# Fish Farm Groundwater Pumping Impacts to Spring and Stream Flows to Blotz Branch and Dodge Branch Creeks, Dodgeville Wisconsin

Kenneth Wade, P.E., P.G., Kenneth Wade Consulting

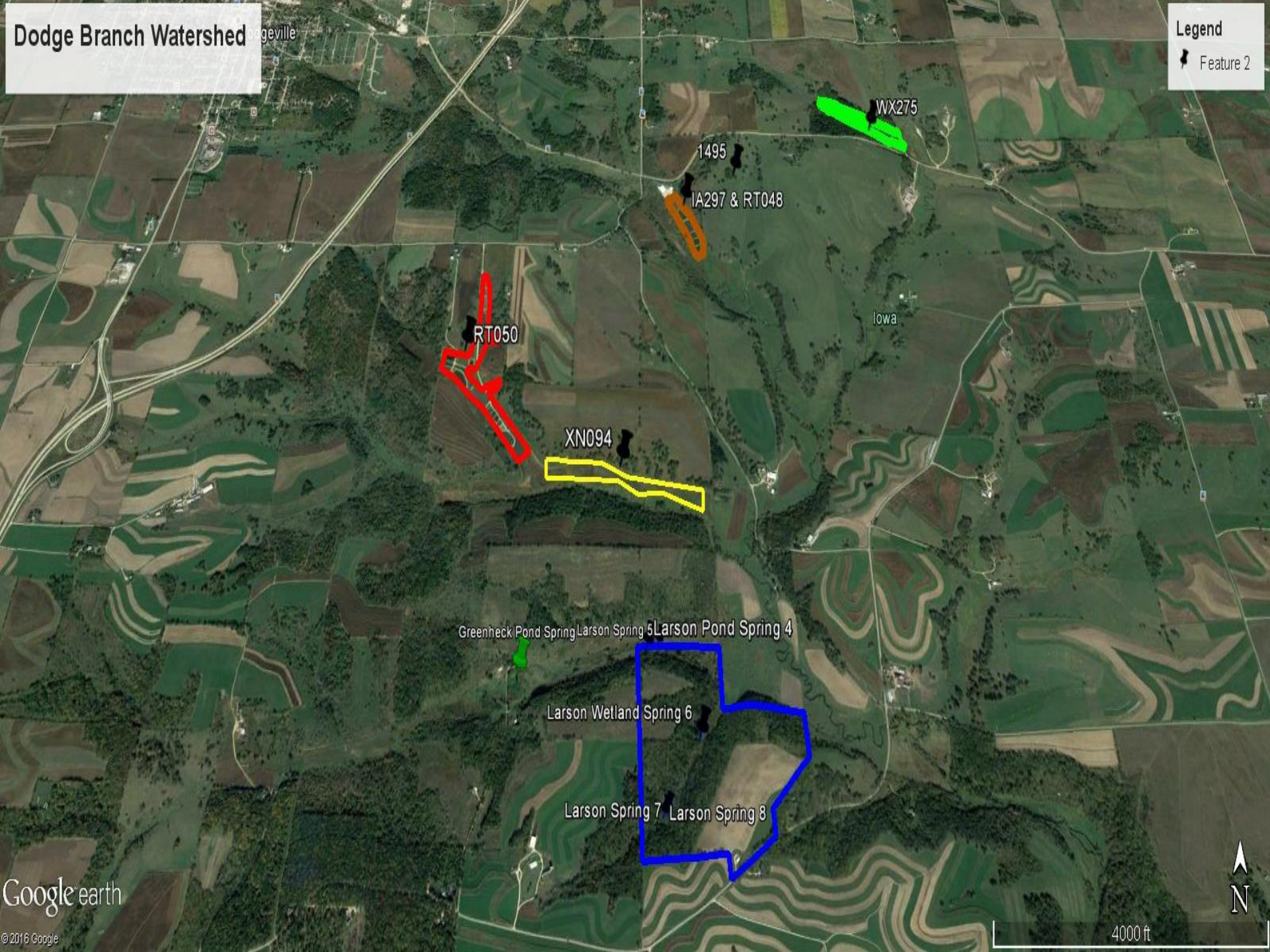
Larry Larson, Dodgeville WI

AMERICAN WATER RESOURCES ASSOCIATION – WISCONSIN SECTION 41st ANNUAL MEETING

March 9 & 10, 2017

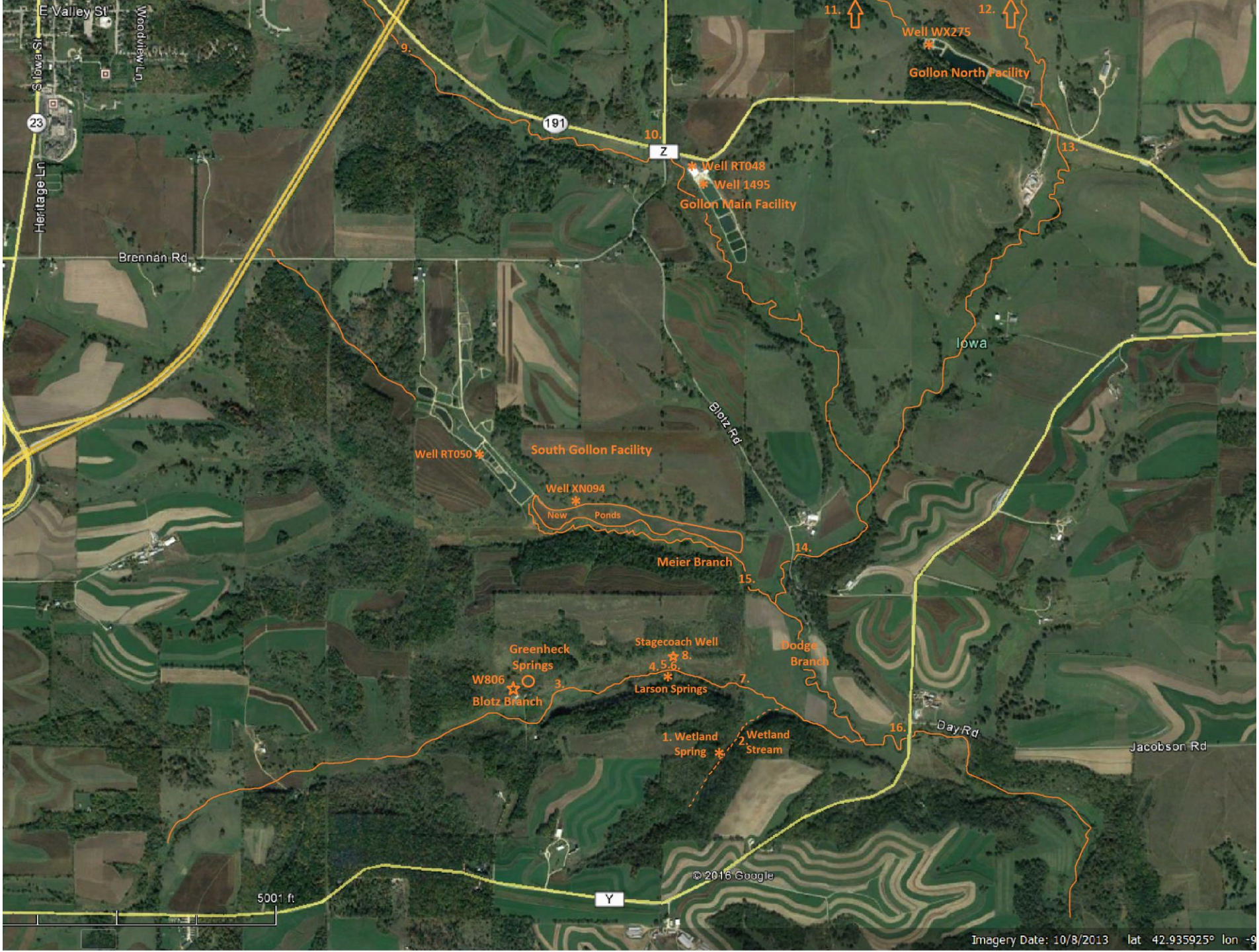
# Citizen Monitoring of Pumping Impacts to Springs and Streams

- Larry Larson, Dodgeville Landowner
- Blotz & Dodge Branch & Springs, (Upper Pecatonica River)
- Gollon Fish Hatchery High Capacity Well Pumping

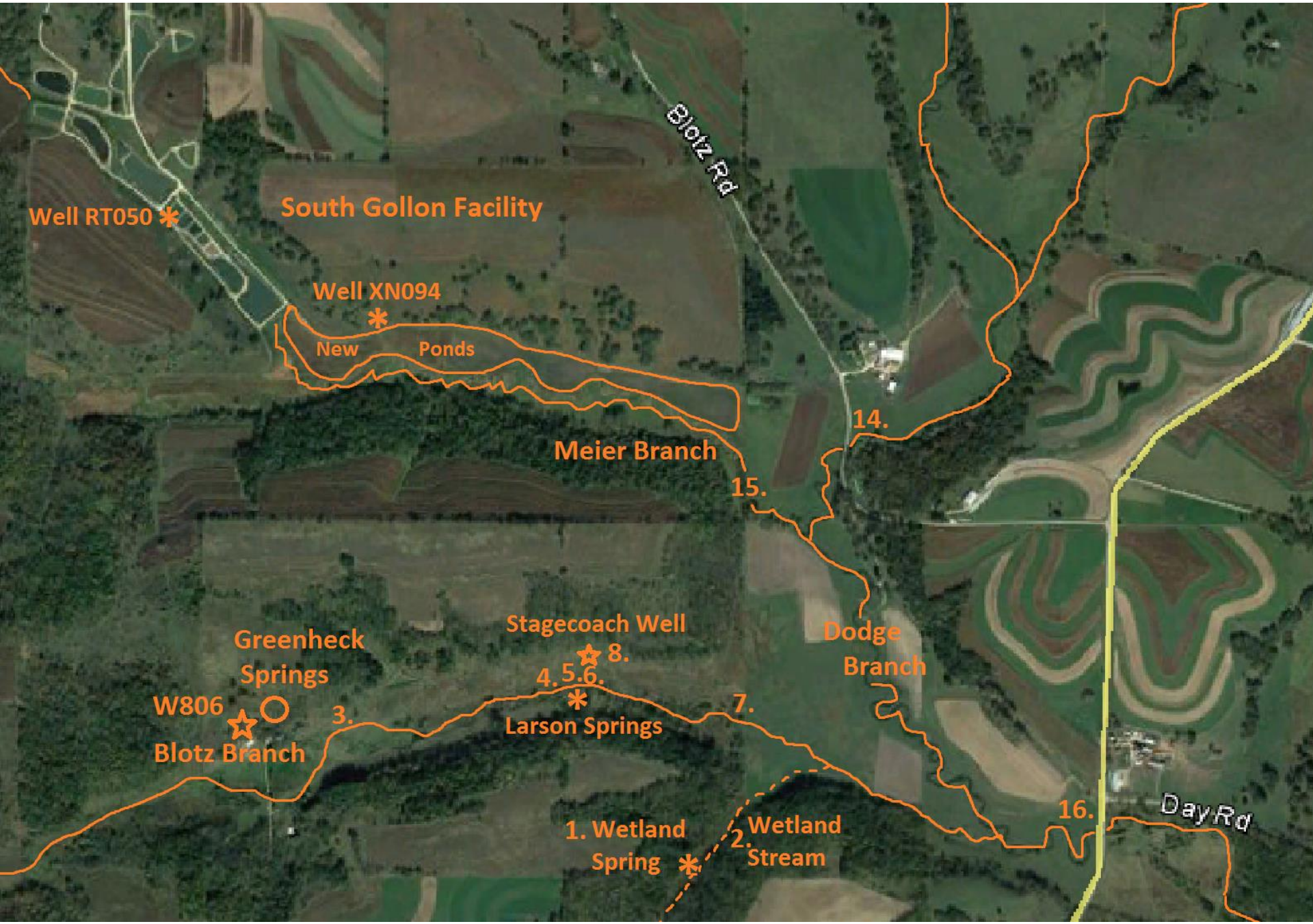

Dodge Branch Watershed
Legend
Feature 2
WX275
1495
IA297 & RT048
RT050
XN094
Iowa
Greenheck Pond Spring
Larson Spring 5
Larson Pond Spring 4
Larson Wetland Spring 6
Larson Spring 7
Larson Spring 8
N
4000 ft
Google earth
© 2016 Google

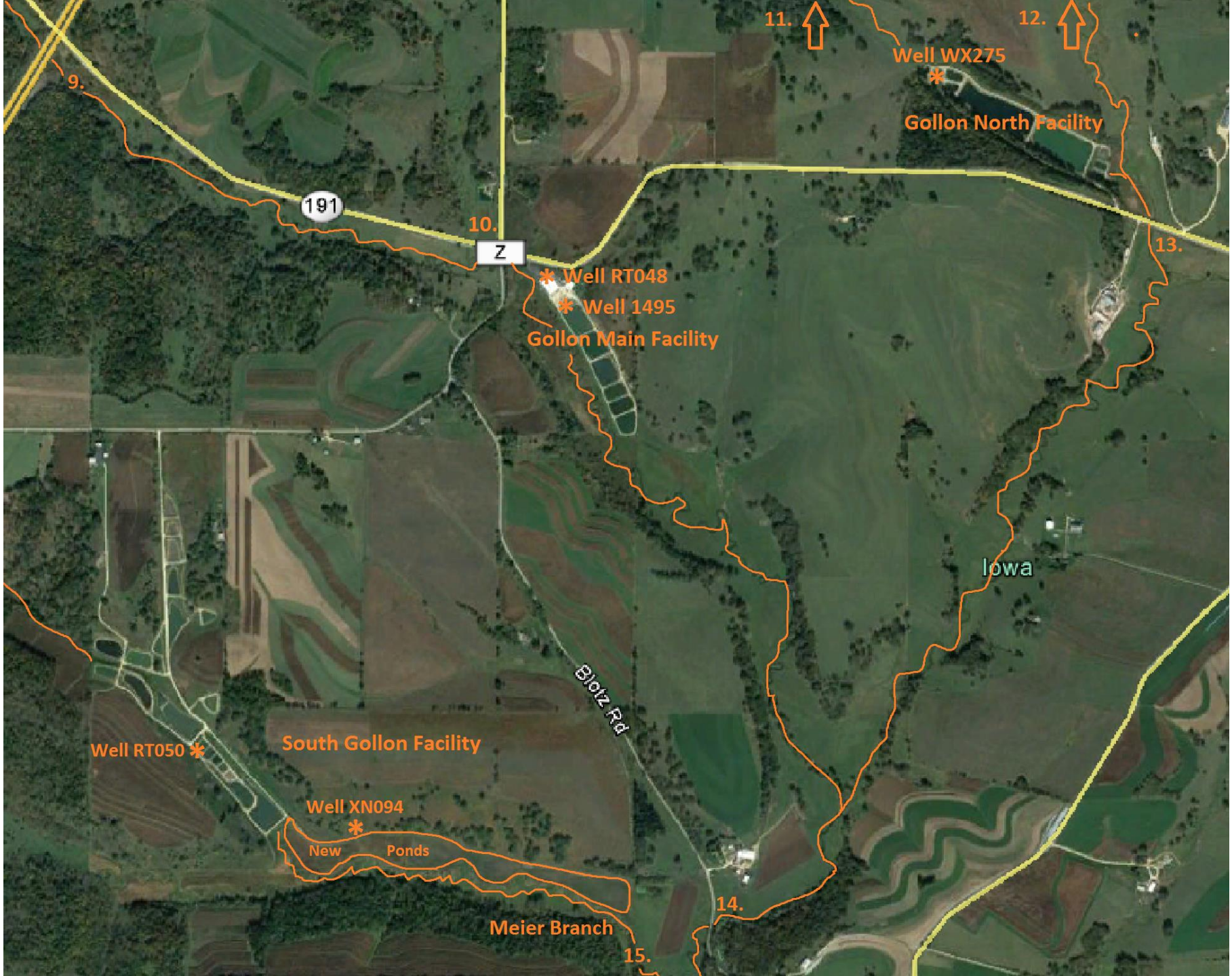
Pond Spring 05/19/2016
Discharge = 30.41 GPM

- **June 6, 2015 – First Time Larson Pond Spring Dries Up**
- **Remained Dry Through October 27th**
- **Flow Returned November 29th**
- **Comprehensive Monitoring Starts May 2016 in Consultation with Ken Wade**



E Valley St
Woodview Ln
S Iowa St
23
Heritage Ln
Brennan Rd
191
Z
9.
10.
11.
12.
13.
14.
15.
16.
Well WX275
Gollon North Facility
Well RT048
Well 1495
Gollon Main Facility
Iowa
Blotz Rd
Well RT050
South Gollon Facility
Well XN094
New Ponds
Meier Branch
Dodge Branch
Stagecoach Well
8.
4.5.6.
Larson Springs
7.
Greenheck Springs
W806
Blotz Branch
3.
1. Wetland Spring
2. Wetland Stream
Day Rd
Jacobson Rd
Y
5001 ft
© 2016 Google
Imagery Date: 10/8/2013 lat 42.935925° lon -9


Blotz Rd
Well RT050
South Gollon Facility
Well XN094
New
Ponds
14.
Meier Branch
15.
Stagecoach Well
8.
Greenheck
Springs
4. 5. 6.
Dodge
Branch
W806
3.
7.
Larson Springs
Blotz Branch
16.
Day Rd
1. Wetland
Spring
2. Wetland
Stream


9.
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Well WX275
Gollon North Facility
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Well RT048
Well 1495
Gollon Main Facility
Iowa
Blotz Rd
Well RT050
South Gollon Facility
Well XN094
New
Ponds
14.
Meier Branch
15.

# Larry Larson - Wetland Spring

# Larry Larson – Wetland Stream

# Larry Larson - Lower Spring

# Larry Larson – Blotz Branch – Near Pond Spring

Dodge Branch@CTH 'Y'
06/08/2016 10:48

2010

## EXPLANATION

### Quaternary deposits

Wisconsin River lowlands in northern part of Iowa County. Deposits exceed 60 m in thickness and overlie undifferentiated Cambrian sandstone.

ws — **Windblown sand.** Typically more than 1.5 m thick in dune areas; thinner windblown sand occurs over much of the surface of units ss and sj.

sm — **Modern stream sediment.** Primarily sand or slightly gravelly sand on modern valley bottoms; most deposited during last part of the Holocene; overlain by thin peat and thin silty overbank sediment in many places; includes some premodern valley-side fans of fluvial and slope sediment.

ss — **Stream sediment of Elderon Phase.** Sand and gravelly sand deposited by braided streams carrying meltwater from the Green Bay Lobe during the Elderon Phase of glaciation and by floodwater during drainage of glacial Lake Wisconsin; occurs on terraces below the Johnstown terraces.

sp — **Younger premodern, nonglacial stream sediment.** Primarily sand or slightly gravelly sand; typically several meters thick; most deposited during early part of the Holocene or during the last part of the Wisconsin Glaciation; commonly occurs on fans or on flat terraces above modern floodplains; includes fans of hillslope sediment.

Sj — **Stream sediment of Johnstown Phase.** Sand and gravelly sand; deposited by braided streams that carried meltwater from the Green Bay Lobe during the Johnstown Phase of glaciation; occurs as a high terrace in the northeastern part of the county.

### Paleozoic bedrock units

Su — **Silurian dolomite.** Silicified dolomite of Silurian age. Thought to originate from alteration of limestone containing siliceous fossil shells by leaching and weathering. Only present under West Blue Mound in east-central Iowa County.

Om — **Maquoketa Formation.** Blue-gray dolomitic shale with occasional thin gray dolomite layers. Only present under West Blue Mound in east-central Iowa County.

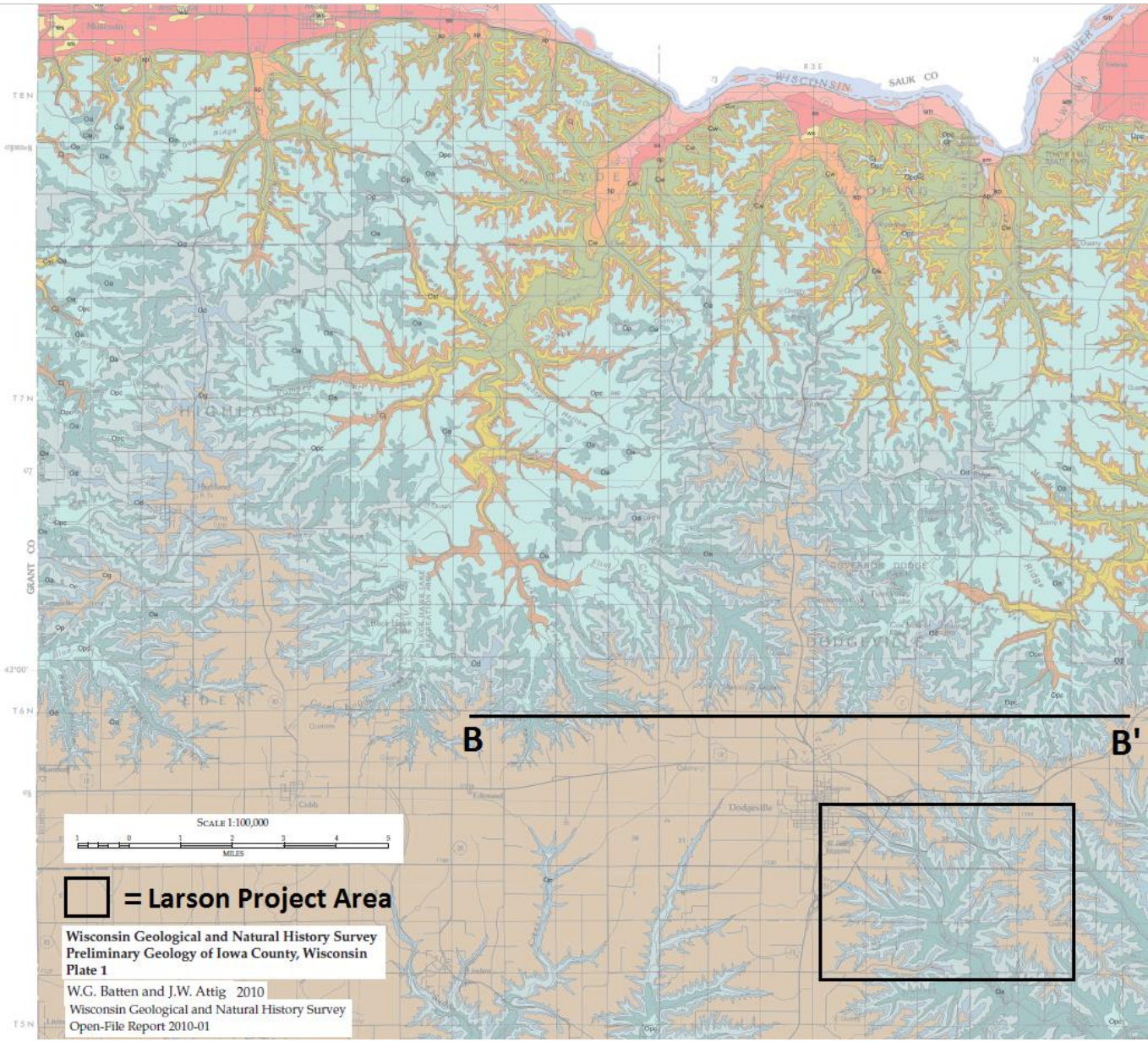
Og — **Galena Formation (Sinnipee Group).** Drab yellowish-gray to brown dolomite and dolomitic limestone with some yellow-gray shale partings. Coarsely granular to crystalline, noticeably vuggy in outcrop. Medium to thick bedded. Laterally extensive chert beds in lower parts of the formation.

Od — **Decorah Formation (Sinnipee Group).** Darkish gray and blue clayey limestone and olive-green to brown shale beds. Overall thin with some wavy bedding, about 10 m thick.

Op — **Platteville Formation (Sinnipee Group).** Generally fine-grained light-gray dolomite. Somewhat clayey becoming sandy near base. Upper part of formation generally thin and wavy bedded. Lower part of formation is browner in color and medium to thick bedded. Some parts are quite fossiliferous.

Oa — **Ancell Group (St. Peter Formation).** Basal Readstown Member is a mixture of sandstone, chert, shale, and dolomitic sandstone; thickness is extremely variable, from missing to more than 60 m thick. Overlain by Tonti Member, which is fine- to medium-grained well-sorted sandstone with occasional thin green shale layers. White, red, to yellow in color. Generally poorly cemented. Overlain by the Glenwood Member, a dolomitic, poorly sorted sandstone to sandy dolomite with thin dark green shale layers. Glenwood Member absent in some areas and generally less than 1.5 m thick. Ancell Group is deposited on major cratonic unconformity and ranges from 0 to over 100 m thick.

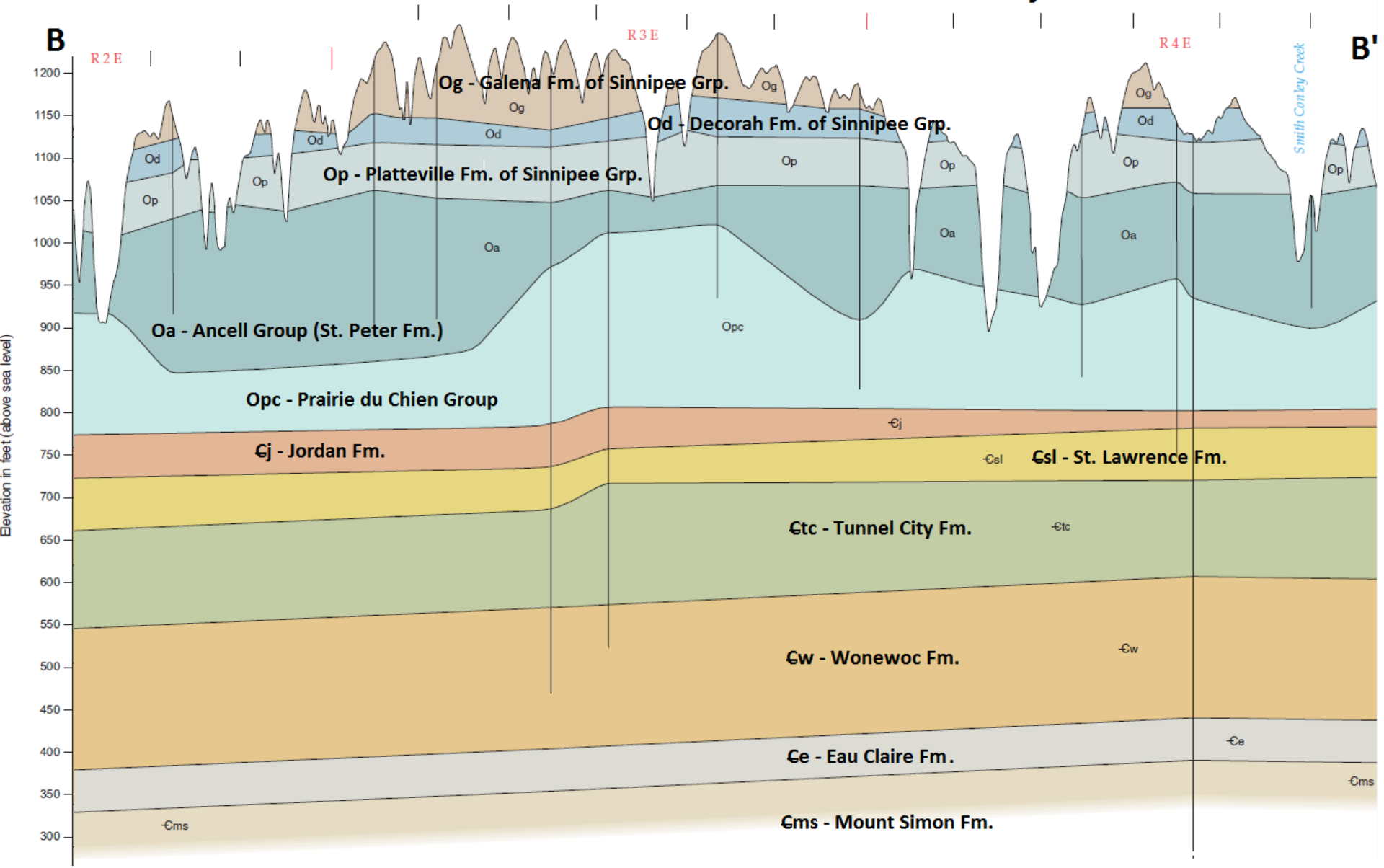
Opc — **Prairie du Chien Group (Shakopee and Oneota Formations).** Light brown to yellow to light reddish-brown dolomite, sandy dolomite, and




**Wisconsin Geological and Natural History Survey**
**Preliminary Geology of Iowa County, Wisconsin**
**Plate 1**

W.G. Batten and J.W. Attig 2010
Wisconsin Geological and Natural History Survey
Open-File Report 2010-01

# Cross Section B-B' - Three Miles North of Larson Project Area



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## Explanation

### Quaternary deposits

Wisconsin River lowlands in northern part of Iowa County. Deposits exceed 60 m in thickness and overlie undifferentiated Cambrian sandstone.

sm — **Modern stream sediment.** Primarily sand or slightly gravelly sand on modern valley bottoms; most deposited during last part of the Holocene; overlain by thin peat and thin silty overbank sediment in many places; includes some premodern valley-side fans of fluvial and slope sediment.

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Og — **Galena Formation of Sinnipee Group.** Drab yellowish-gray to brown dolomite and dolomitic limestone with some yellow-gray shale partings. Coarsely granular to crystalline, noticeably vuggy in outcrop. Medium to thick bedded. Laterally extensive chert beds in lower parts of the formation.

Od — **Decorah Formation of Sinnipee Group.** Dark gray and blue argillaceous limestone and olive-green to brown shale beds. Overall, thin with some wavy bedding, about 9 m thick.

Op — **Platteville Formation of Sinnipee Group.** Generally fine-grained light-gray dolomite. Somewhat argillaceous becoming sandy near base. Upper part of formation generally thin and wavy bedded; lower part is browner and medium to thick bedded. Somewhat more fossiliferous than Galena Formation.

Oa — **Ancell Group (St. Peter Formation).** Basal Readstown Member is a mixture of sandstone, chert, shale, and dolomitic sandstone. Extremely variable thickness from absent to more than 60 m thick. Overlain by Tonti Member which is fine- to medium-grained, well-sorted sandstone with occasional thin green shale layers. White, red, to yellow. Generally poorly cemented. Overlain by the Glenwood Member, a dolomitic, poorly sorted sandstone to sandy dolomite with thin dark green shale layers. Glenwood Member absent in some areas and generally less than 1.5 m thick. Ancell Group deposited on major cratonic unconformity and ranges from 0 to more than 90 m thick.

Opc — **Prairie du Chien Group (Shakopee and Oneota Formations).** Light brown to yellow to light reddish-brown dolomite, sandy dolomite, and dolomitic sandstone. Commonly karstified; many cavities filled with dark brown to red silt and clay sediment. Local vuggy, oolitic, and cherty zones or irregular beds. Contact with overlying Ancell Group is very irregular.

Cj — **Jordan Formation.** White, brown, to red-brown fine- to coarse-grained quartz sandstone. Fine-grained parts of formation can be hummocky to trough cross-stratified.

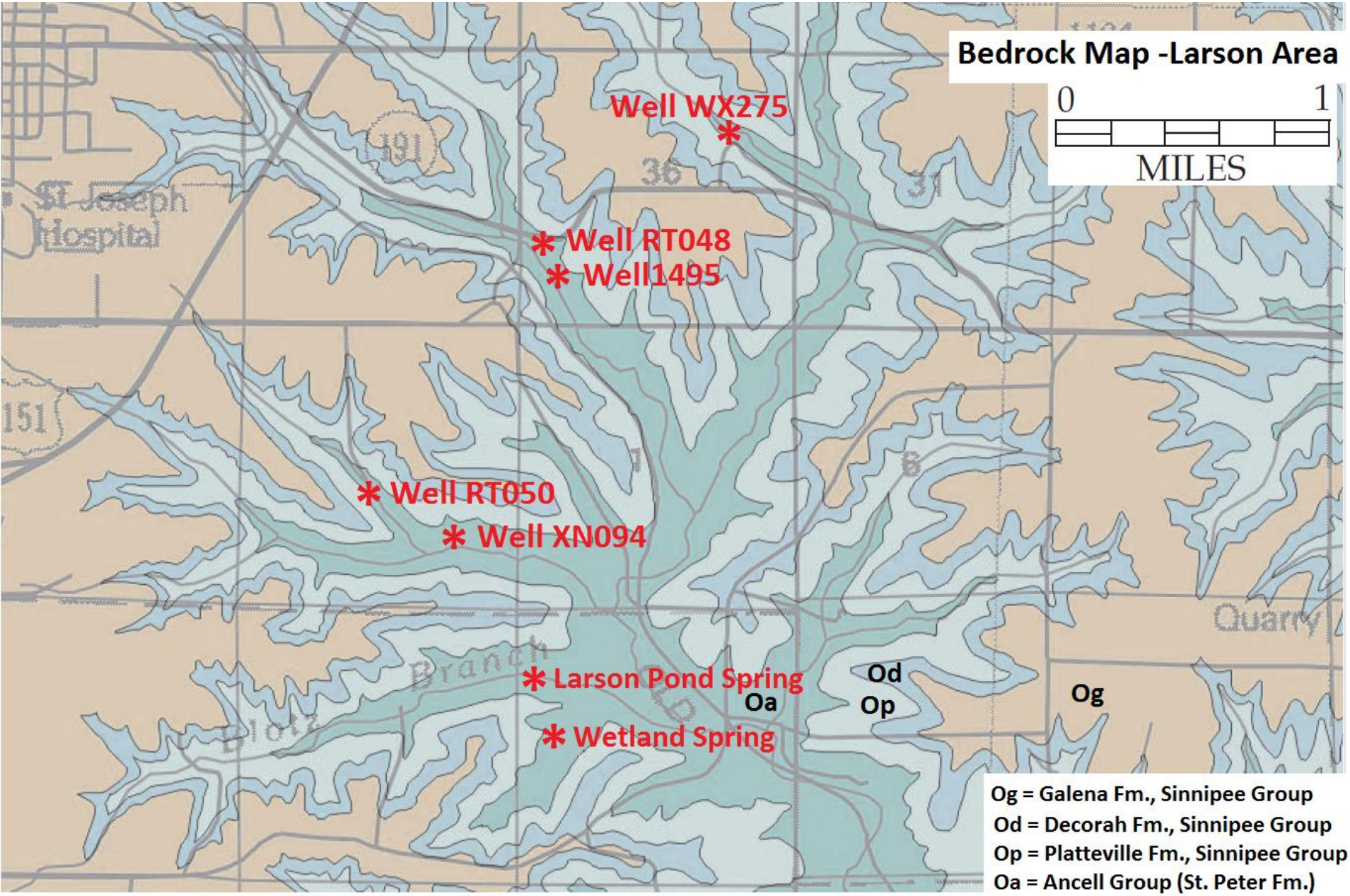
Csl — **St. Lawrence Formation.** Light yellow-brown fine-grained dolomitic sandstone, siltstone, and some thin shale beds. Generally thin-bedded.

Ctc — **Tunnel City Formation.** Light brown to distinct glauconitic (green) fine-grained sandstone with green-gray shale partings. Commonly cross-stratified and extensively bioturbated.

Cw — **Wonowoc Formation.** Light brown fine- to coarse-grained quartzose sandstone. Trough cross-stratification common. Contacts with overlying and underlying units are gradational.

Ce — **Eau Claire Formation.** Light- to dark-gray shale. Occasional thin beds of very fine- to fine-grained dolomitic sandstone and siltstone. Fossil fragments and trace of pyrite throughout the shale. Sandstone and siltstone are locally slightly glauconitic. Based on limited well data, sandstone beds appear to increase in thickness in northeastern part of the county.

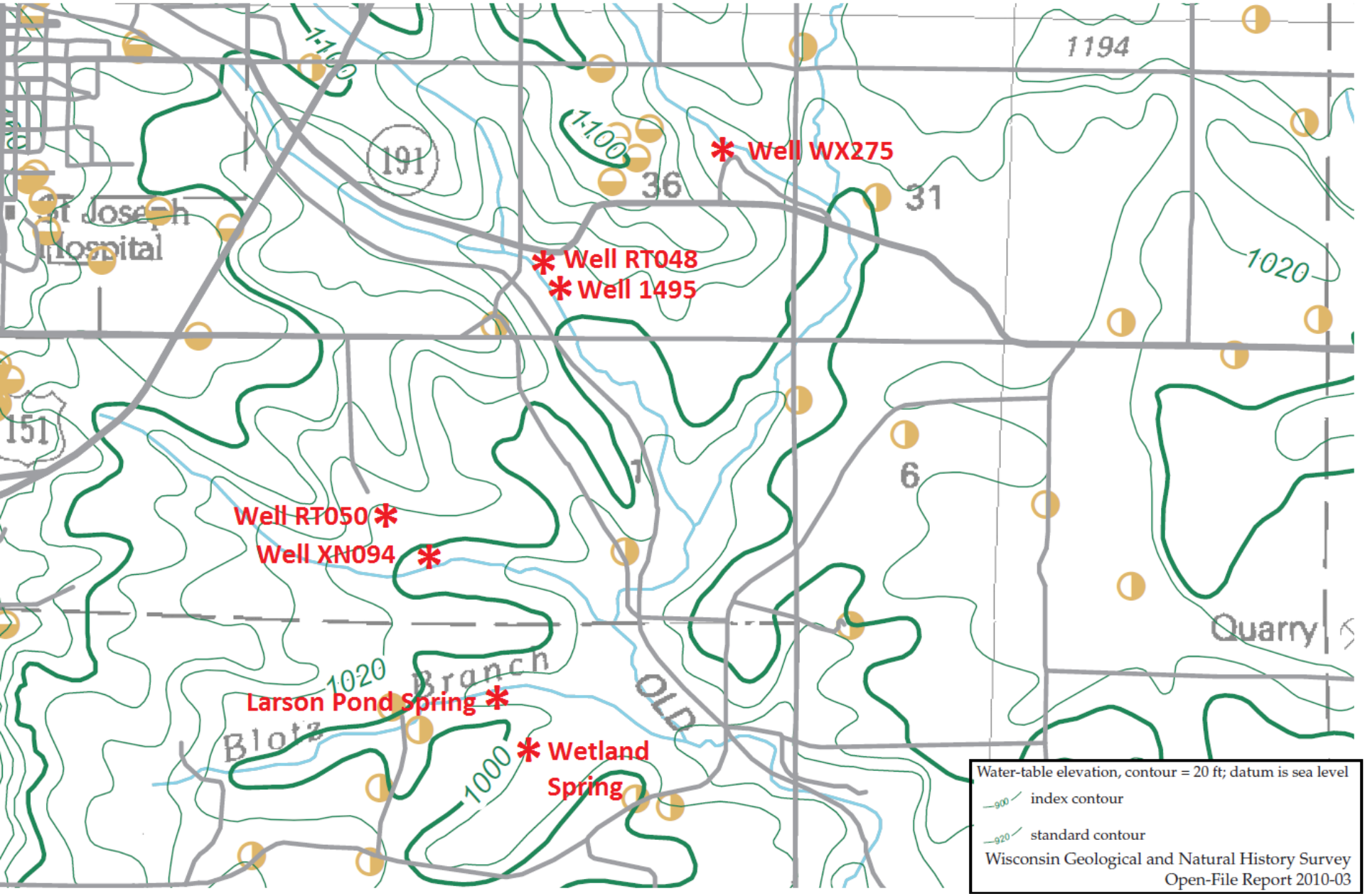
Cms — **Mount Simon Formation.** Fine- to coarse-grained sandstone. Mostly light gray or light brown. Dolomite cement, occasionally very well cemented. Some dark-brown sandy dolomite beds occur at varying intervals and thicknesses. Traces of fine white silica, pyrite, and gray shale throughout entire unit.


Bedrock Map -Larson Area
0
1
MILES
Well WX275
Well RT048
Well1495
Well RT050
Well XN094
Larson Pond Spring
Wetland Spring
Od
Op
Oa
Og
St Joseph Hospital
Quarry
Og = Galena Fm., Sinnipee Group
Od = Decorah Fm., Sinnipee Group
Op = Platteville Fm., Sinnipee Group
Oa = Ancell Group (St. Peter Fm.)

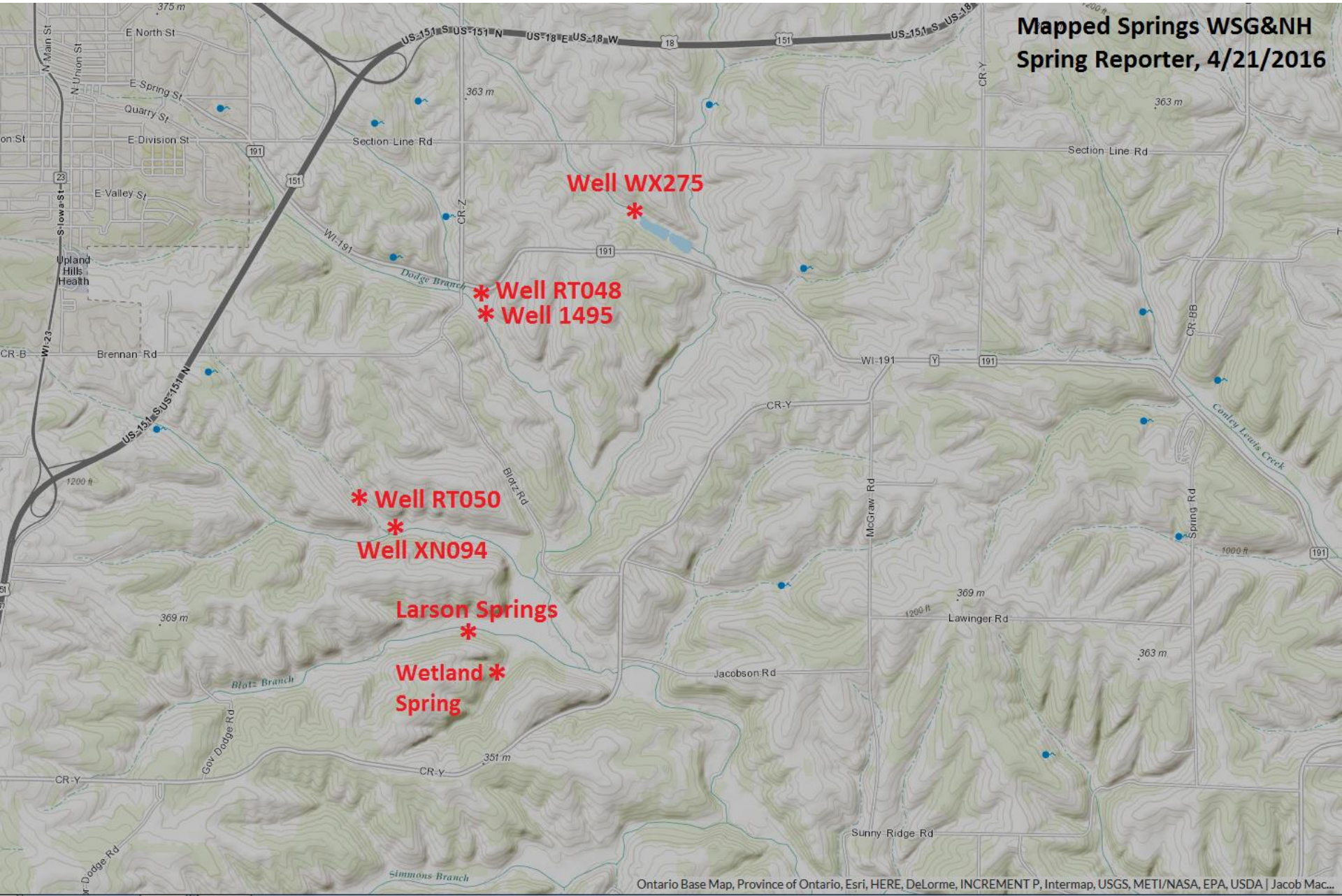
# Local Hydrogeological Studies


- Carter, Jonathon T. V., M. B. Gotkowitz, and M. P. Anderson. 2011. Field Verification of Stable Perched Groundwater in Layered Bedrock Uplands. *Groundwater*, Vol. 49, No. 3: p. 383-392.
- Dott, R.H. and Mai, H. 1985. A Subsurface Study of the St. Peter Sandstone in Southern and Eastern Wisconsin. Information Circular Number 47, Geological and Natural History Survey Open File Report.
- Swanson, S.K., K.R. Bradbury, and D.J. Hart. 2007. Assessing the ecological status and vulnerability of springs in Wisconsin. University of Wisconsin Water Resources Institute Report. Madison, Wisconsin: University of Wisconsin Water Resources Institute. Also as Wisconsin Geological and Natural History Survey Open File Report 2007-04, 15p. plus appendices.
- Swanson, S.K., K.R. Bradbury, and D.J. Hart. 2009. Assessing the vulnerability of spring systems to groundwater withdrawals in southern Wisconsin. *Geoscience Wisconsin* 20, no.1: 1-13.
- Swanson, S. K., 2010. Springs of Iowa County. Wisconsin Geological and Natural History Survey Educational Series 50-4.
- Tipping, Robert G., A.C. Runkel, E.C Alexander Jr., S.C. Alexander and J.A. Green. 2006. Evidence for hydraulic heterogeneity and anisotropy in the mostly carbonate Prairie du Chien Group, southeastern Minnesota, USA. Sedimentary Geology 184, p. 305-330.

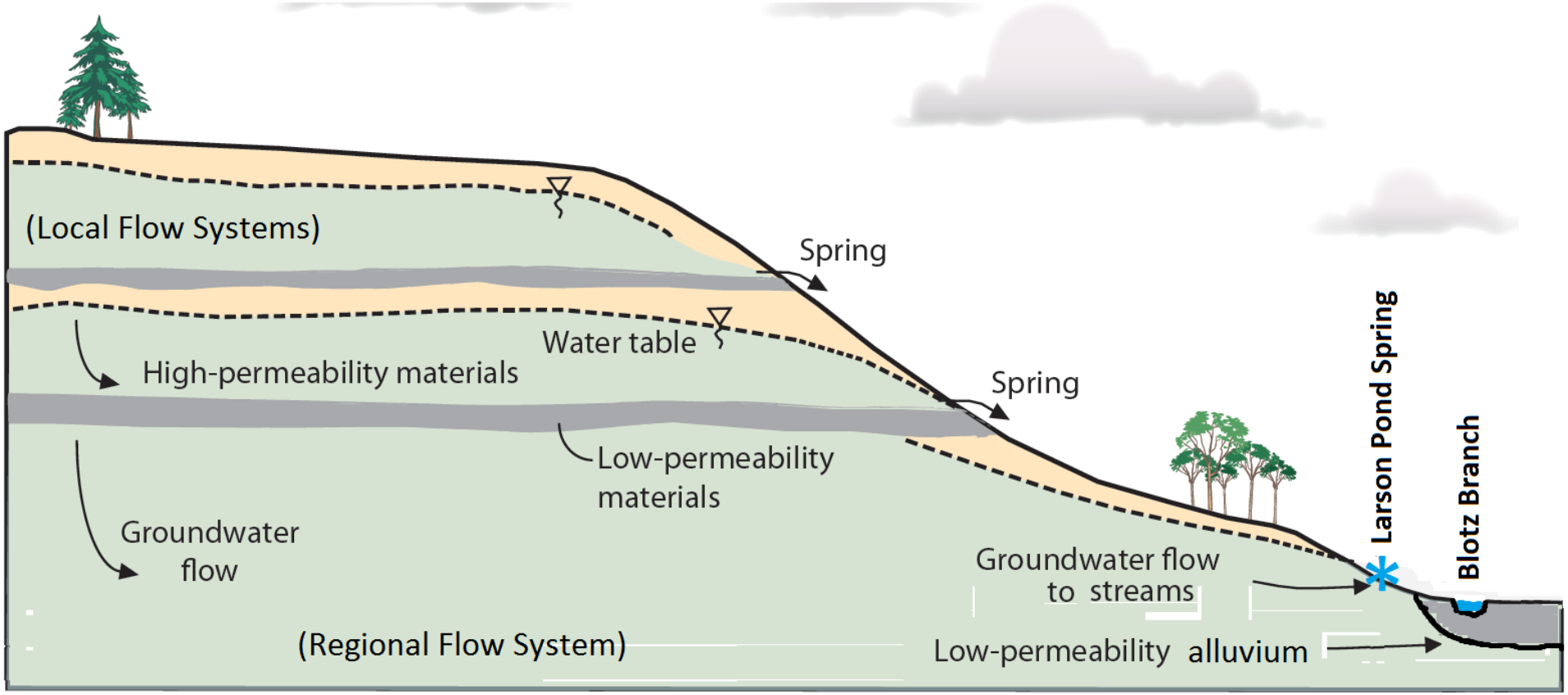
# Water Table in the Project Area – from WG&NHS Iowa County Map



# Project Area Springs Mapped in WG&NHS Spring Reporter

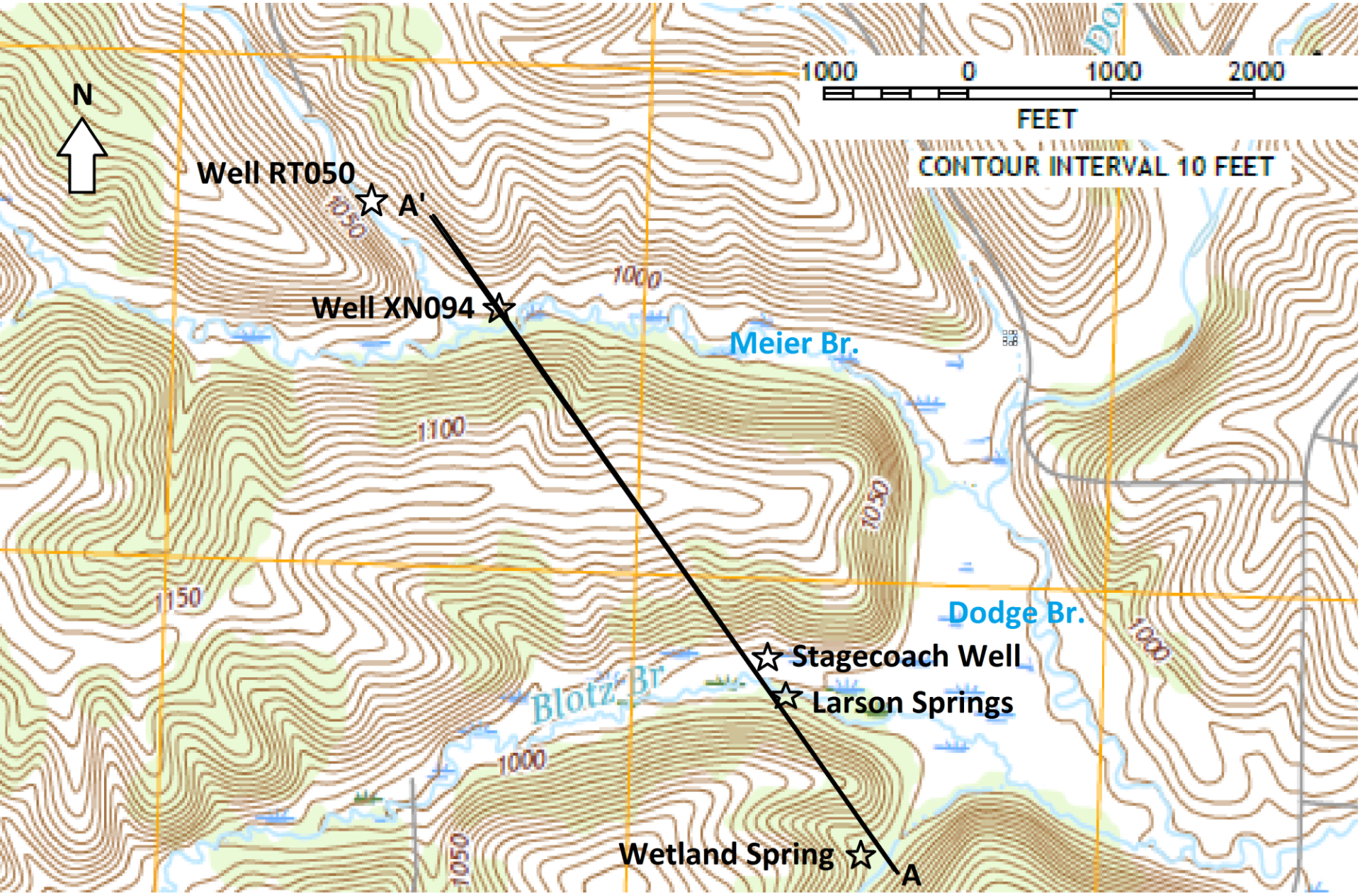


# Project Area Conceptual Hydrogeology

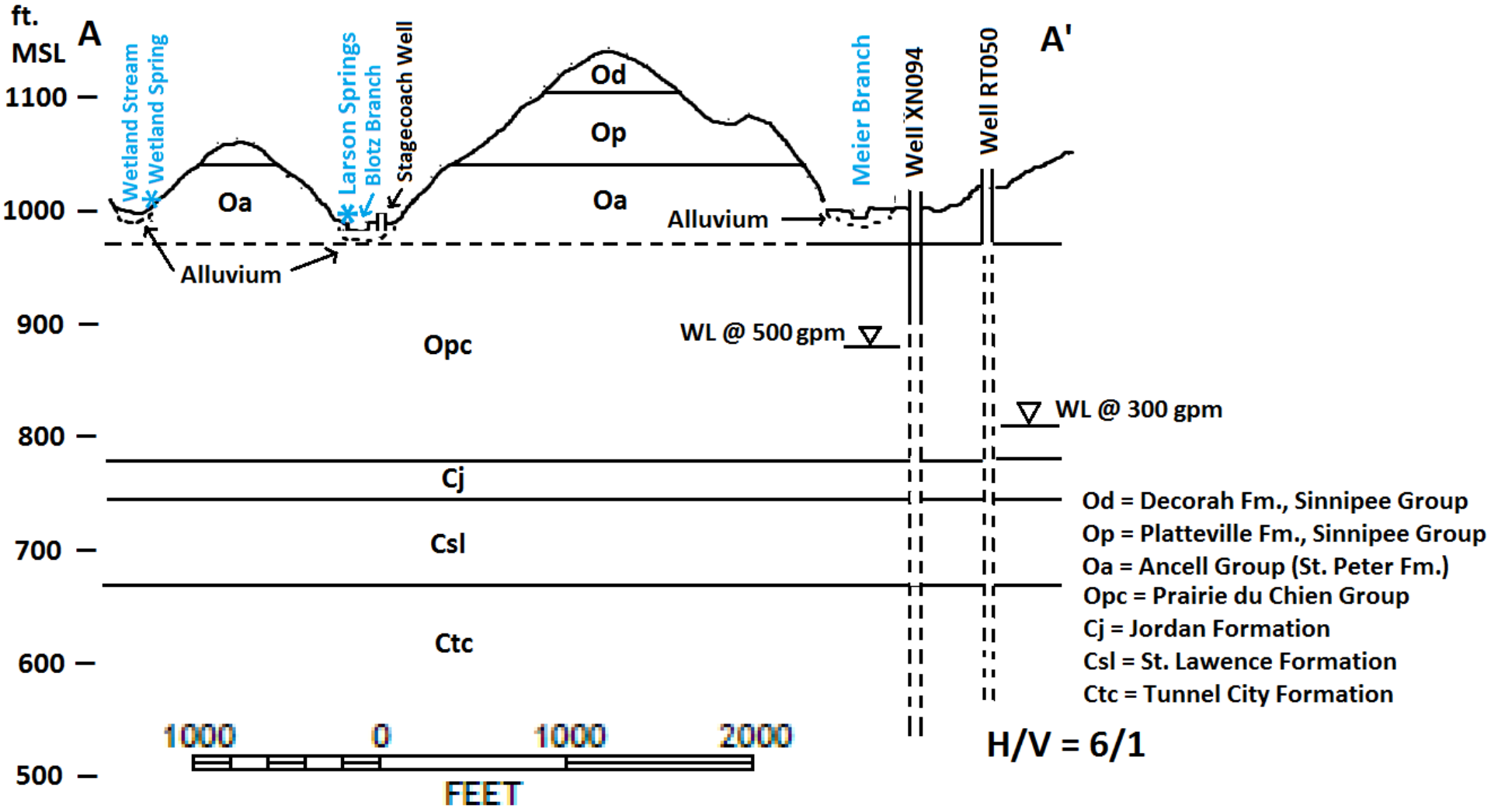



Modified from Swanson, 2010

# Project Area Cross Section A'-A Location



# Project Cross Section A-A’



**Rapid increase in water pumped from both the Main facility high capacity well #1495 and total pumping from all Gollon facilities.**

| Pumping Year | Main Facility Well #1495, gal. | Total Gollon Pumping, gal |
|---|---|---|
| 2015 | 76,590,000 | 182,807,700 |
| 2014 | 70,044,500 | 165,429,000 |
| 2013 | 60,338,000 | 58,647,400 |
| 2012 | 50,002,000 | 98,548,500 |
| 2011 | 57,995,000 | 31,964,600 |
| 2010 | 55,518,000 | 30,873,500 |
| 2009 | 51,637,000 | 43,161,800 |
| 2008 | 49,041,000 | 16,094,700 |
| 2007 | 43,278,000 | 9,855,500 |

# Gollon High Capacity Well Pumping - 2015 DNR Report

| Source Name | Farm | Pines | Meur/Walker Ponds | Pond West-Outside | Main Well-Inside | IA297-Standby |
|---|---|---|---|---|---|---|
| Hi Cap Well #/WUWN | **72210/WX275** | **79423/RT050** | **#74149/XN094** | **#4180/RT048** | **#1495/NA** | **#1494/IA297** |
| Field Name | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 |
| Property No | 12447 | 11880 | 11880 | 9644 | 9644 | 9644 |
| Property Name | The Pines | The Farm | The Farm | Main Business | Main Business | Main Business |
| Month | Withdrawal (gallons/month) | | | | | |
| January | 0 | 0 | 0 | 0 | 6,277,900 | 0 |
| February | 0 | 0 | 0 | 0 | 6,555,200 | 0 |
| March | 0 | 0 | 0 | 0 | 6,065,700 | 0 |
| April | 0 | 0 | 0 | 0 | 6,674,200 | 0 |
| May | 0 | 0 | 0 | 4,804,500 | 5,975,700 | 0 |
| June | 0 | 5,234,200 | 0 | 3,029,400 | 7,555,200 | 3,500 |
| July | 0 | 7,562,200 | 0 | 1,692,700 | 3,531,700 | 0 |
| August | 6,186,750 | 6,067,800 | 4,979,300 | 1,861,100 | 10,872,300 | 0 |
| September | 6,889,900 | 5,402,500 | 4,177,200 | 2,724,900 | 6,569,500 | 0 |
| October | 3,053,150 | 6,218,300 | 4,714,900 | 2,328,100 | 7,344,300 | 0 |
| November | 2,261,500 | 4,249,900 | 3,110,500 | 13,759,200 | 5,531,300 | 0 |
| December | 1,160,500 | 1,604,700 | 461,600 | 2,682,300 | 3,637,600 | 0 |
| Total | 19,551,800 | 36,339,600 | 17,443,500 | 32,882,200 | 76,590,000 | 3,500 |
| Reporting Type | Water Use System | Water Use System | Water Use System | Water Use System | Water Use System | Water Use System |
| Reporting Status | Complete | Complete | Complete | Complete | Complete | Complete |
| **2015 Total = 182,807,100 gal.** | **10.7%** | **20%** | **9.5%** | **18%** | **42%** | |

| Gollon 2015 High Capacity Well Pumping | | | |
|---|---|---|---|
| **Well** | **Gallons Pumped** | **% of total** | **Distance to Larson Springs, miles** |
| **WX275** | **19,551,800** | **10.7%** | **2.10** |
| **RT050** | **36,339,600** | **20%** | **0.80** |
| **XN094** | **17,443,500** | **9.5%** | **0.61** |
| **RT048** | **32,882,200** | **18%** | **1.49** |
| **1495** | **76,590,000** | **42%** | **1.49** |
| **Total:** | **182,807,100** | **100%** | |

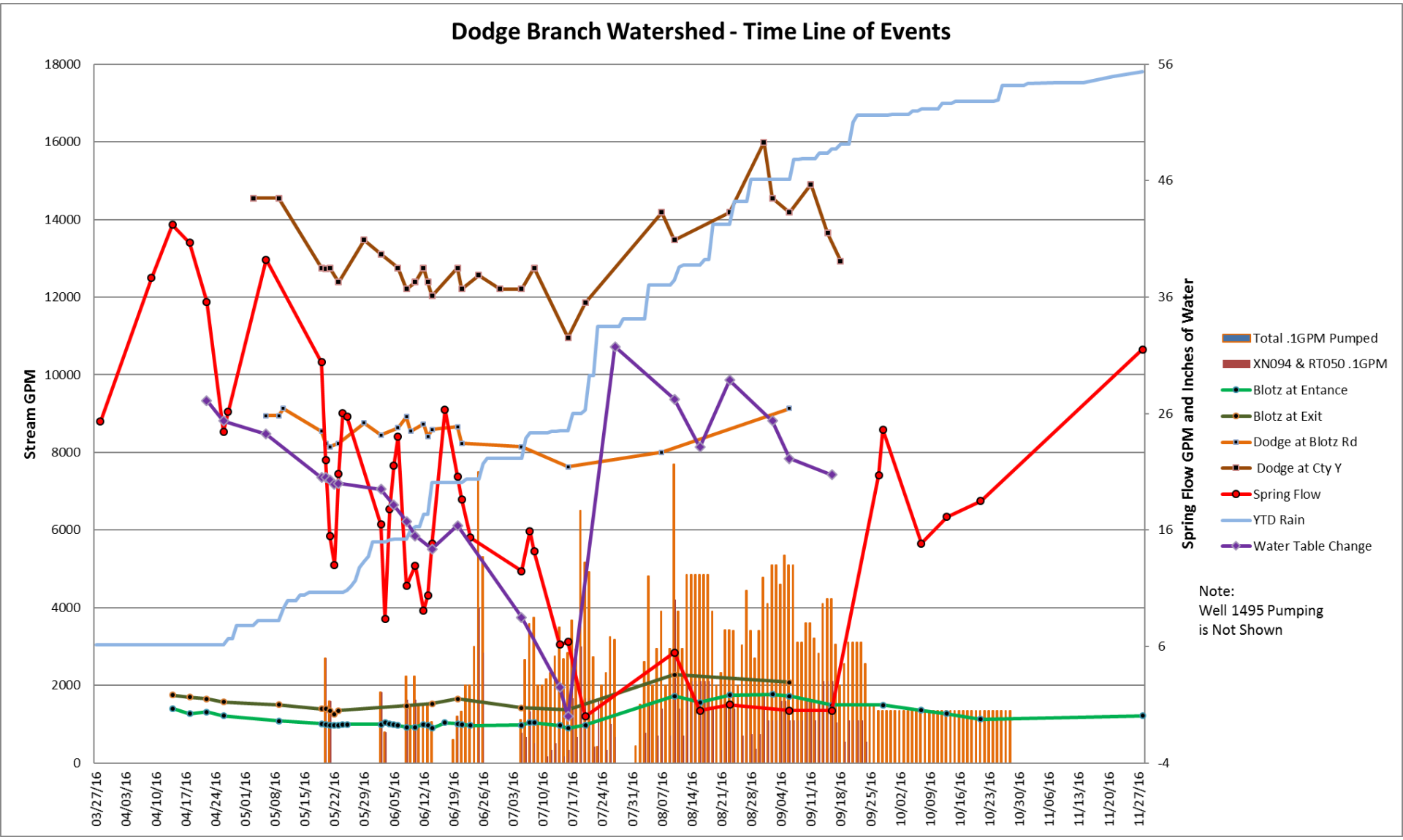
**2014**

| Gollon 2014 Pumping, June - October | | | |
|---|---|---|---|
| **Month** | **Total, All Wells** | **South Wells - RT050 & XN094** | **North Wells -1495 & WX275 & RT048** |
| **June** | **8,790,600** | **0** | **8,790,600** |
| **July** | **12,641,100** | **0** | **12,641,100** |
| **Aug.** | **26,408,100** | **0** | **26,408,100** |
| **Sept.** | **33,956,600** | **5,958,900** | **27,997,700** |
| **Oct.** | **22,395,00** | **2,601,300** | **19,793,700** |
| **Total, June – Oct.** | **81,818,795** | **8,560,200** | **95,631,200** |

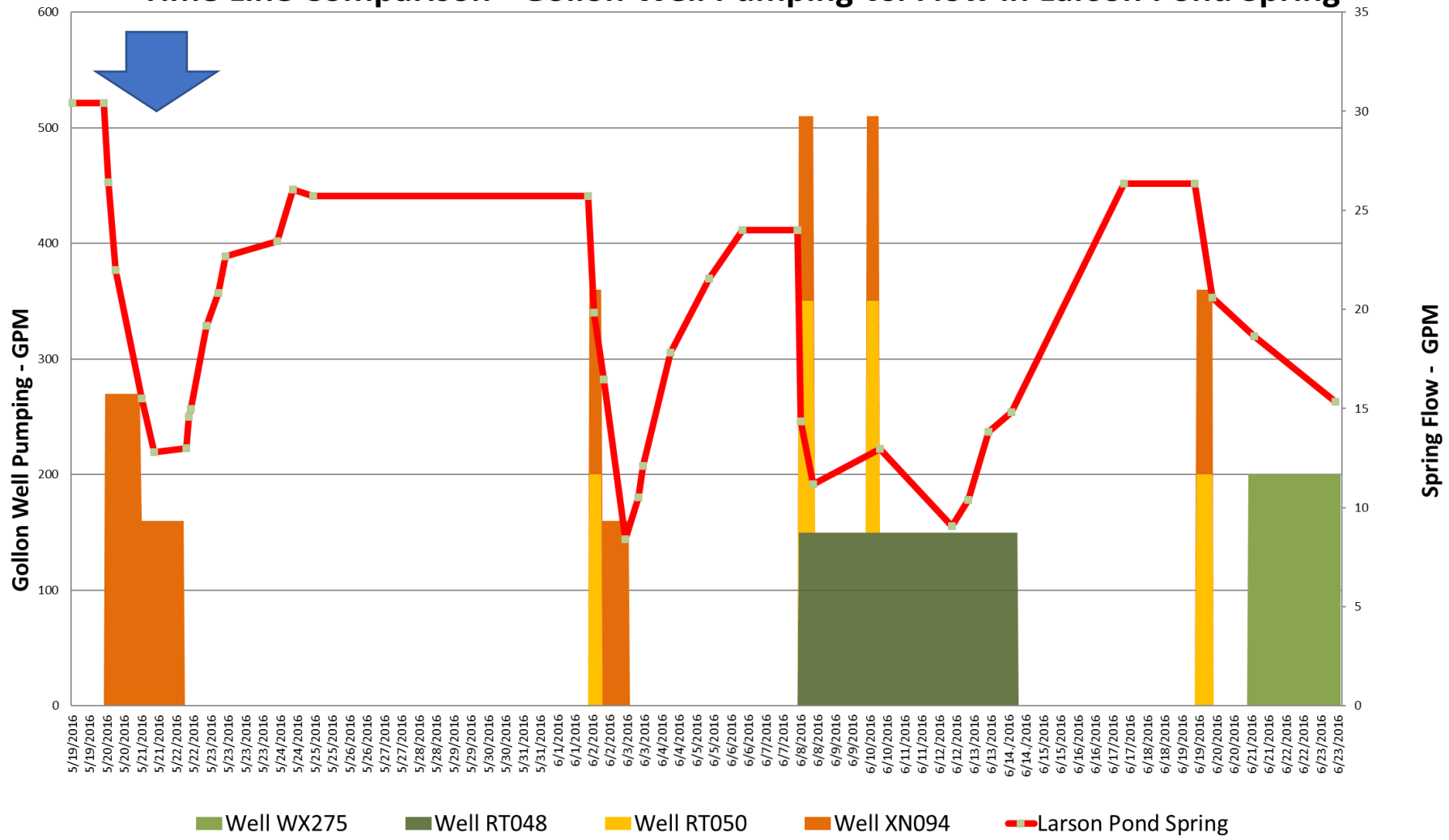
**2015**

| Gollon 2015 Pumping, June - October | | | |
|---|---|---|---|
| **Month** | **Total, All Wells** | **South Wells - RT050 & XN094** | **North Wells -1495 & WX275 & RT048** |
| **June** | **15,818,800** | **5,234,200** | **10,584,600** |
| **July** | **12,786,600** | **7,562,200** | **5,224,400** |
| **Aug.** | **29,967,300** | **11,047,100** | **18,920,200** |
| **Sept.** | **25,764,000** | **9,579,700** | **16,184,300** |
| **Oct.** | **23,658,800** | **10,933,200** | **12,725,600** |
| **Total, June – Oct.** | **107,995,500** | **44,356,400** | **63,639,100** |

# Monitoring Results



# Time Line Comparison - Gollon Well Pumping vs. Flow in Larson Pond Spring




Note: Well 1495 is also pumping at approximately 150 gpm

Pond Spring 05/19/2016
Discharge = 30.41 GPM

Pond Spring 05/22/2016
Discharge = 13.01 GPM.
The Pond Spring discharge dropped more than 10% within two hours and 50% within 24 hours.

# Pond Spring Response to Pumping

| Date | Time | | Notes | Pump GPM | Spring Discharge (GPM) | % Baseflow | |
|---|---|---|---|---|---|---|---|
| 5/19/2016 | 10:00 | AM | No Pumps On | 0 | 30.41 | 100.0% | |
| 5/20/2016 | 9:00 | AM | XN094 On | 270 | | | |
| | 11:00 | AM | XN094 On | 270 | 26.40 | 86.8% | 2 Hr |
| | 4:00 | PM | XN094 On | 270 | 22.00 | 72.3% | 7 Hr |
| 5/21/2016 | 10:00 | AM | XN094 On | 160 | 15.50 | 51.0% | 25 Hr |
| | 7:00 | PM | XN094 On | 160 | 12.81 | 42.1% | 34 Hr |
| 5/22/2016 | 4:00 | PM | Well Off | 0 | | | |
| | 5:00 | PM | Well Off | 0 | 13.01 | 42.8% | |
| | 7:00 | PM | Well Off | 0 | 14.57 | 47.9% | |
| | 8:00 | PM | Well Off | 0 | 14.99 | 49.3% | |
| 5/23/2016 | 7:00 | AM | Well Off | 0 | 19.18 | 63.1% | |
| | 3:00 | PM | Well Off | 0 | 20.82 | 68.5% | |
| | 8:00 | PM | Well Off | 0 | 22.68 | 74.6% | |
| 5/24/2016 | 8:00 | AM | Well Off | 0 | 23.43 | 77.0% | |
| | 7:00 | PM | Well Off | 0 | 26.04 | 85.6% | 72 Hr After Shut Off |
| 5/25/2016 | 8:30 | AM | Well Off | 0 | 25.71 | 84.5% | |

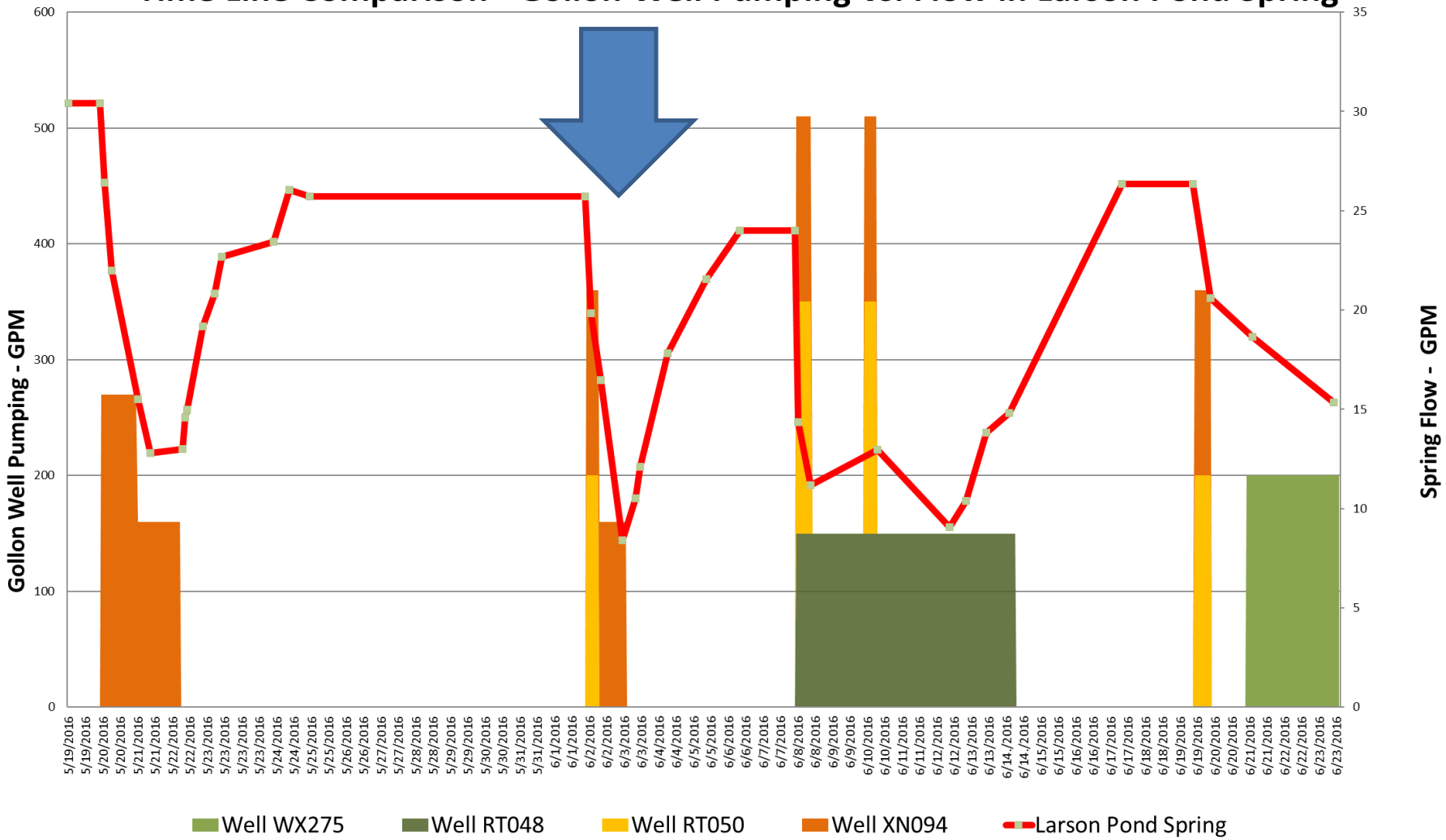
**Magnitude of Pumping Compared to Pond Spring Impacts – 5/20 to 5/24/2016**

- 693,000 gallons pumped over 55 hours
- Over the 55 hours of pumping and 76 hours of recovery Pond Spring flow was reduced 83,422 gallons.
- The Pond Spring flow reduction therefore represents 12% of the water pumped by Well XN094.

**Magnitude of Pumping Compared to Blotz Branch Impacts – 5/20 to 5/24/2016**

- Blotz Branch discharge decreased from 1012 gpm to 966 gpm and recovered to 989 gpm during the pumping event.
- A 23 gpm base flow reduction over 48 hours = 66,240 gallons
- A 46 gpm base flow reduction over 48 hours = 132,480 gallons
- This represents from 10 to 20% of the 693,000 gallons pumped.

# Time Line Comparison - Gollon Well Pumping vs. Flow in Larson Pond Spring

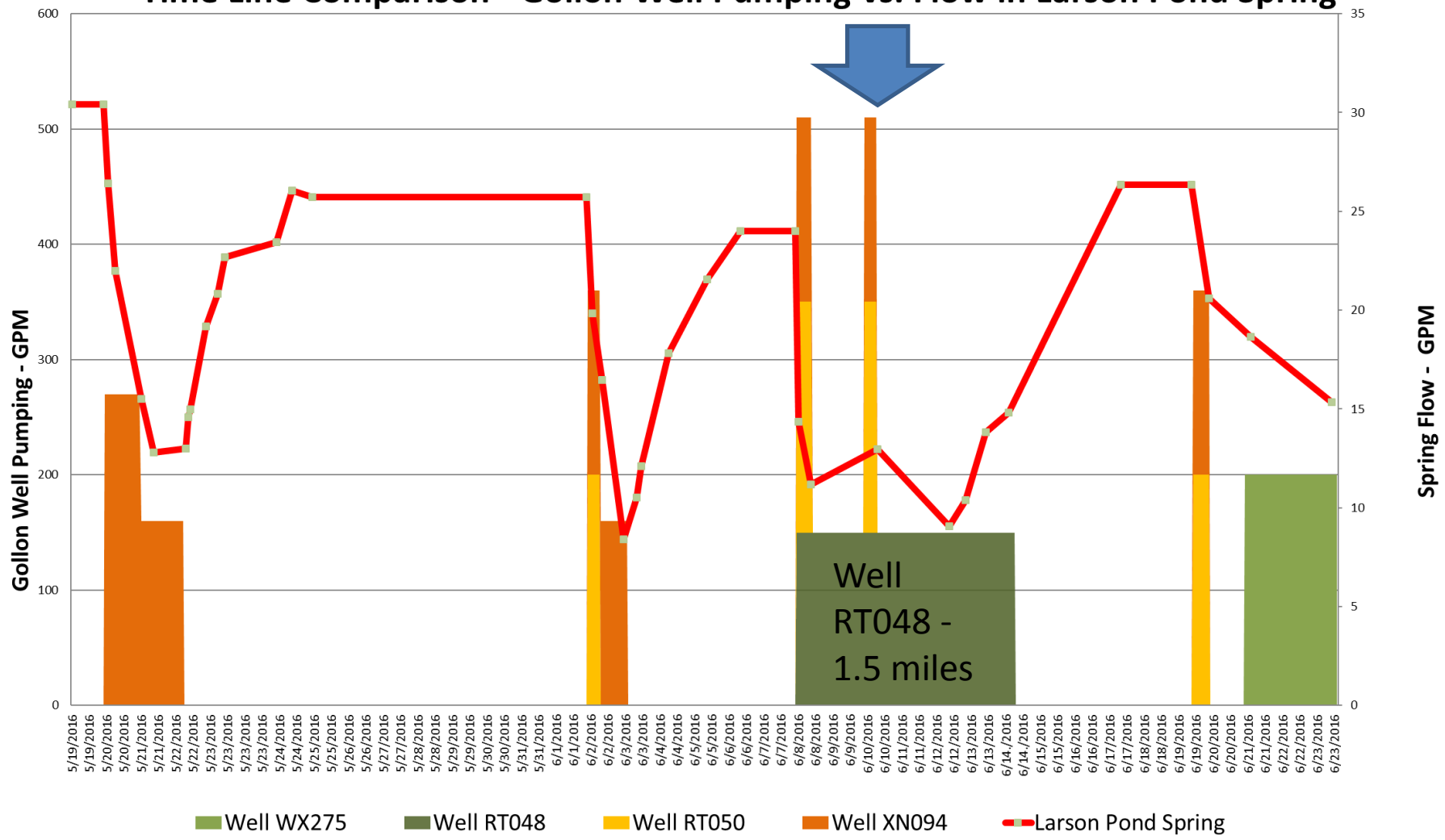



Note: Well 1495 is also pumping at approximately 150 gpm

**Magnitude of Pumping Compared to Pond Spring Impacts – 9AM 6/2 to 6AM 6/6/2016**

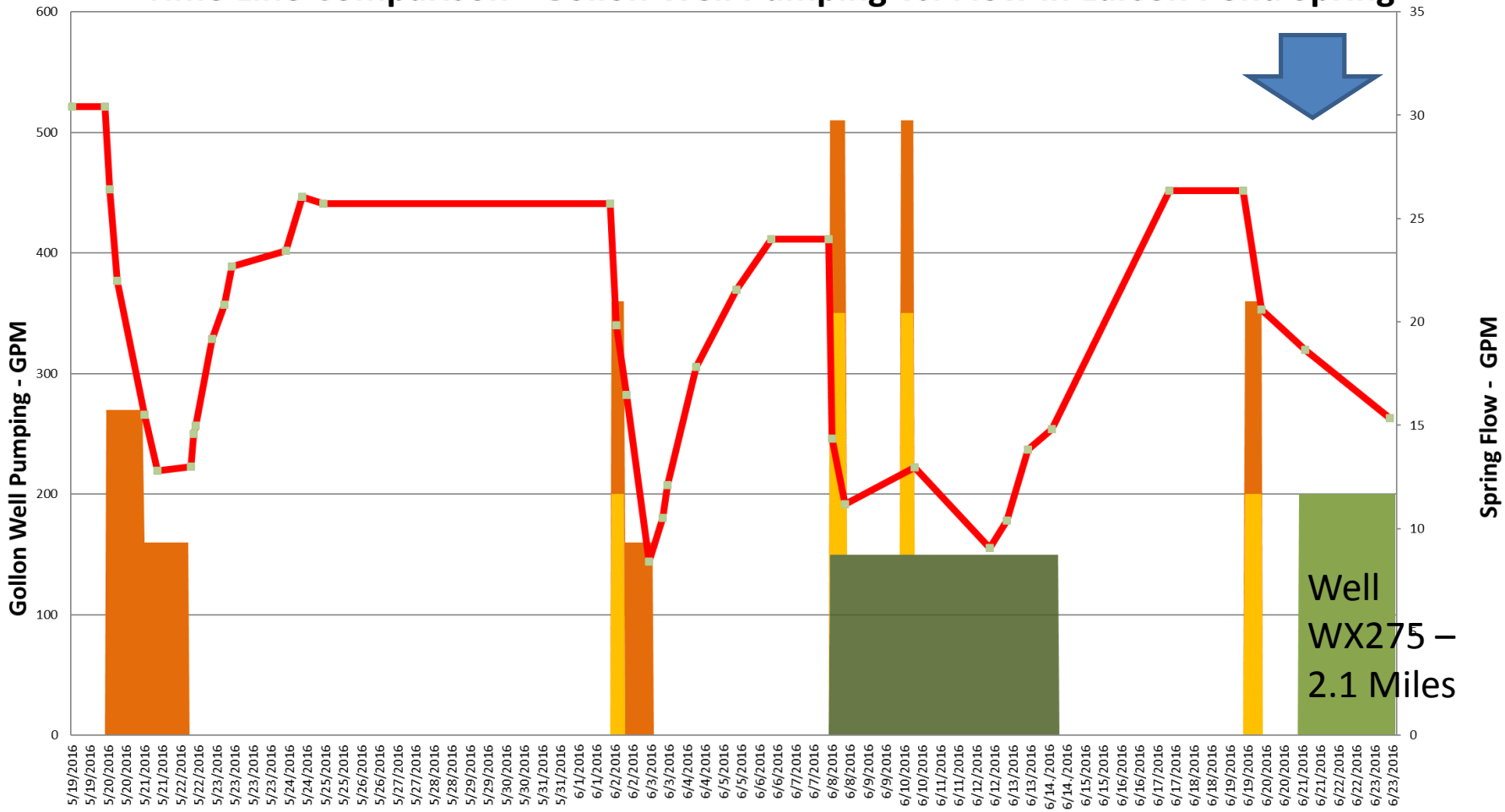
- Well XN094 pumped 268,800 gallons
- Well RT050 pumped 108,000 gallons
- Total of 376,800 gallons pumped
- Pond Spring volume reduction during pumping and recovery = 48,000 gallons
- The Spring Pond reduction represents approximately 12.7 % of the water pumped

# Time Line Comparison - Gollon Well Pumping vs. Flow in Larson Pond Spring




Note: Well 1495 is also pumping at approximately 150 gpm

# Time Line Comparison - Gollon Well Pumping vs. Flow in Larson Pond Spring




Note: Well 1495 is also pumping at approximately 150 gpm

| Gollon 2016 Pumping Reported to WDNR | | | | | | |
|---|---|---|---|---|---|---|
| Well | RT048 | 1495 | RT050 | XN094 | WX275 | Total of All Wells |
| Month | | | | | | |
| January | | 7,426,400 | 0 | | 0 | 7426400 |
| February | | 6,592,100 | 0 | | 0 | 6592100 |
| March | | 7,370,800 | 0 | | 0 | 7370800 |
| April | 2,724,200 | 6,146,800 | 0 | | 0 | 8,871,000 |
| May | 7,611,700 | 7,001,900 | 0 | | 0 | 14,613,600 |
| June | 1,213,300 | 8,418,800 | 596,800 | 10,318,500 | 990,200 | 21,537,600 |
| July | 2,816,000 | 5,681,500 | 4,585,300 | 5,223,400 | 1,895,600 | 20,201,800 |
| August | 3,885,600 | 7,439,200 | 12,799,800 | 6,334,400 | 2,128,500 | 32,587,500 |
| September | 7,577,400 | 7,398,200 | 2,252,500 | 4,973,800 | 3,150,800 | 25,352,700 |
| October | 8,878,600 | 7,856,600 | 0 | 13,600 | 2,980,600 | 19,729,400 |
| November | 368,400 | 5,594,400 | 0 | 2,405,600 | 3,820,400 | 12,188,800 |
| December | 0 | 7,945,900 | 0 | 221,600 | 0 | 8,167,500 |
| Total | 35,075,200 | 84,872,600 | 20,234,400 | 29,490,900 | 14,966,100 | 184,639,200 |

| Comparison of WDNR Reported vs Larry Larson Estimated 2016 Pumping Estimates | | | | | | |
|---|---|---|---|---|---|---|
| Well | RT048 | 1495 | RT050 | XN094 | WX275 | Total of All Wells |
| WDNR Reported Total | 35,075,200 | 84,872,600 | 20,234,400 | 29,490,900 | 14,966,100 | 184,639,200 |
| Larry Larson Total | 7,333,500 | 55,856,649 | 5,166,000 | 10,497,000 | 30,675,000 | 109,528,140 |

- The total 2016 pumping of 184,639,200 gallons reported by Gollon is similar to the 182,807,100 gallons reported for 2015.
- Assuming the WDNR-reported pumping is accurate it appears Larry Larson, except for well WX275, may have underestimated the amount of pumping during 2016.
- The pumping of May 20, 21 and 22, attributed by Larry Larson to Well XN094, may actually be from Well RT048 if the WDNR-reported information is accurate.

# Conclusions

- The Larson Pond Spring receives groundwater discharge from a regional flow system.
- The Gollon high capacity wells are hydraulically connected to the Larson Pond Spring and Blotz Branch which experience significant and rapid reductions in flow in response to pumping of all facility wells which range from 0.61 to 2.1 miles from the spring.
- Paleo-karst development and an associated high degree of secondary permeability in the Prairie du Chien Formation allows for rapid hydraulic response to pumping.
- Groundwater flow within the Prairie du Chien Formation in the project area may be further limited by the presence of the fine-grained post-settlement alluvium deposits in the valleys and local occurrence of the fine-grained Readstown Member of the St. Peter Formation, creating a significant hydraulic separation to the valleys' stream systems

# Recommendations

Continued monitoring and evaluation of the Gollon pumping impacts:

- Larson Pond Spring and Blotz Branch Flows
- Installation of a water level data logger at the former Chester Larson well (W806) would allow for measurement of the direct hydraulic response in the Prairie du Chien Formation underlying the Pond Spring and Blotz Branch
- Record daily pumping volumes for all Gollon high capacity wells to allow correlation with flow and water level measurements
- Use down-hole geophysical measurements at the high capacity wells to evaluate fracture size and distribution
- Conduct packer tests at all Gollon high capacity wells to evaluate whether extending casing below the Prairie du Chien would provide a significant reduction in pumping impacts

# Questions?