turbidity Impaired Reaches

Redwood – Cottonwood Rivers Control Area (RCRCA)



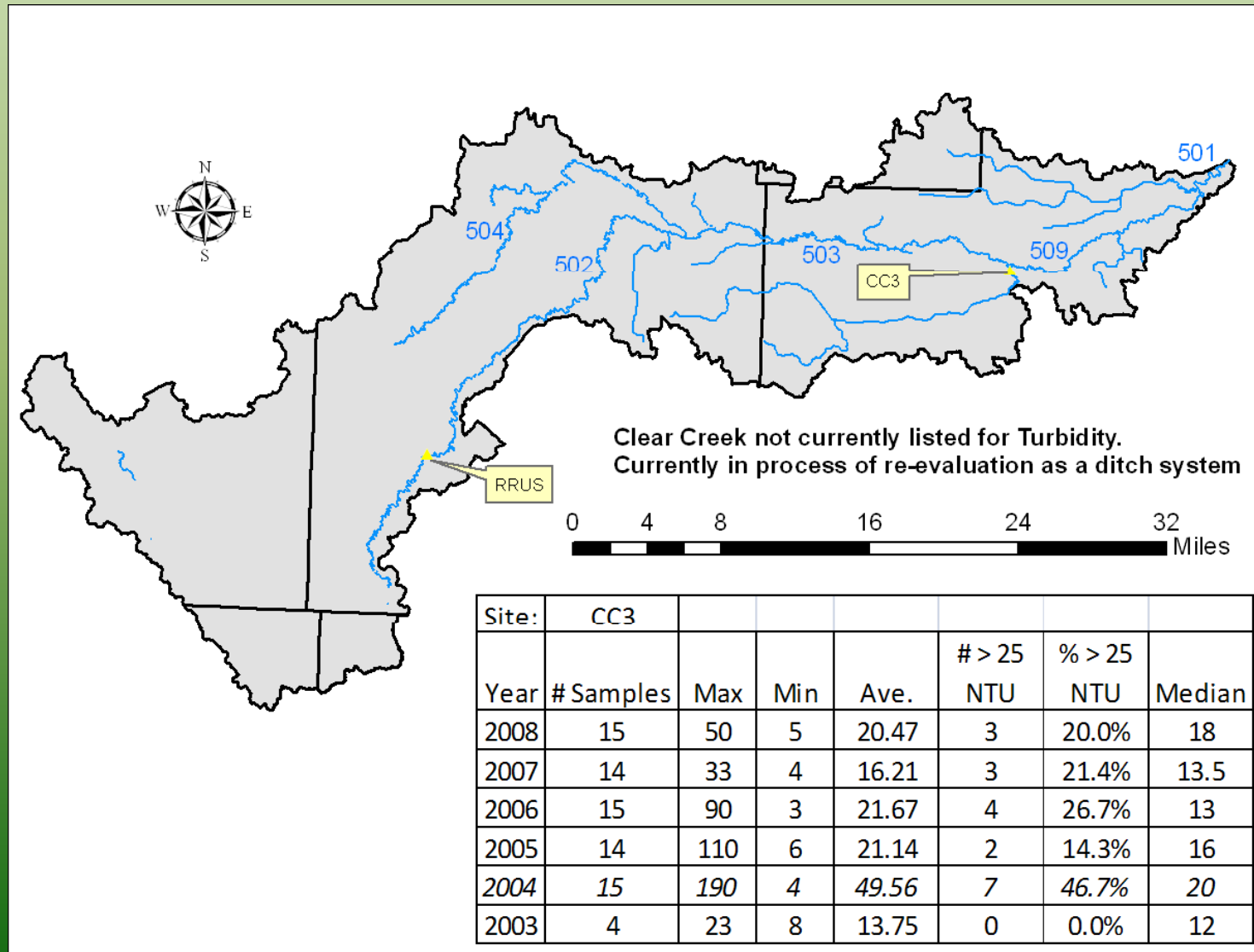
Site:	RR1						
Year	# Samples	Max	Min	Ave.	# > 25 NTU	% > 25 NTU	Median
2008	25	120	4	37.36	15	60.0%	30
2007	25	150	2	52.96	19	76.0%	48
2006	20	170	5	35.55	11	55.0%	33
2005	24	160	6	42.28	11	45.8%	24.5
2004	14	130	6.8	37.56	5	35.7%	15
2003	6	30	4	16.67	1	16.7%	16.5

AUID: 07020006-509
Turbidity_TT_TSS
24/50(4)_2/7(3)_48/72(8)
violations/observations (years of data)



RCRCA Turbidity Data

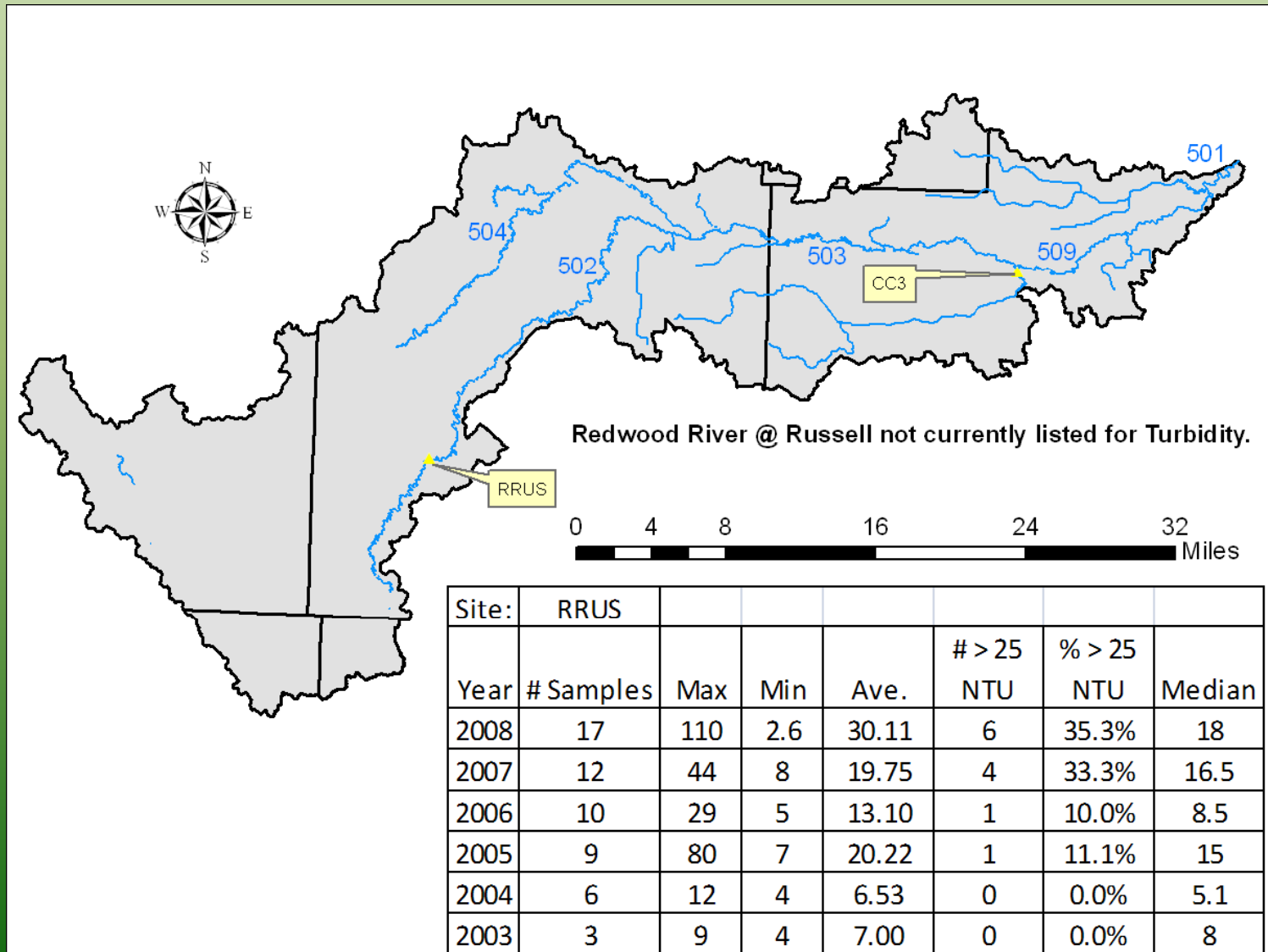
Redwood – Cottonwood Rivers Control Area (RCRCA)





RCRCA Turbidity Data

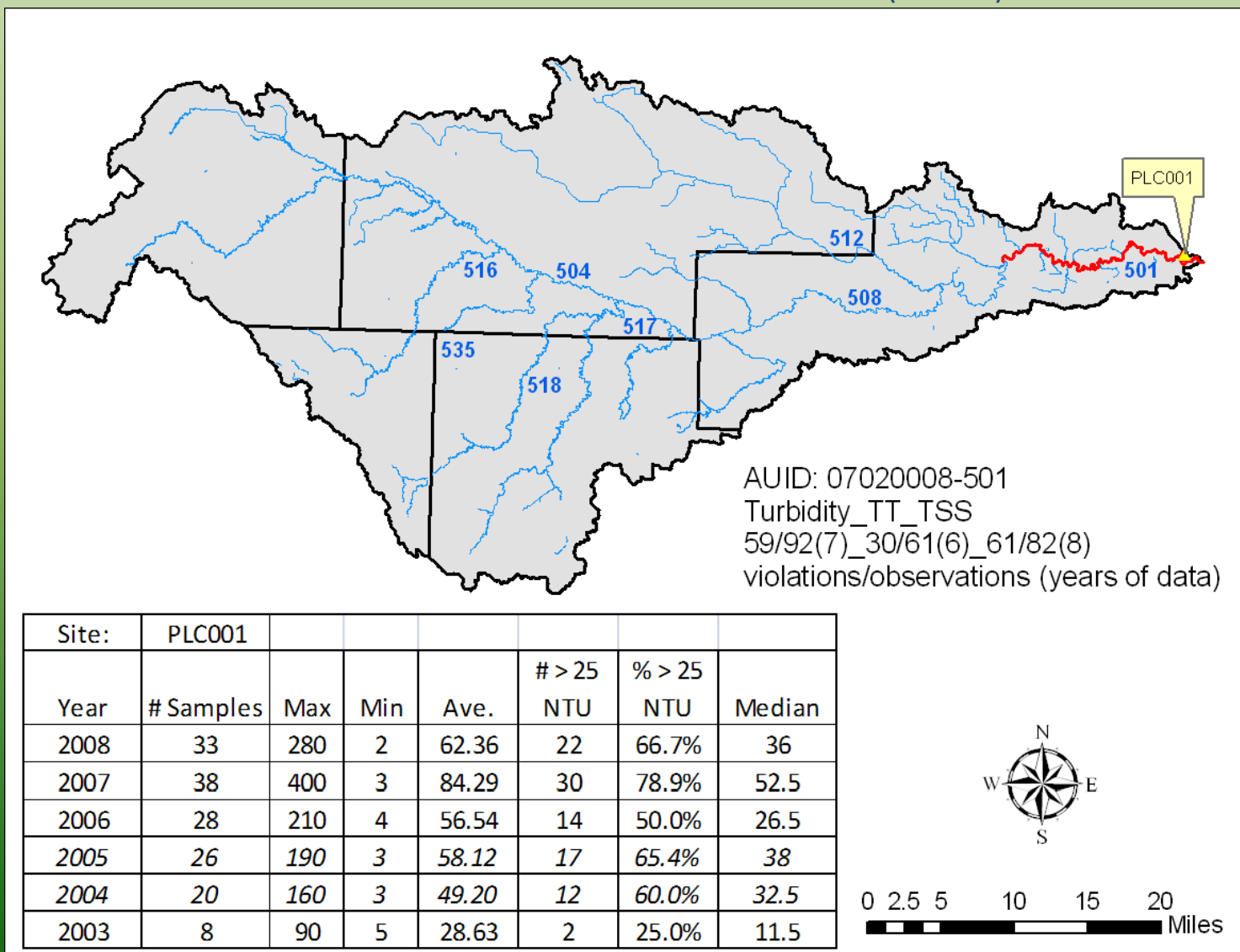
Redwood – Cottonwood Rivers Control Area (RCRCA)





Turbidity Impaired Reaches

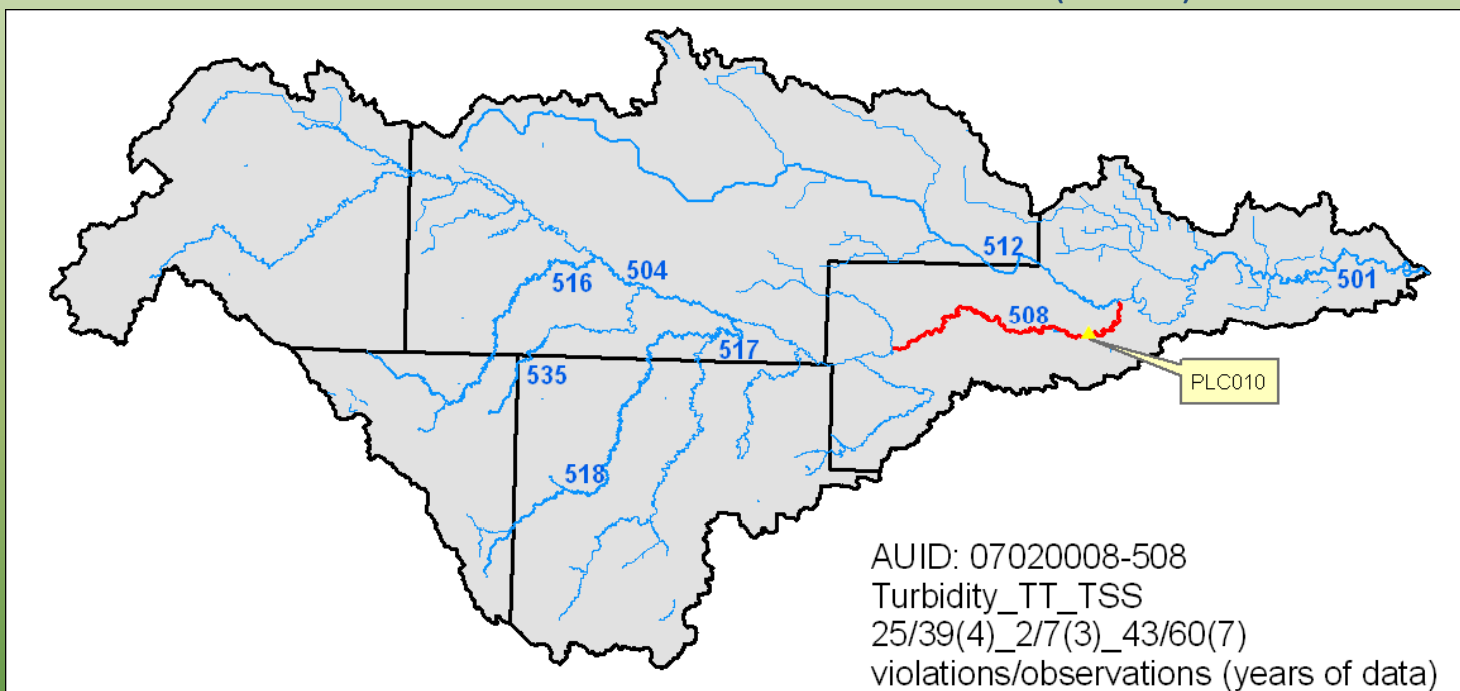
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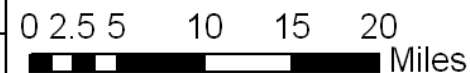
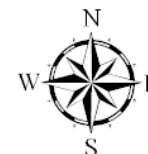


Turbidity Impaired Reaches

Redwood – Cottonwood Rivers Control Area (RCRCA)



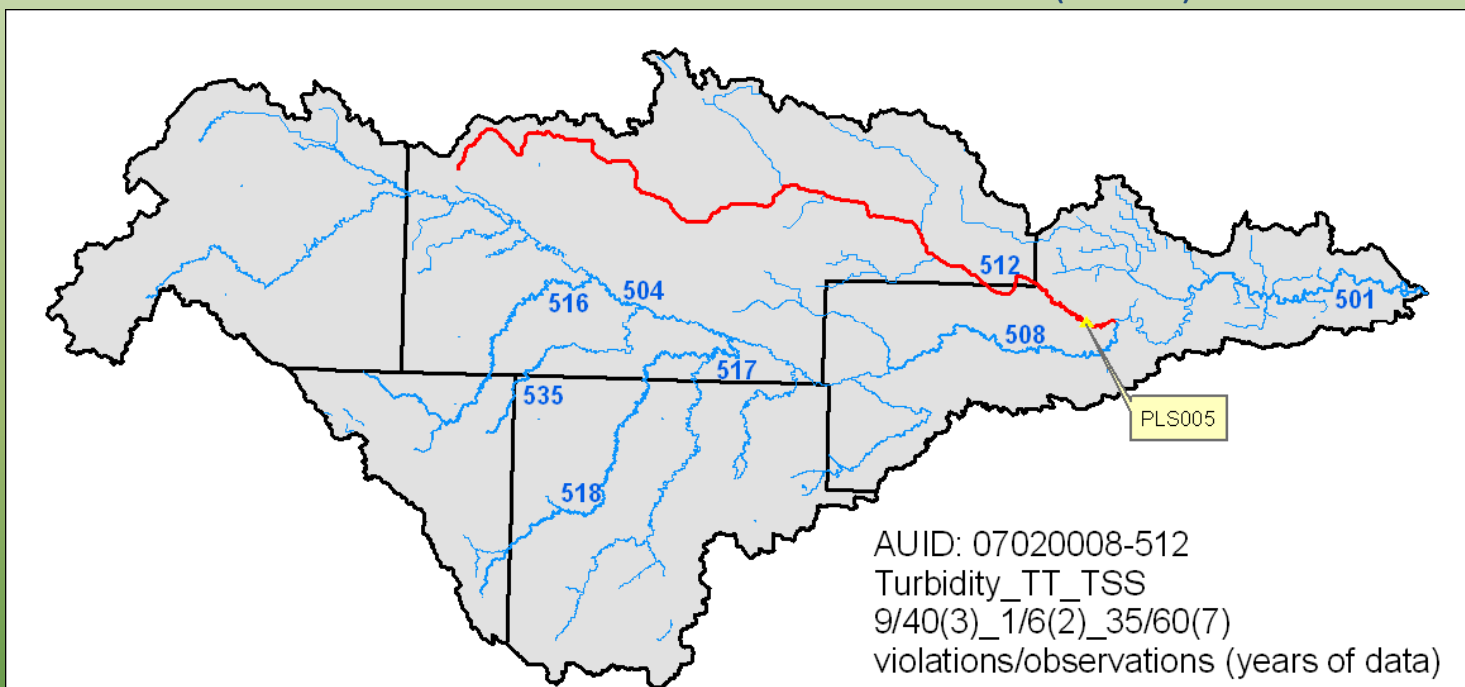
Year	# Samples	Max	Min	Ave.	# > 25 NTU	% > 25 NTU	Median
2008	16	200	11	49.38	9	56.3%	31
2007	16	140	13	50.13	11	68.8%	40
2006	17	320	12	54.53	10	58.8%	28
2005	18	160	11	59.44	13	72.2%	34
2004	13	320	6	60.92	8	61.5%	30
2003	6	38	5	24.50	3	50.0%	26





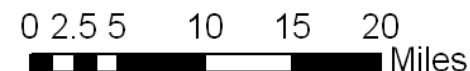
Turbidity Impaired Reaches

Redwood – Cottonwood Rivers Control Area (RCRCA)



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 violations/observations (years of data)

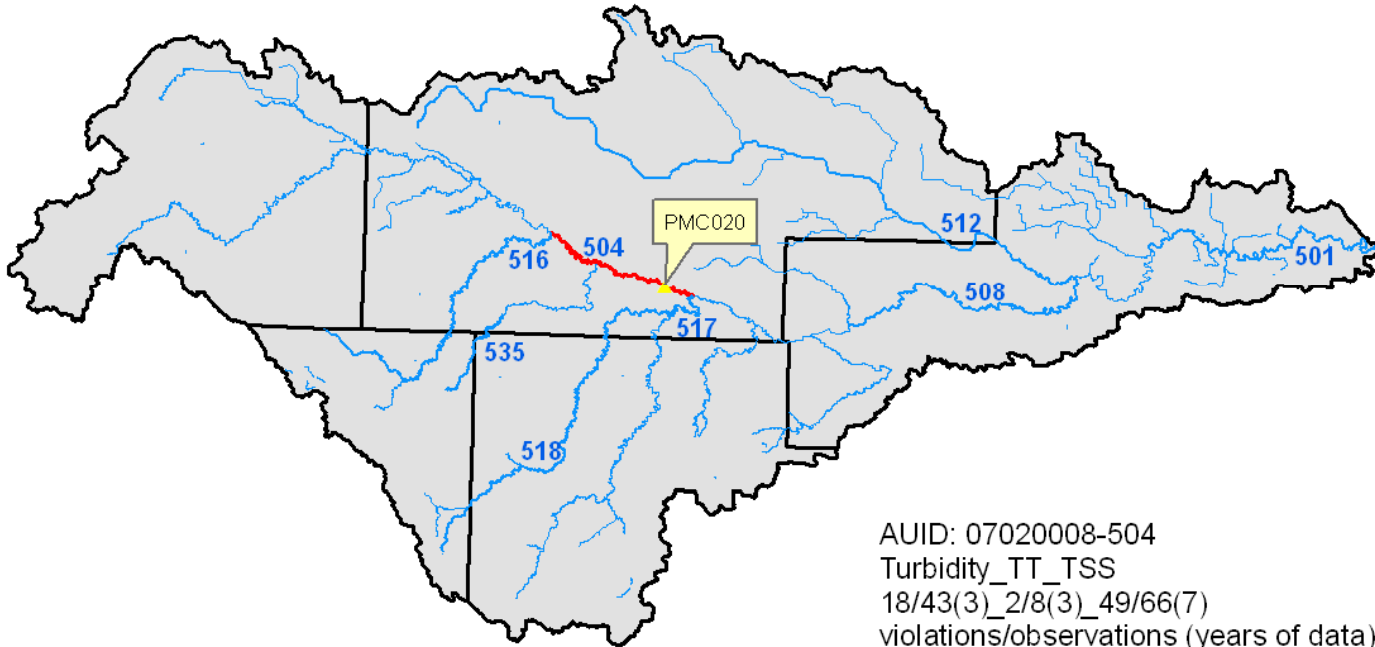
Site:	PLS005						
Year	# Samples	Max	Min	Ave.	# > 25 NTU	% > 25 NTU	Median
2008	15	82	6	22.67	4	26.7%	12
2007	14	240	6	33.93	4	28.6%	14
2006	17	120	3	26.18	5	29.4%	16
2005	19	38	6	16.37	3	15.8%	14
2004	15	110	5	36.73	6	40.0%	17
2003	5	18	7	12.80	0	0.0%	12





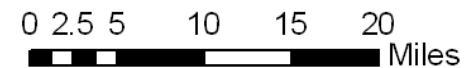
Turbidity Impaired Reaches

Redwood – Cottonwood Rivers Control Area (RCRCA)



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 Turbidity_TT_TSS
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 violations/observations (years of data)

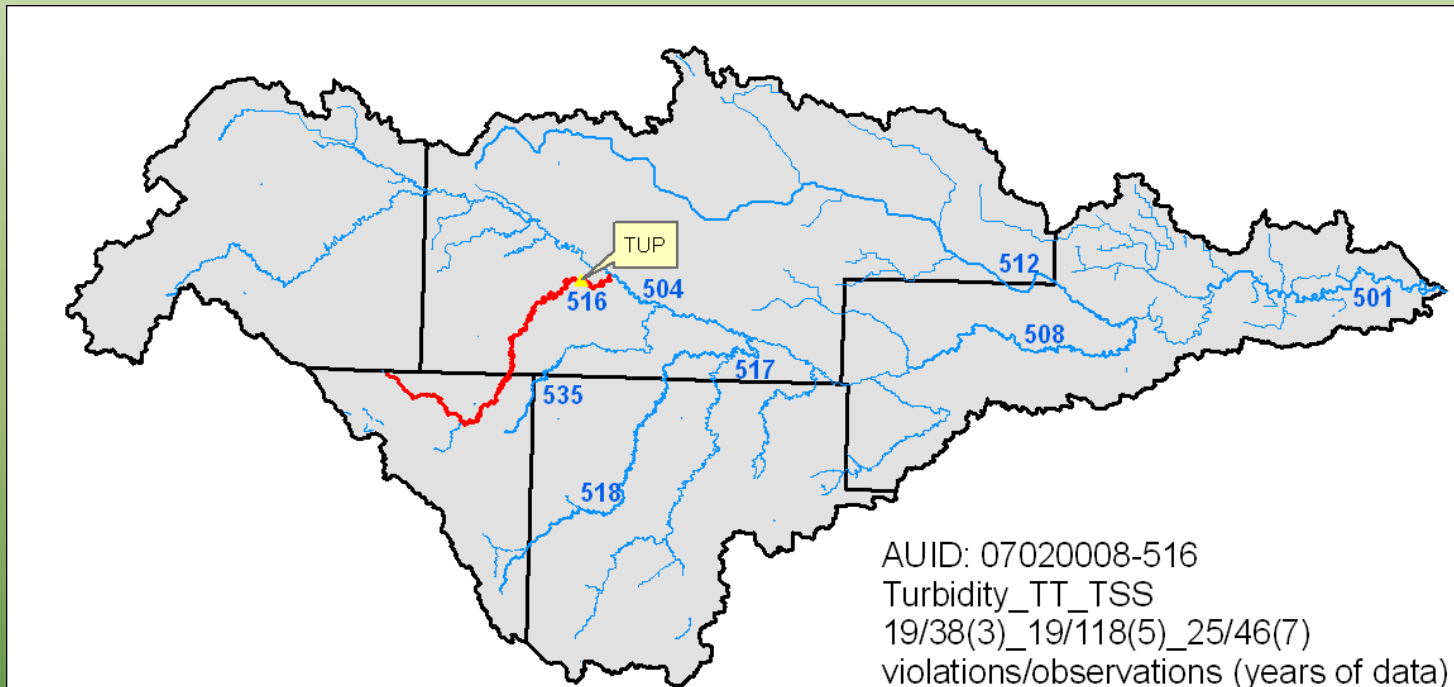
Site:	PMC020						
Year	# Samples	Max	Min	Ave.	# > 25 NTU	% > 25 NTU	Median
2008	17	98	9.8	34.05	10	58.8%	28
2007	15	140	13	47.93	11	73.3%	40
2006	17	560	10	67.24	8	47.1%	23
2005	18	100	10	33.56	7	38.9%	22
2004	15	120	10	38.00	5	33.3%	22
2003	5	27	9	17.40	1	20.0%	17





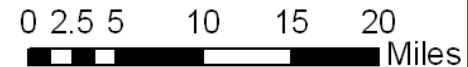
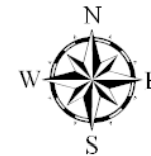
Turbidity Impaired Reaches

Redwood – Cottonwood Rivers Control Area (RCRCA)



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 violations/observations (years of data)

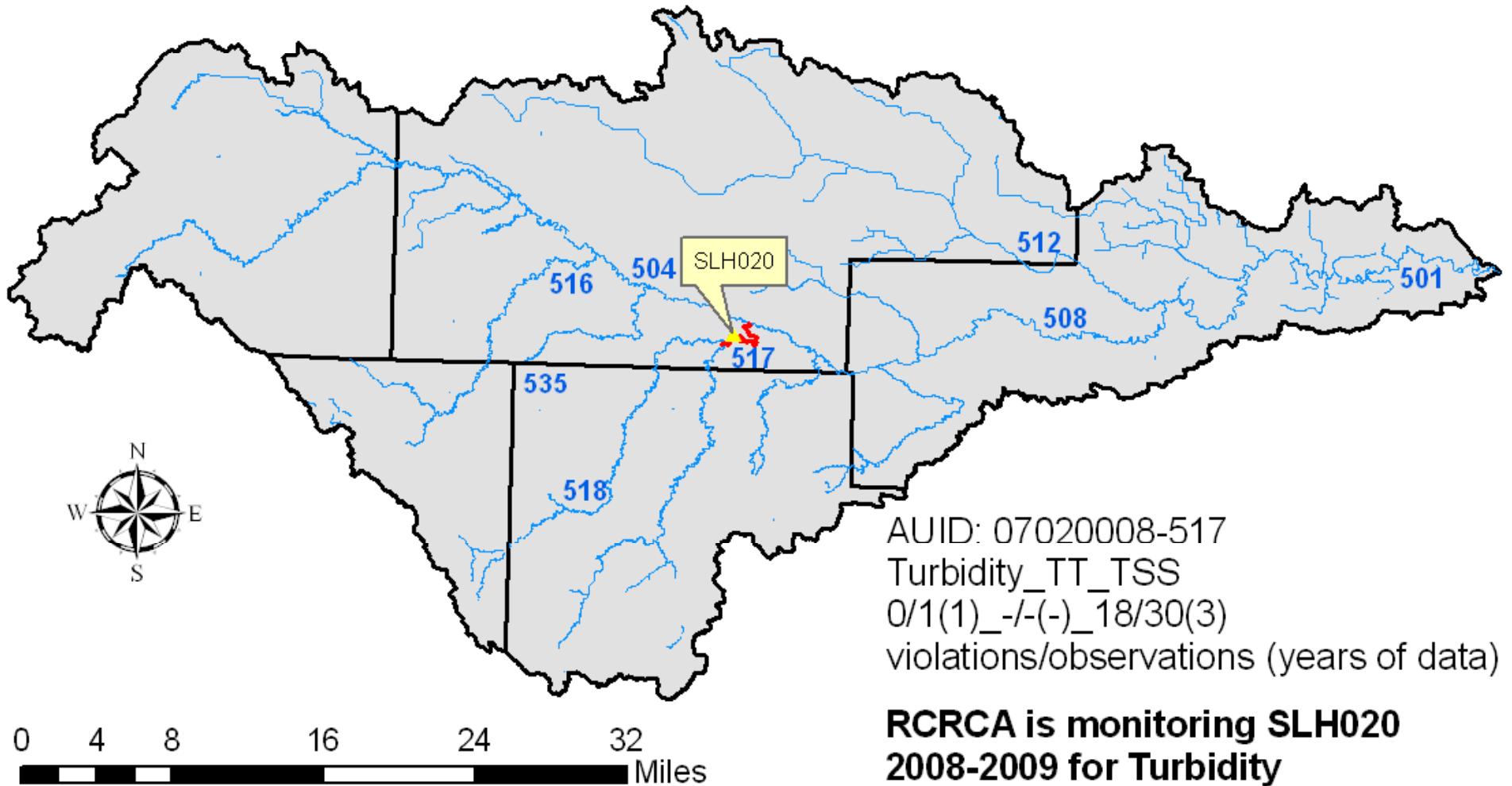
Site:	TUP						
Year	# Samples	Max	Min	Ave.	# > 25 NTU	% > 25 NTU	Median
2008	15	190	4	39.00	6	40.0%	15
2007	12	90	6	33.17	6	50.0%	27.5
2006	15	180	4	45.00	6	40.0%	16
2005	16	130	7	34.75	6	37.5%	23.5
2004	14	120	2.8	46.84	6	42.9%	20.5
2003	3	14	10	12.33	0	0.0%	13





Turbidity Impaired Reaches

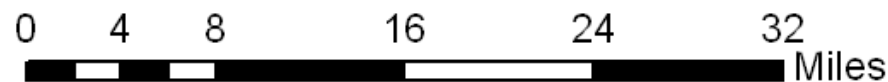
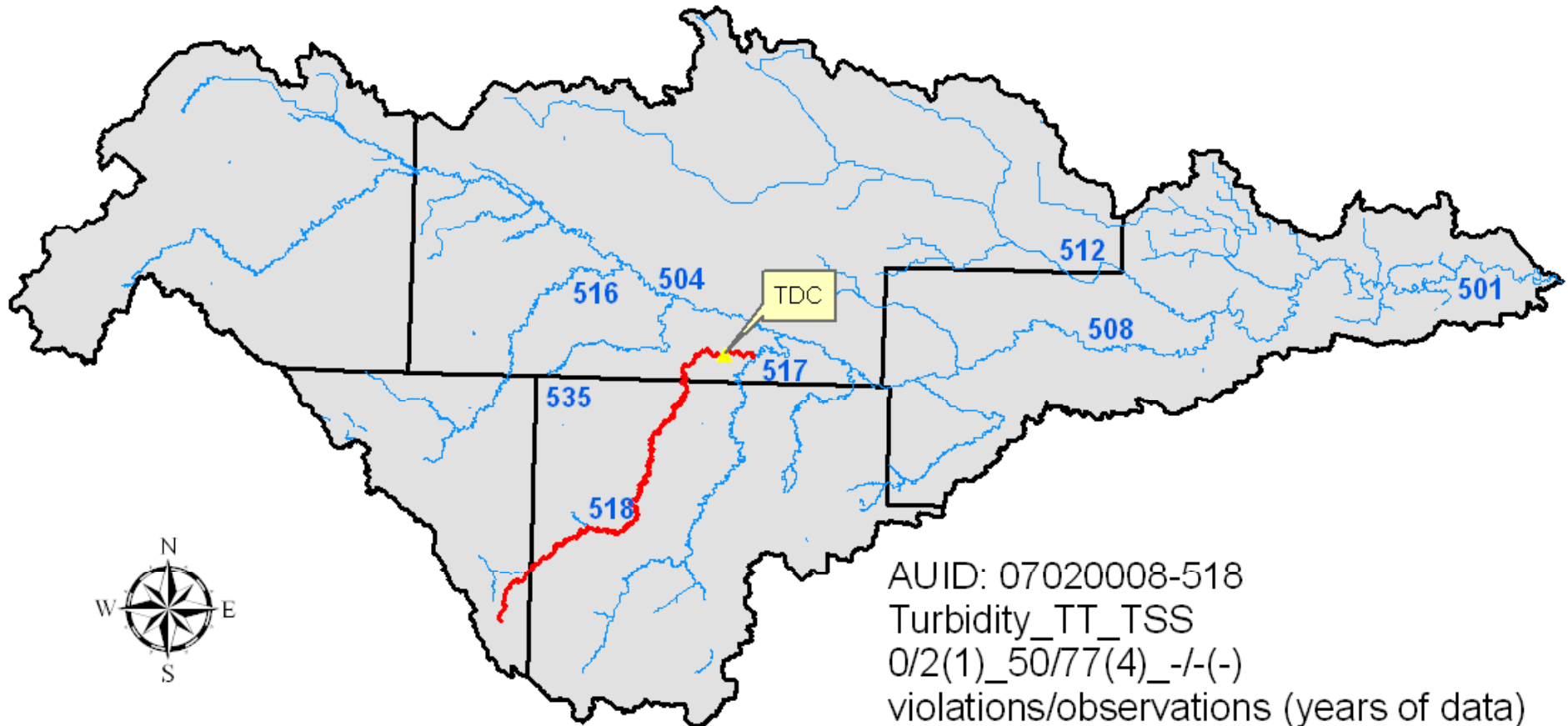
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Turbidity Impaired Reaches

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**RCRCA is monitoring TDC
2008-2009 for Turbidity**



Turbidity Impaired Reaches

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