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Strand Associates, Inc.®

Stormwater Master Planning to Address Flooding, Hydromodification, and Water Quality

Kentucky Stormwater Association

July 20, 2017

Chris Rust, P.E.

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Agenda

- **Stormwater Master Planning Considerations**
  - Water Quantity
  - Water Quality
  - Asset Management
  - Regulatory Compliance

- **Upper Woolper Creek Watershed Case Study**

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Stormwater Master Planning Considerations

- Water Quantity

Flooding Issues

Detention/Retention Basins

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Stormwater Master Planning Considerations

- Water Quality

Hydromodification Issues

Green Infrastructure

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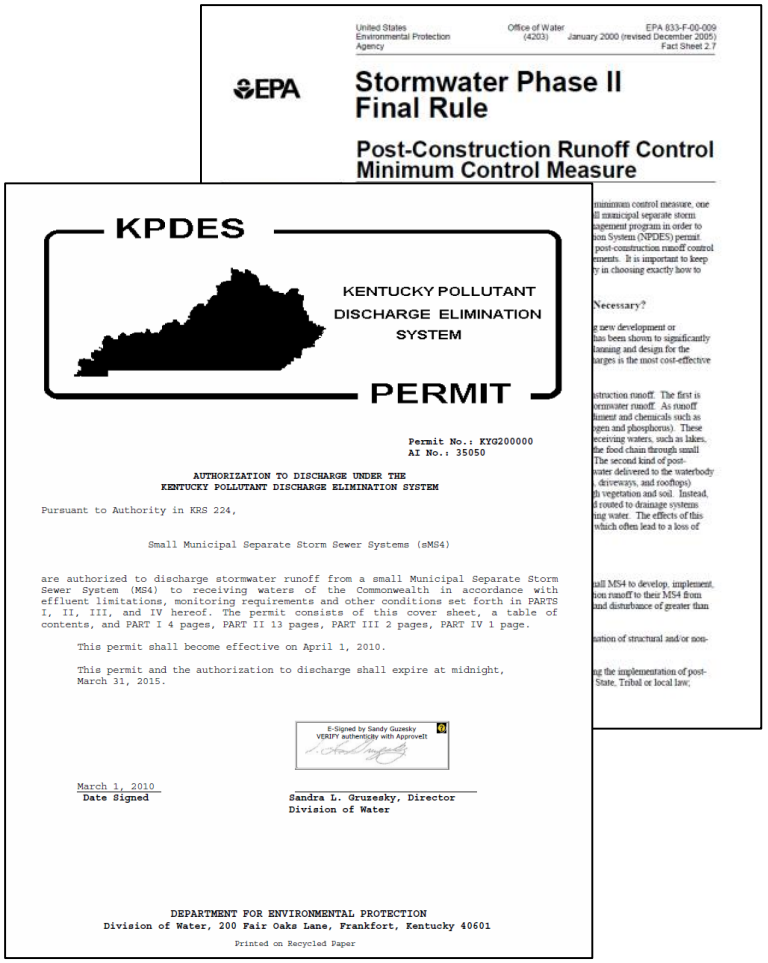
Stormwater Master Planning Considerations

- Asset Management

Storm Infrastructure Issues

- Regulatory Compliance



United States Environmental Protection Agency | Office of Water (4203) | EPA 833-F-00-009 January 2000 (revised December 2005) Fact Sheet 2.7

EPA

Stormwater Phase II Final Rule

Post-Construction Runoff Control Minimum Control Measure

KPDES

KENTUCKY POLLUTANT DISCHARGE ELIMINATION SYSTEM

PERMIT

Permit No.: KYG200000
AI No.: 35050

AUTHORIZATION TO DISCHARGE UNDER THE KENTUCKY POLLUTANT DISCHARGE ELIMINATION SYSTEM

Pursuant to Authority in KRS 224,

Small Municipal Separate Storm Sewer Systems (sMS4)

are authorized to discharge stormwater runoff from a small Municipal Separate Storm Sewer System (MS4) to receiving waters of the Commonwealth in accordance with effluent limitations, monitoring requirements and other conditions set forth in PARTS I, II, III, and IV hereof. The permit consists of this cover sheet, a table of contents, and PART I 4 pages, PART II 13 pages, PART III 2 pages, PART IV 1 page.

This permit shall become effective on April 1, 2010.

This permit and the authorization to discharge shall expire at midnight, March 31, 2015.

E-Signed by Sandy Guzesky
VERIFY authenticity with ApproveIt

March 1, 2010
Date Signed

Sandra L. Gruzesky, Director
Division of Water

DEPARTMENT FOR ENVIRONMENTAL PROTECTION
Division of Water, 200 Fair Oaks Lane, Frankfort, Kentucky 40601

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MS4 Program

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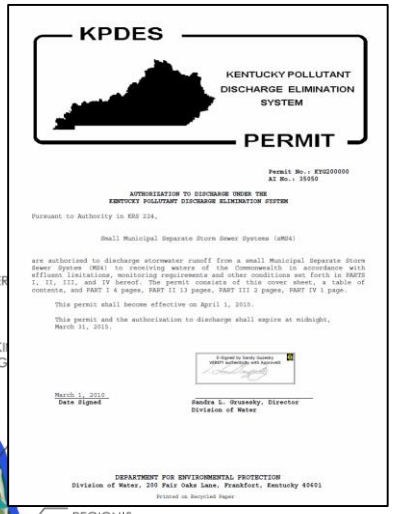
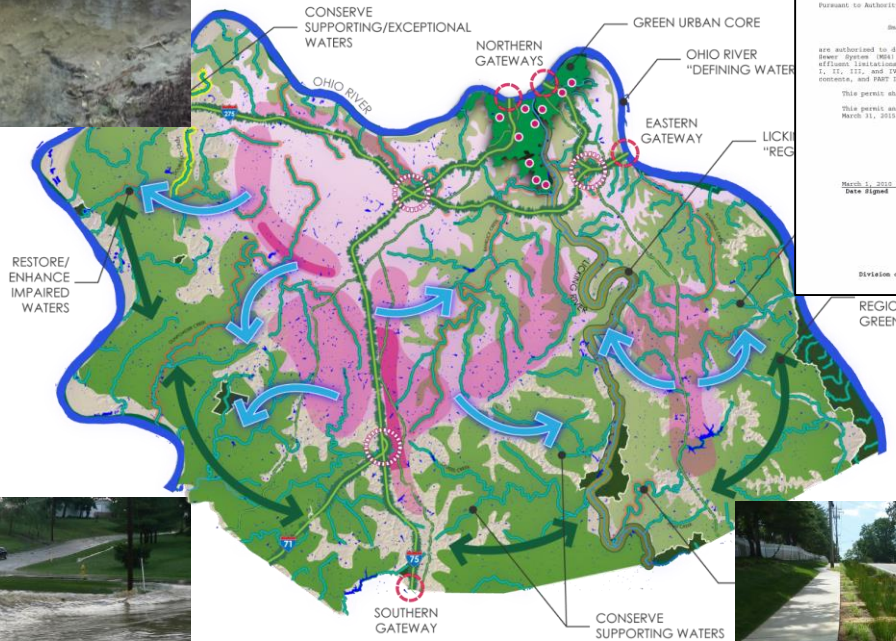
Stormwater Master Planning Considerations





Stormwater master planning can mean many different things….

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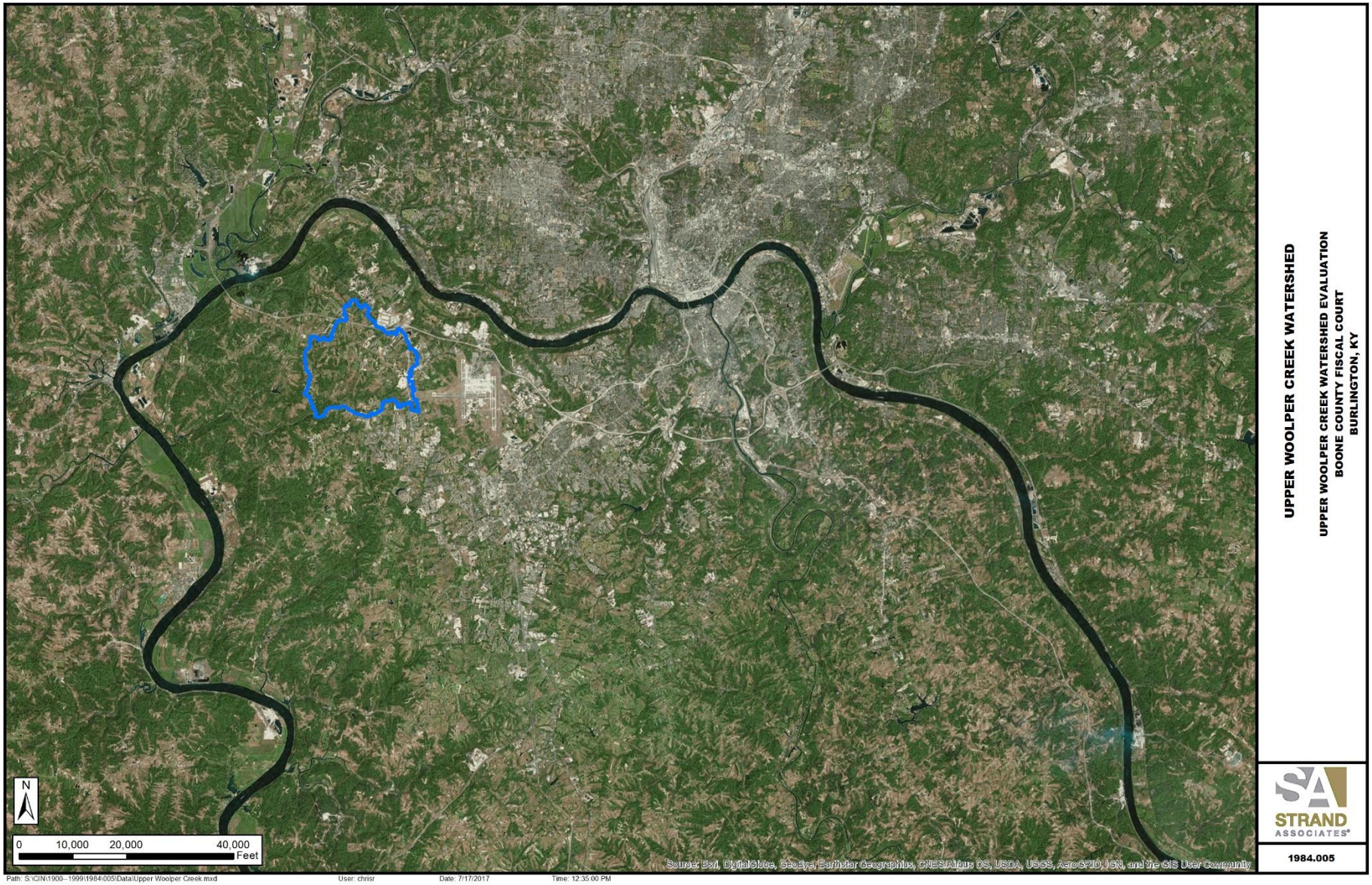
Upper Woolper Creek Watershed Case Study



Upper Woolper Creek Watershed Case Study

- Project partners and collaboration key to the development and implementation of stormwater master plan.

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Boone County
Conservation District

Sustainable
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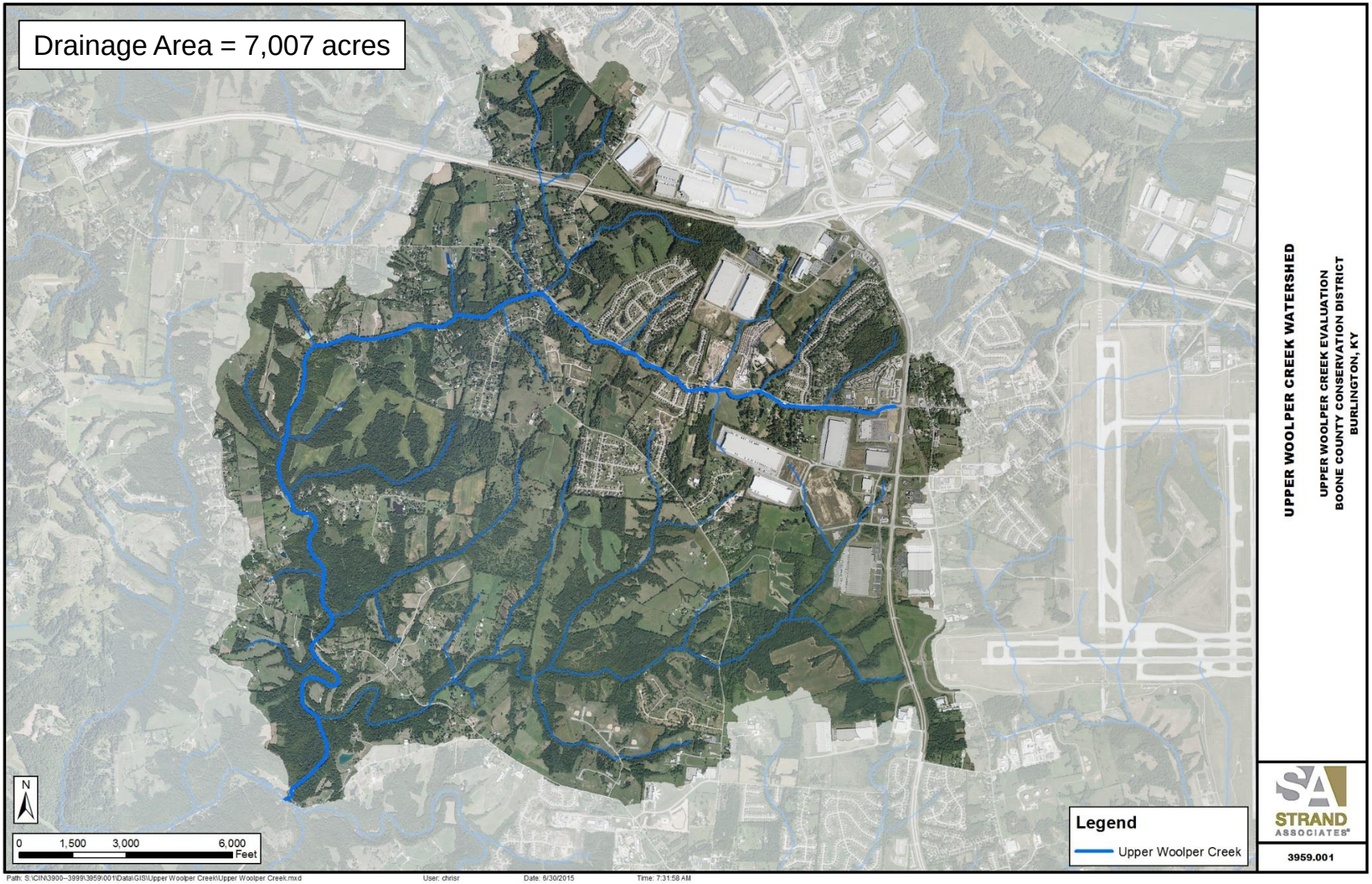
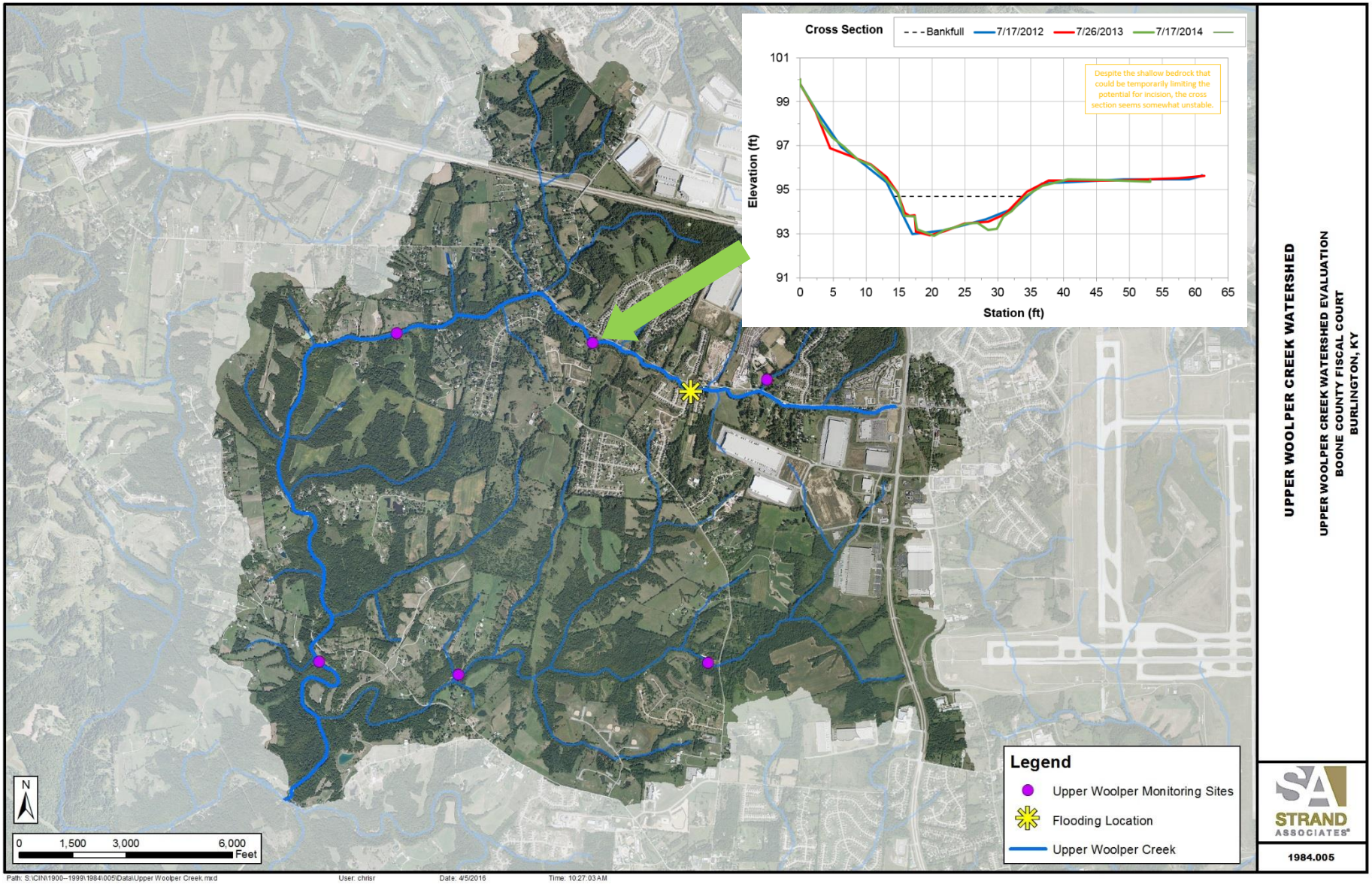
Managing Northern Kentucky's Wastewater and Storm Water
SD1

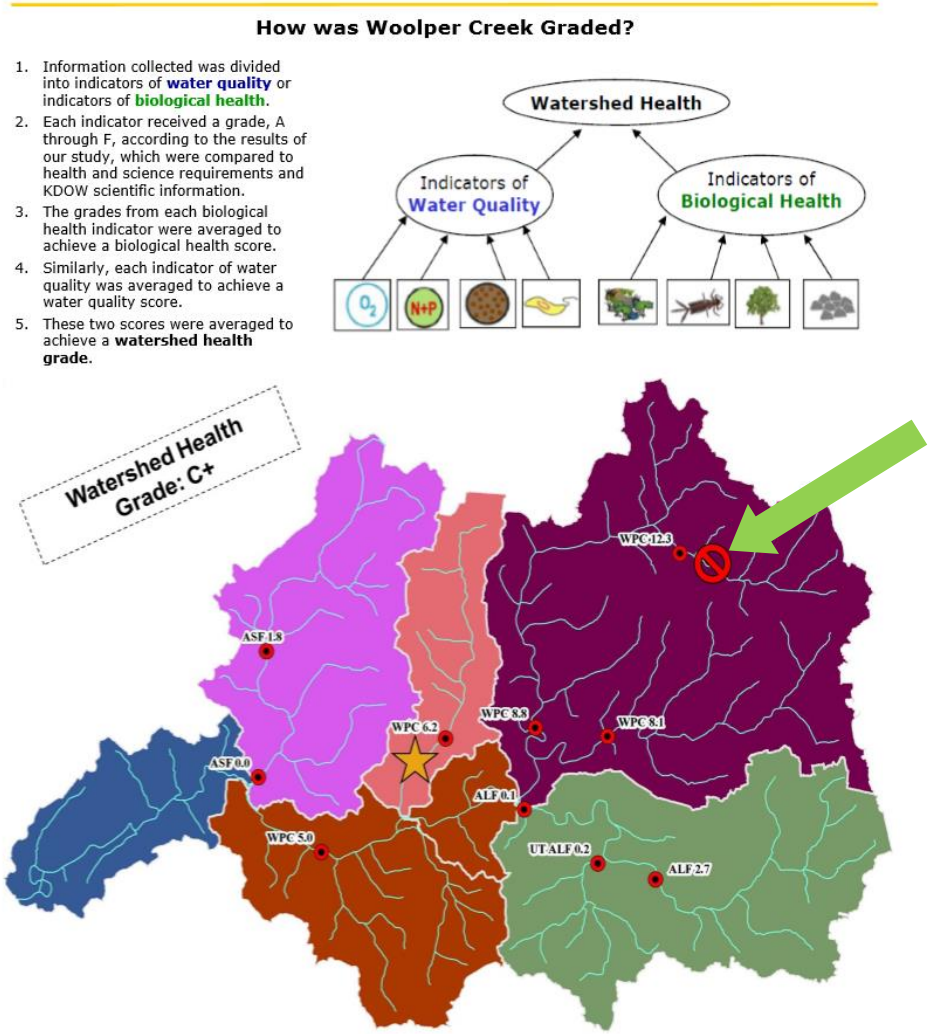
Upper Woolper Creek Watershed Case Study



Hydromodification Issues



Water Quality Issues



Water quality issues within the watershed are worst in locations immediately downstream of Upper Woolper Creek watershed study area.

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Water Quantity / Flooding Issues

Photos provided by Boone County Conservation District

Evaluation of Existing Culverts

Lauren Meadows Drive Culvert

Benjamin Lane Culvert

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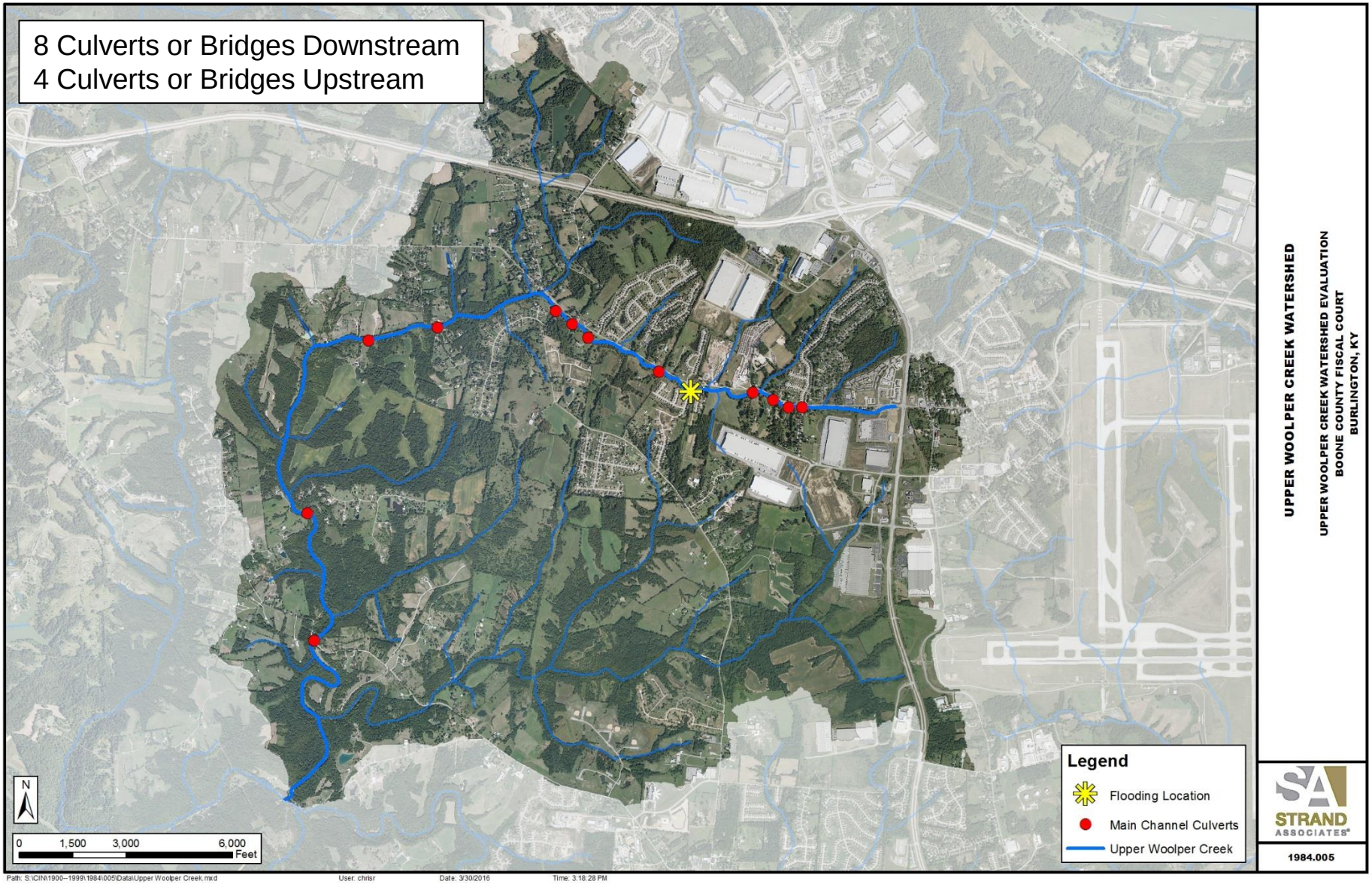
Evaluation of Existing Culverts



Evaluation of Existing Culverts

Several locations of stormwater bottlenecks identified

Understanding of Historic Rainfall Events

June 25, 2009 Rainfall Event
(Hourly Rainfall Recorded at CVG Airport)

Time	Incremental Rainfall (in)	Cumulative Rainfall (in)
2:00 p.m.	0.11	0.11
6:00 p.m.	**0.57**	0.68
7:00 p.m.	**1.95**	2.63
8:00 p.m.	0.02	2.65

2.52 inches of rainfall with a 2-hour duration is approximately equivalent to a 10-year storm event.

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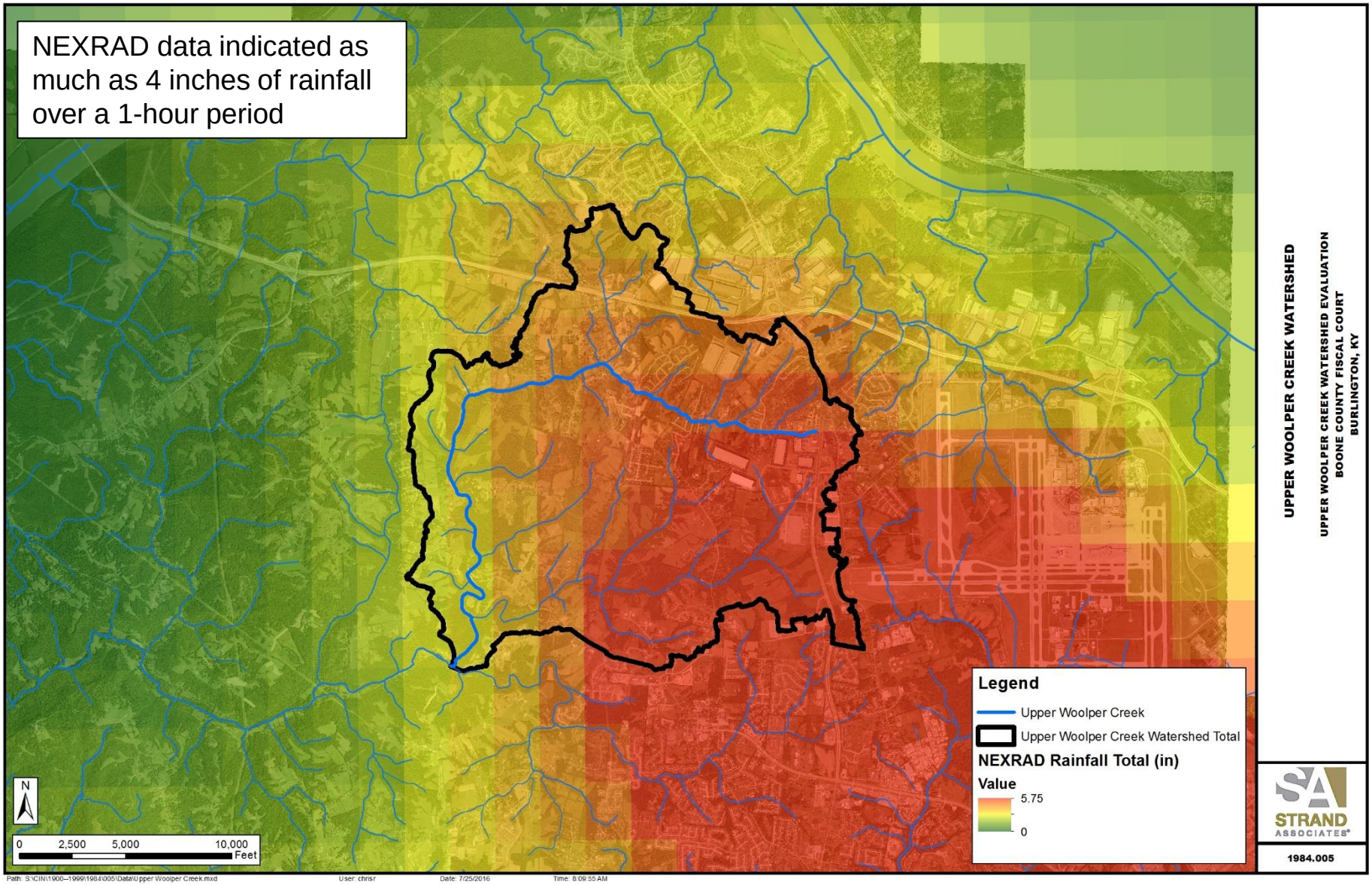
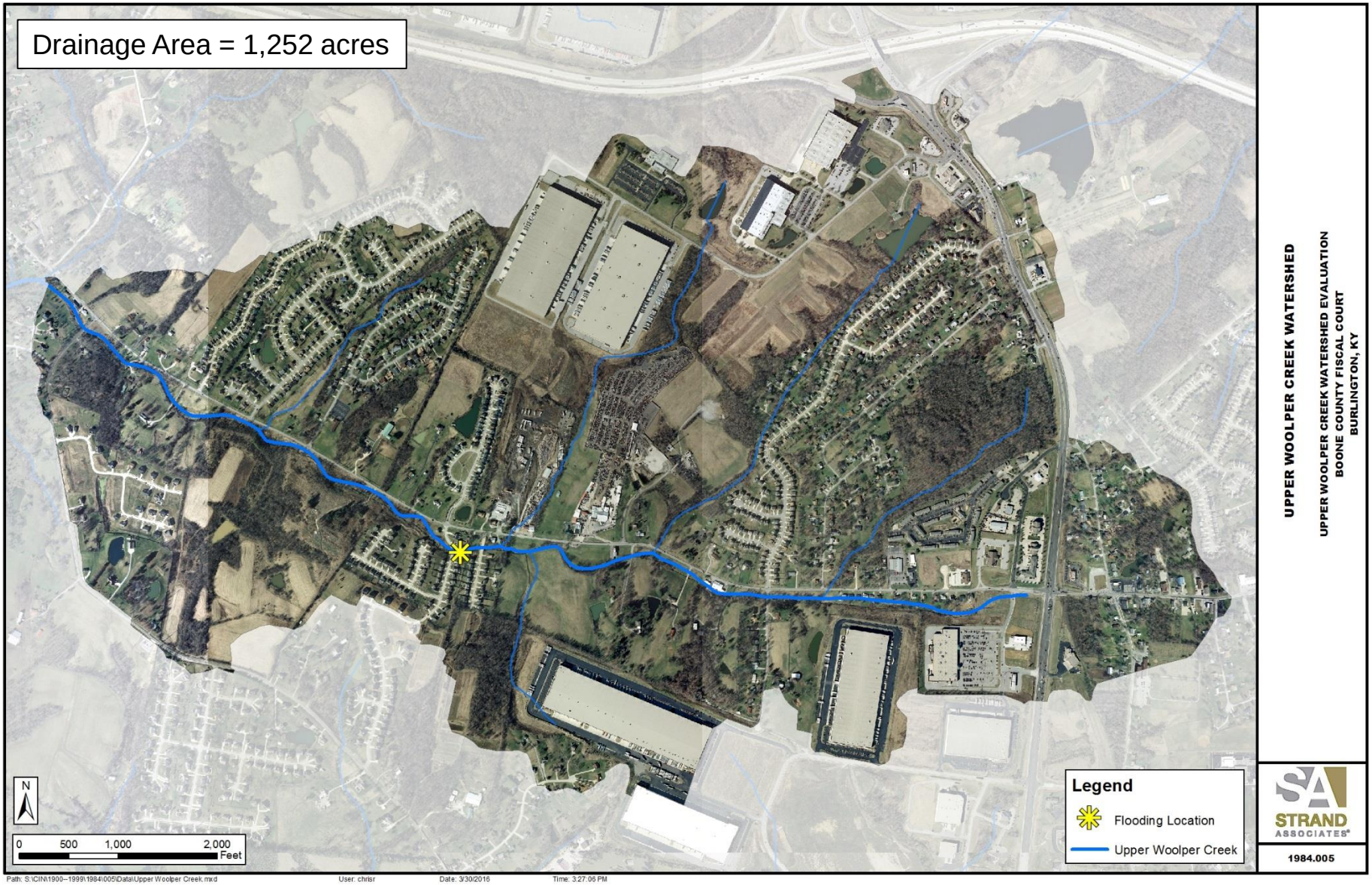
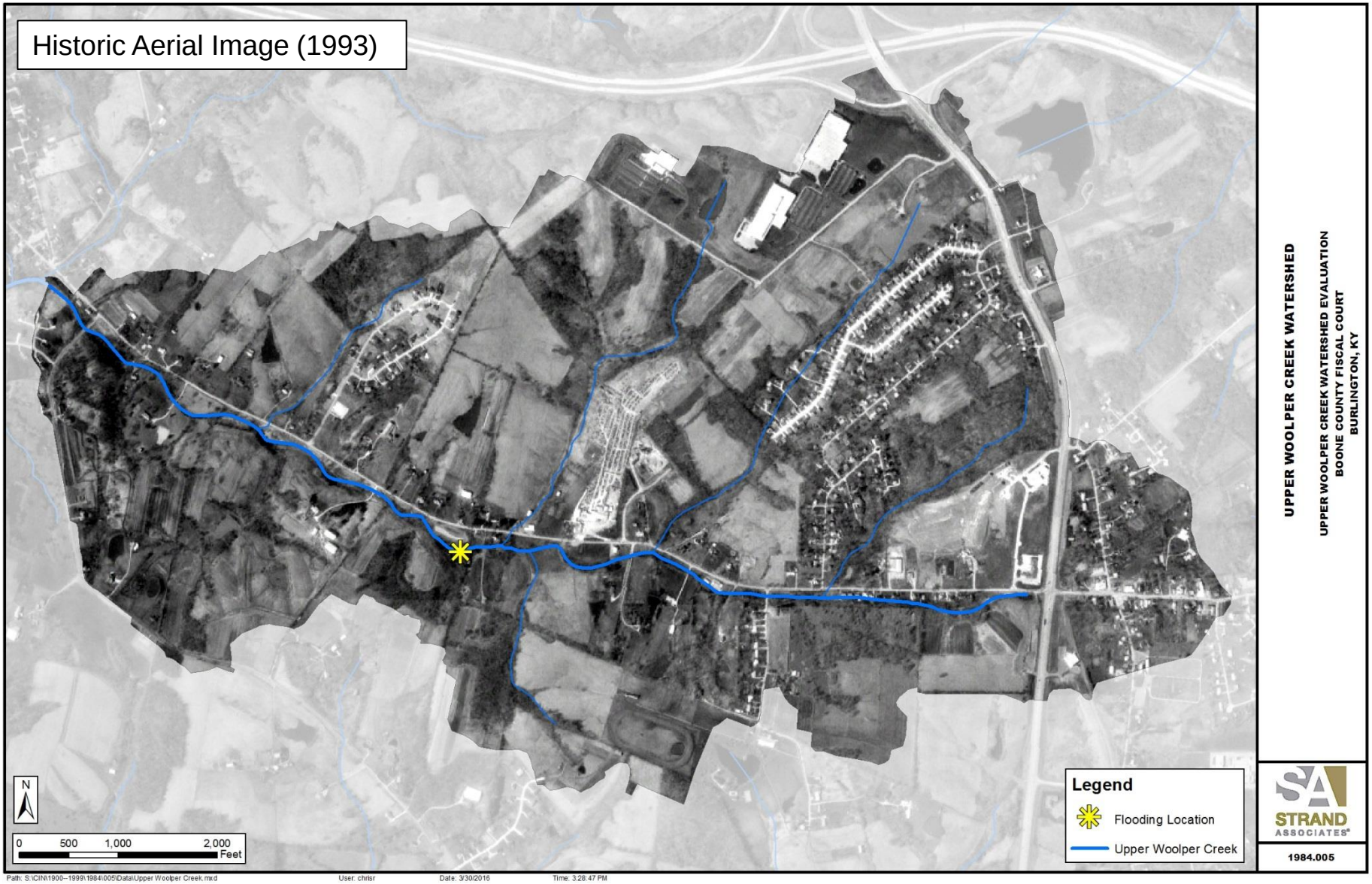
Understanding of Historic Rainfall Events



Upper Woolper Creek Watershed Existing Conditions



Looking Back to Understand Land Cover Changes



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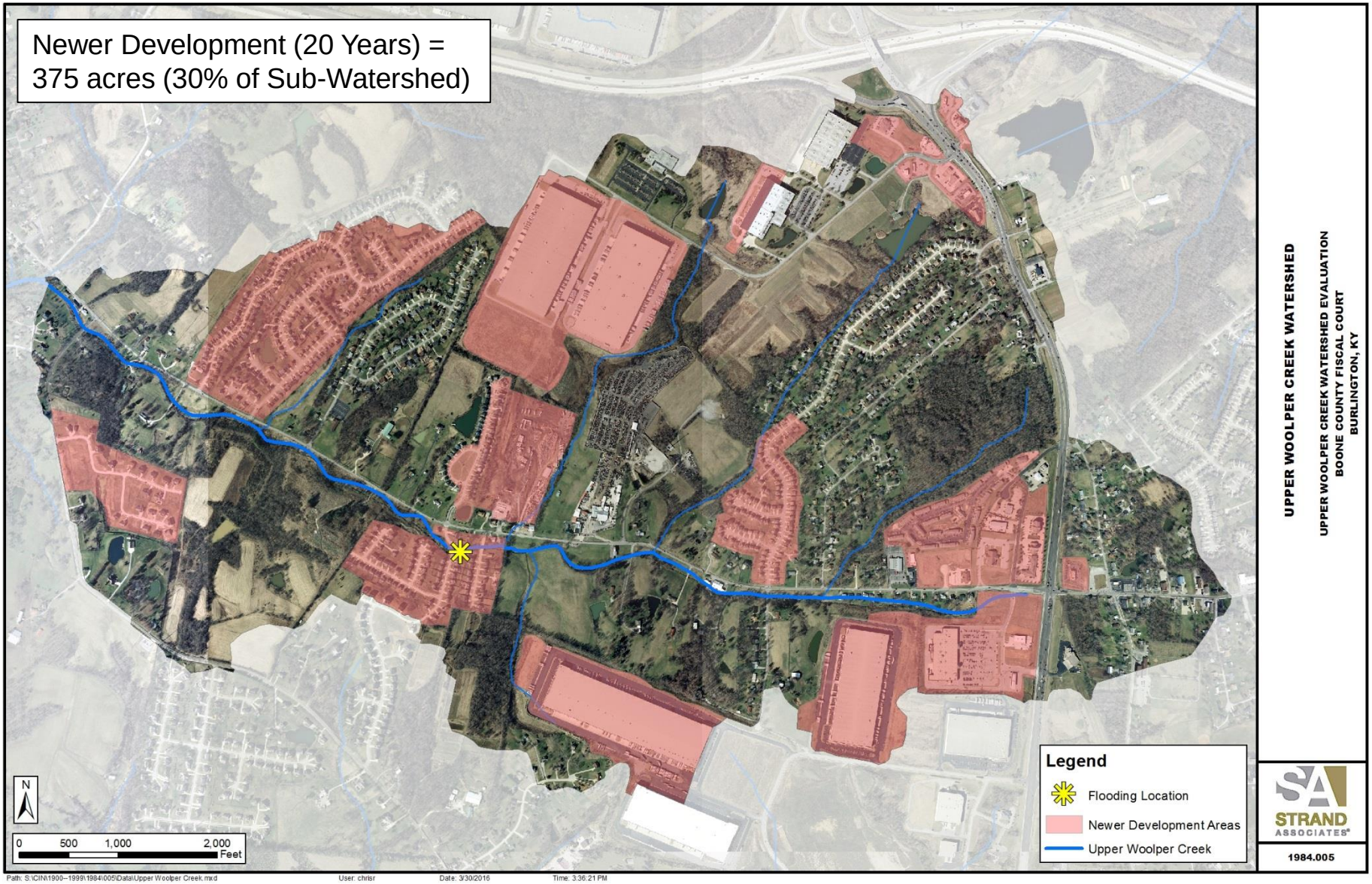
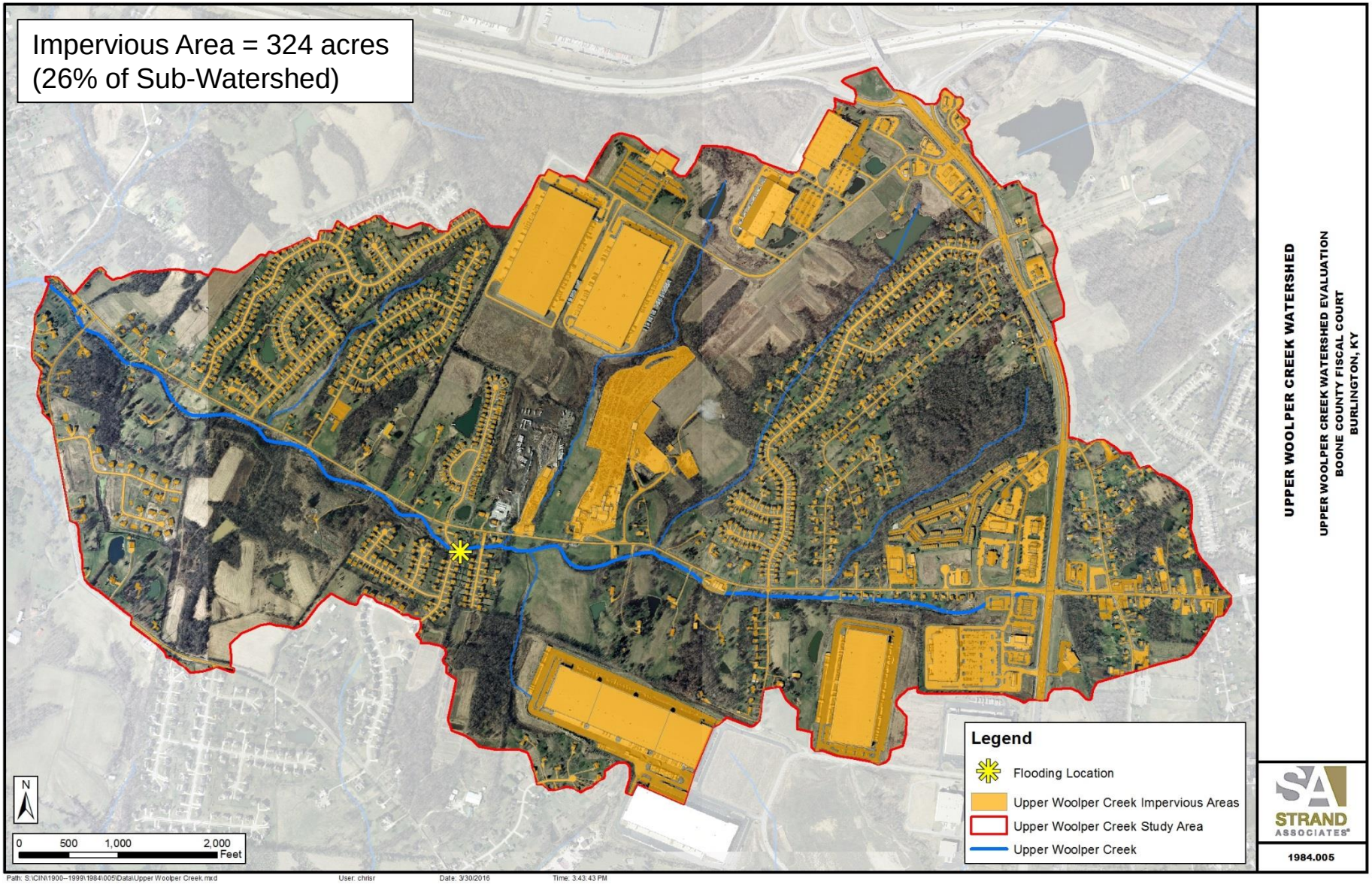
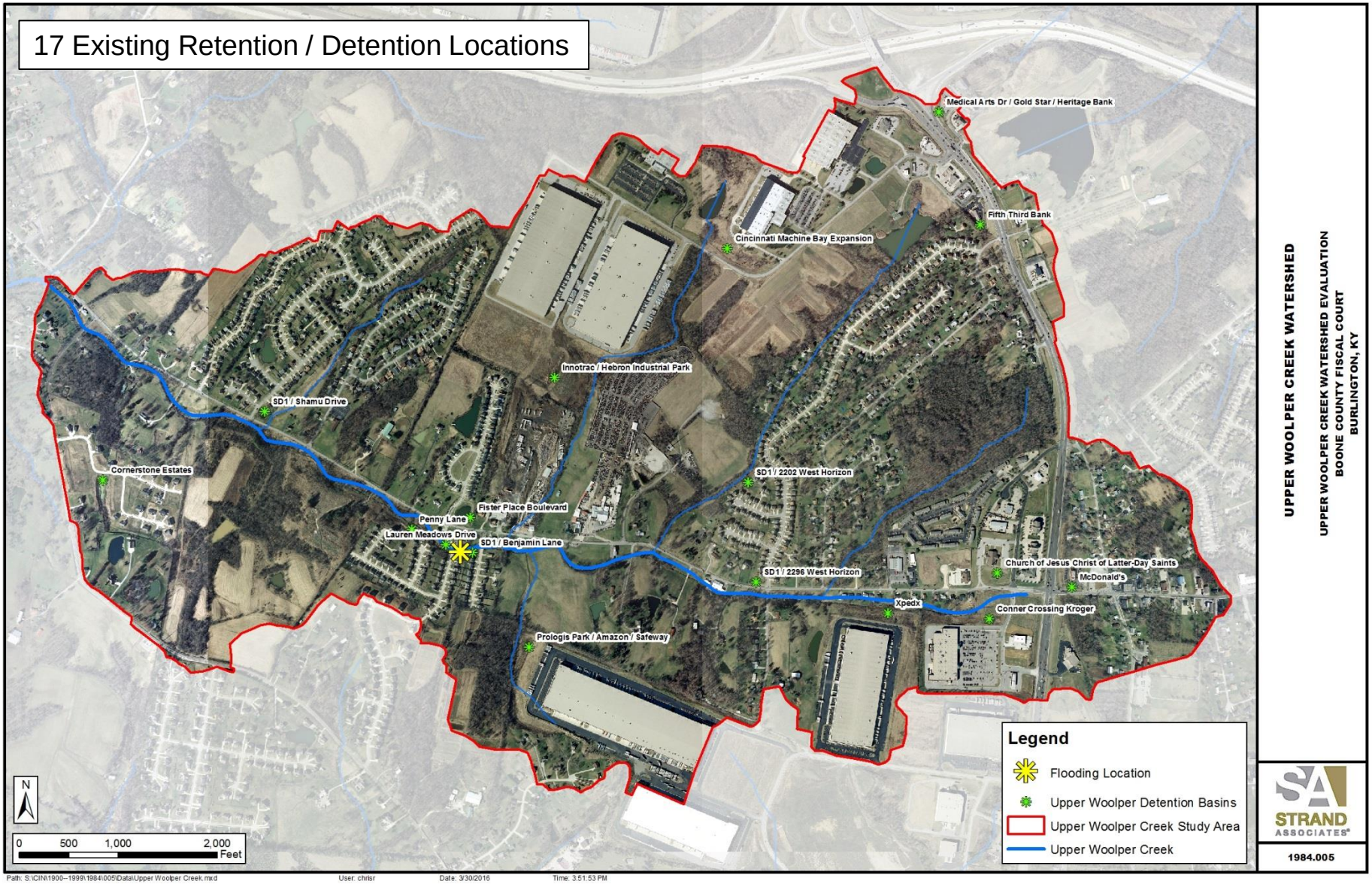


Impacts of Impervious Surfaces



Evaluation of Existing Detention Basins



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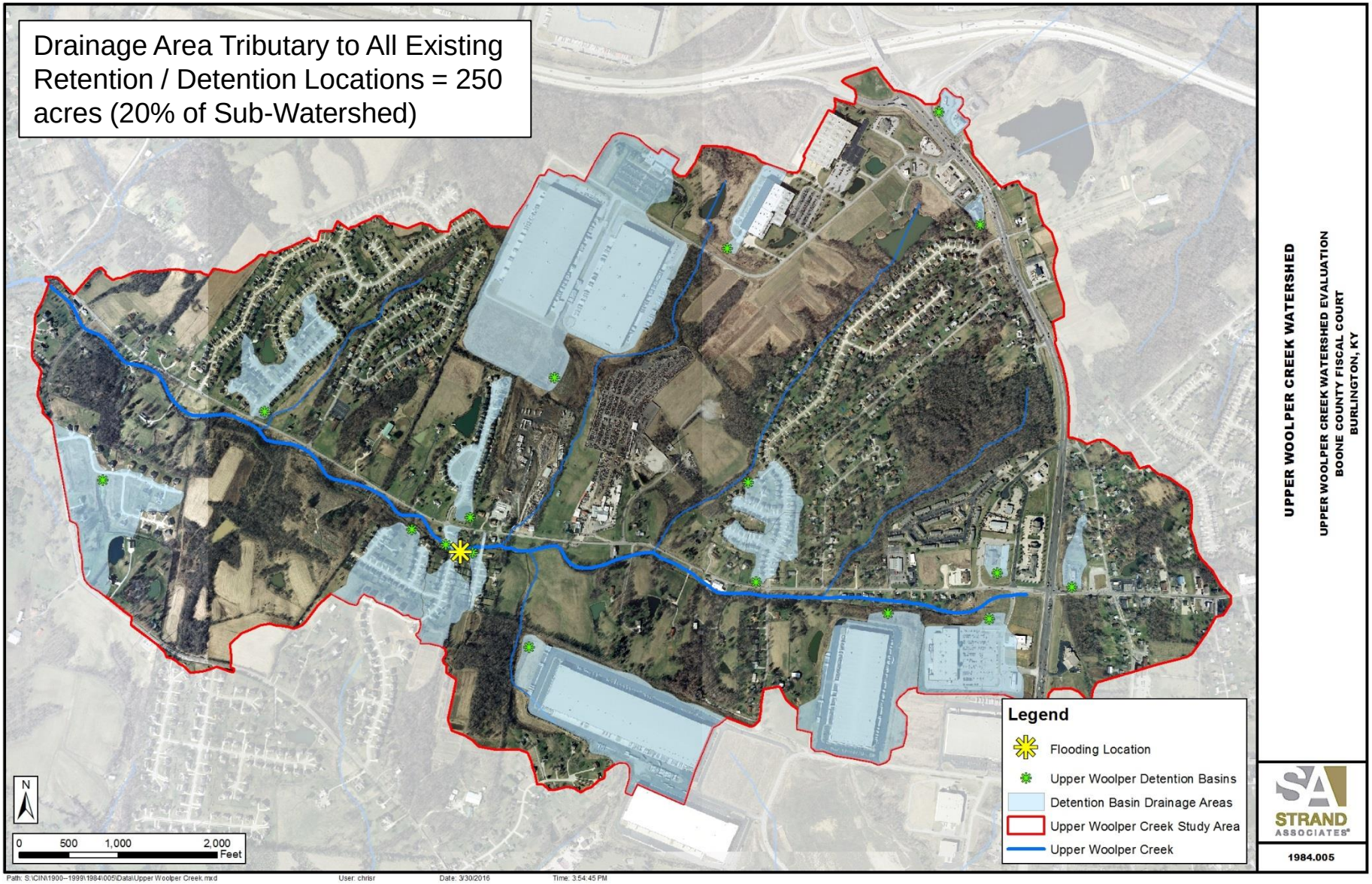

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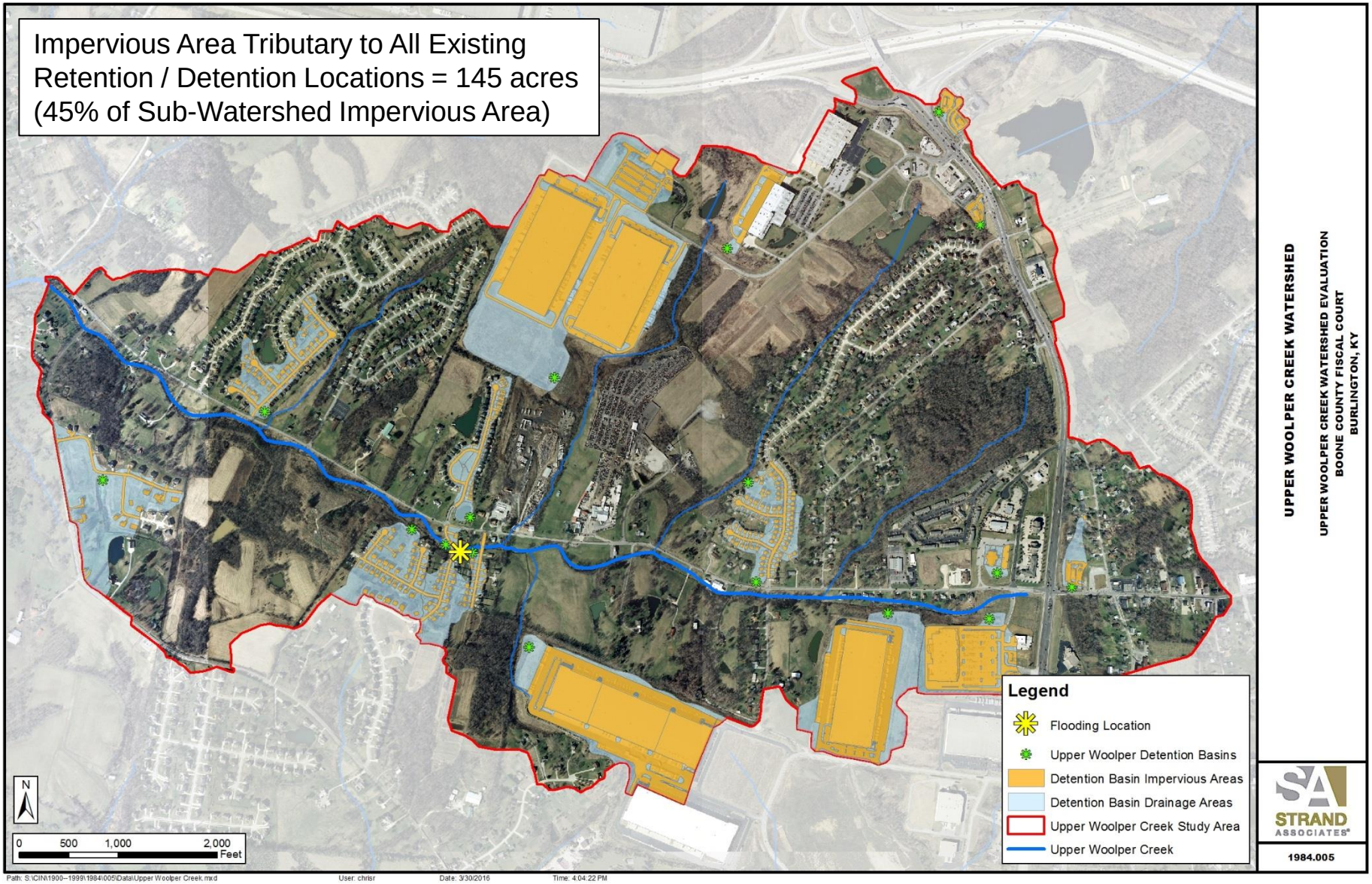

Evaluation of Existing Detention Basins

Evaluation of Existing Detention Basins

Basin #	Basin Name	Owner	Drainage Area (acres)	Impervious Area (acres)	Perc. Imperv.	Storage Vol. (ac-ft)
1	Innotrac / Hebron Industrial Park	Private - Industry	79.67	50.26	63.09%	20.31
2	Prologis Park / Amazon / Safeway	Private - Industry	39.12	32.44	82.92%	7.77
3	Xpedx	Private - Industry	31.14	21.60	69.36%	2.01
4	Cornerstone Estates	Residential	20.64	2.88	13.95%	2.61
5	Kroger / Conner Crossing	Private - Commercial	16.42	12.61	76.80%	3.08
6	Penny Lane	Residential	12.89	3.44	26.69%	0.43
7	Shamu Drive	SD1	10.76	4.32	40.15%	0.35
8	Lauren Meadows Drive	Residential	7.82	2.14	27.37%	0.06
9	2202 West Horizon	SD1	7.50	3.09	41.20%	0.11
10	Fister Place Boulevard	Residential	5.87	2.46	41.91%	0.64
11	2296 West Horizon	SD1	5.37	2.14	39.85%	0.22
12	Cincinnati Machine Bay Expansion	Private - Industry	4.02	2.65	65.92%	0.02
13	McDonald's	Private - Commercial	2.67	0.89	33.33%	0.07
14	Medical Arts Dr / Gold Star / Heritage Bank	Private - Commercial	1.95	1.37	70.26%	0.08
15	Church of Jesus Christ of Latter-Day Saints	Private - Religion	1.74	0.76	43.68%	0.25
16	Benjamin Lane	SD1	1.72	0.91	52.91%	0.04
17	Fifth Third Bank	Private - Commercial	0.95	0.67	70.53%	0.09
Total	**-**	**-**	**250.25**	**144.63**	**-**	**38.15**

Evaluation of Existing Detention Basins

BIG **VS.** **SMALL**

Innotrac / Hebron Industrial Park

Benjamin Lane

Prologis Park / Amazon / Safeway

Shamu Drive

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Evaluation of Existing Detention Basins

Basin #	Basin Name	Owner	LIDAR Storage Vol. (ac-ft)	Design Storage Vol. (ac-ft)	Percent Difference
1	Innotrac / Hebron Industrial Park	Private - Industry	20.31	20.53	-1.1%
4	Cornerstone Estates	Residential	2.61	6.69	-61.0%
5	Kroger / Conner Crossing	Private - Commercial	3.08	3.43	-10.2%
6	Penny Lane	Residential	0.43	1.27	-66.1%
7	Shamu Drive	SD1	0.35	0.63	-44.5%
8	Lauren Meadows Drive	Residential	0.06	0.22	-72.1%
9	2202 West Horizon	SD1	0.11	0.52	-78.9%
10	Fister Place Boulevard	Residential	0.64	0.89	-27.7%
11	2296 West Horizon	SD1	0.22	0.42	-49.0%
12	Cincinnati Machine Bay Expansion	Private - Industry	0.02	0.34	-93.1%
13	McDonald's	Private - Commercial	0.07	0.12	-46.4%
14	Medical Arts Dr / Gold Star / Heritage Bank	Private - Commercial	0.08	0.11	-22.0%
15	Church of Jesus Christ of Latter-Day Saints	Private - Religion	0.25	0.44	-43.3%
Total	-	-	**28.23**	**35.61**	**-20.7%**

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Majority of existing detention basins appear to be undersized when comparing LIDAR-based storage volume to design-based storage volume (especially on smaller basins).

Identifying Opportunities for Detention Basin Retrofits

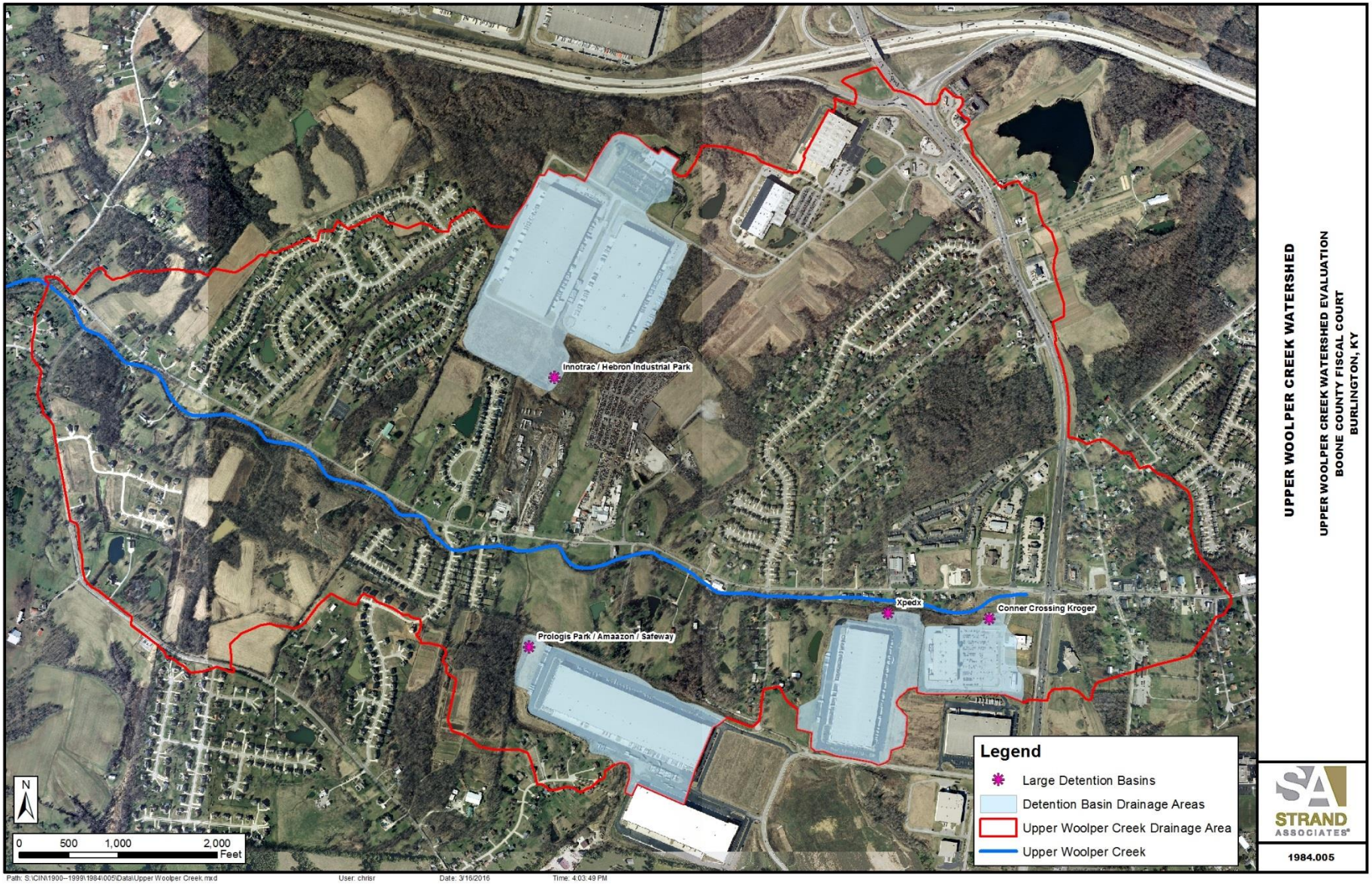
Basin #	Basin Name	Owner	Drainage Area (acres)	Impervious Area (acres)	Perc. Imperv.	Storage Vol. (ac-ft)
1	Innotrac / Hebron Industrial Park	Private - Industry	79.67	50.26	63.09%	20.31
2	Prologis Park / Amazon / Safeway	Private - Industry	39.12	32.44	82.92%	7.77
3	Xpedx	Private - Industry	31.14	21.60	69.36%	2.01
4	Cornerstone Estates	Residential	20.64	2.88	13.95%	2.61
5	Kroger / Conner Crossing	Private - Commercial	16.42	12.61	76.80%	3.08
6	Penny Lane	Residential	12.89	3.44	26.69%	0.43
7	Shamu Drive	SD1	10.76	4.32	40.15%	0.35

Statistics on "Big 4" Detention Basins:

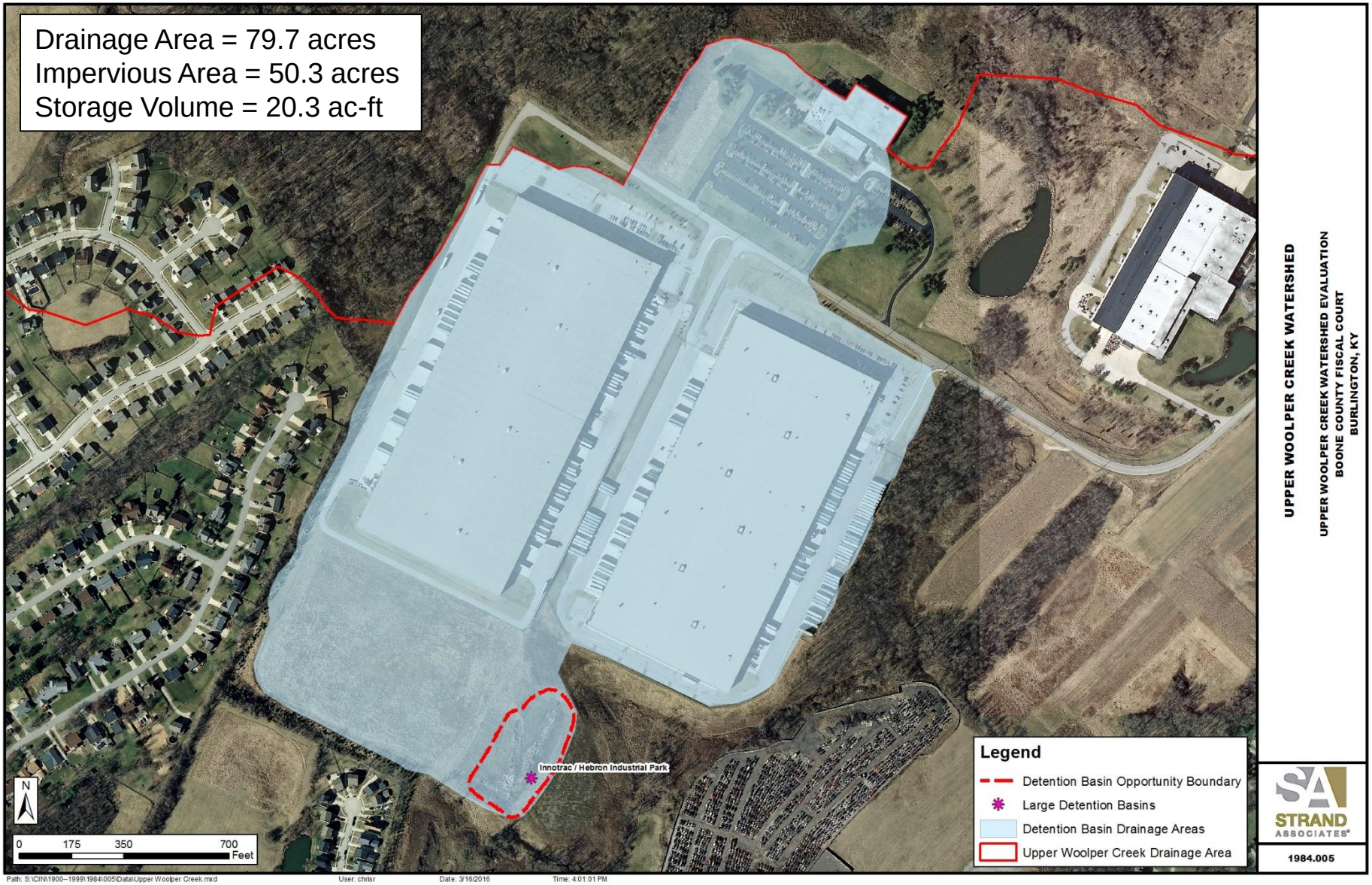
- Total drainage area of 166.35 acres represents 66% of drainage area to all detention basins.
- Impervious drainage area of 116.91 acres represents 81% of impervious area to all detention basins.
- Storage volume of 33.2 ac-ft represents 87% of storage volume provided by all detention basins.

15	Church of Jesus Christ of Latter-Day Saints	Private - Religion	1.74	0.76	43.68%	0.25
16	Benjamin Lane	SD1	1.72	0.91	52.91%	0.04
17	Fifth Third Bank	Private - Commercial	0.95	0.67	70.53%	0.09
Total	**-**	**-**	**250.25**	**144.63**	**-**	**38.15**

Identifying Opportunities for Detention Basin Retrofits



Identifying Opportunities for Detention Basin Retrofits



Identifying Opportunities for Detention Basin Retrofits

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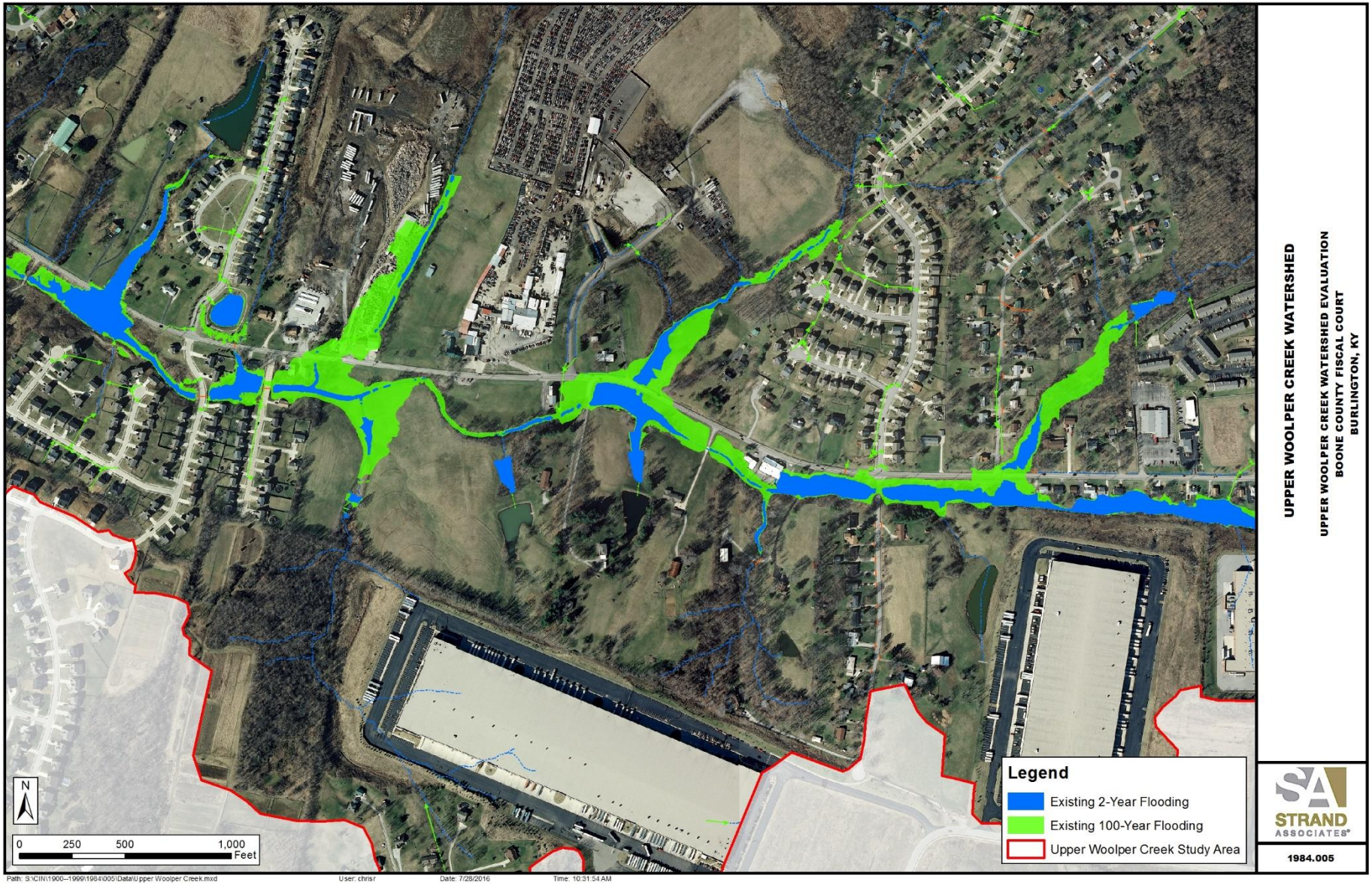
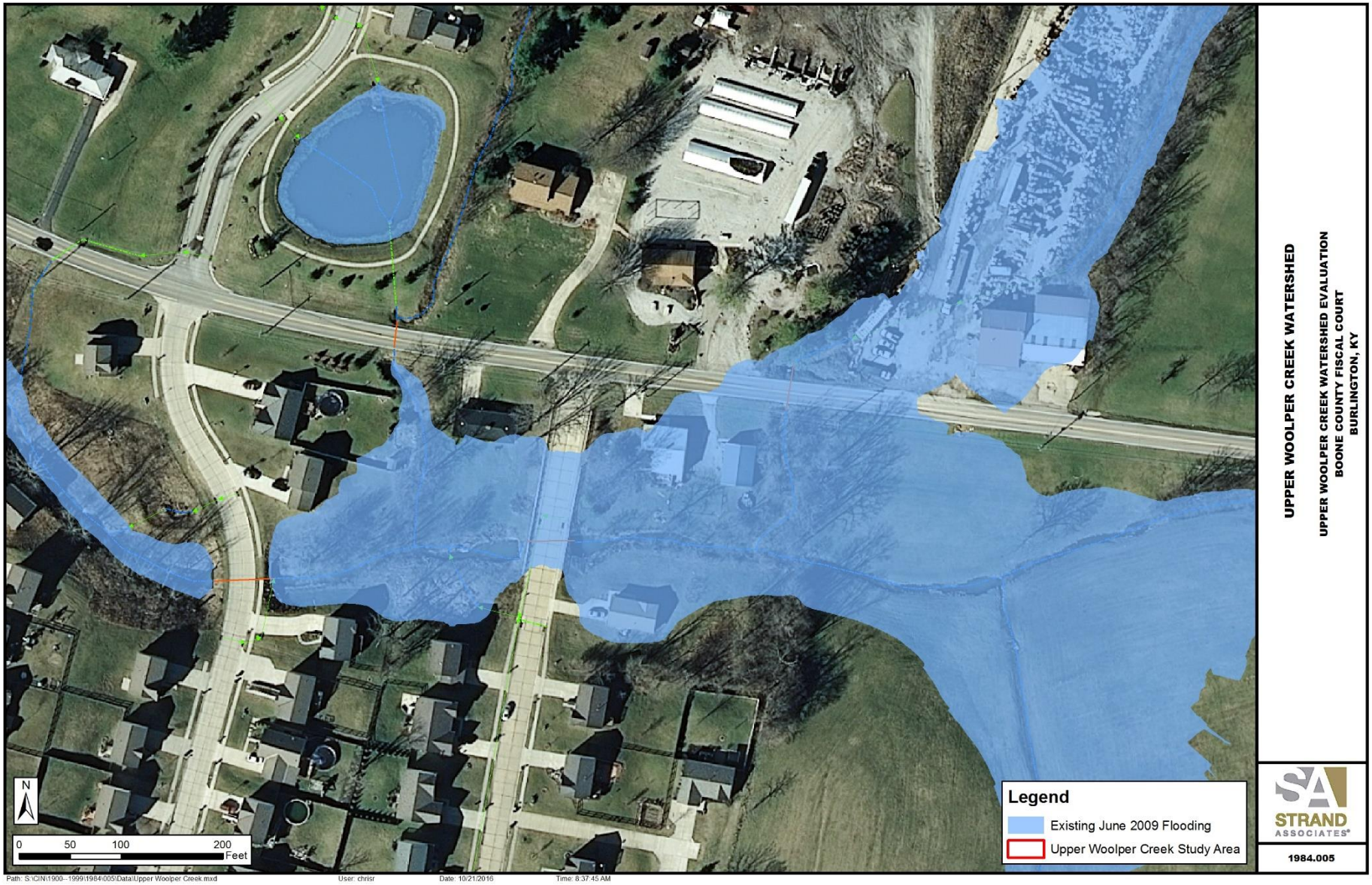
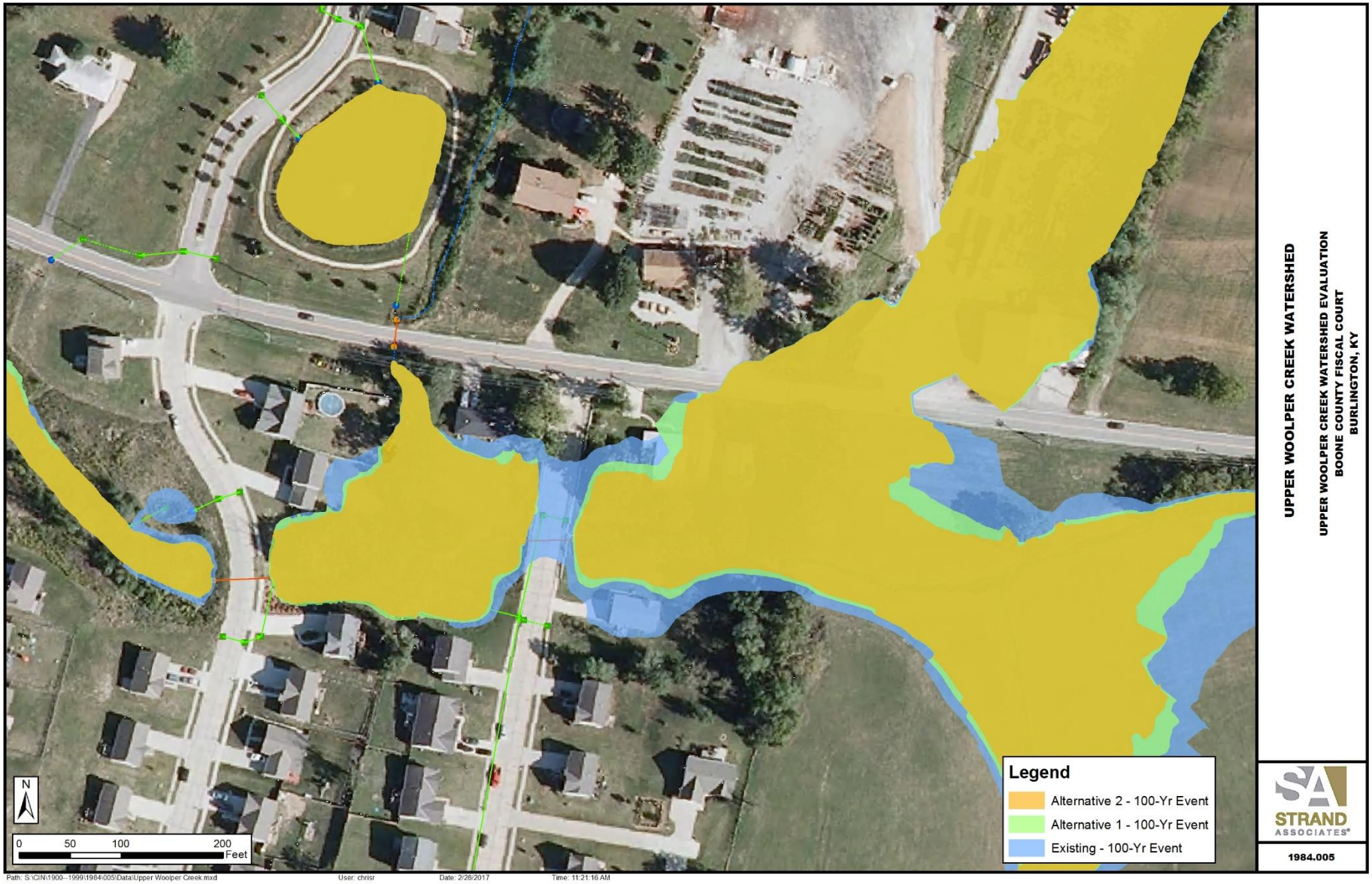
Evaluating Opportunities for Detention Basin Retrofits



Evaluating Opportunities for Detention Basin Retrofits



Evaluating Opportunities for Detention Basin Retrofits



Water Quantity / Flood Reduction Benefits

	Existing Conditions	Alternative No. 1 Culvert Replacement		Alternative No. 2 Culvert Replacement with Detention Basin Retrofits	
Culvert Location	**Peak Flow Rate (cfs)**	**Peak Flow Rate (cfs)**	**Percent Increase**	**Peak Flow Rate (cfs)**	**Percent Increase**
Benjamin Lane	351	356	1.4%	314	-10.5%
Lauren Meadows Drive	362	368	1.7%	327	-9.7%
2607 Petersburg Road	376	386	2.7%	346	-8.0%
2903 Petersburg Road	453	464	2.4%	426	-6.0%
2939 Petersburg Road	462	474	2.6%	437	-5.4%
Bullittsville Road	470	481	2.3%	445	-5.3%
Peel Road	1,043	1,049	0.6%	1,023	-1.9%

Culvert Location	**WSE (ft)**	**WSE (ft)**	**Change (ft)**	**WSE (ft)**	**Change (ft)**
Benjamin Lane	807.16	805.61	-1.55	805.47	-1.69
Lauren Meadows Drive	804.53	804.56	0.03	804.37	-0.16
2607 Petersburg Road	798.17	798.20	0.03	798.08	-0.09
2903 Petersburg Road	783.78	783.88	0.10	783.57	-0.21
2939 Petersburg Road	780.65	780.68	0.03	780.58	-0.07
Bullittsville Road	776.18	776.26	0.08	775.97	-0.21
Peel Road	757.92	757.94	0.02	757.87	-0.05

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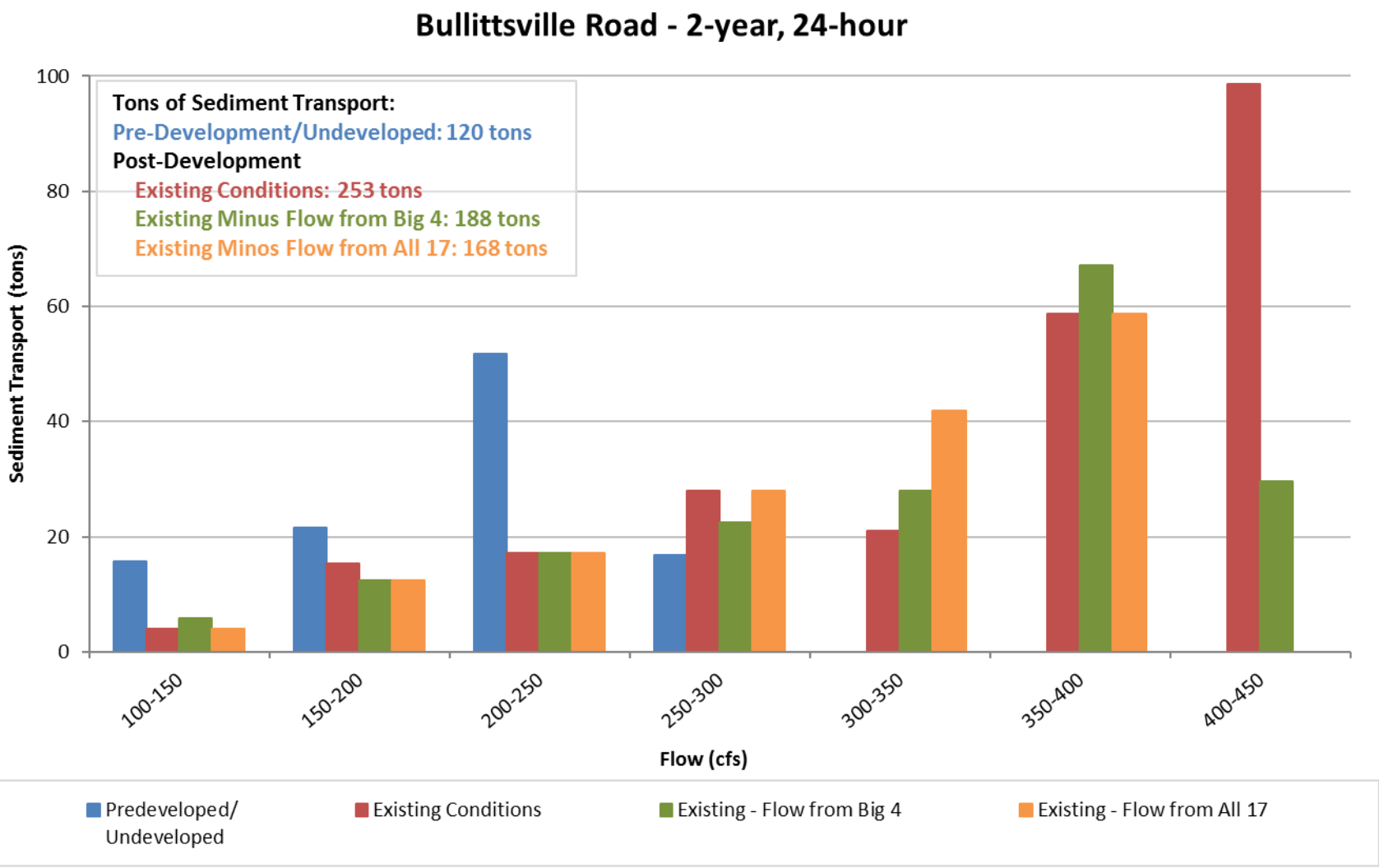
Strategic detention basin retrofits can help offset the increased peak flow rates and water surface elevations that would occur if only culvert replacement alternative was implemented.

Water Quality / Hydromodification Benefits



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Water Quality / Hydromodification Benefits

	Predeveloped/ Undeveloped	Post-Developed		
		Existing Conditions	Existing Minus Flow from Big 4	Existing Minus Flow from All 17
Peak Flow (cfs)	353	538	504	470
Minutes > $Q_{critical}$	168	180	132	123
Sediment (tons)	120	253	188	168

% Change from Pre-Developed	Predeveloped/ Undeveloped	Post-Developed		
		Existing Conditions	Existing Minus Flow from Big 4	Existing Minus Flow from All 17
Peak Flow (cfs)	-	52%	43%	33%
Minutes > $Q_{critical}$	-	7%	-21%	-27%
Sediment (tons)	-	111%	57%	40%

EXCESS Peaks, Duration, and Sediment Transport	Predeveloped/ Undeveloped	Post-Developed		
		Existing Conditions	Existing Minus Flow from Big 4	Existing Minus Flow from All 17
Peak Flow (cfs)	-	185	151	116
Minutes > $Q_{critical}$	-	12	-36	-45
Sediment (tons)	-	133	68	48

- Goal: Reduce excess sediment transport by 100%
- Detention basin retrofits at the 4 biggest detention basins = 49% of goal
- Detention basin retrofits at all 17 detention basins = 64% of goal

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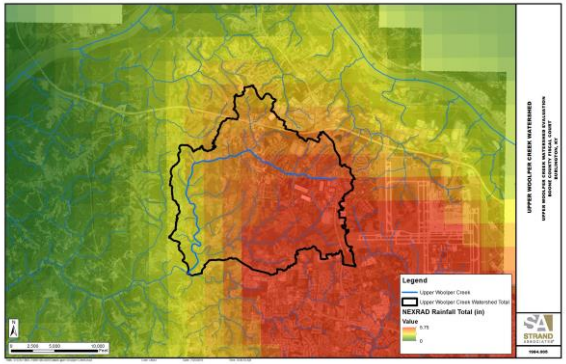
Upper Woolper Creek Watershed Case Study

- Understanding of magnitude of stormwater management issues is important to guide stormwater master planning initiatives.
- Identification of stormwater management improvements through stormwater master planning can potentially lead to improvements in water quantity (flood reduction) and water quality (sediment transport reduction) improvements.
- Simple modifications at existing detention basins with excess storage capacity can have a big impact downstream.
- Collaboration and partnerships are critical for stormwater master planning evaluations and implementation.



BOONE COUNTY KENTUCKY

Boone County Conservation District

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QUESTIONS?

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chris.rust@strand.com

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