The Loup River Hydroelectric Project
Second Initial Study Results Meeting

February 23-24, 2011

Loup Power District
Hydro Project

Agenda

Wednesday - Feb. 23rd

9:30 AM	Welcome and Introductions
9:45 AM	Integrated Licensing Process Overview
10:00 AM	Presentation of Study Results
	• Study 4.0 – Water Temp in the Loup River Bypass Reach
	• Study 8.0 – Recreation Use and CREEL Survey
Noon	Lunch
1:00 PM	Studies 1.0, 2.0 & 5.0 Goals and Methodology Discussion
3:00 PM	Presentation of Study Results (continued)
	• Study 1.0 – Sedimentation (Ungaged Sites)
	• Study 12.0 – Ice Jam Flooding on the Loup River
5:00 PM	Adjourn

Thursday - Feb. 24th

8:00 AM	Presentation of Study Results (continued)
	• Study 2.0 – Hydrocycling
	• Study 5.0 – Flow Depletion and Flow Diversion
11:30 AM	Next Steps in Process
	• Second Initial Study Results Meeting Summary
	• Study Modifications
	• Updated Study Report – August 26, 2011
12:00 PM	Adjourn

Ground Rules

1. When speaking, please speak in a microphone, speak clearly and have your number towards the court reporter for identification.
2. Phone attendees may not put this call on hold – mute is appropriate.
3. An alternate phone number is required for all phone attendees.
4. All attendees should shut off their cell phones.
5. Breaks will be provided as needed. If needed, please step out.
6. If phone attendees have difficulty hearing the audio, please let the moderator know as soon as possible.

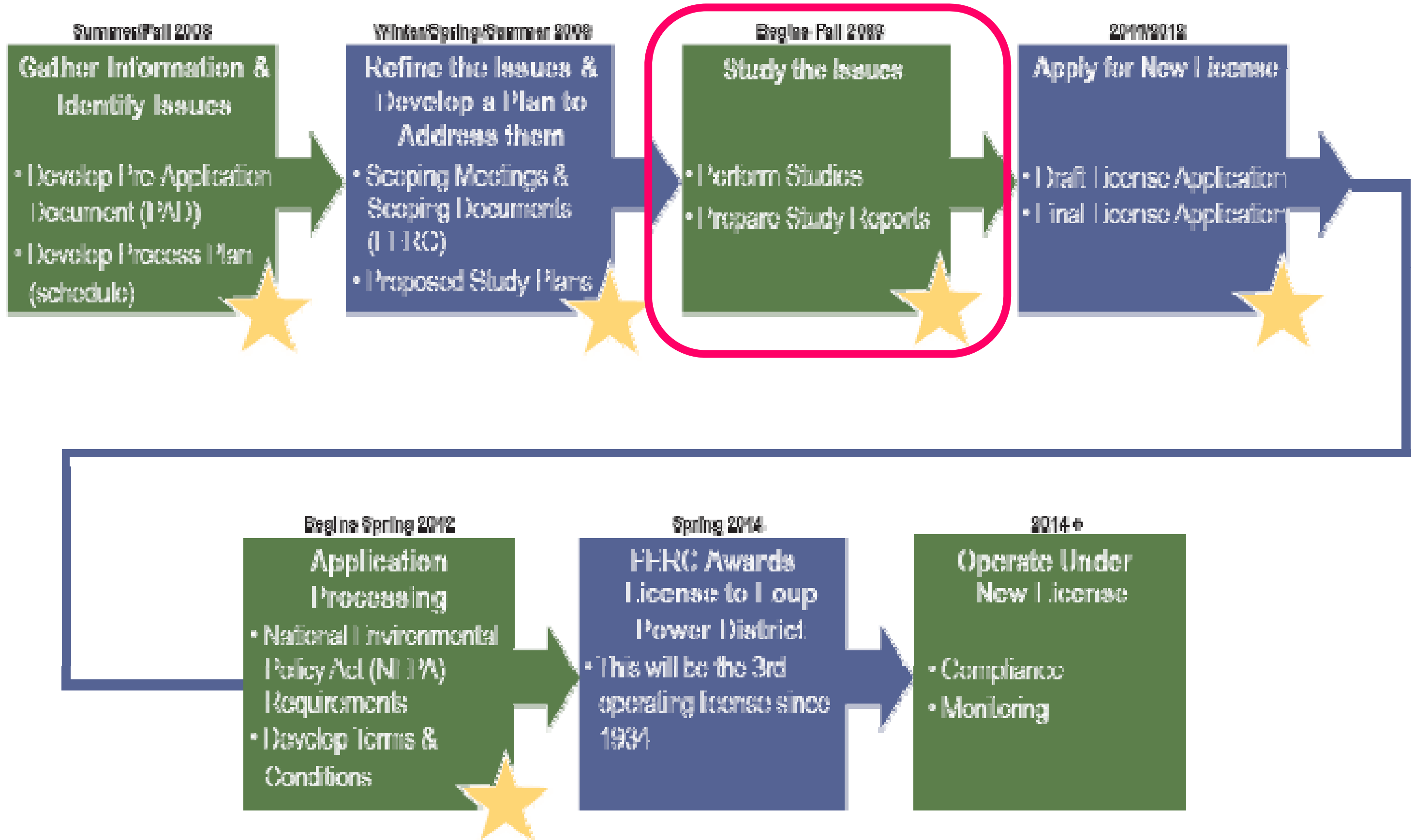
Goals of the Second ISR Meeting

- To present the remaining results of the studies identified in the Revised Study Plan and Study Plan Determination
- To discuss any proposals to modify the study plan (by the District or other participants) in light of study results and data collected

Previous Meetings

- May 2008 – Introduction to the Process and the Project
- June 2008 – Issues Discussion
- July 2008/August 2008 – Studies Discussions
- January 2009 – FERC Scoping Meeting
- April 2009 – Study Goals/Objectives Discussion
- May 2009 – Section 106/Recreation Discussions
- May 2009 – Study Methodology Discussion
- January 2010 – Discussions w/ NGPC/USFWS & FERC/NPS on study data needs/methods
- September 2010 – First Initial Study Results Meeting

Overview of Integrated Licensing Process



Includes Public Comment Opportunities

Study Plan Determination

- FERC issued on August 26, 2009
- Removed three studies:
  - Water Temperature in the Platte River, Fish Sampling, and Creel Survey [combined with Recreation Use]
- Approved three studies without modification:
  - Fish Passage, Land Use Inventory, and Section 106 Compliance
- Approved six studies with modification:
  - Sedimentation, Hydrocycling, Water Temperature in the Loup River Bypass Reach, Flow Depletion and Flow Diversion, Recreation Use, and Ice Jam Flooding on the Loup River

Studies Completed for the First Initial Study Results Report

- Study 1.0 Sedimentation
- Study 7.0 Fish Passage
- Study 8.0 Recreation Use (Telephone Survey)
- Study 10.0 Land Use Inventory
- Study 11.0 Section 106 Compliance
- PCB Fish Tissue Sampling

First Initial Study Results Meeting/ FERC Determination

- No Revisions
  - Study 7.0 – Fish Passage
  - Study 10.0 – Land Use Inventory
  - Study 11.0 – Section 106 Compliance

First Initial Study Results Meeting/ FERC Determination

- Study Revisions
  - Study 1.0 – Sedimentation
    - Confidence limits for sediment rating curves
    - Aggradation/degradation analysis for Duncan, North Bend, Ashland and Louisville (from PAD)
    - Aggradation/degradation analysis for Genoa
    - Kendall Tan test to assess aggradation/degradation trends
    - Additional statistical analysis related to Tern and Plover nesting
    - Provide Chen et all (1999) and MRBC report to FERC
  - Study 2.0 – Hydrocycling
    - Conduct sediment transport analysis using HEC-RAS

Studies Completed for the Second Initial Study Results Report

- Study 1.0 Sedimentation (ungaged sites)
- Study 4.0 Water Temp in Loup River Bypass Reach
- Study 5.0 Flow Depletion and Flow Diversion
- Study 8.0 Recreation Use
- Study 12.0 Ice Jam Flooding on the Loup River

Next Steps

18CFR5.15

- March 11, 2011
  - District submits meeting summary
- April 11, 2011
  - Agencies file meeting summary disagreements and submit requests for modification to on-going studies
- May 12, 2011
  - District responds to summary comments and study modification requests
- June 12, 2011
  - FERC resolves comments and study modification requests

Next Steps

18CFR5.15

- August 26, 2011
  - District submits Updated Initial Study Report to FERC
- September 9, 2011
  - Updated Study Report Agency Meeting (Location TBD)
- November 18, 2011
  - District files Draft License Application

4. Water Temperature in the Loup River Bypass Reach

4. Water Temperature in the Loup River Bypass Reach

Goal

- To determine if Project operations (flow diversion to the Loup Power Canal) materially affect water temperature in the Loup River bypass reach (with particular emphasis on the reach between the Diversion Weir and the confluence of Beaver Creek with the Loup River) or in the Platte River bypass reach.

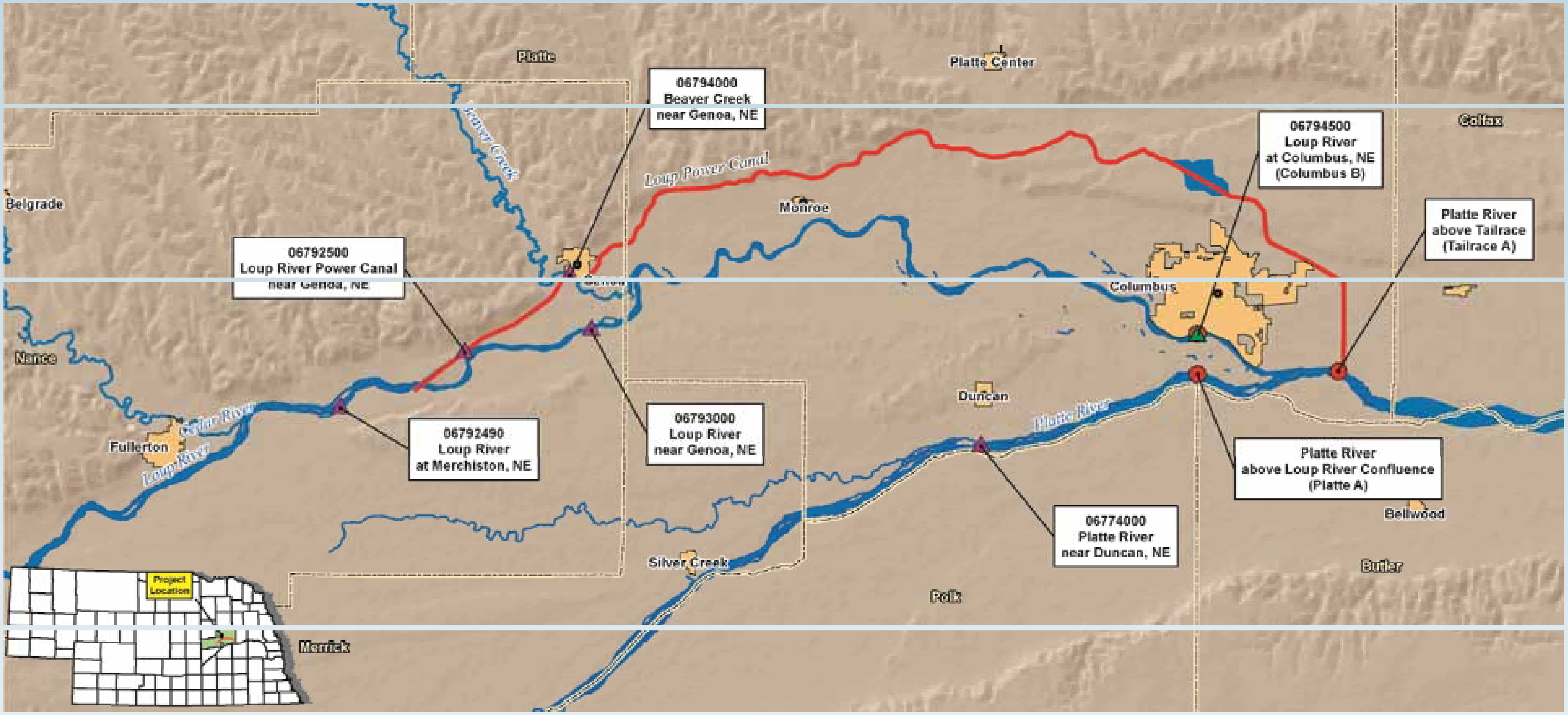
4. Water Temperature in the Loup River Bypass Reach

Objectives

1. To estimate the relationship between flow in the Project bypass reach, ambient air temperature, water temperature, relative humidity, and solar radiation.
2. To describe and quantify the relationship, if any, between diversion of water into the Loup Power Canal and water temperature in the Project bypass reach.
3. To determine if a “critical reach” relative to water temperature excursions exists within the Project bypass reach.
4. To determine if an accurate and reasonable method exists for predicting water temperature excursion events.

4. Water Temperature in the Loup River Bypass Reach

Study Area



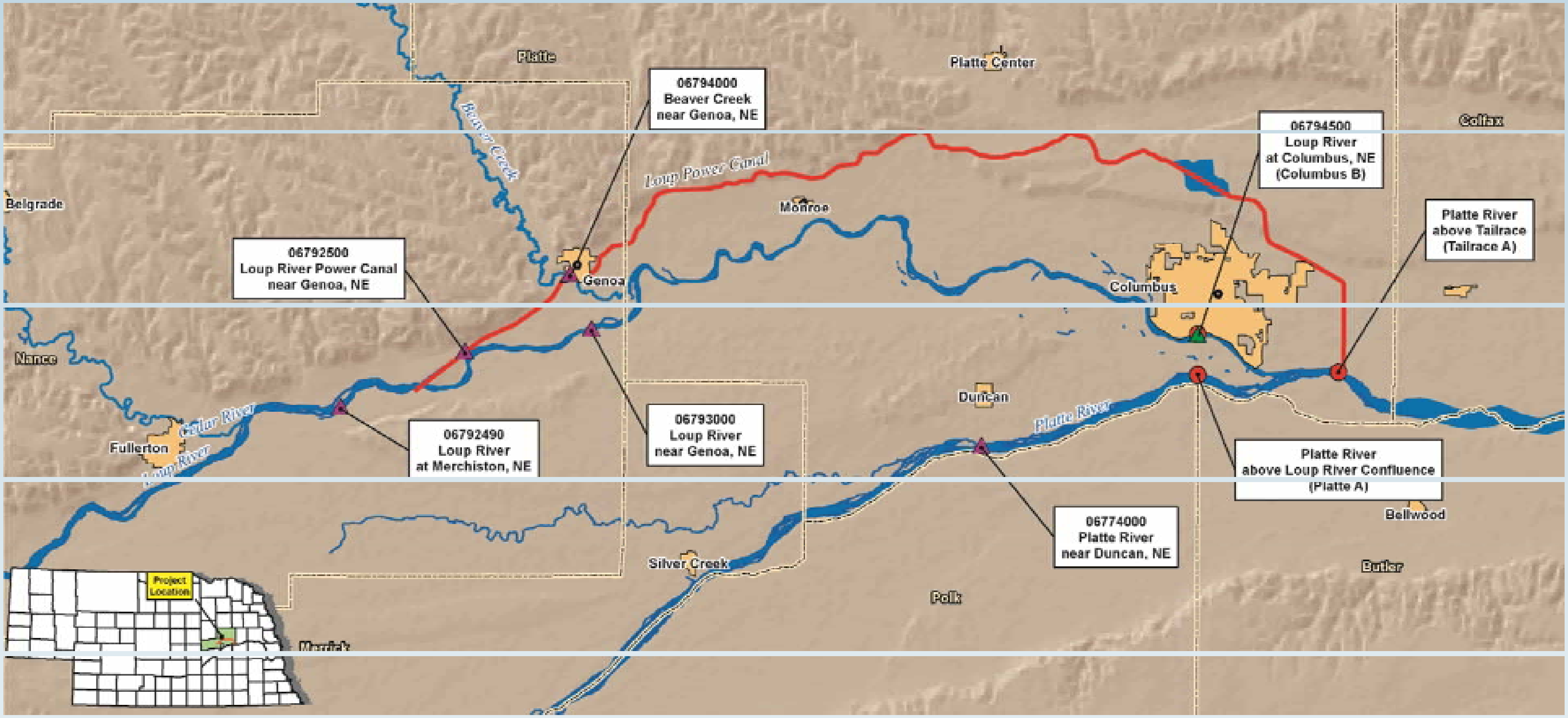
4. Water Temperature in the Loup River Bypass Reach

Methodology

1. USGS Coordination
2. Data Collection
   – USGS Discharge
   – USGS Water Temperature/District Data Loggers
   – High Plains Regional Climate Center Meteorological Data
3. Data Analysis
   – Linear Regression
   – ANOVA
   – Logistic Regression
   – Exceedance Probability

4. Water Temperature in the Loup River Bypass Reach

Data Collection



4. Water Temperature in the Loup River Bypass Reach

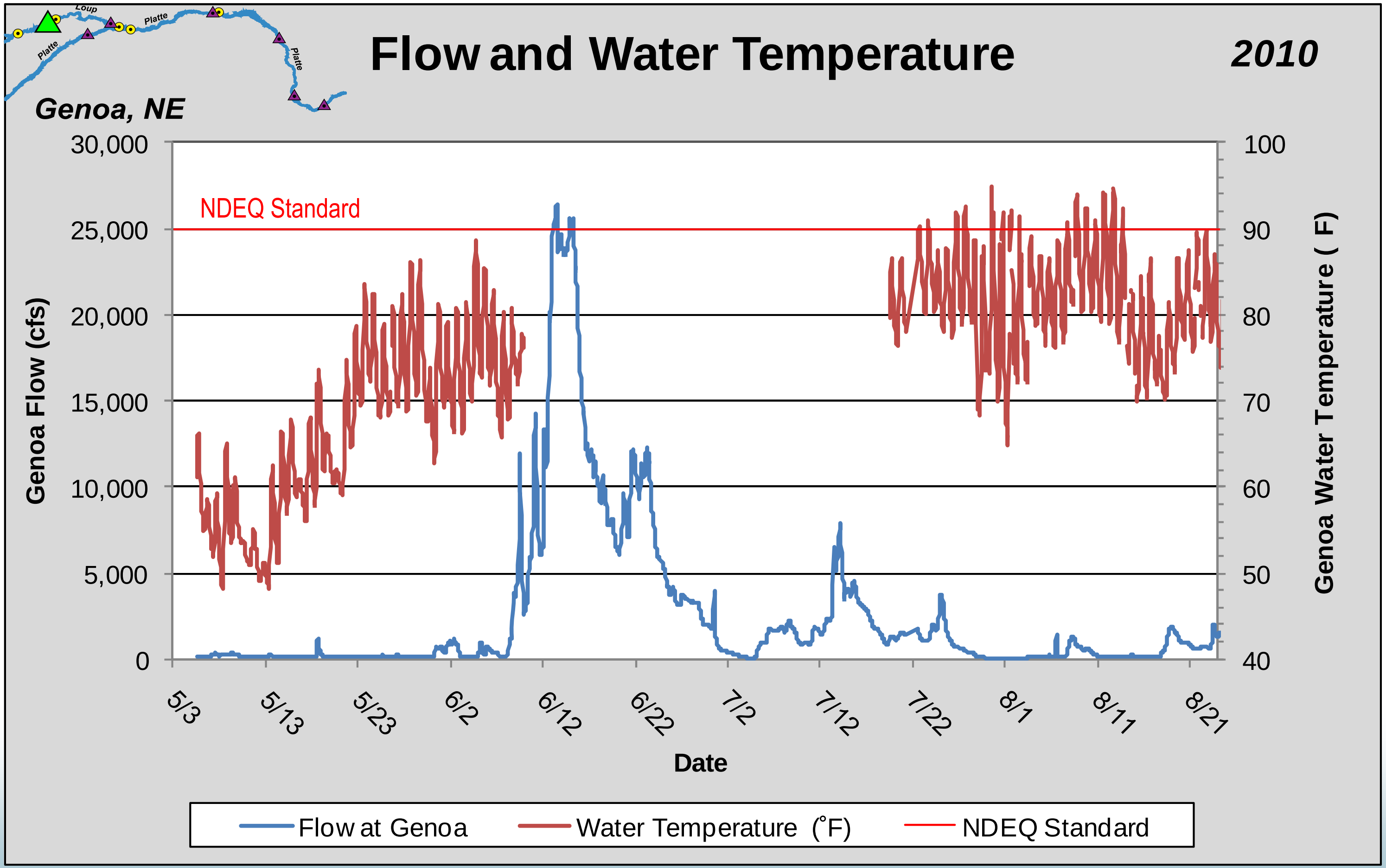
Objective 1: To estimate the relationship between flow in the Project bypass reach, ambient air temperature, water temperature, relative humidity, and solar radiation.

Results:

- There is not a statistically significant relationship between water temperature and:
  - flow, radiative flux, or relative humidity
- There is a statistically significant relationship between water temperature and:
  - air and soil temperatures

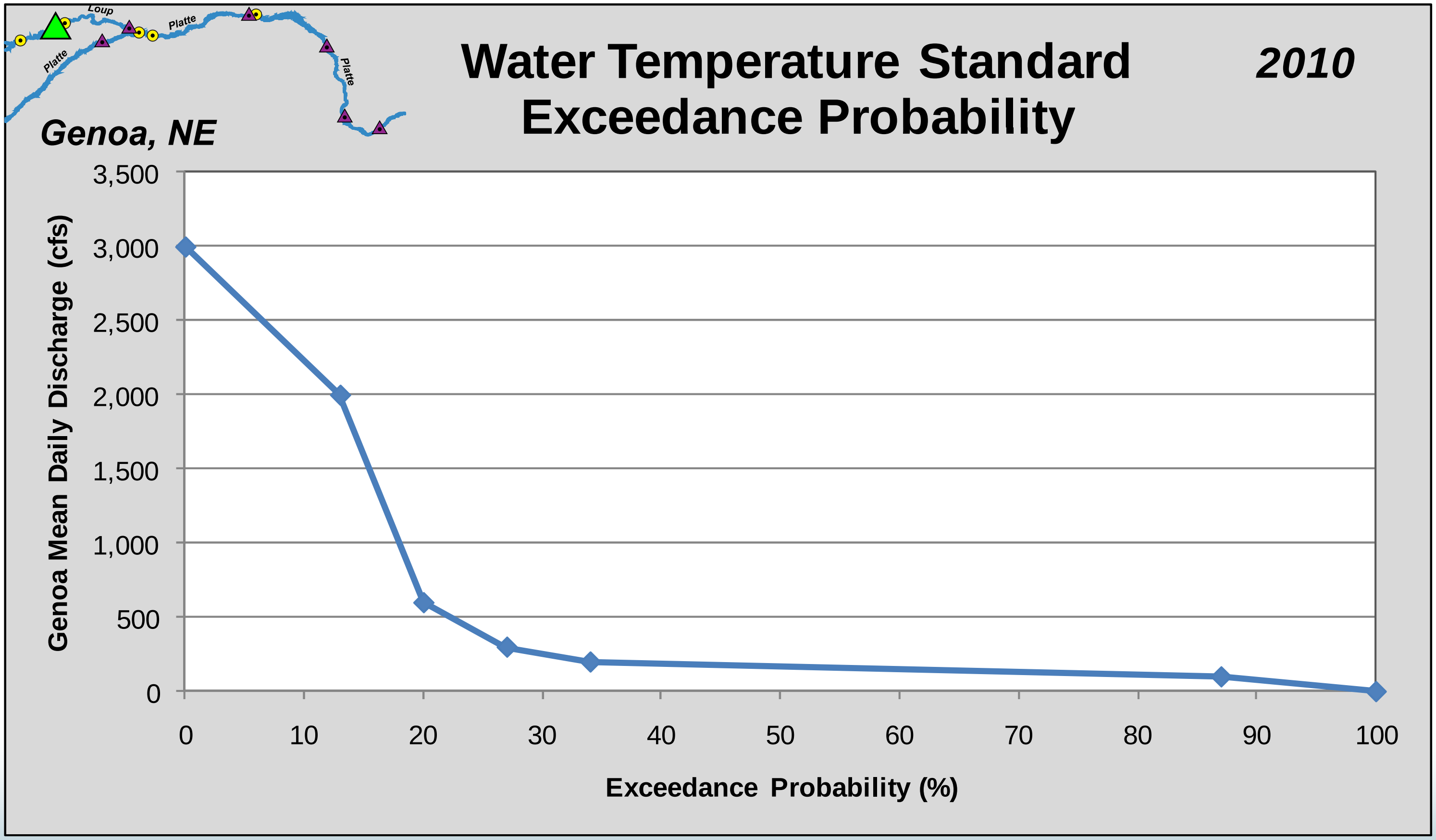
4. Water Temperature in the Loup River Bypass Reach

Results – Loup River Near Genoa



4. Water Temperature in the Loup River Bypass Reach

Results – Sinokrot & Gulliver's Method



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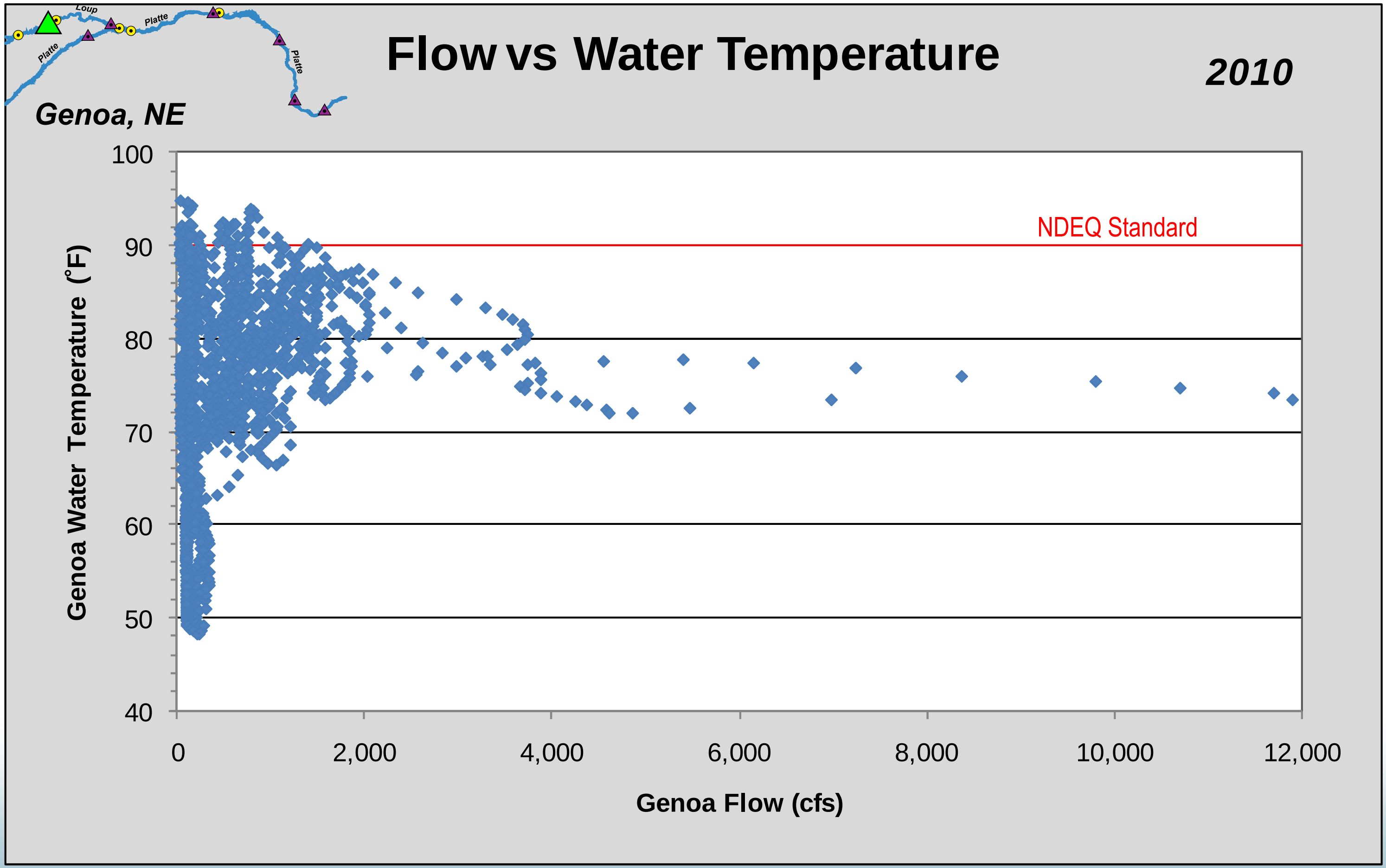
Results – Loup River Near Genoa



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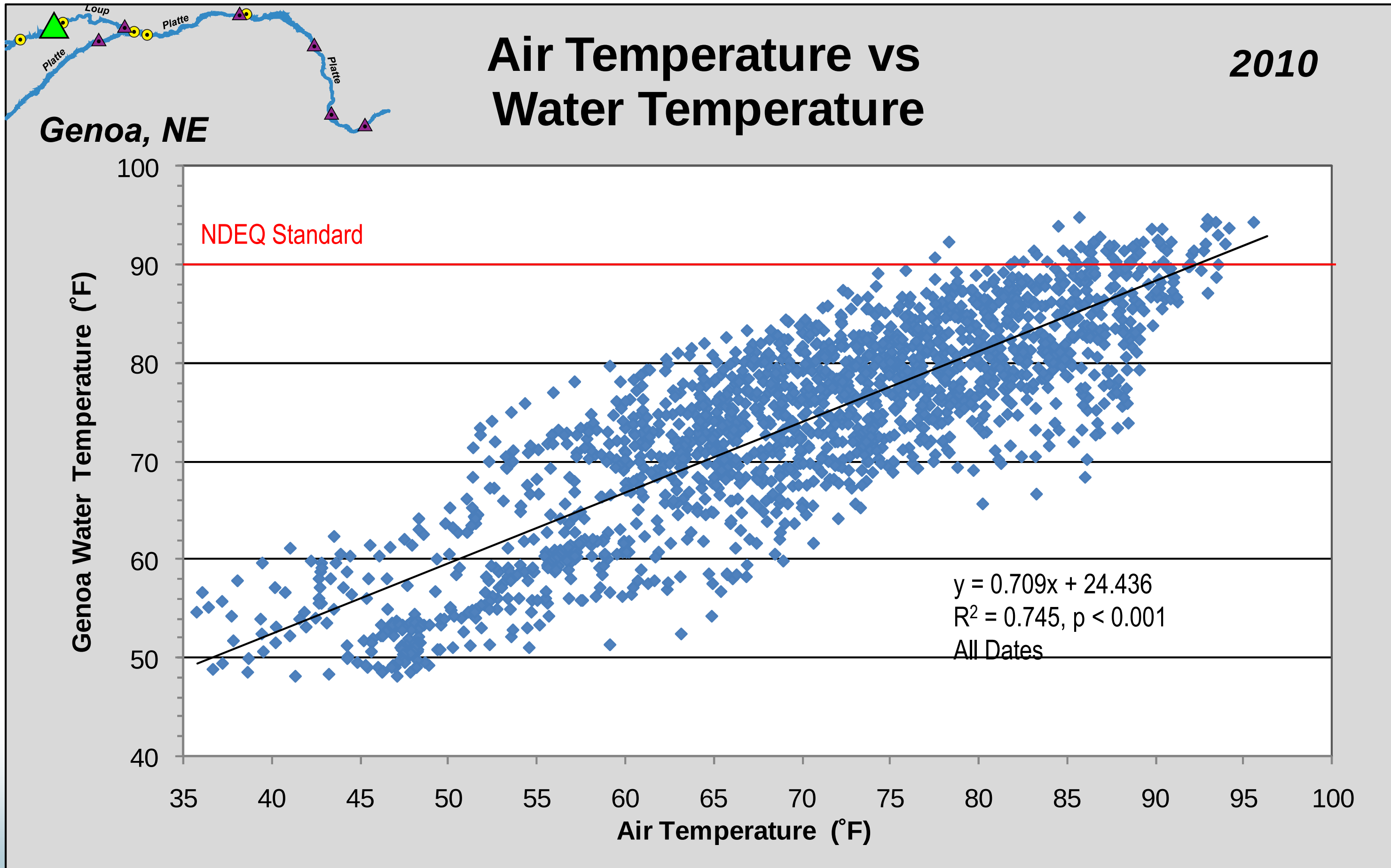
Results – Loup River Near Genoa



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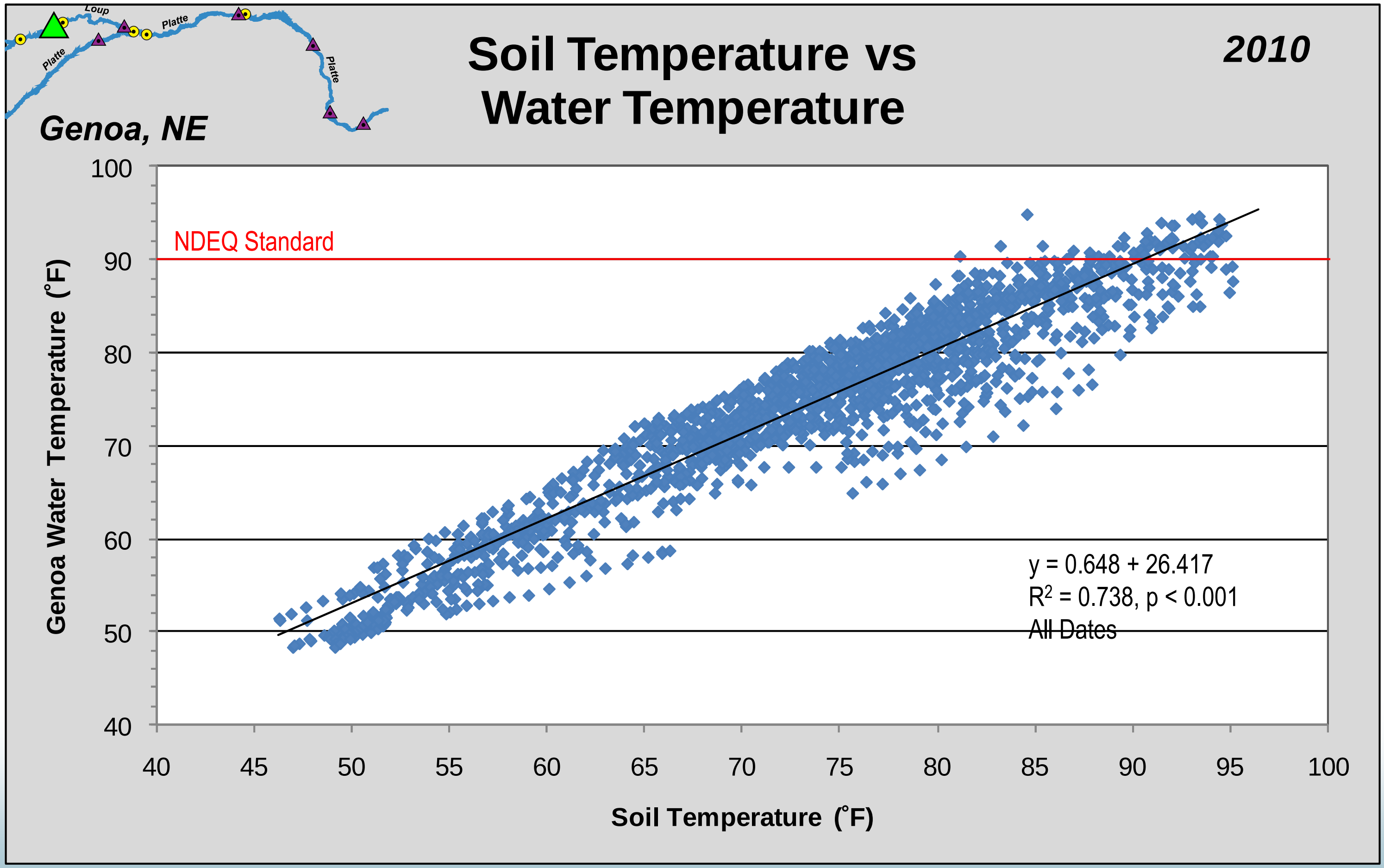

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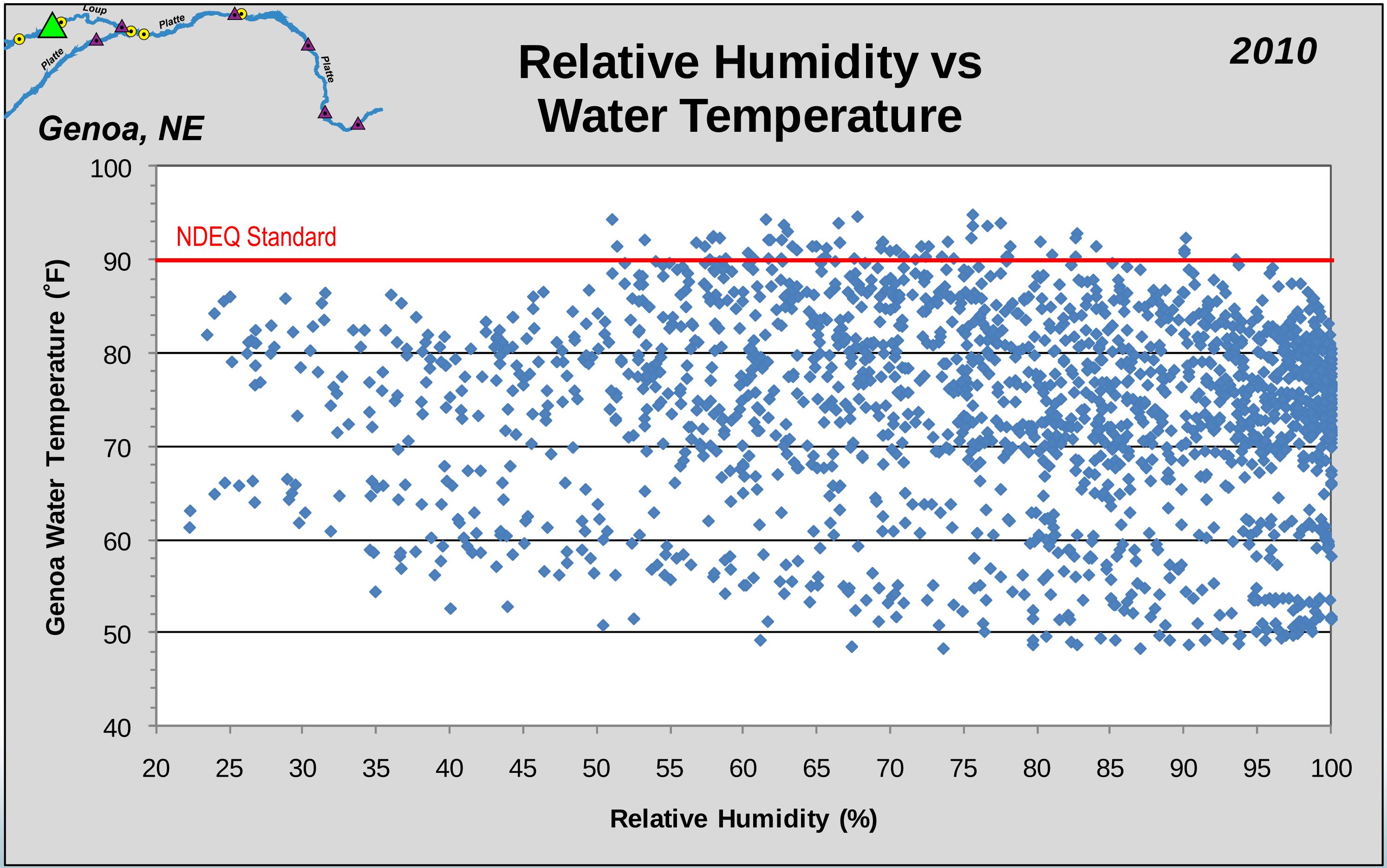
Results – Loup River Near Genoa



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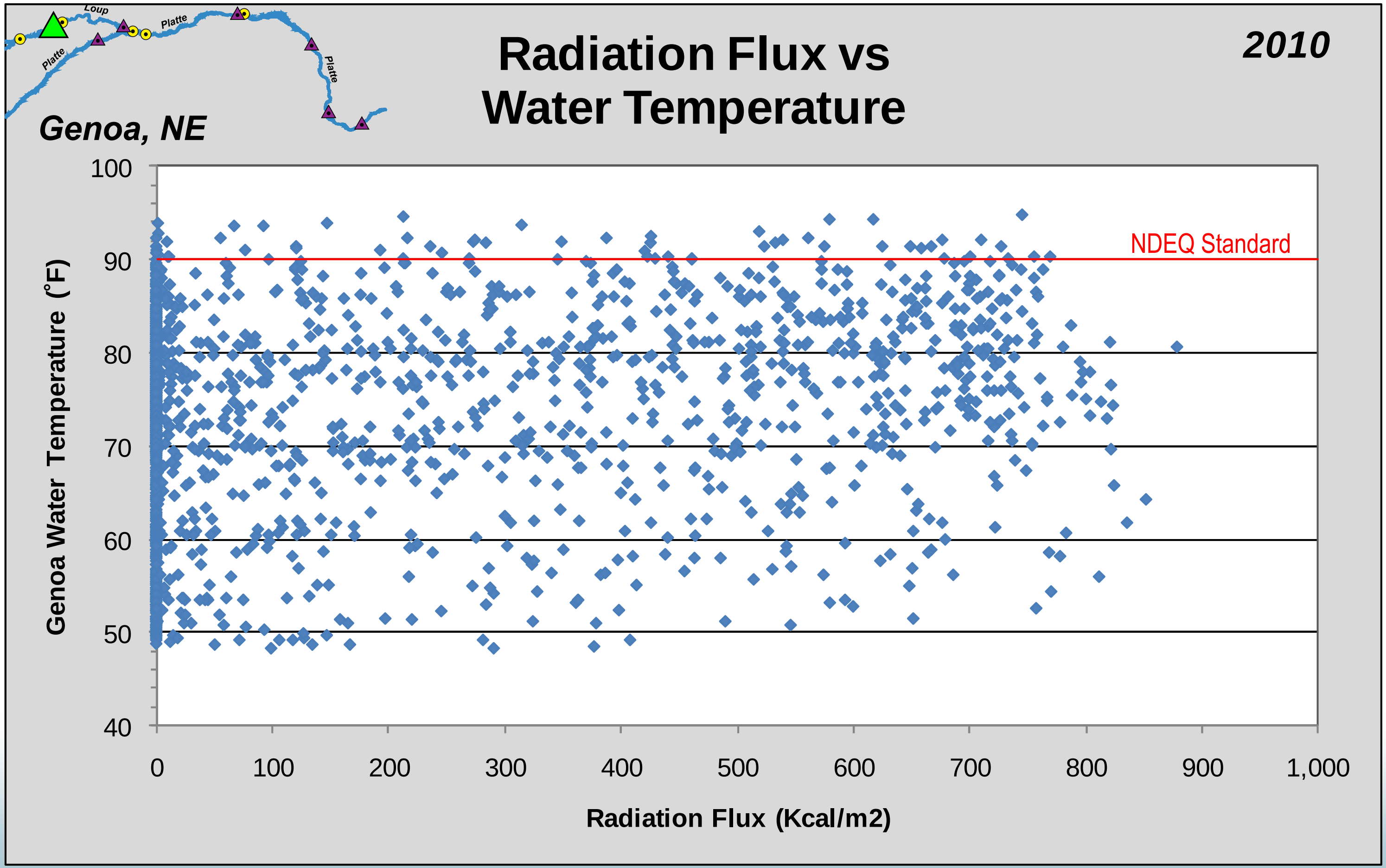
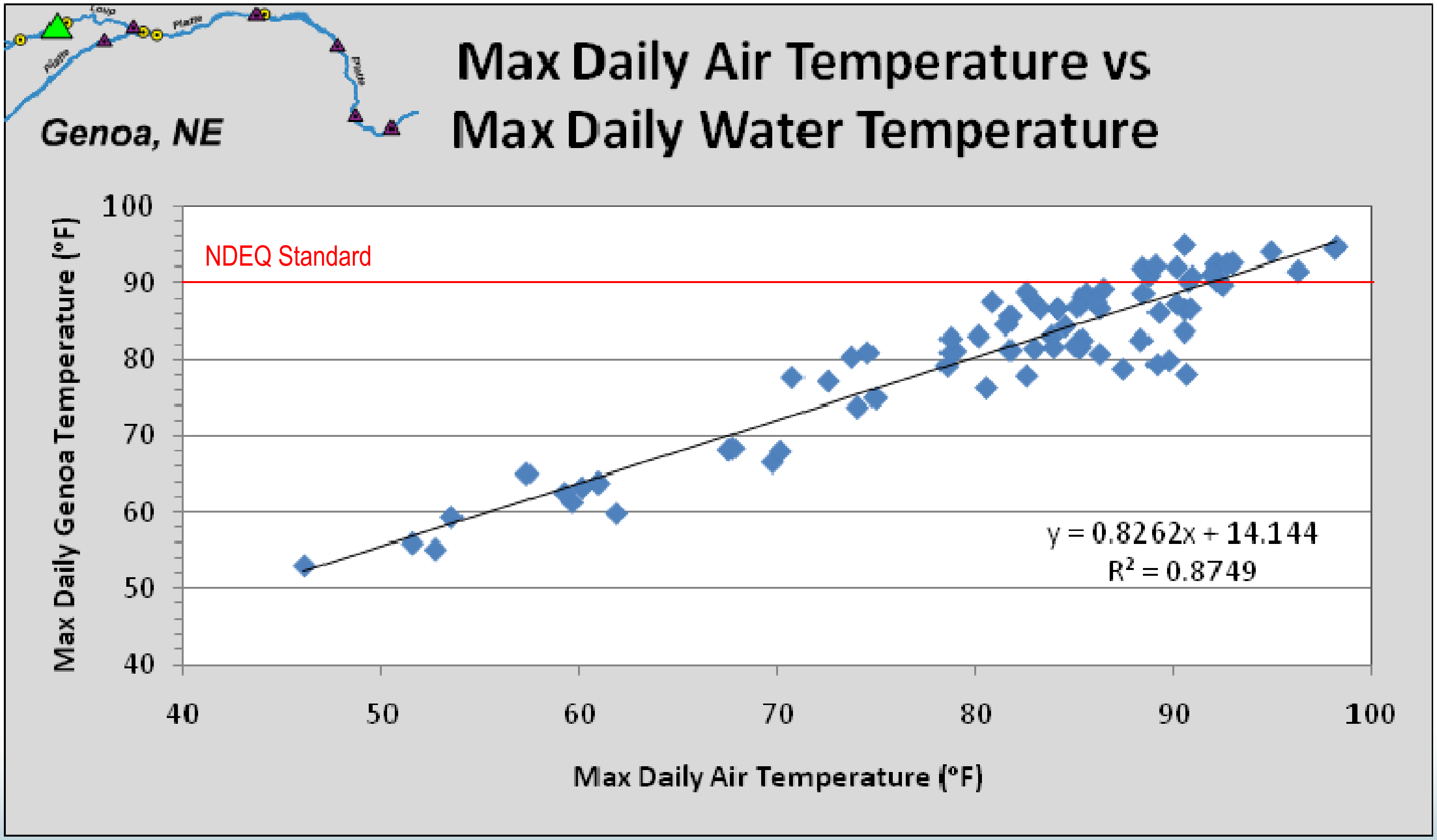


4. Water Temperature in the Loup River Bypass Reach

Results – Loup River Near Genoa



4. Water Temperature in the Loup River Bypass Reach

- Daily maximum water temperature analysis and all water temperature data above 63°F analysis
  - Multiple Logistic Regression Model
    - Air temperature is best predictor, slightly improved by inclusion of relative humidity
    - Model performance is not improved by including flow
  - Multiple Linear Regression Model
    - Air temperature is best predictor
    - Model performance is not improved by including flow

4. Water Temperature in the Loup River Bypass Reach

Objective 1 Summary – Loup River at Genoa

- There is not a statistically significant relationship between:
  - Water temperature and flow
  - Water temperature and relative humidity
  - Water temperature and radiative flux
- There is a statistically significant relationship between:
  - Water temperature and air temperature
  - Water temperature and soil temperature

4. Water Temperature in the Loup River Bypass Reach

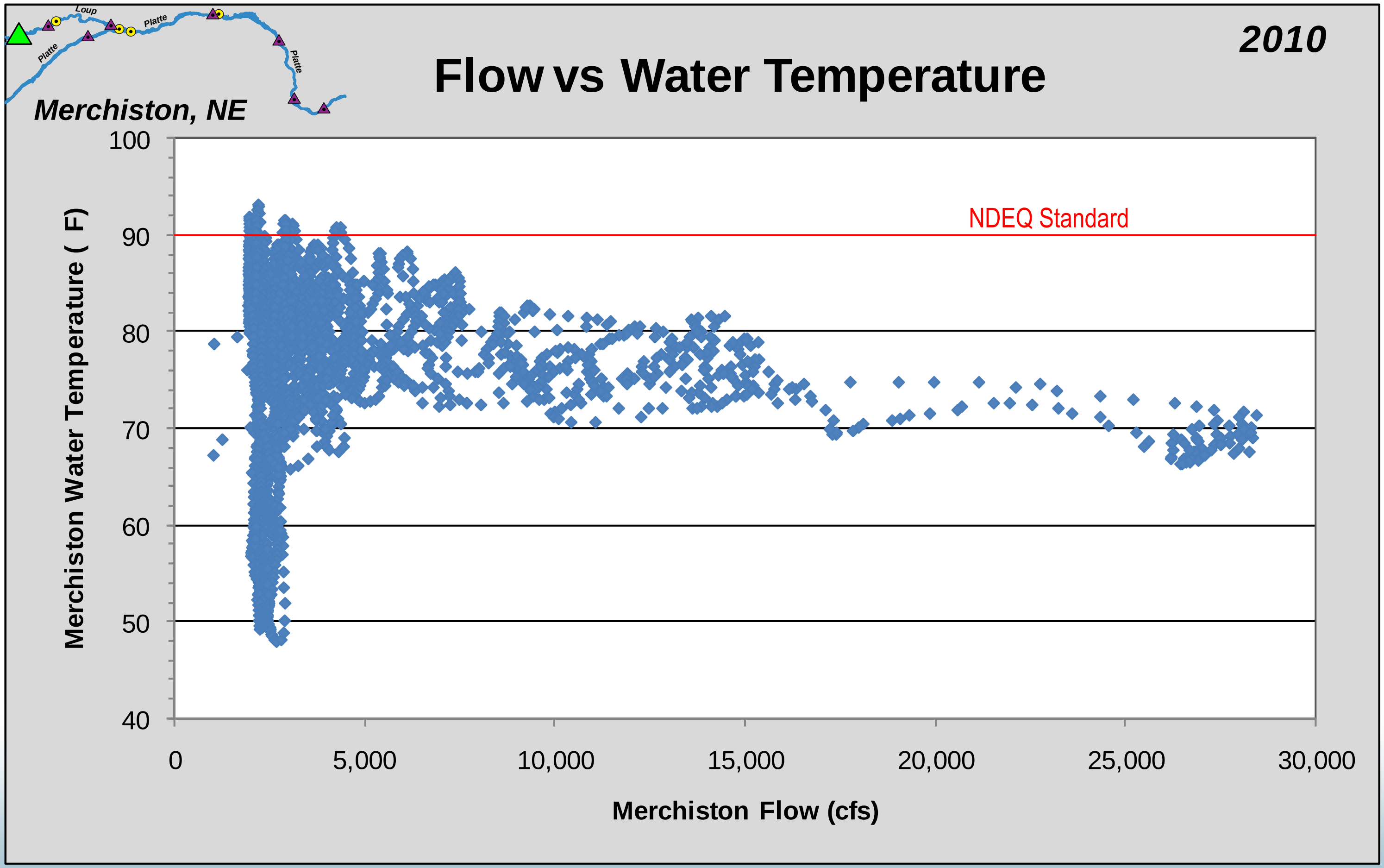
Objective 2: To describe and quantify the relationship, if any, between diversion of water into the Loup Power Canal and water temperature in the Project bypass reach.

Results:

- Merchiston Site was analyzed similarly to Genoa, same relationships were found
- Synchronous daily oscillations in water temperature are seen between the stations
- A statistically significant relationship exists between the recorded water temperatures at the two stations

4. Water Temperature in the Loup River Bypass Reach

Results – Loup River at Merchiston



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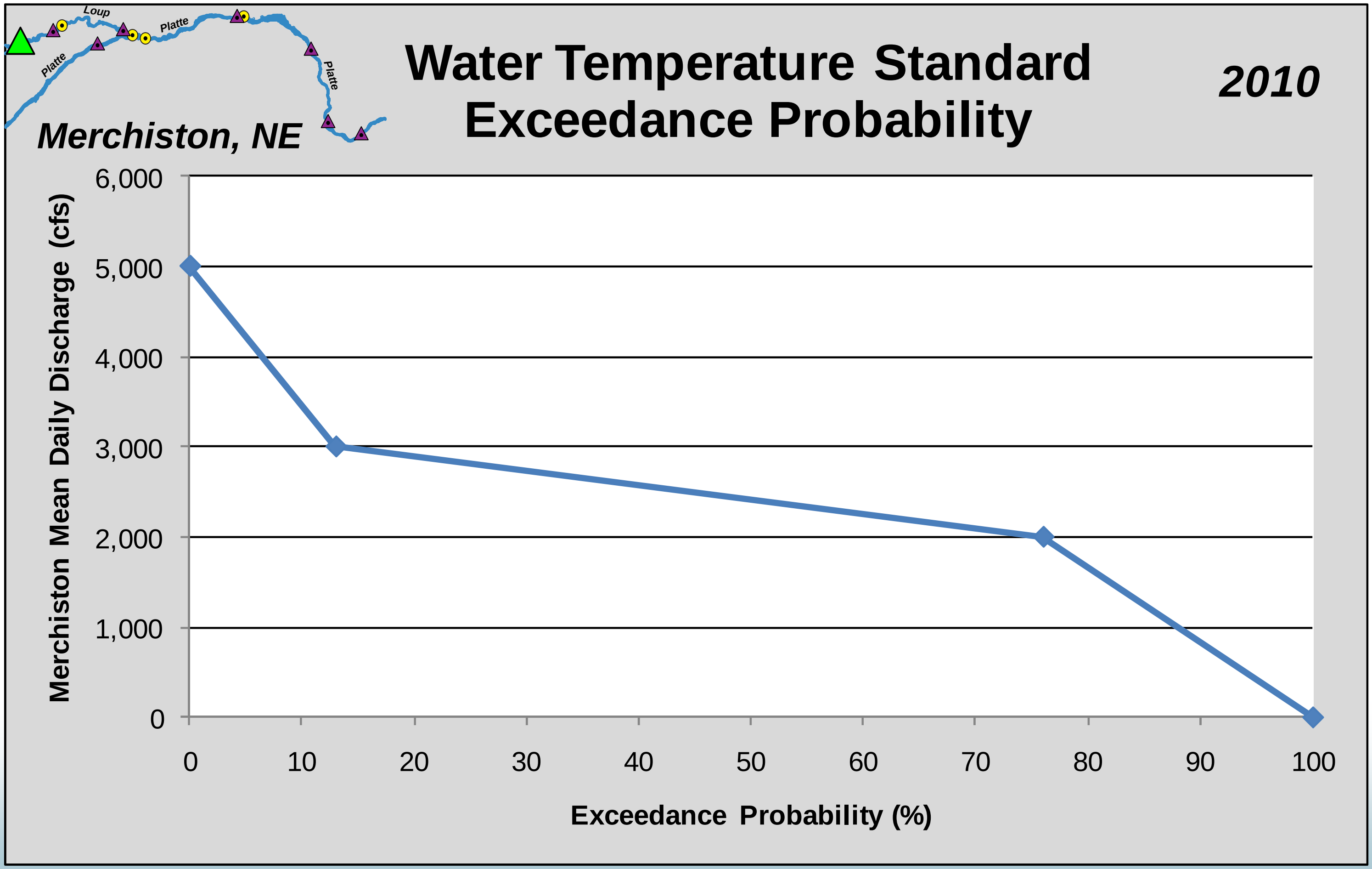
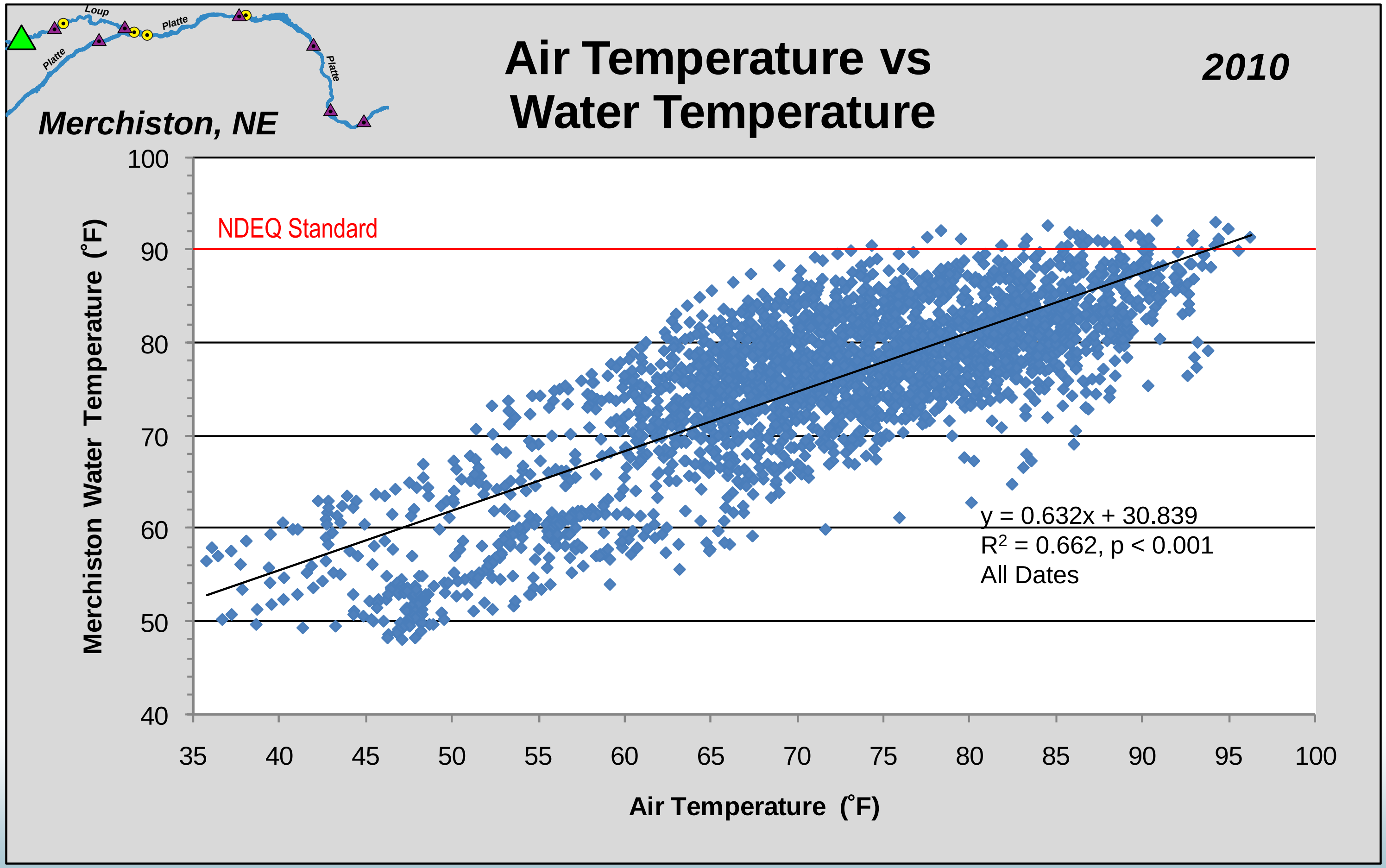
Results – Sinokrot & Gulliver's Method



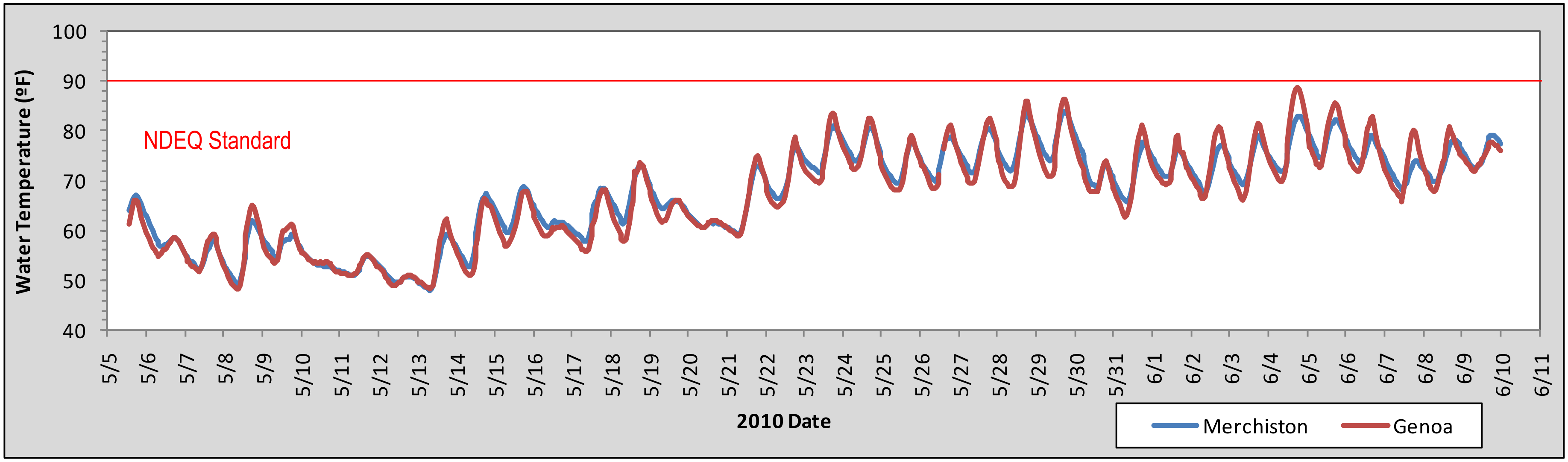
4. Water Temperature in the Loup River Bypass Reach

Results – Loup River at Merchiston



4. Water Temperature in the Loup River Bypass Reach

Results – Comparison Genoa and Merchiston



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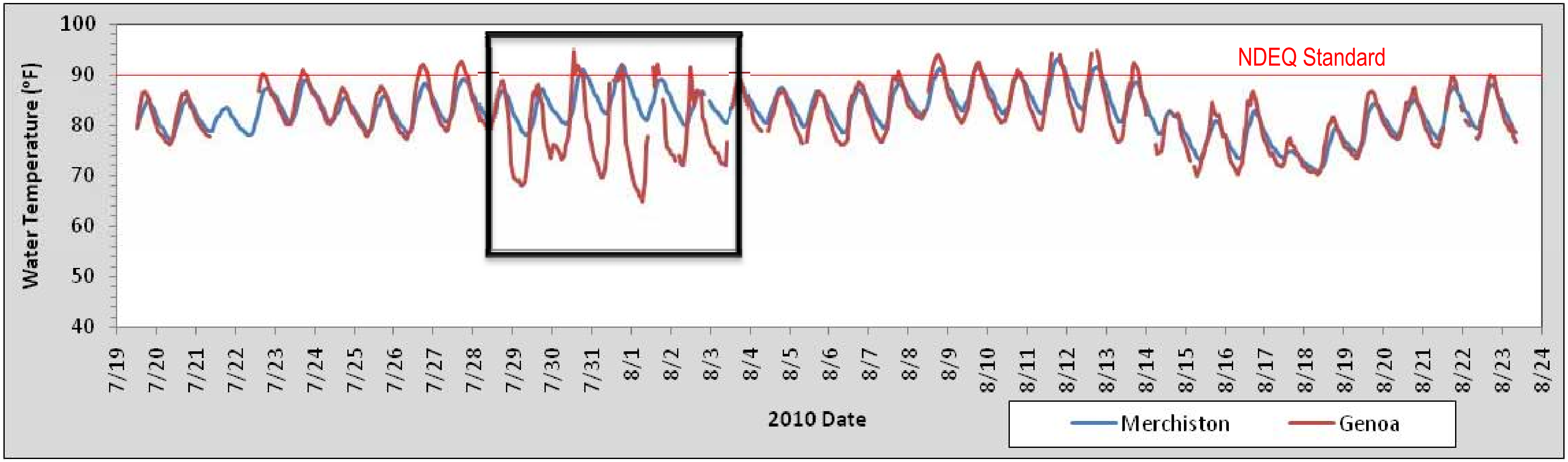
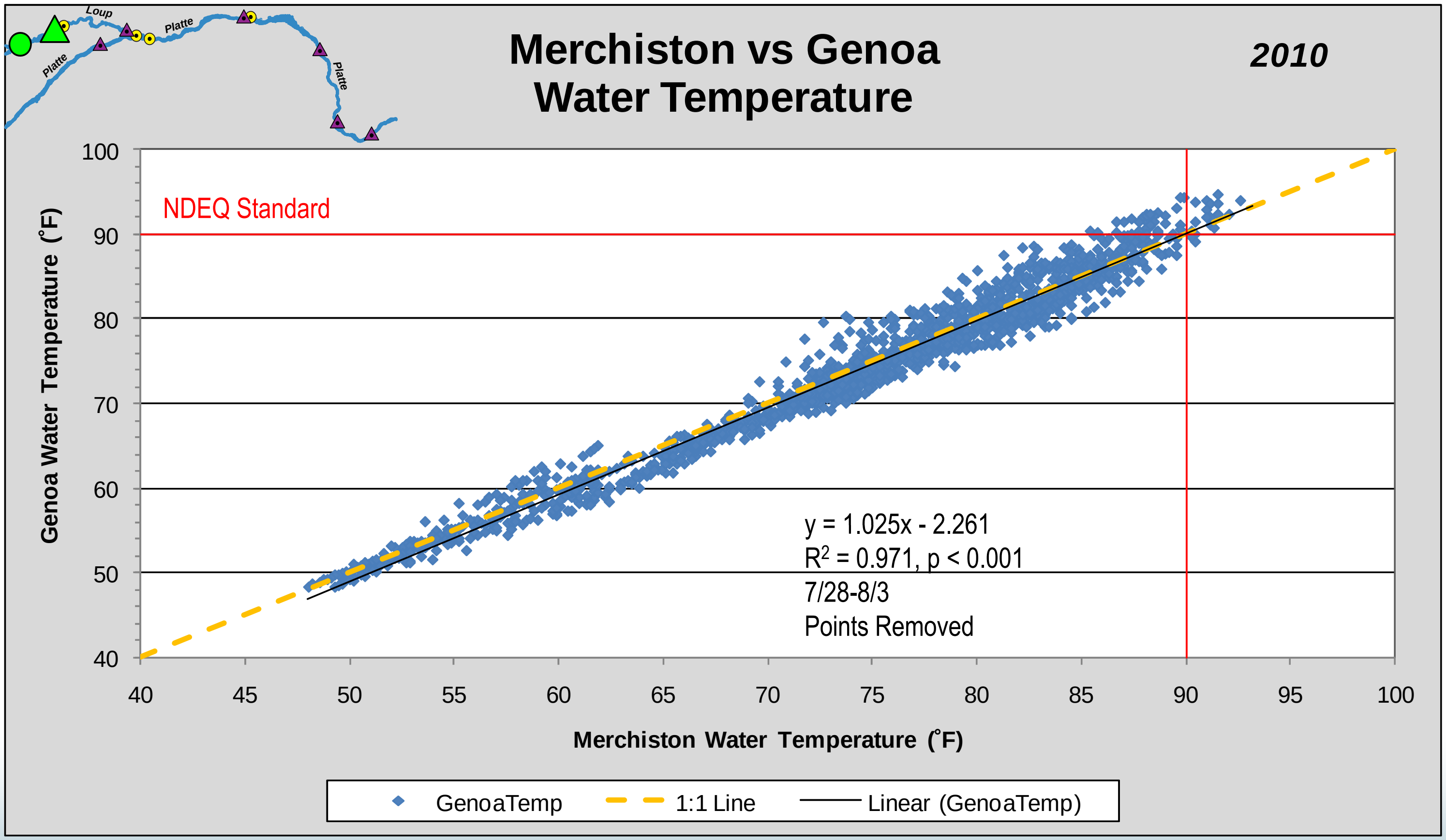
Results – Comparison Genoa and Merchiston



4. Water Temperature in the Loup River Bypass Reach

Results – Comparison Genoa and Merchiston



4. Water Temperature in the Loup River Bypass Reach

Objective 2 Summary – Comparison Genoa and Merchiston

- Water temperature at Merchiston had no statistically significant relationship to flow, relative humidity, or radiative flux.
- Water temperature at Merchiston had a statistically significant relationship to air temperature.
- Synchronous daily oscillations in water temperature are seen between the stations
- A statistically significant relationship exists between the recorded water temperatures at the two stations

4. Water Temperature in the Loup River Bypass Reach

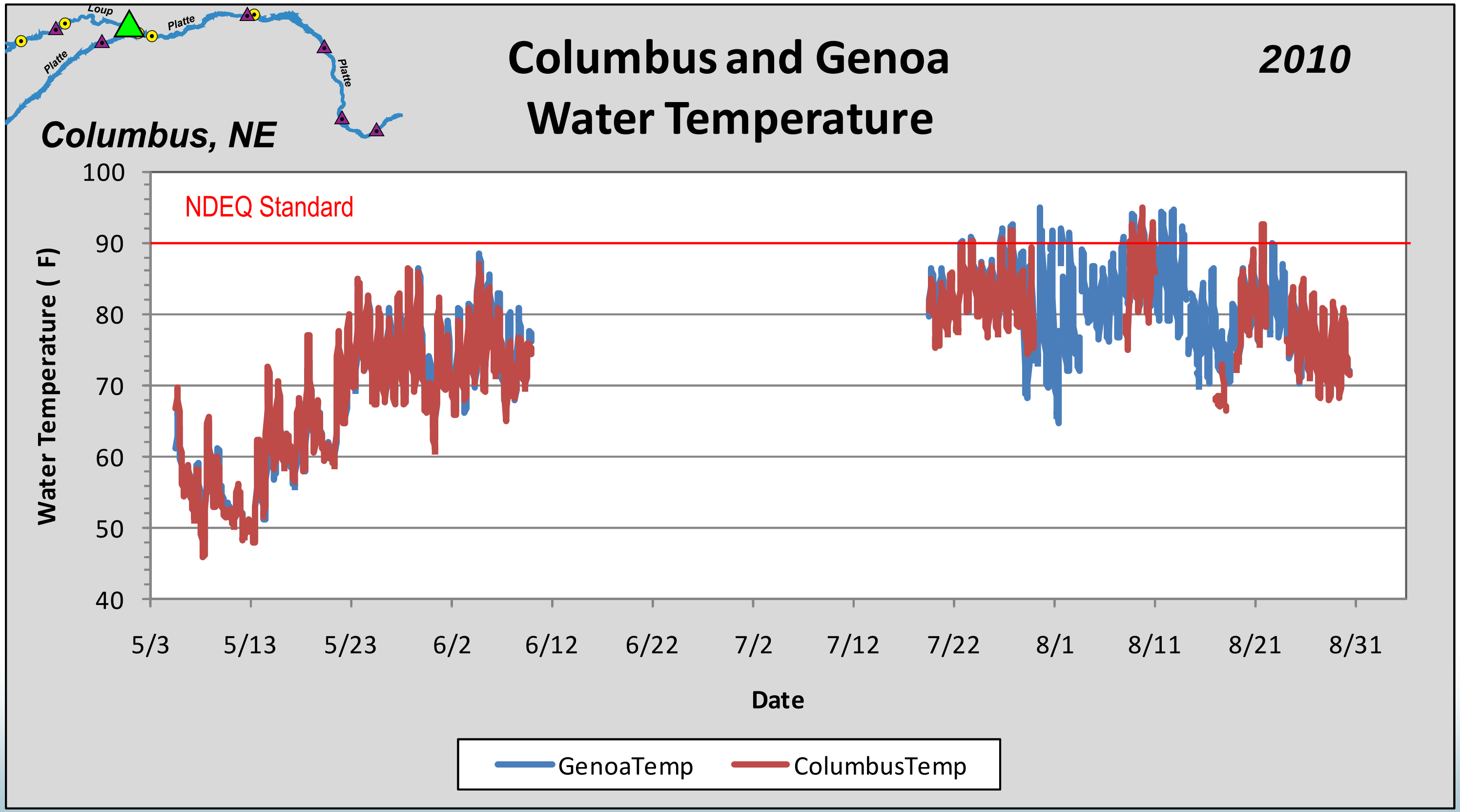
Objective 3: To determine if a "critical reach" relative to water temperature excursions exists within the Project bypass reach.

Results:

- Synchronous daily oscillations in water temperature at Genoa and Columbus
- Synchronous daily oscillations in water temperature on the Platte River bypass reach
- Platte River bypass reach correlated with upstream temperature on the Platte River
- **No critical reach identified**

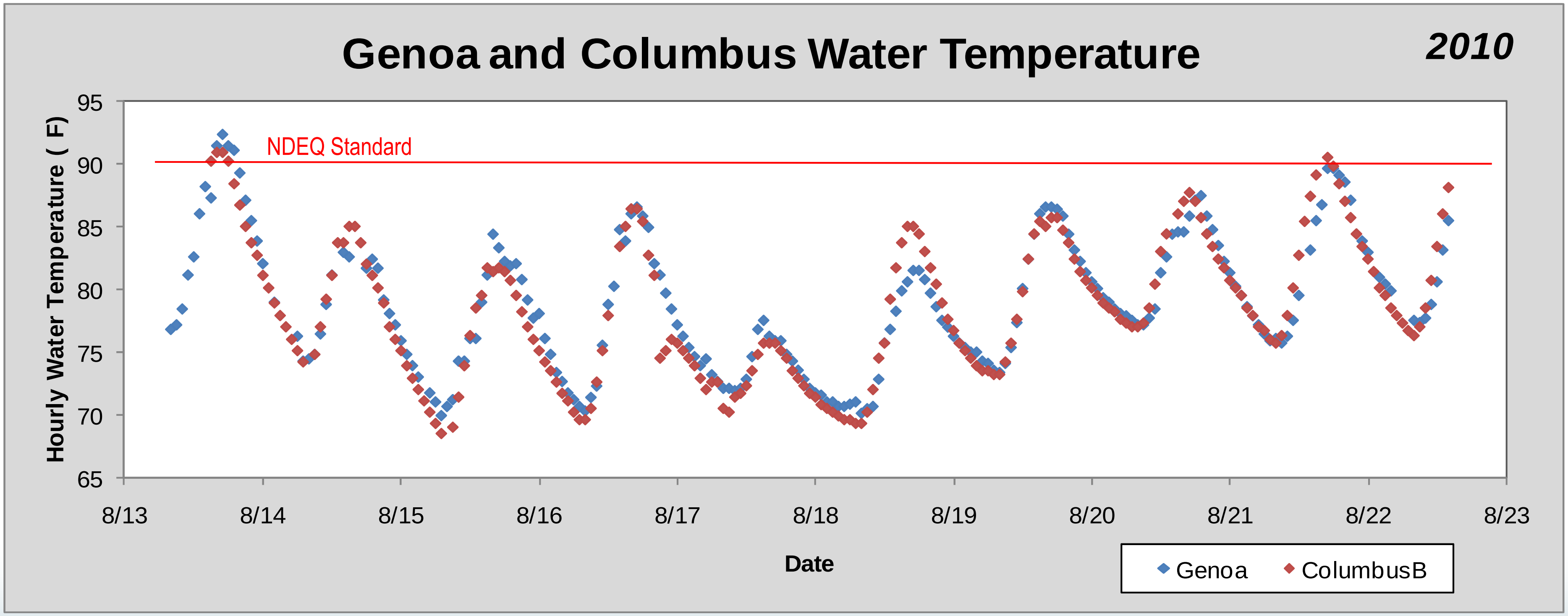
4. Water Temperature in the Loup River Bypass Reach

Results – Loup River Near Genoa vs. Loup River at Columbus



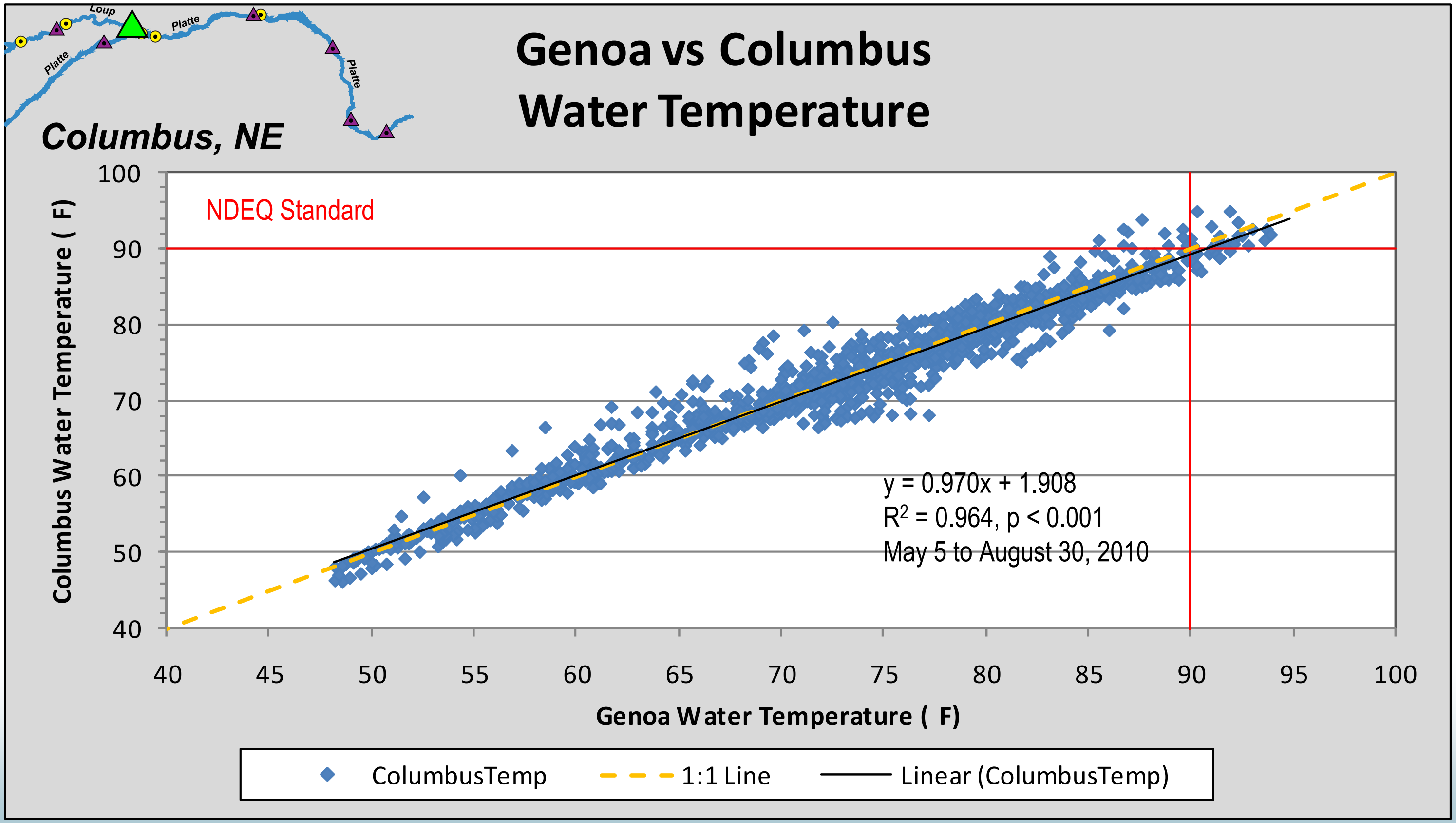
4. Water Temperature in the Loup River Bypass Reach

Results – Loup River Near Genoa vs. Loup River at Columbus



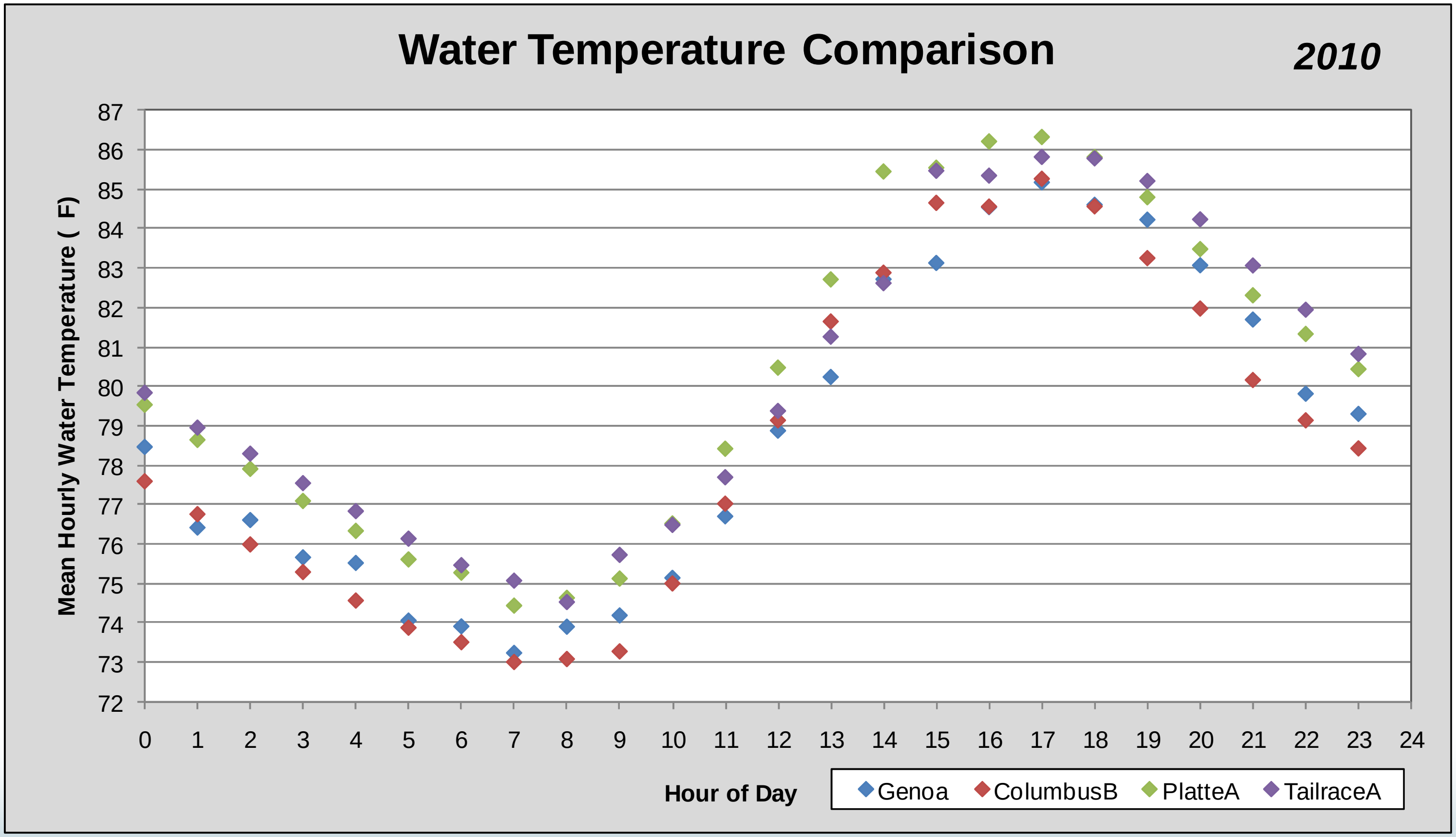
4. Water Temperature in the Loup River Bypass Reach

Results – Loup River Near Genoa vs. Loup River at Columbus



4. Water Temperature in the Loup River Bypass Reach

Results – Loup River Bypass vs. Platte River Bypass



4. Water Temperature in the Loup River Bypass Reach

Objective 3 Summary:

- Synchronous daily oscillations in water temperature are seen between Genoa and Columbus
- There is a statistically significant relationship between water temperature at Genoa and Columbus
- Temperature on the Platte River between Loup River confluence and power canal Tailrace return confluence
  - Highly correlated with upstream temperature on the Platte River
- **No critical reach**

4. Water Temperature in the Loup River Bypass Reach

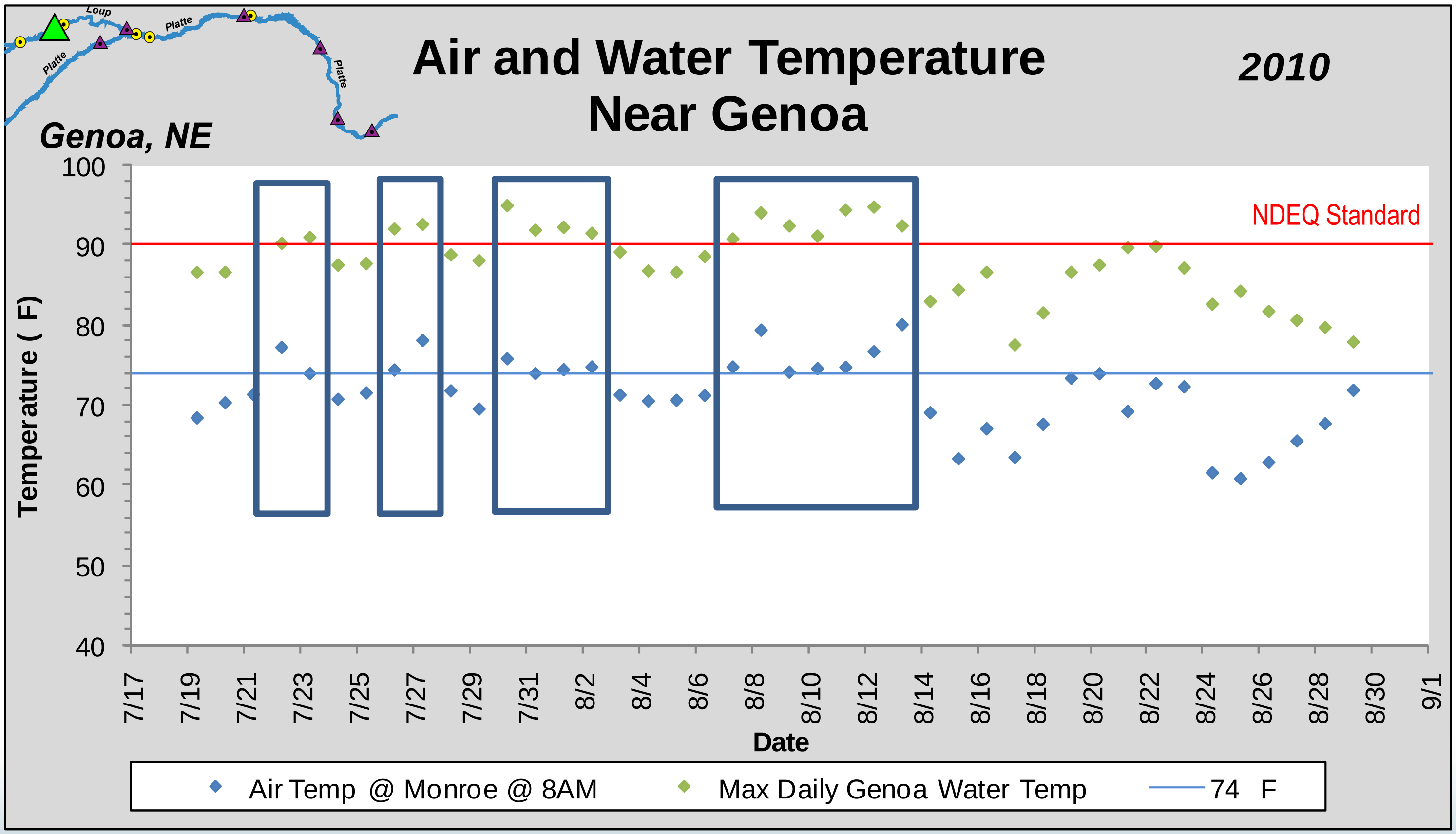
Objective 4: To determine if an accurate and reasonable method exists for predicting water temperature excursion events.

Results:

- Best predictor of a possible excursion was 8 AM air temperature.

4. Water Temperature in the Loup River Bypass Reach

Results – Prediction of Excursions



QUESTIONS?

8. Recreation Use & CREEL Survey

8(a). General Recreation Use

Goals

- To determine the public awareness, usage, perception, and demand of both the Project's existing recreation facilities (including fisheries) and the Loup River bypass reach (including the Loup Lands WMA), to determine if potential improvements are needed, and to develop a Recreation Management Plan to address existing and future recreation needs.

8(a). General Recreation Use

Objectives

1. To measure recreation usage of Project recreation facilities (including fisheries) and the Loup River bypass reach (including the Loup Lands WMA).
2. To document the types of recreation use occurring at Project recreation facilities and along the Loup River bypass reach.
3. To determine whether Project recreation facilities meet current demand.

8(a). General Recreation Use

Objectives (continued)

4. To determine the public's perception and awareness of Project recreation facilities, including fisheries, and to identify the impact of Project operations on recreation experiences.
5. To determine what species anglers are targeting and catching, including catch rates.
6. To collect data for use in the preparation of a Recreation Management Plan for the District's facilities.

8(a). General Recreation Use

Study Area

- Loup Power Canal (including developed recreation areas):
  - Headworks Park
  - Lake Babcock Park
  - Lake North Park
  - Columbus Powerhouse Park
  - Tailrace Park
- Loup River Bypass Reach:
  - 2 public parks
  - 4 wildlife management areas
  - 3 public road bridges

8(a). General Recreation Use

Methodology

- Outreach
- Facility Inventory
- In-Person Surveys and User Counts
- Trail Counters
- Telephone Survey

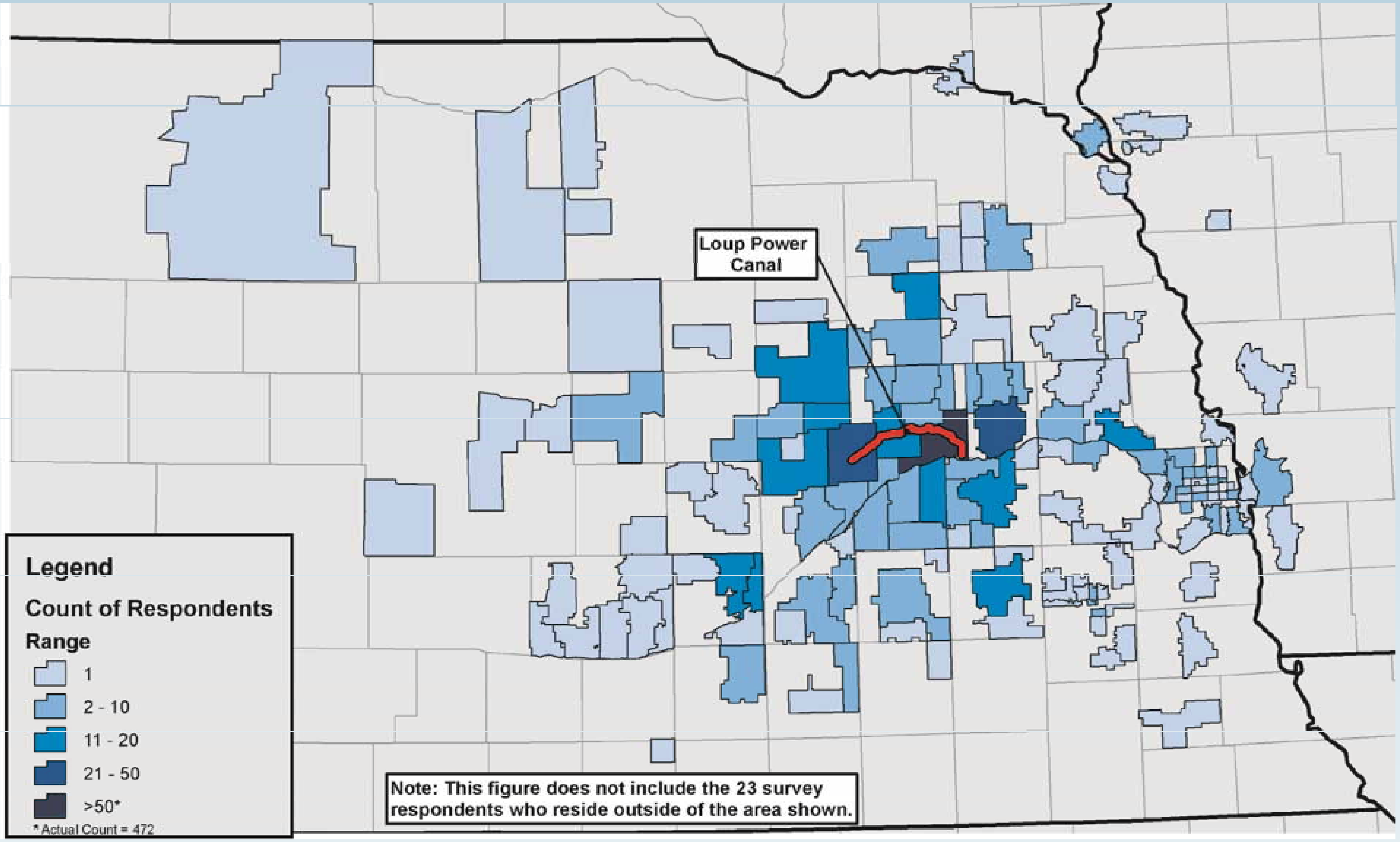
Loup Power Canal
Recreation Survey Results

8(a). General Recreation Use

Canal Survey Results – User Demographics

- Racial Composition
  - 89% White; 10% Hispanic
- Annual Household Income
  - $26K-$50K = 34%
- Age of Users
  - 12 and Under = 22%
- Residence of Users
  - Nebraska = 96%; Columbus = 46%

8(a). Residence of Recreation Use Survey Respondents



8(a). General Recreation Use

Canal Survey Results – General Findings

- Size of Party
  - Party Size of 1-2 = 51%
- Miles Traveled
  - 60% traveled 25 miles or less
  - 92% traveled 100 miles or less
- Overnight Stays
  - 35% were staying overnight (67% cited RVs)
  - 39% were staying for two nights

8(a). General Recreation Use

Canal Survey Results – General Findings

- Special Access Needs
  - Applied to 2% of respondents
- Adequacy of Site Access
  - 98% cited adequate access
- Reason for Recreating
  - 70% cited "Close to home"
- Frequency of Visitation
  - 36% cite 2-3 visits/year

8(a). General Recreation Use

Canal Survey Results – General Findings

- Visitation by Month
  - May, June, July, and August = 66% of visitation
- Use of Non-District Recreation Sites
  - 93% do not use

8(a). General Recreation Use

Canal Survey Results – Activity Participation

1. Fishing from Shore (23.8%)
2. Relaxing/Hanging Out (22.2%)
3. Camping (14.9%)
4. Off-Highway Vehicles (8.7%)
5. Wildlife/Scenic Viewing (7.6%)
6. Picnicking (5.2%)

8(a). General Recreation Use

Canal Survey Results – Activity Importance

1. Relaxing/Hanging Out (79.1%)
2. Fishing (75.8%)
3. Camping (59.0%)
4. Wildlife/Scenic Viewing (58.4%)
5. Picnicking (50.3%)
6. Trails (42.5%)

8(a). General Recreation Use

Canal Survey Results – Facility Ratings

1. Trails (84.7%)
2. OHV Park (83.3%)
3. Campground (72.4%)
4. Swimming Beach (66.4%)
5. Picnic Areas (66.4%)

Lowest Rating – Restrooms

8(a). General Recreation Use

Canal Survey Results – Activity Interference

- 88% cite no interference
- Most commonly noted interference
  - OHV/ATV operation late at night
  - Bugs (mosquitoes and Asian beetles)
  - Unleashed dogs

REQUESTED IMPROVEMENTS BY RECREATION SITE

8(a). General Recreation Use

Requested Improvements

- Headworks Park
  - Additional camper hookups and power in restrooms (65)
  - Shower install in OHV area (45)
- Lake Babcock Park
  - Cleanliness of restrooms (8)
  - Shower install (5)
- Lake North Park
  - Fish cleaning station, fish stocking and structure (24)
  - Cleanliness and shower install in restroom (14)

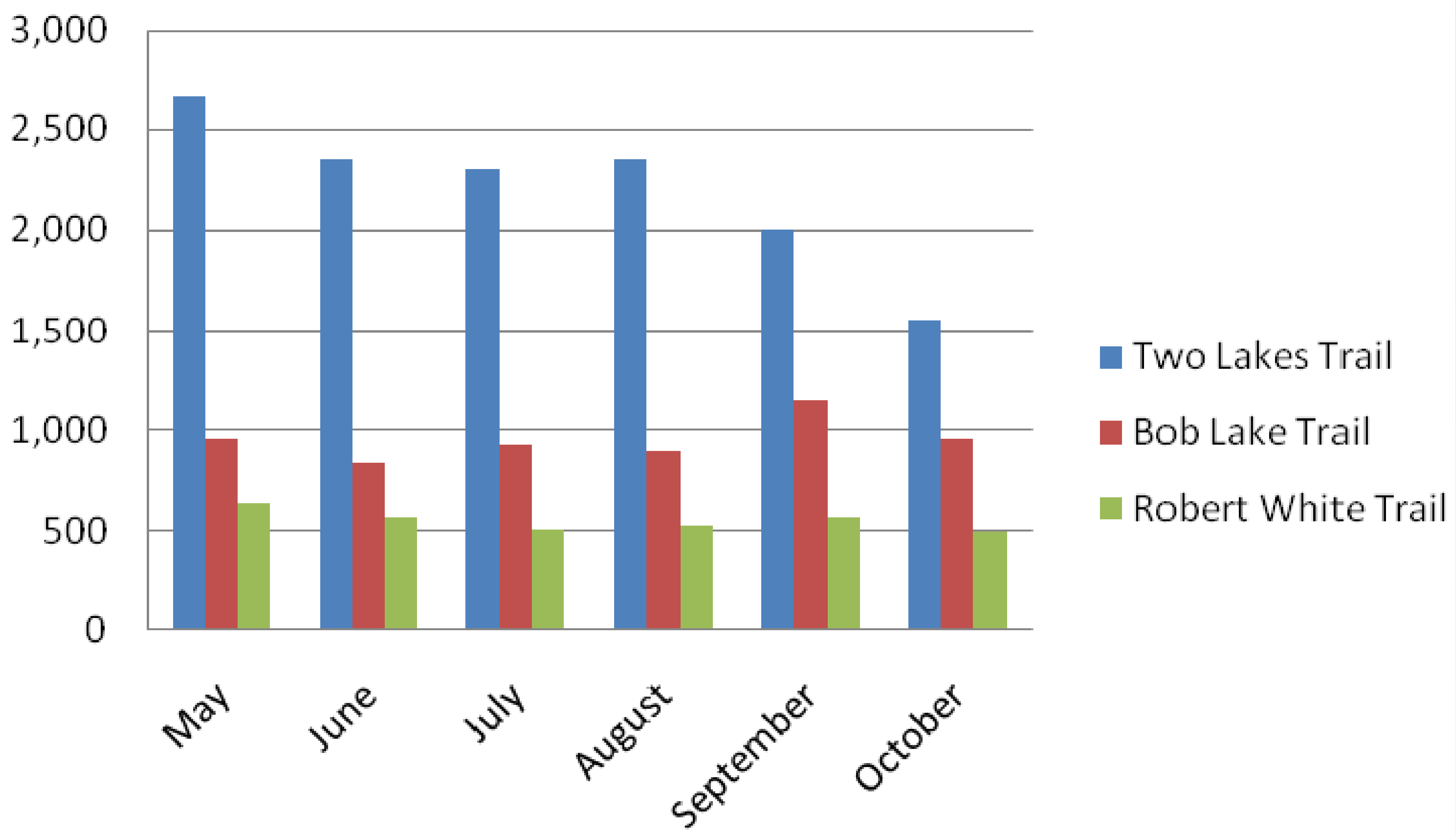
8(a). General Recreation Use

Requested Improvements

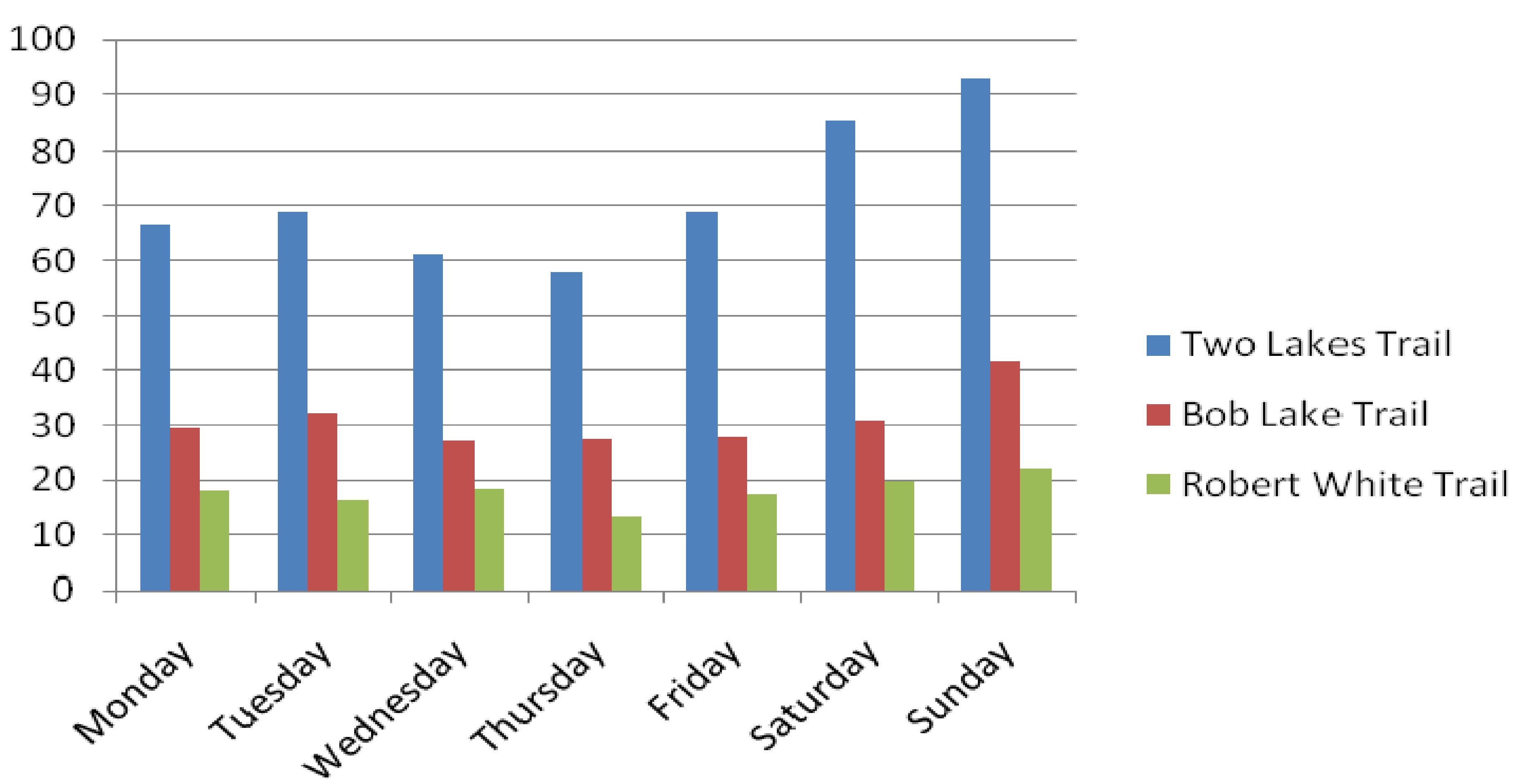
- Powerhouse Park
  - Restroom lighting (3)
  - Fish cleaning station (3)
- Tailrace Park
  - Install restroom (39)
  - General cleanup (15)
  - Fish cleaning station (12)

Trail Counts

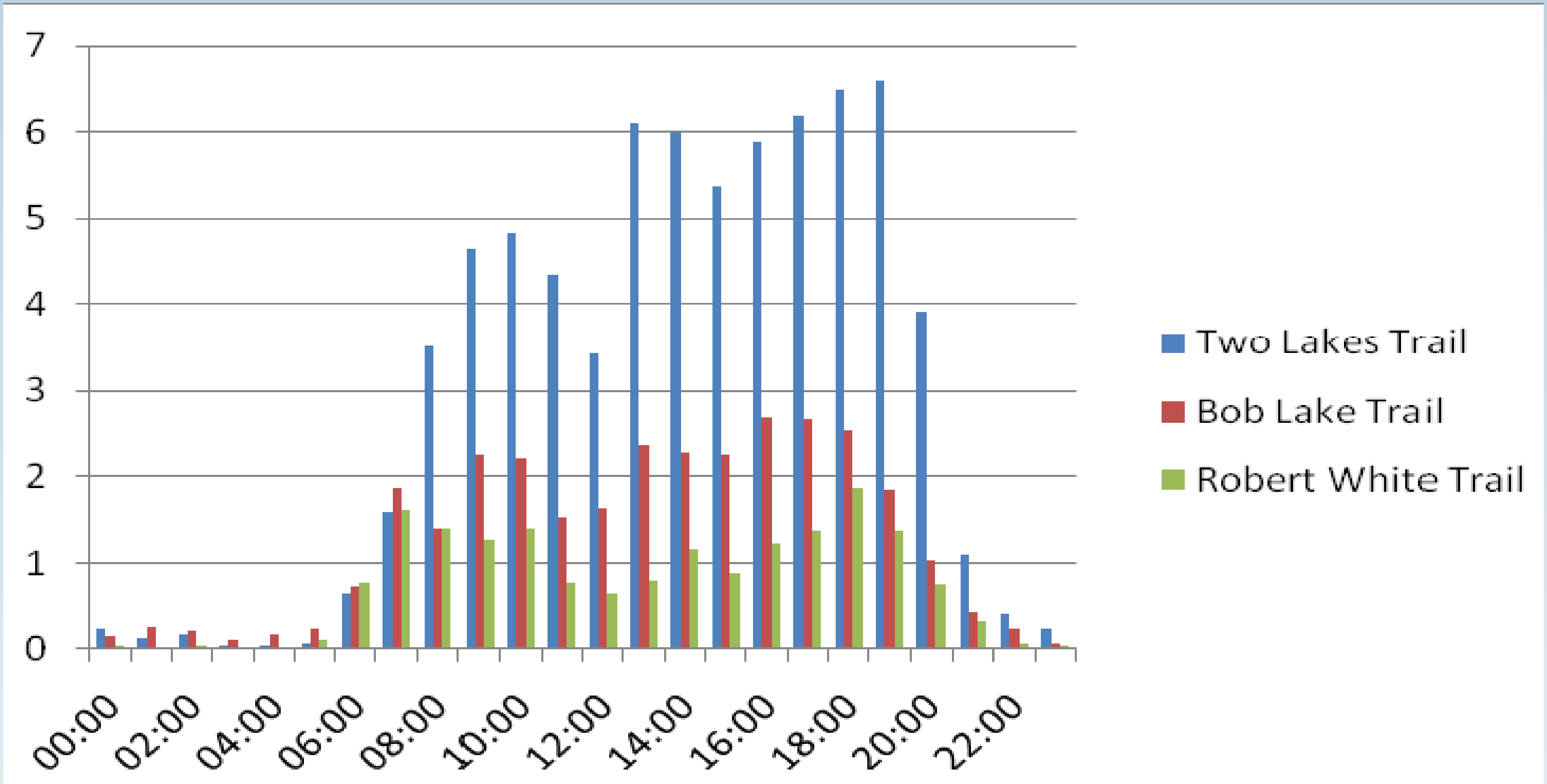
8(a). General Recreation Use Monthly Trail Counts



8(a). General Recreation Use
Average Daily Trail Counts



8(a). General Recreation Use Trail Traffic by Time of Day



Recreation Use Estimates

8(a). General Recreation Use

Recreation Use Estimates

- 82,000 = Annual Visits
- 720 = Average Weekend Day
- 260 = Average Weekday

8(a). General Recreation Use

Capacity at Which Facilities Currently Operate

- Generally ample recreation capacity
  - Exception – Holiday weekends
  - Exception – NOHVA jamborees
- Methods
  - Project survey findings
  - Camper counts
  - District staff observations

8(a). General Recreation Use

Demand of District Recreational Facility

- Satisfy NRPA Standards for Platte and Nance counties
  - 2,562 rec acres / 360 rec acres
  - 5.2 trail miles / 4.5 trail miles
- Future Demand
  - Static Local Population
  - NGPC SCORP Statewide Recreation Findings

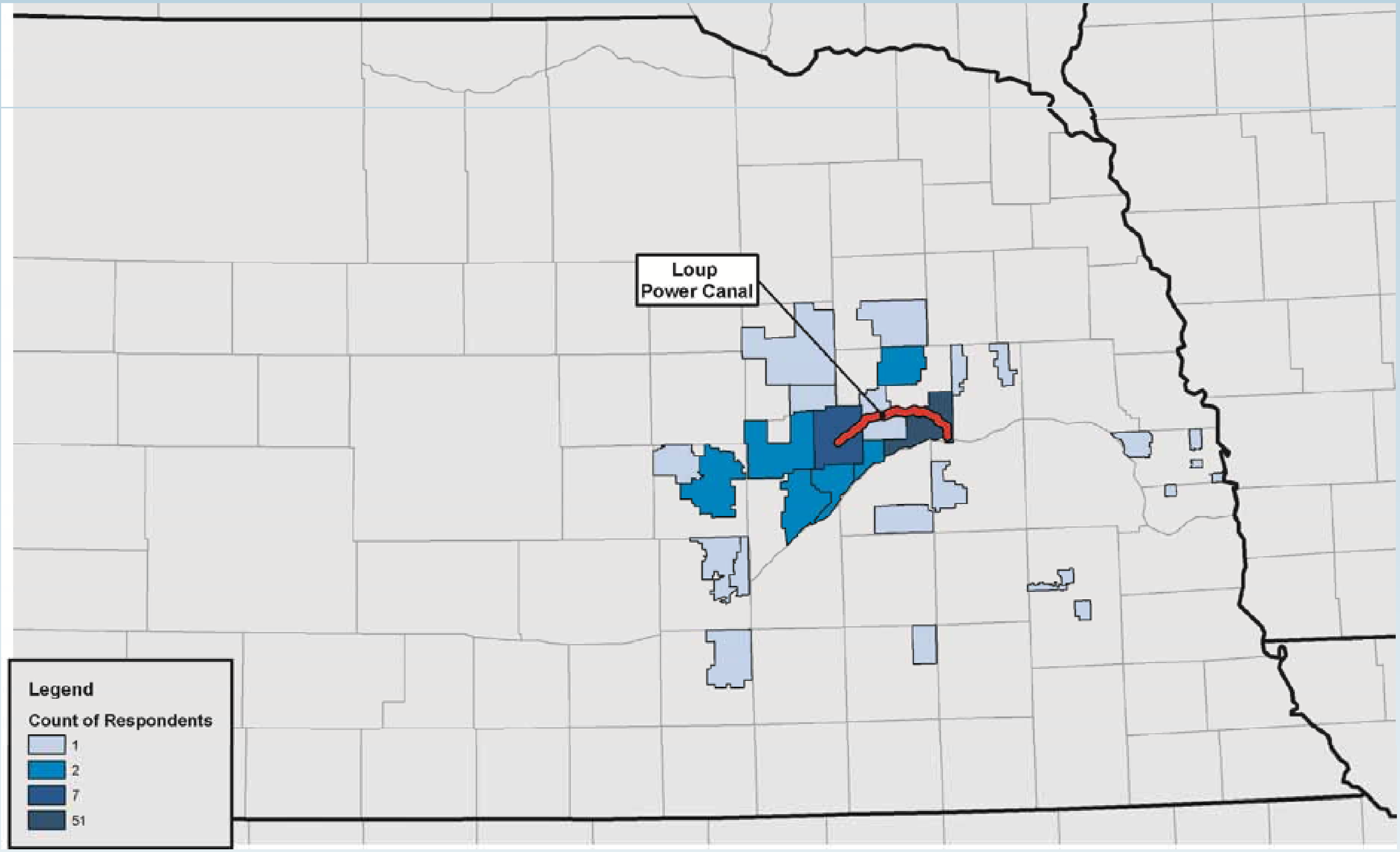

Loup River Bypass Reach Recreation Survey Results

8(a). General Recreation Use

Bypass Reach Survey Results – User Demographics

- Racial Composition
  - 82% White; 5% Hispanic
- Annual Household Income
  - $26K-$50K = 47%
- Age of Users
  - 12 and Under = 17%
- Residence of Users
  - Nebraska = 95%; Columbus = 52%

8(a). Residence of Bypass Reach Survey Respondents



8(a). General Recreation Use

Bypass Reach Survey Results – General Findings

- Size of Party
  - Party Size of 1-2 = 63%
- Miles Traveled
  - 70% traveled 25 miles or less
  - 90% traveled 100 miles or less
- Overnight Stays
  - 22% were staying overnight (63% cited RVs)
  - 31% were staying for four nights

8(a). General Recreation Use

Bypass Reach Survey Results – General Findings

- Frequency of Visitation
  - 48% cite weekly visitation
- Visitation by Month
  - May, June, July, and August = 59% of visitation

8(a). General Recreation Use

Bypass Reach Survey Results – Activity Participation

1. Relaxing/Hanging Out
2. Other
3. Fishing from Shore
4. Swimming / Wading
5. Hiking

85% of respondents cite no hindrance to activities.

8(a). General Recreation Use

Bypass Reach Survey Results – Loup Lands WMA

- Frequency of Visitation
  - 77% have never visited
  - 10% visit annually
- Visitation by Month
  - September, October, April and May receive most use

8(a). General Recreation Use

Loup Lands WMA – Activity Participation

1. Hunting
2. Camping
3. Fishing from Shore
4. Wildlife/Scenic Viewing
5. Relaxing/Hanging Out

8(b). Creel Survey

8(b). Creel Survey

Study Area

- Loup Power Canal (including):
  - Lake Babcock and Lake North
  - Loup River at Headworks Park
  - Platte River at Tailrace Park

  - Not including Loup River bypass reach

8(b). Creel Survey

Methodology

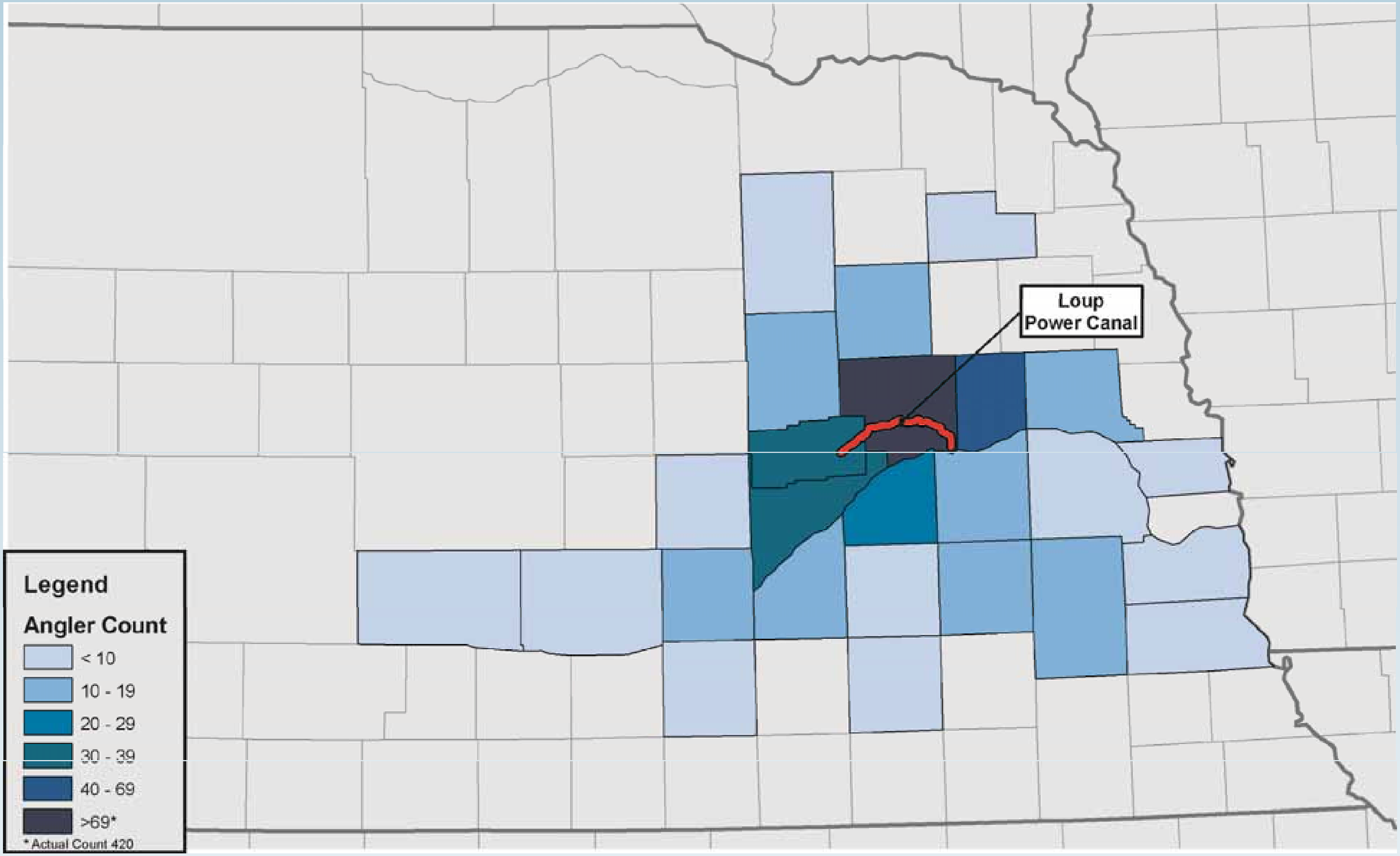
- Progressive count bus-route creel survey design
  - Pressure counts conducted concurrent with interviews
- 6 weekdays and 4 weekend days per month
- Daylight hours
- Analysis run by NGPC Creel Survey Computer System
  - Error check performed by NGPC

8(b). Creel Survey

Creel Survey Results – User Demographics

- Racial Composition
  - 88% White; 12% Hispanic
- Annual Household Income
  - $26K-$50K = 43%
- Residence of Users
  - Nebraska = 99.6%; Platte County = 59%
- Miles Traveled
  - 67% traveled 25 miles or less
  - 96% traveled 100 miles or less

8(b). Residence of Creel Survey Respondents



8(b). Creel Survey

Creel Survey Results – General Findings

- Surveys Conducted = 439
- Mean Party Size = 1.75
- Mean Completed Trip Length = 2.9 hours
- Total Angler Hours = 2,221
- Total Angler Days = 766

8(b). Creel Survey

Creel Survey Results – Fish Species Sought

1. Channel Catfish (65% of anglers)
2. Anything (10%)
3. Walleye/Sauger (9%)
4. Freshwater Drum (6%)
5. Flathead Catfish (4%)
6. Crappie (3%)

8(b). Creel Survey

Creel Survey Results – Fishing Pressure

- September received the most pressure (7,739 hours)
  - Followed by May, July, June, August, October
- 95% of effort occurs via shore fishing

8(b). Creel Survey

Creel Survey Results – Catch, Release, and Harvest

- Total 2010 Catch Estimate = 20,800 fish
- Total 2010 Release Estimate = 11,800 fish
- Total 2010 Harvest Estimate = 9,000 fish

- May = Greatest Catch Values
- October = Greatest Harvest Values

8(b). Creel Survey

Creel Survey Results – 2010 Fish Catch Estimates

- Total Fish Catch Estimate = 20,800
  - Channel Catfish (47% of total catch)
  - Freshwater Drum (20%)
  - Crappie (20%)
  - Flathead Catfish (2%)
  - Walleye/Sauger (1%)

8(b). Creel Survey

Creel Survey Results – 2010 Fish Release Estimates

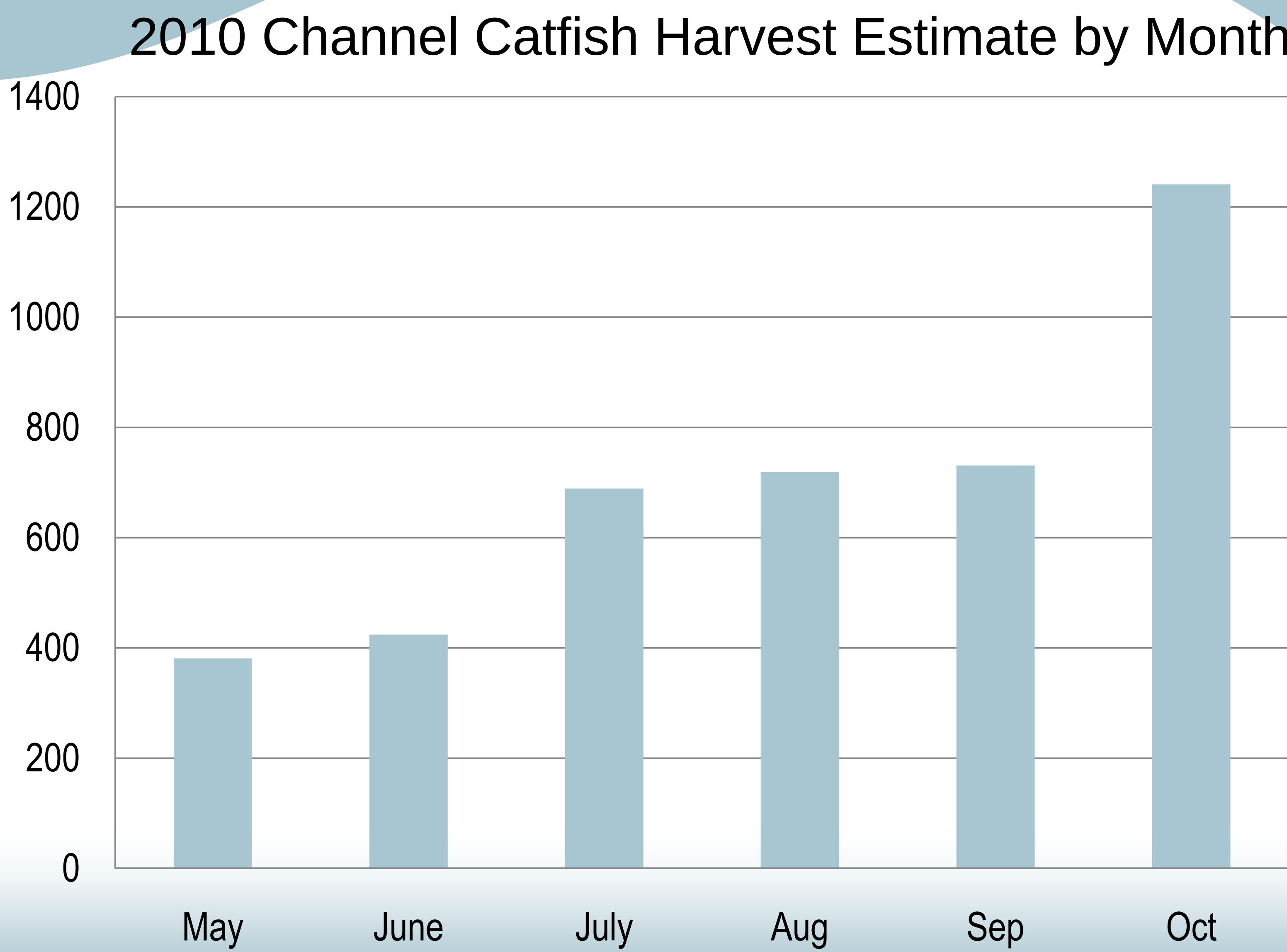
- Total Fish Release Estimate = 11,800
  - Channel Catfish (47% of total release)
  - Crappie (26%)
  - Freshwater Drum (18%)
  - Flathead Catfish (2%)
  - Walleye/Sauger (1%)

8(b). Creel Survey

Creel Survey Results – 2010 Fish Harvest Estimates

- Total Fish Harvest Estimate = 9,000
  - Channel Catfish (47% of total harvest)
  - Freshwater Drum (22%)
  - Crappie (12%)
  - Flathead Catfish (2%)
  - Walleye/Sauger (1%)

8(b). Creel Survey



8(b). Creel Survey

Creel Survey Results – Catch, Release, and Harvest Rates (CPUE)

- Overall Harvest Rate = 0.30 fish/angler-hour
- Highest Estimated Catch Rates:
  - May (1.31 fish/angler-hour)
  - October (0.86 fish/angler-hour)
- Highest Estimated Harvest Rate:
  - October (0.57 fish/angler-hour)

8(b). Creel Survey

Shore Fishing Ratings – Angler Satisfaction

- 57% Rated Above Average or Excellent
- 4% Rated Below Average or Poor

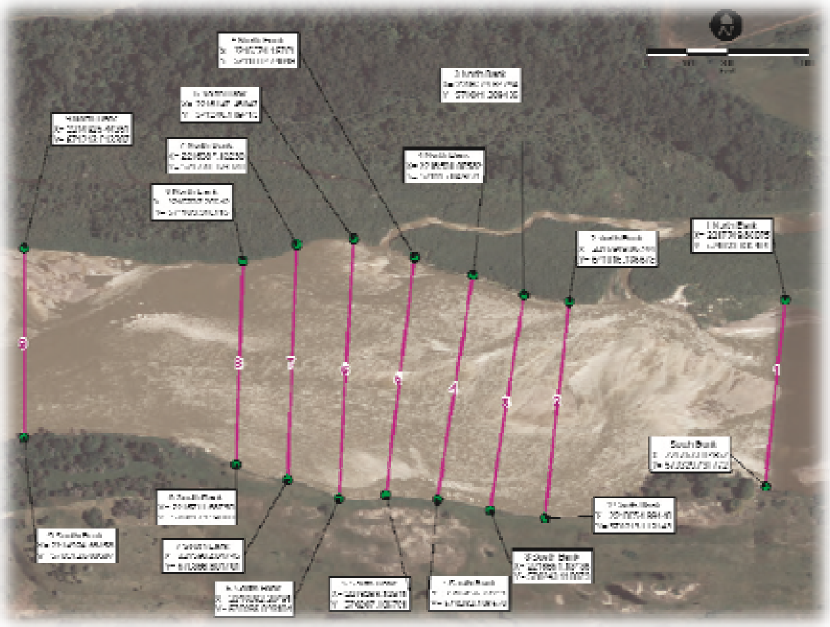
Next Steps

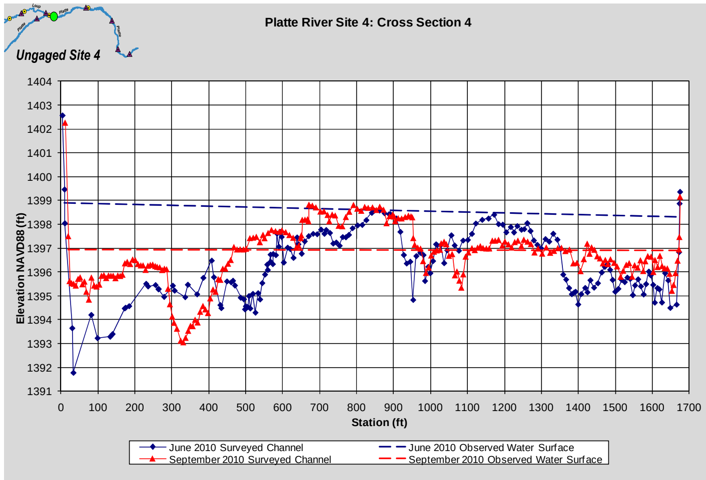
Recreation Management Plan

- Consider Results of Recreation Use and Creel Analysis
  - Identify activities and facilities most utilized by the public and focus improvements accordingly

QUESTIONS?

Preliminary Analysis – Studies 1, 2 & 5

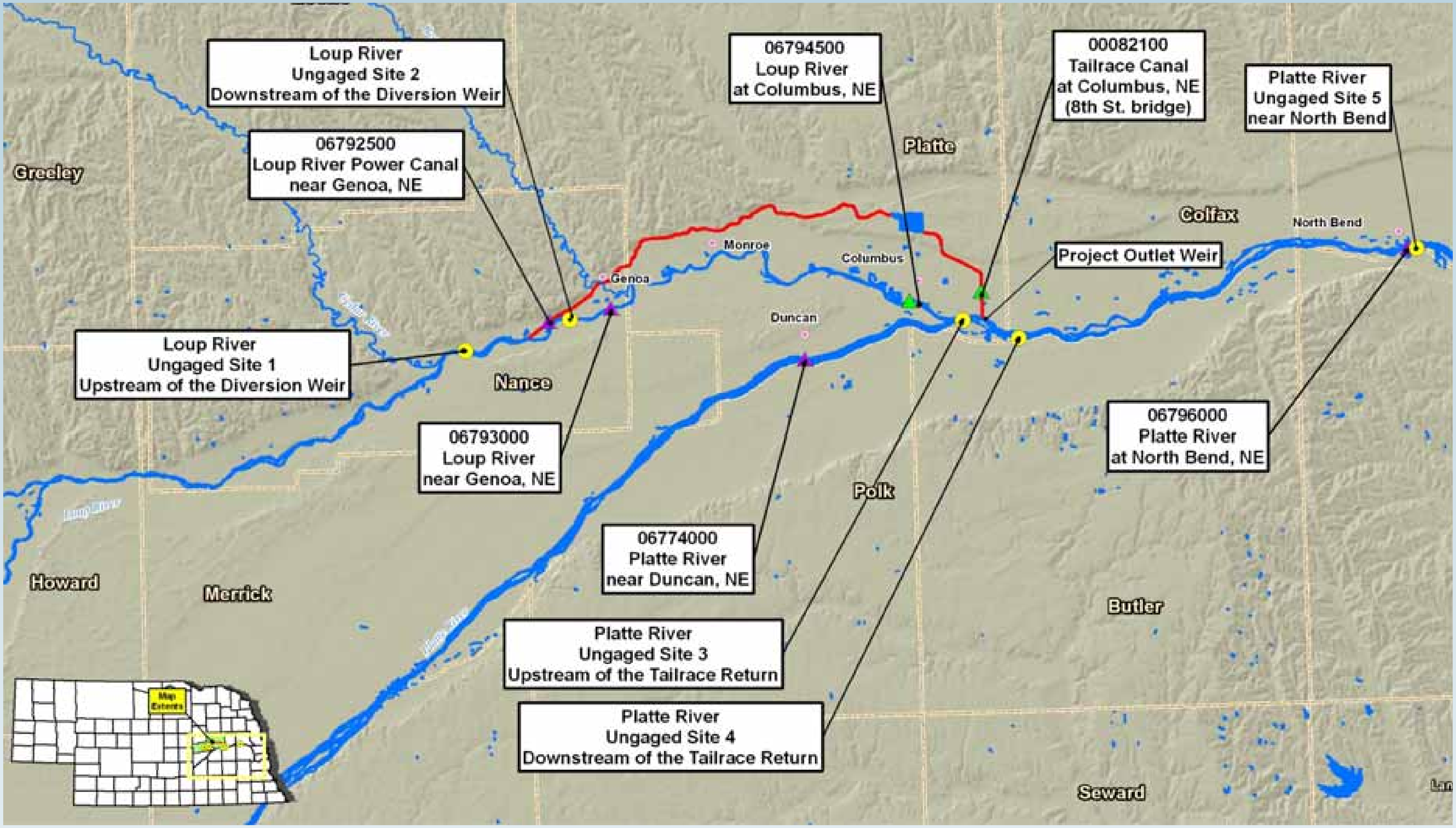




Preliminary Analysis – Studies 1, 2 & 5

- Field Data Collection
- Wet, Dry, Normal Flow Classifications
- Synthetic Hydrograph Development
- Hydraulic Model Development and Calibration
- Flow Duration, Volume Duration, and Flood Flow Frequency Analysis
  - Current Operations
  - Alternative Conditions

Preliminary Analysis – Studies 1, 2 & 5



Field Data Collection

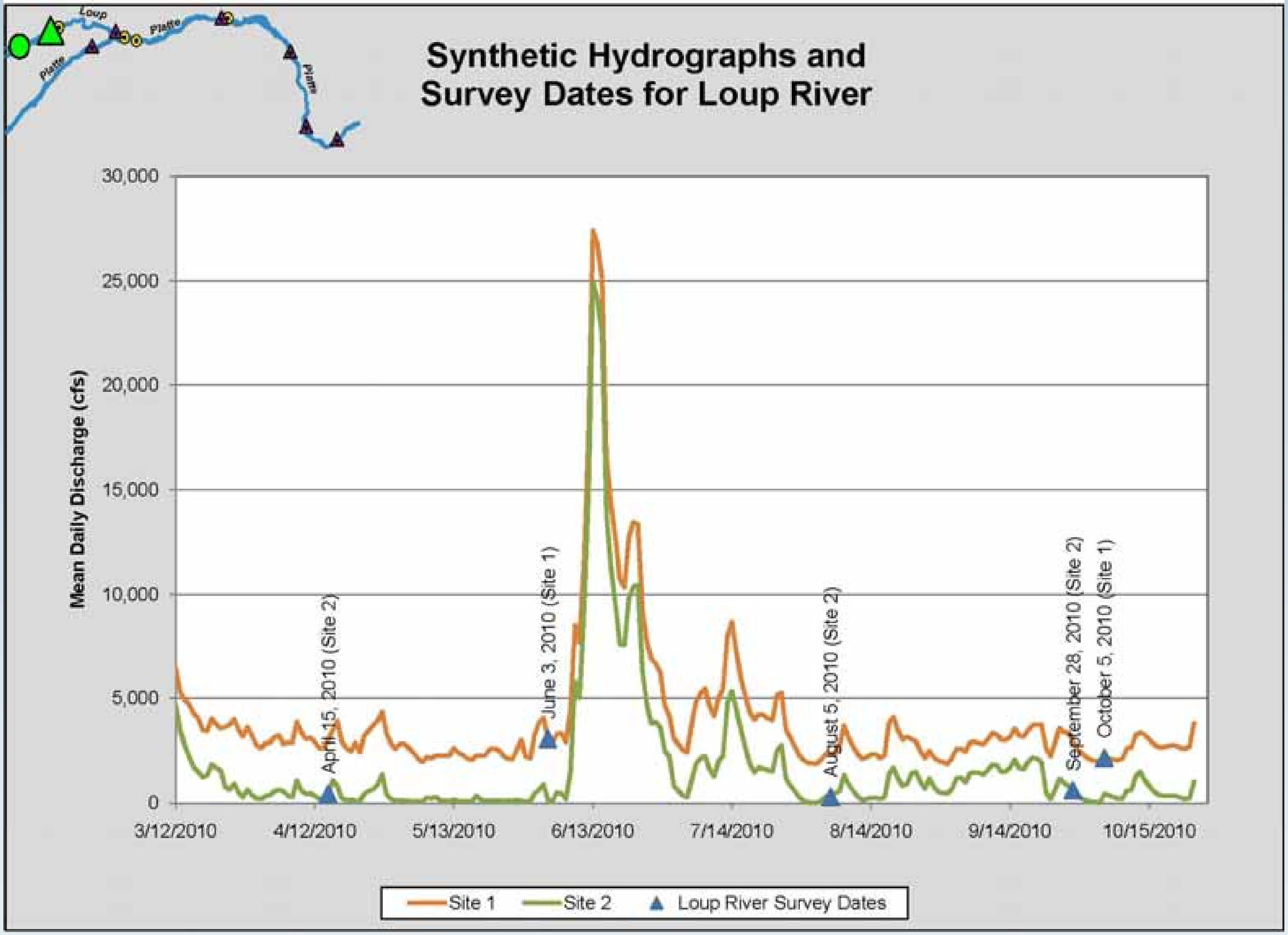
Methodology:

- Data collected: Bathymetric and water surface elevation
- Dates: Pre- and Post Nesting Season
- Velocity: Not collected due to high water

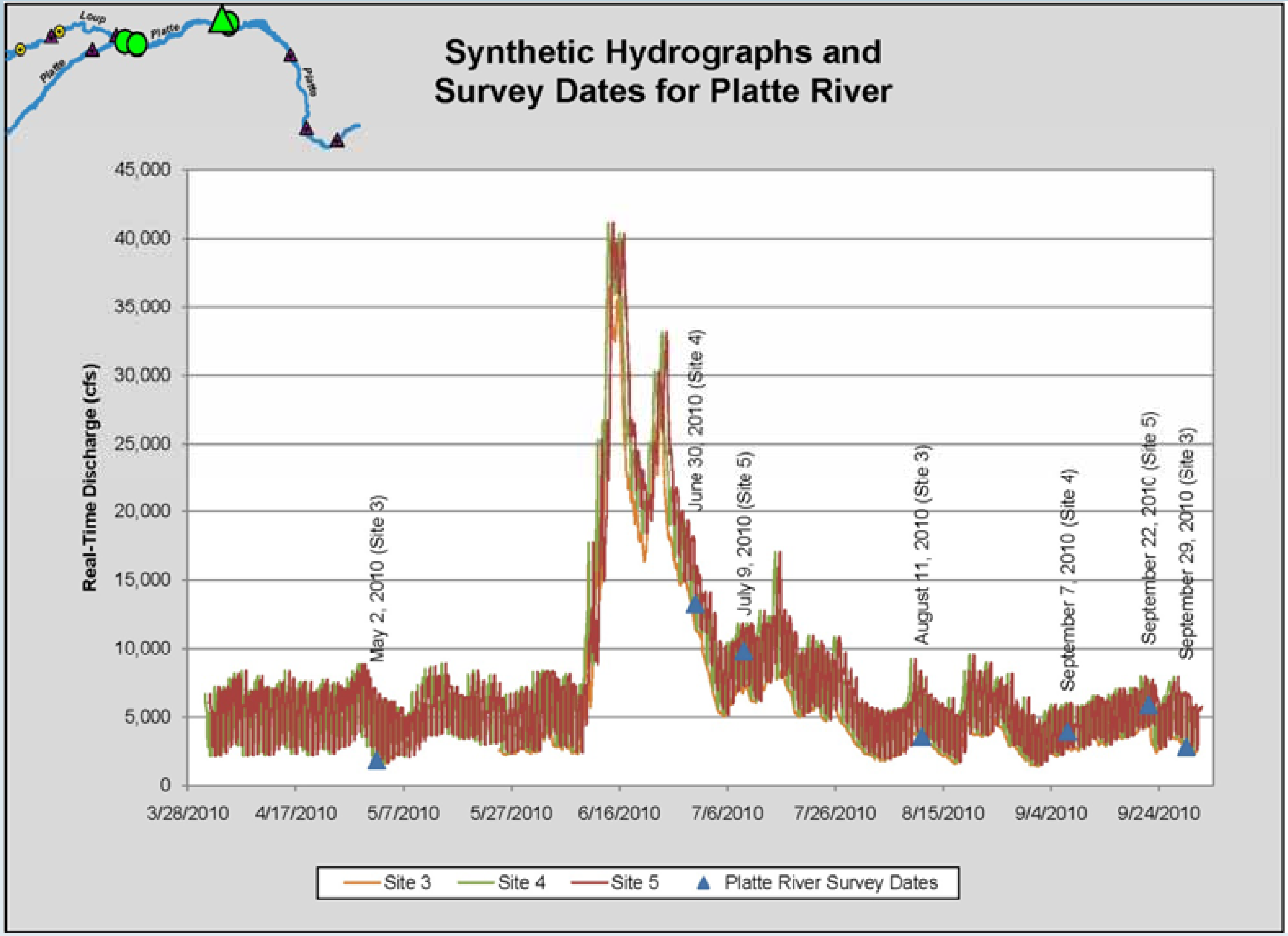
Field Data Collection

Location	Data Collection Effort	Cross Sections (2010)
Site 1 – Upstream of the Diversion Weir	Spring	June 2 – 3
	Fall	October 5
Site 2 – Downstream of the Diversion Weir	Spring	April 15
	Summer	August 5
	Fall	September 28
Site 3 – Upstream of the Tailrace Return	Spring	May 2 – 3
	Summer	August 11
	Fall	September 29
Site 4 – Downstream of the Tailrace Return	Spring	June 29 – 30; July 1
	Fall	September 7 – 8
Site 5 – Near North Bend	Spring	July 8 – 9
	Fall	September 21 – 22
Headworks	Spring	June 3
	Summer	August 5

Field Data Collection



Field Data Collection



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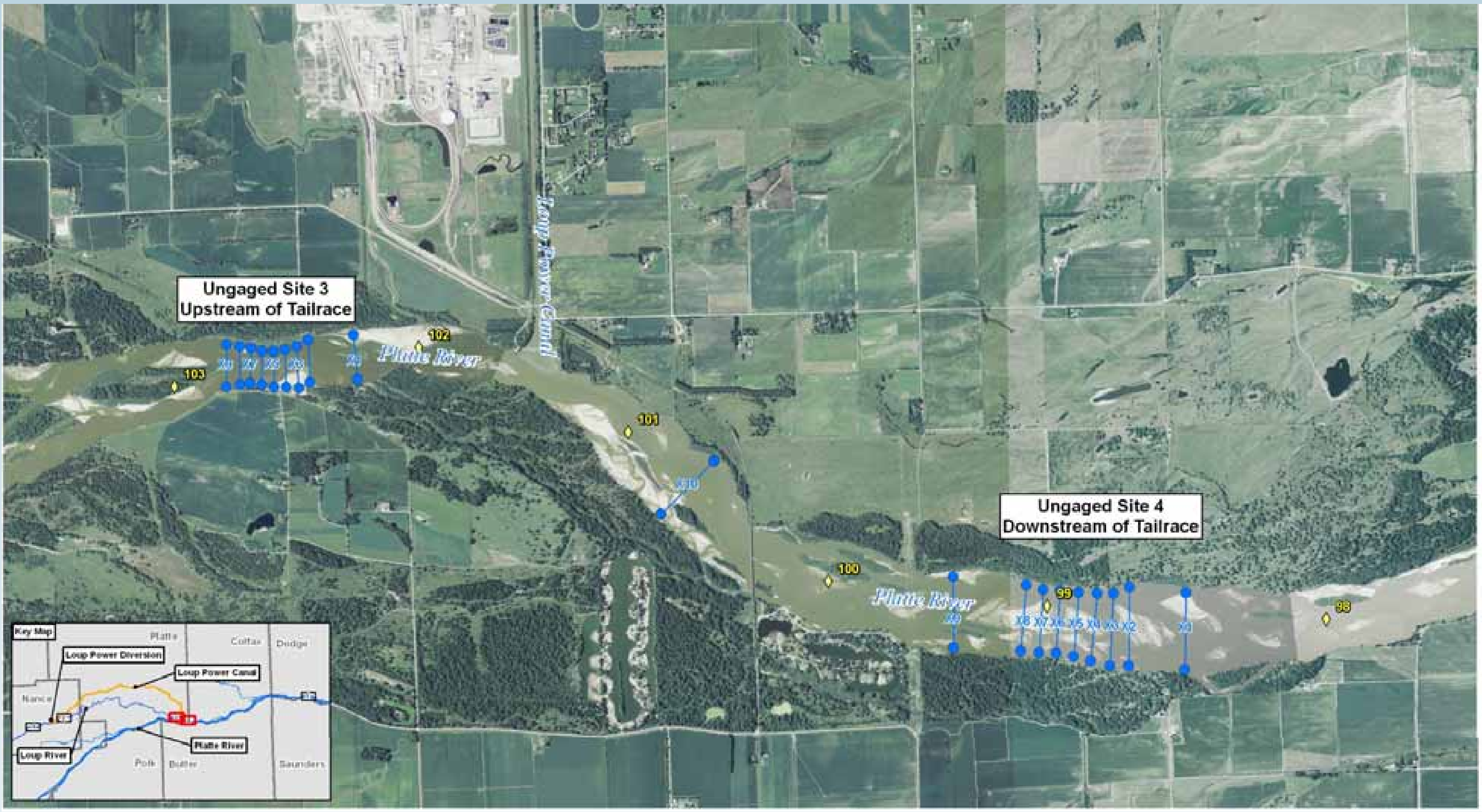

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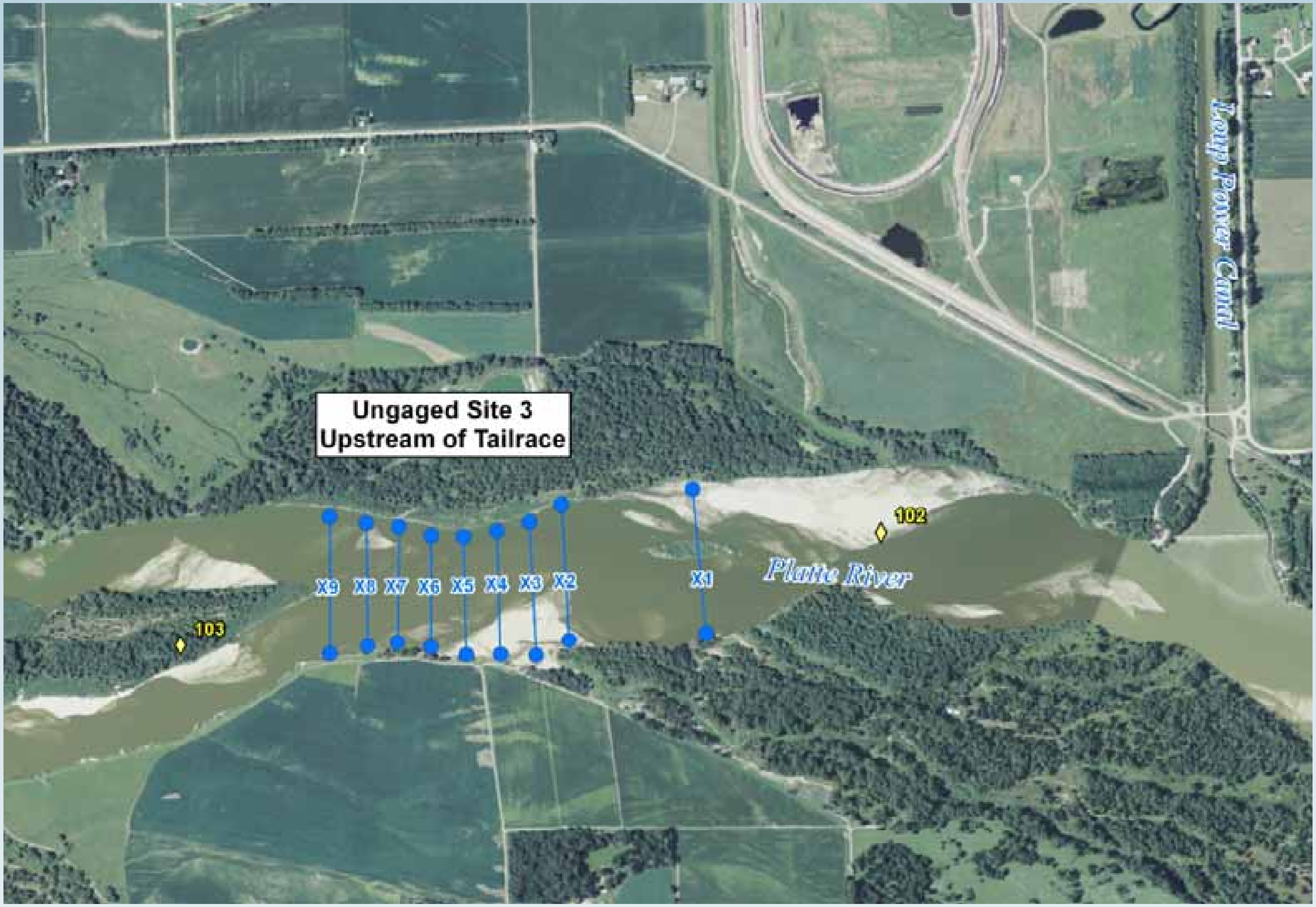
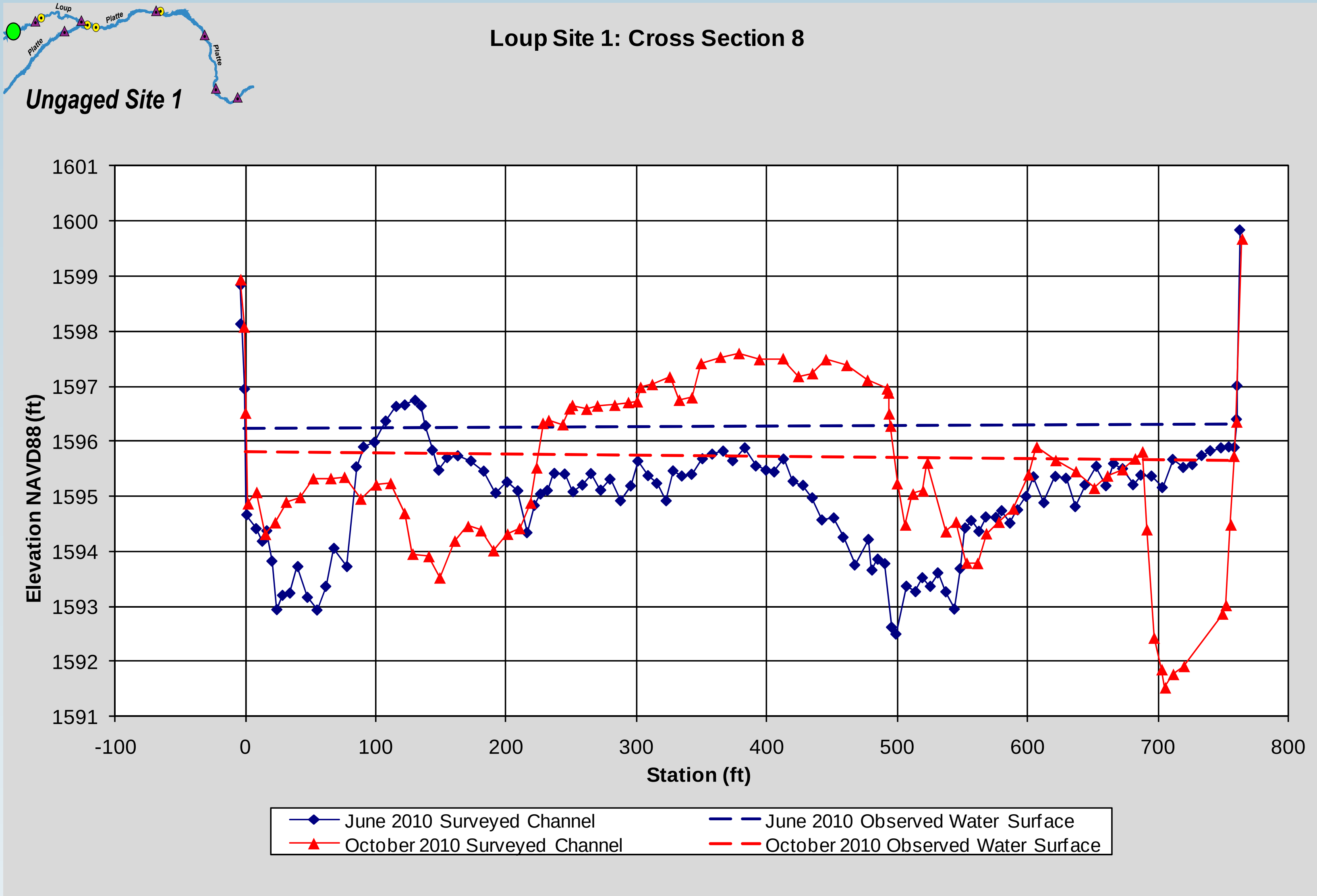


Field Data Collection

Ungaged Site 1

Field Data Collection



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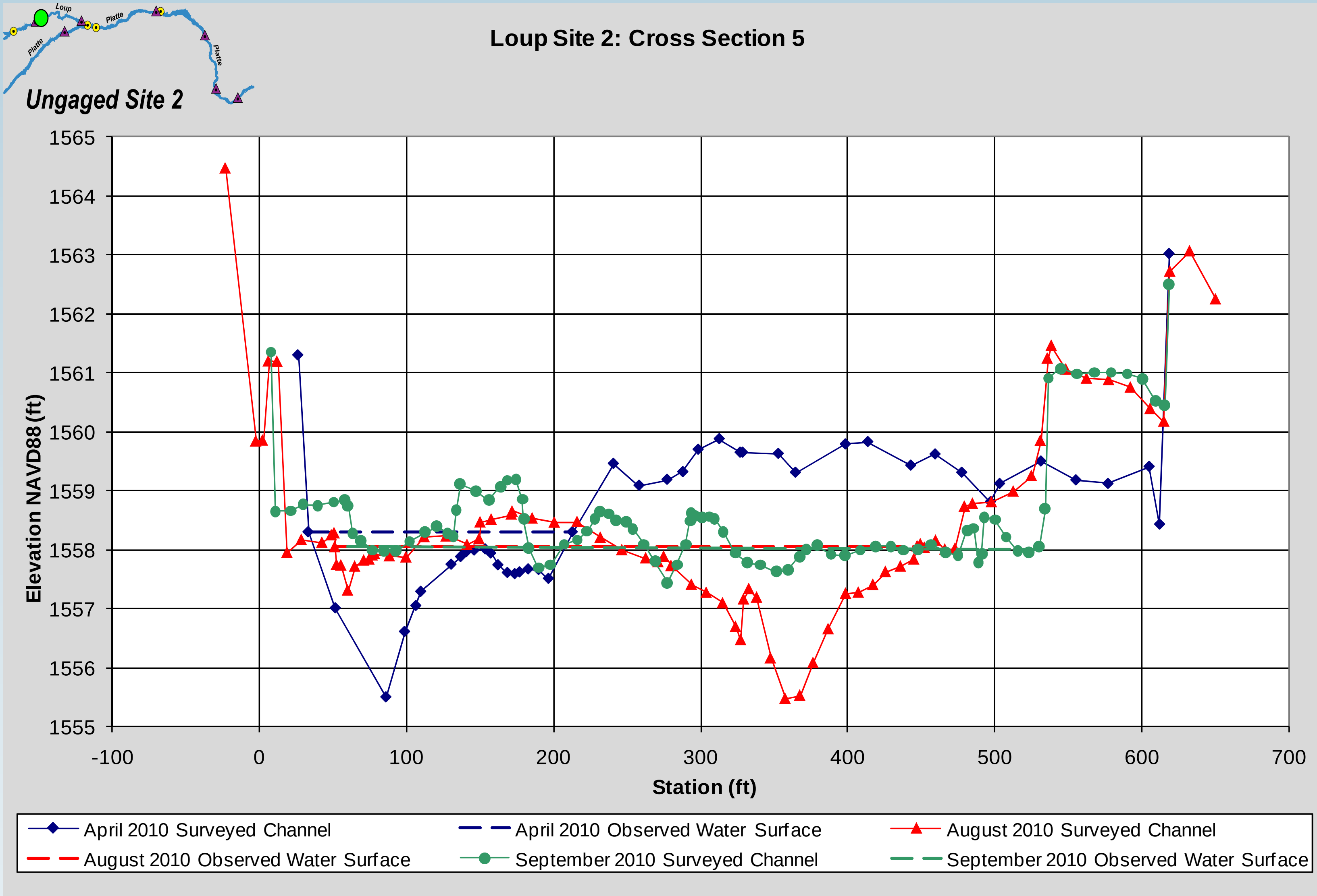

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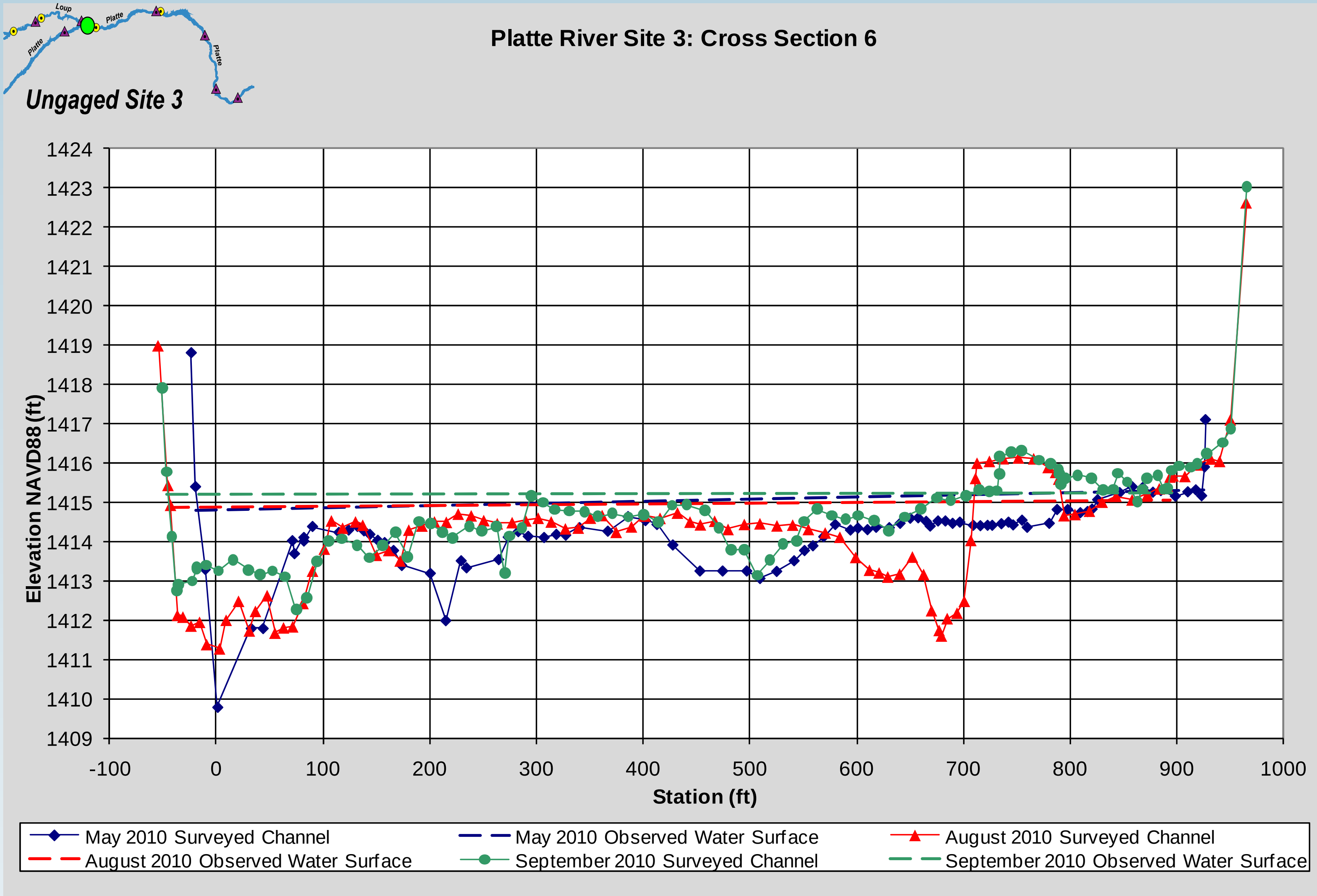

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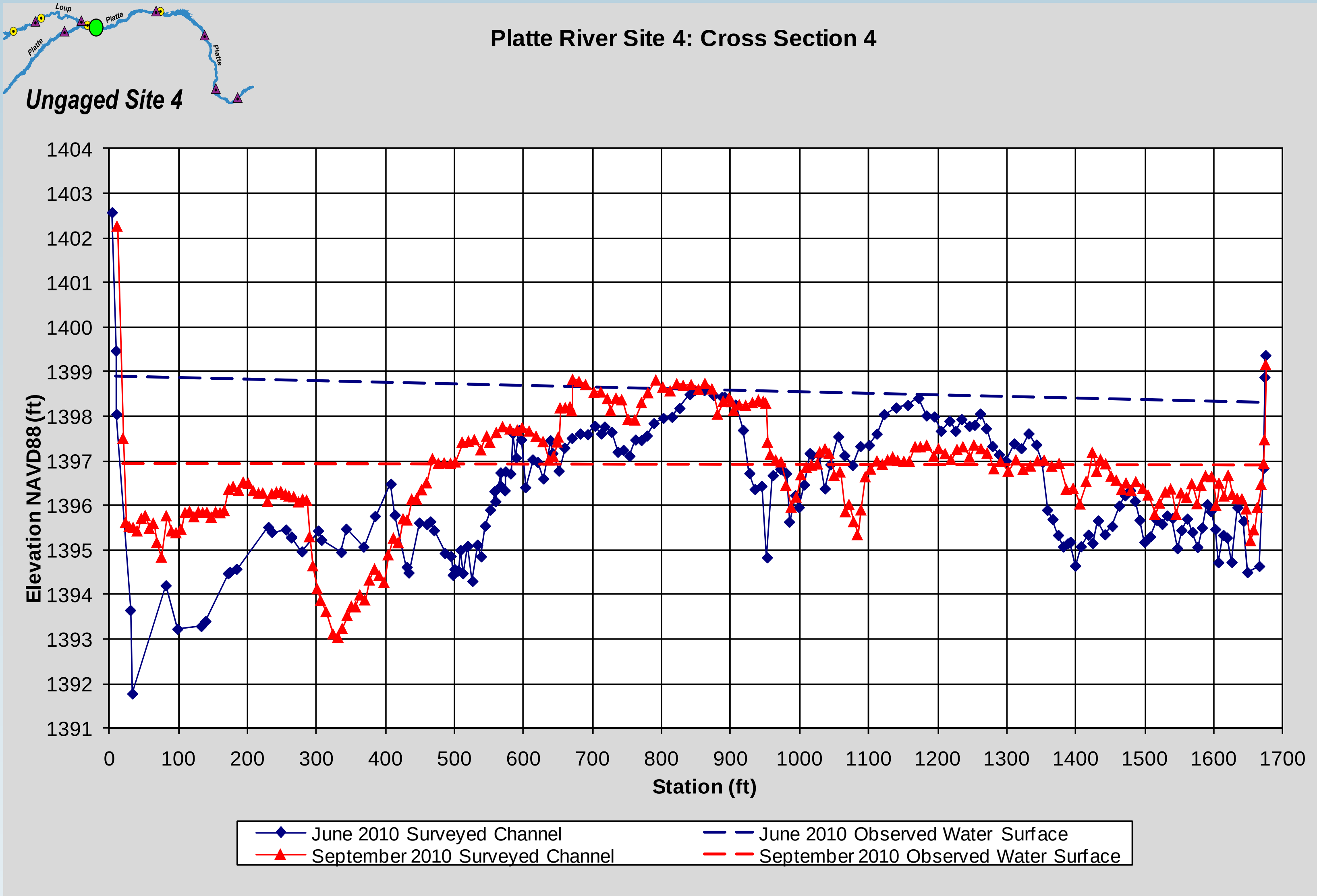

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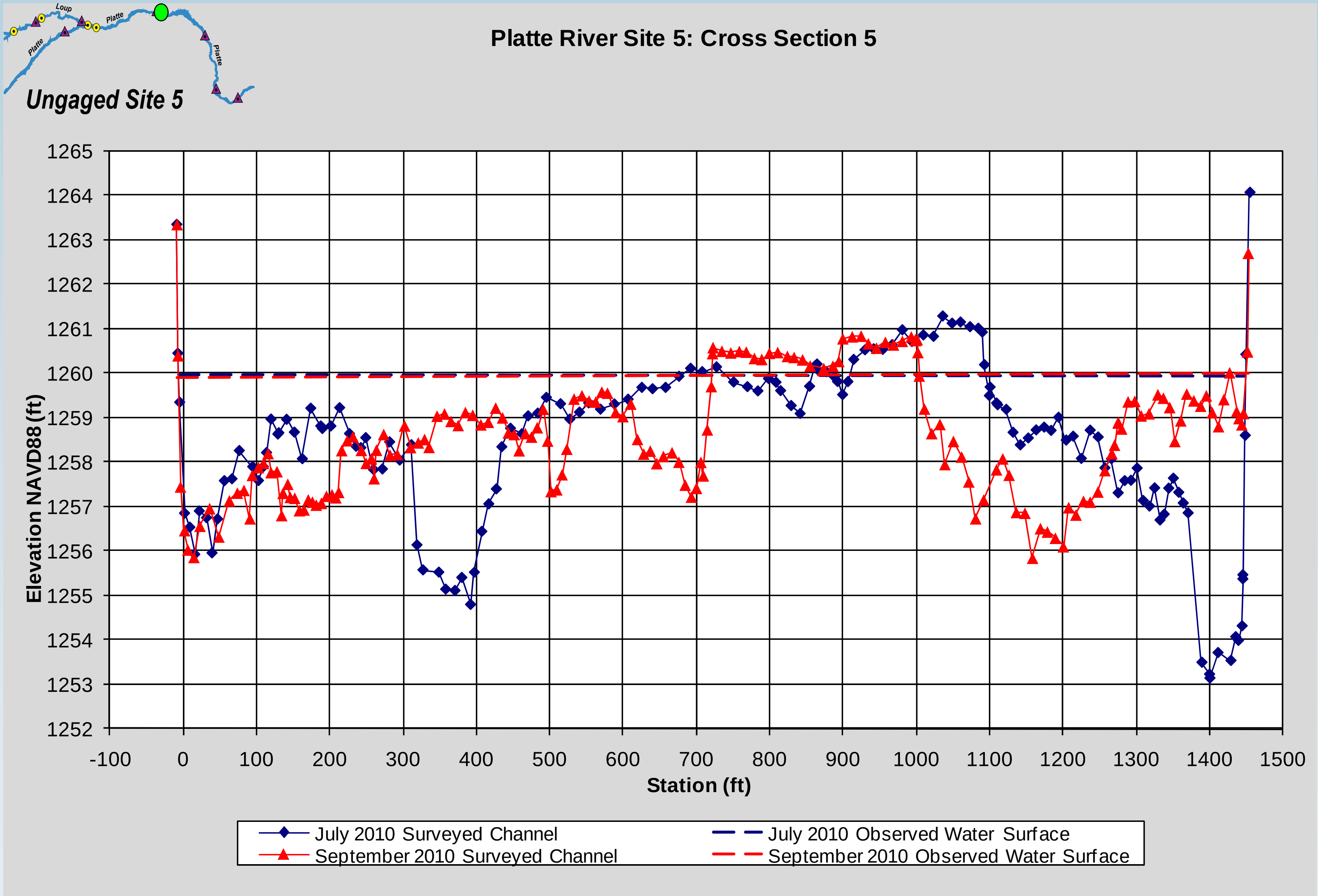


Field Data Collection

Results

Flow area change

Site	Site Average Area Change					
Loup River Site 1	June to October					
	-139 ft^2	-4%				
Loup River Site 2	April to September		April to August		August to September	
	3 ft^2	1%	236 ft^2	8%	-234 ft^2	-7%
Platte River Site 3	May to September		May to August		August to September	
	-337 ft^2	-6%	-83 ft^2	-1%	-254 ft^2	-4%
Platte River Site 4	June to September					
	-343 ft^2	-4%				
Platte River Site 5	July to September					
	-232 ft^2	-3%				

Wet, Dry, Normal Flow classification

Methodology:

- USFWS Methodology
- Highest 33% considered “Wet” Year
- Lowest 25% considered “Dry” Year
- Remaining considered “Normal” Year
- Verified wet, dry, and normal classifications between 2003 and 2009

Wet, Dry, Normal Flow Classification

Calendar Year	Platte River near Duncan		Loup River Basin (Site 1 and 2)		Platte River Upstream of Tailrace Return (Site 3)		Site 4 and Platte River at North Bend (Site 5)	
	Flow Classification	Ranking	Flow Classification	Ranking	Flow Classification	Ranking	Flow Classification	Ranking
2003	Dry	94.2	Dry	82.09	Dry	94.03	Dry	91.8
2004	Dry	98.55	Dry	74.63	Dry	91.04	Dry	90.16
2005	Dry	89.86	Normal	50.75	Dry	76.12	Dry	83.61
2006	Dry	97.1	Dry	83.58	Dry	95.52	Dry	95.08
2007	Normal	49.28	Wet	14.93	Normal	34.33	Wet	31.15
2008	Normal	37.68	Wet	8.96	Wet	22.39	Wet	29.51
2009	Normal	50.72	Wet	11.94	Normal	44.78	Normal	49.18

Wet, Dry, Normal Flow Classification

Summary Results

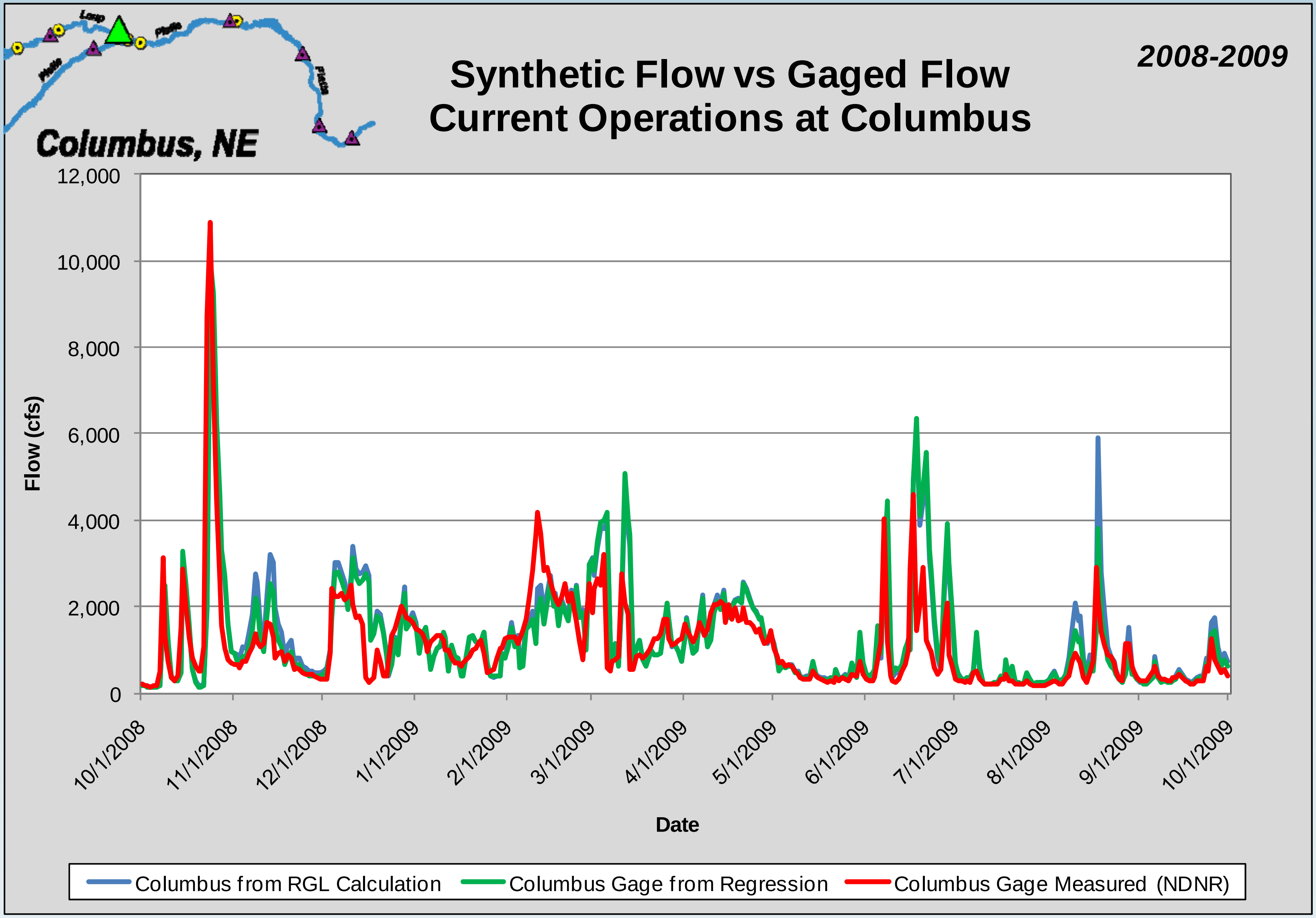
- Platte River
  - 2006 “Dry”
  - 2008 “Wet”
  - 2009 “Normal”
- Loup River
  - 2005 “Normal”
  - 2006 “Dry”
  - 2008 “Wet”

Synthetic Hydrograph Development

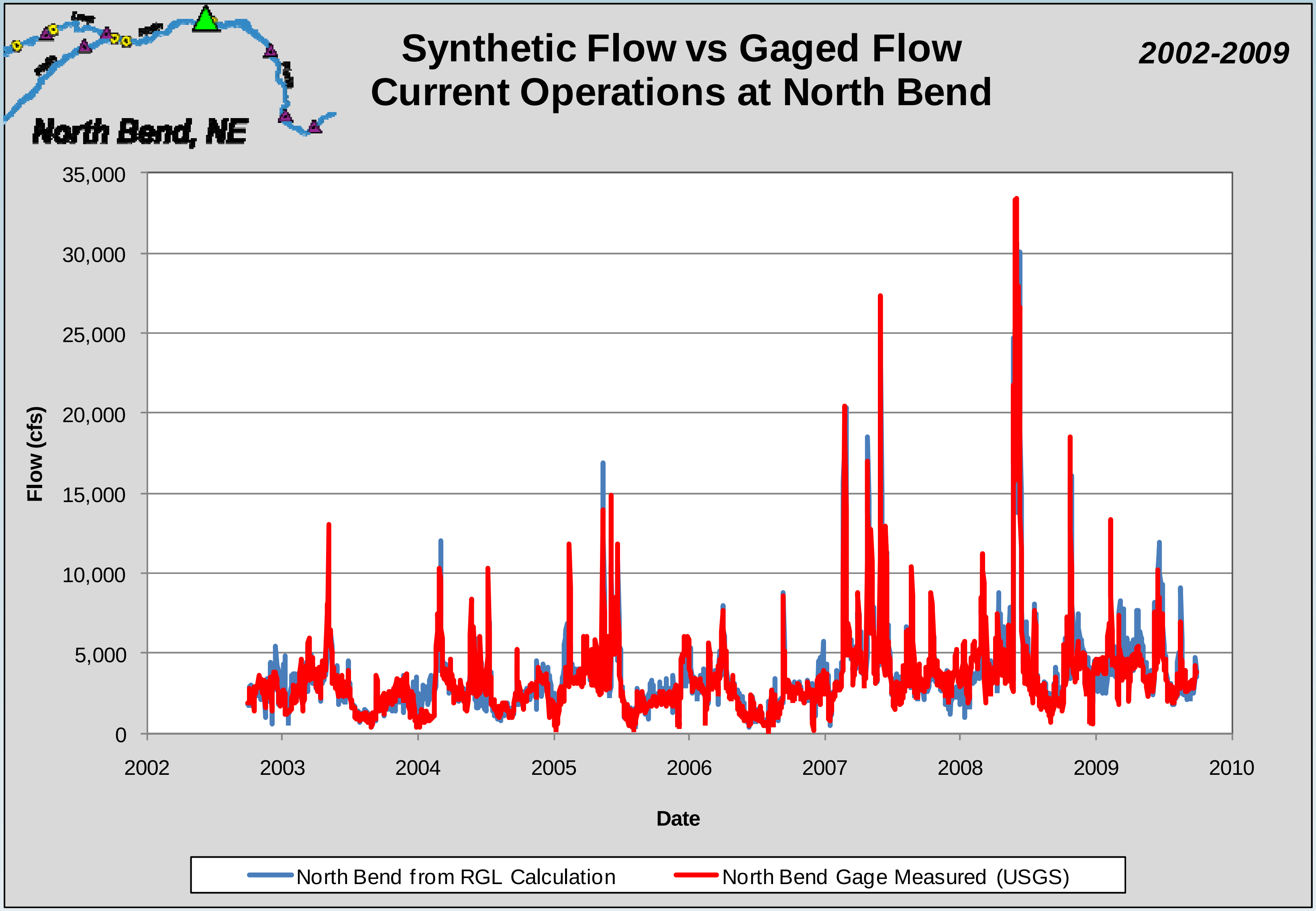
Methodology:

- Real Time Gage Data
- Calculated Reach Gain/Loss
- Adjusted for Travel Time
- Developed Current Conditions at Ungaged Sites
- Developed Run-of-River Condition at All Sites

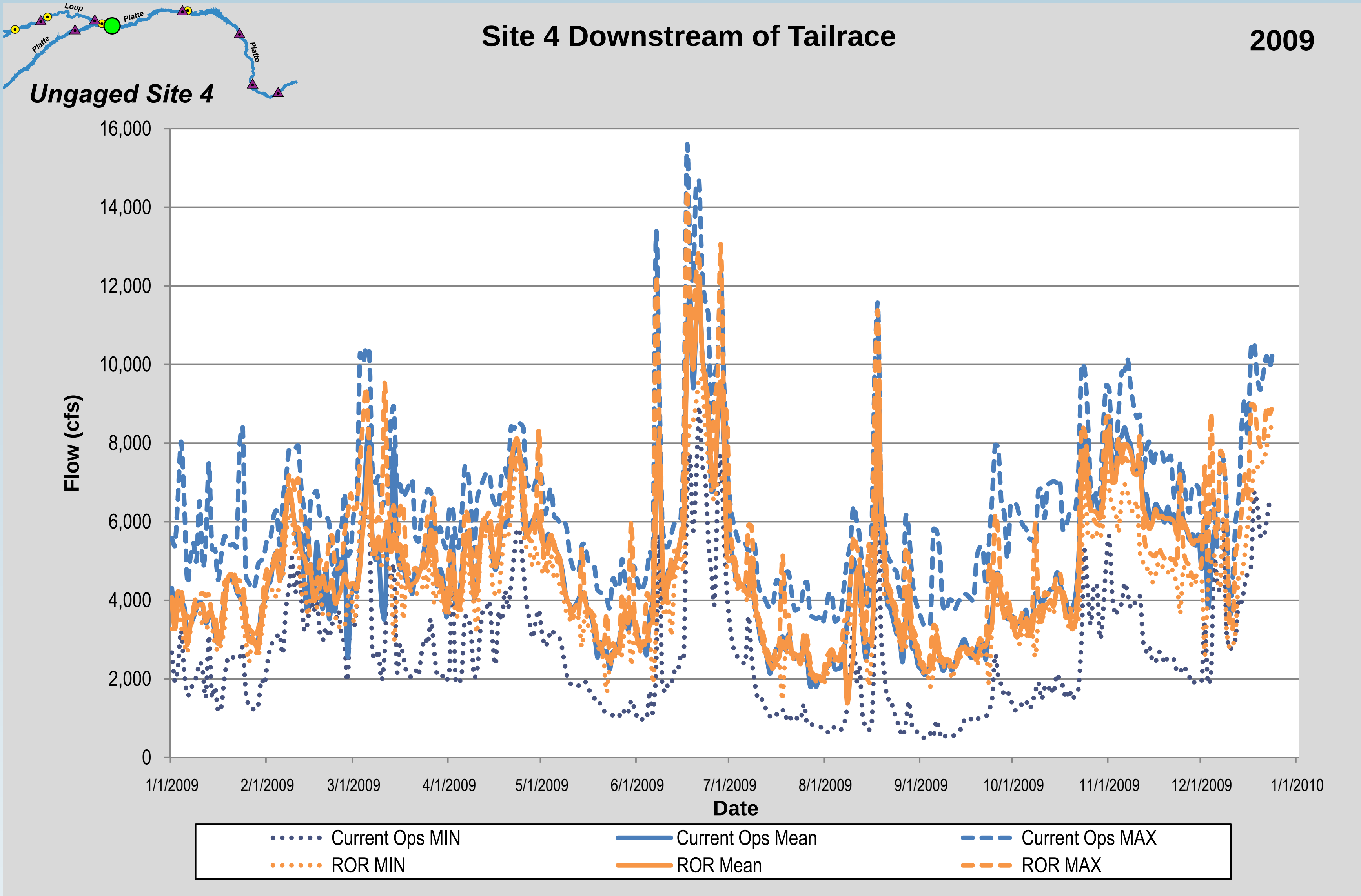
Synthetic Hydrograph Development



Synthetic Hydrograph Development



Synthetic Hydrograph Development

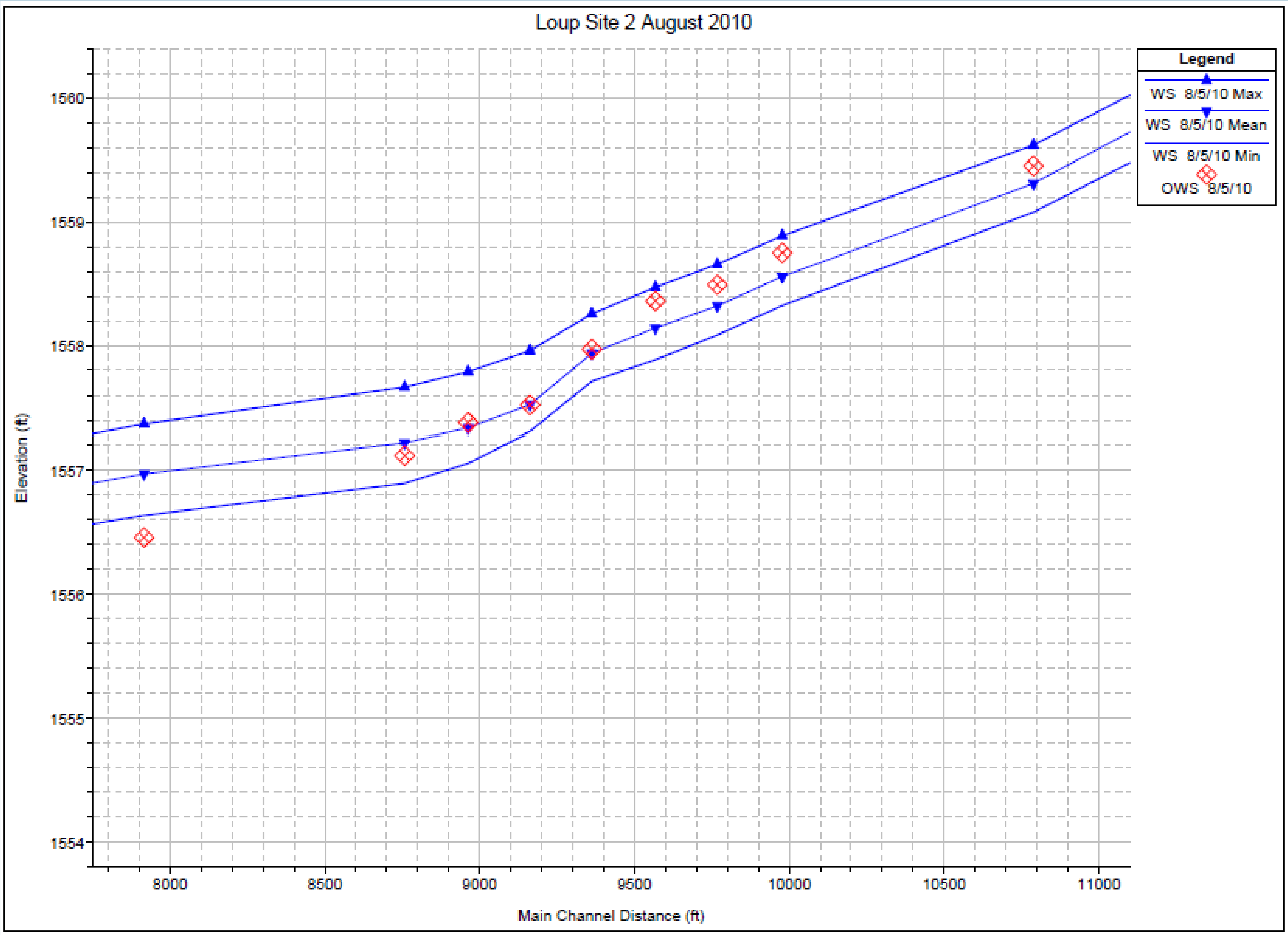


Hydraulic Model Development and Calibration

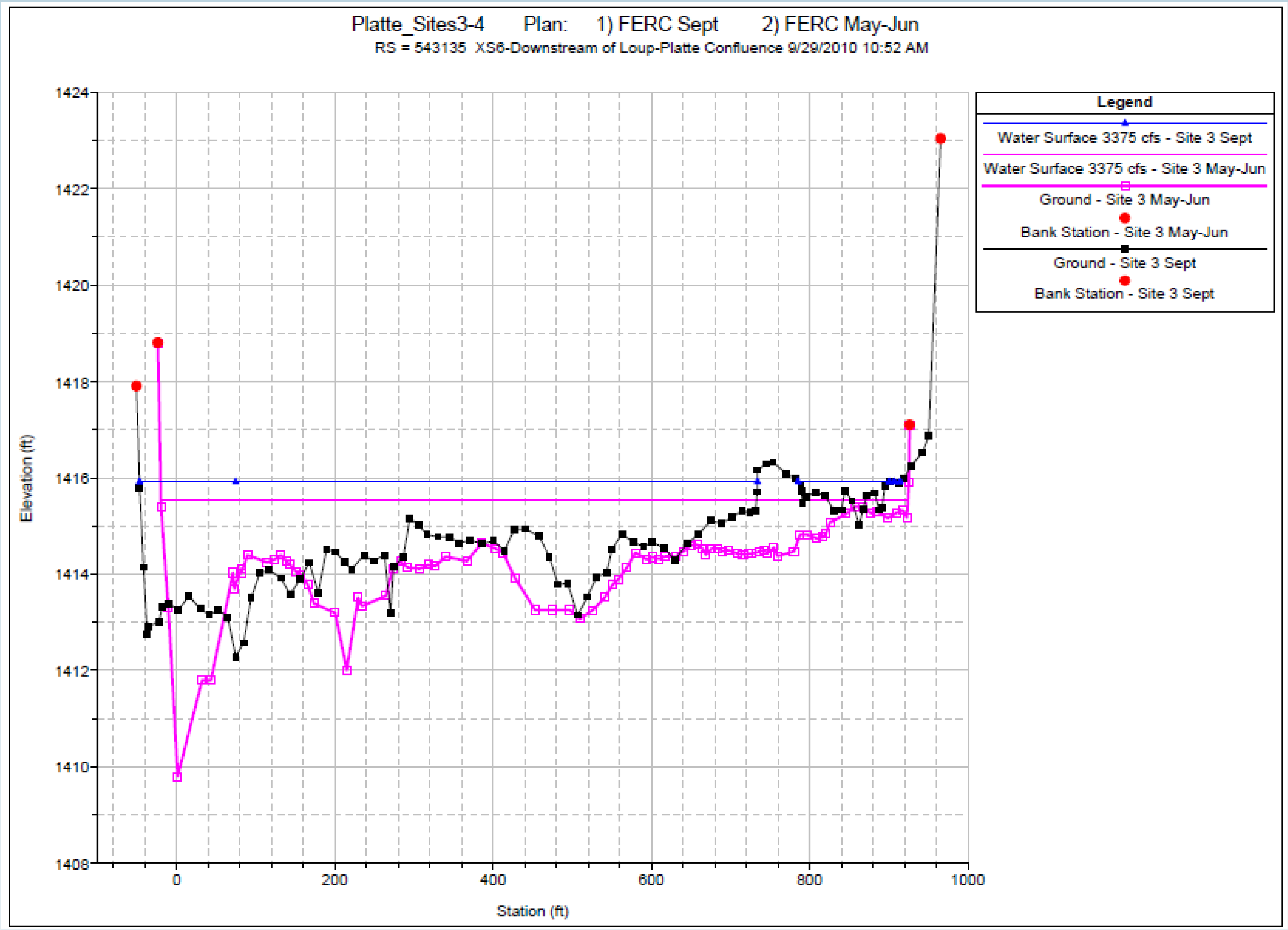
Inputs

- HEC-RAS (worked in conjunction with USACE)
- Steady-state water surface profiles
  - Cross sectionally averaged hydraulic conditions
  - Depth
  - Velocity Distribution
  - Wetted Width
- Cross Section Surveys
- Measured WSELs
- Calibration (Loup River and Platte River)
- Inserted our model into Loup River developed by the USACE

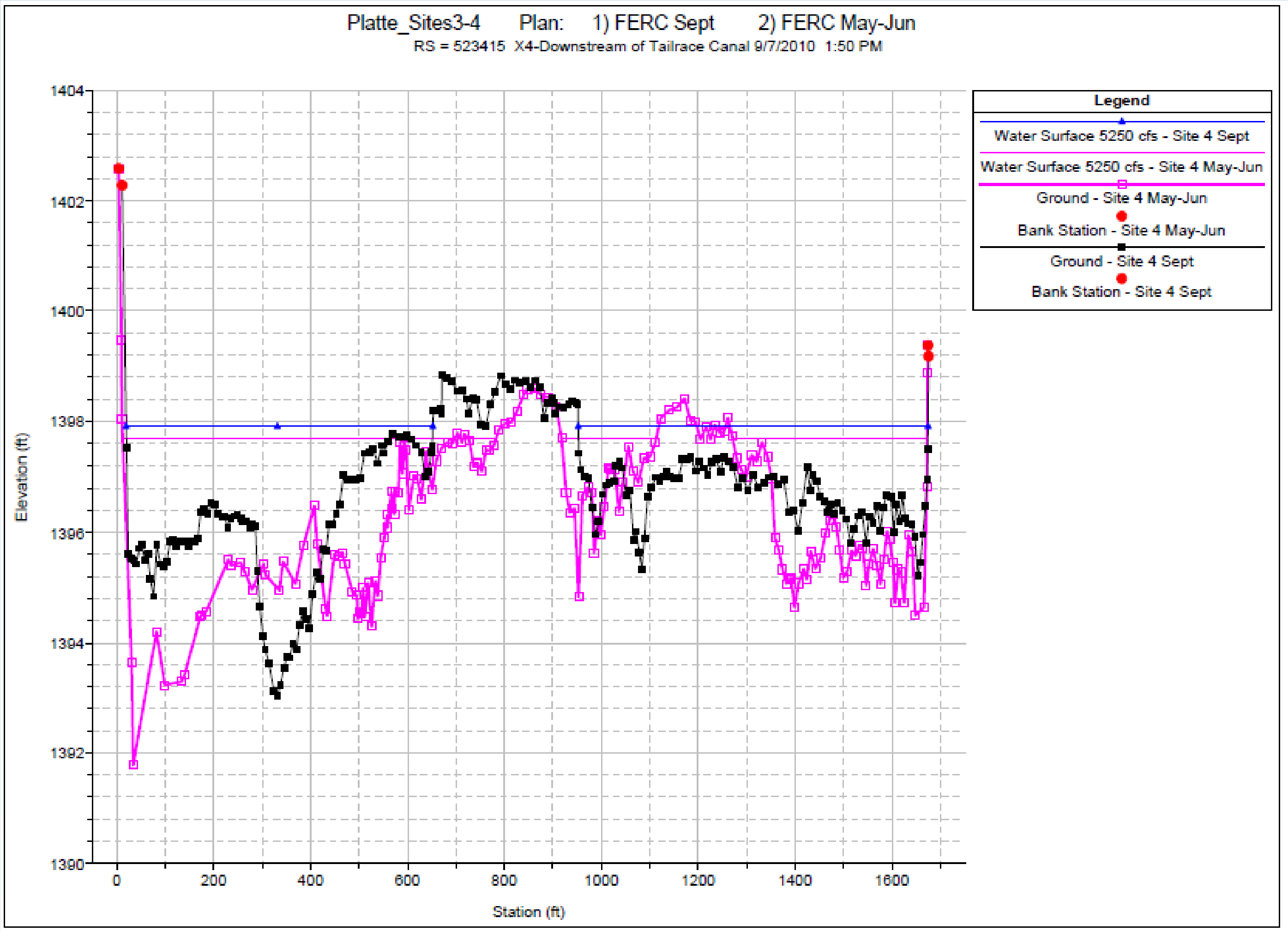
Hydraulic Model Development and Calibration – Site 2



Hydraulic Model Development – Site 3 – XS 6



Hydraulic Model Development – Site 4 – XS 4



Flow Duration, Volume Duration, and Flood Flow Frequency Analysis

Methodology:

- HEC-SSP – for Flood Flow Frequency Analysis
- Standard Spreadsheet Ranking for Flow Duration
- Inputs – USGS gage data and synthetic data for ungaged sites

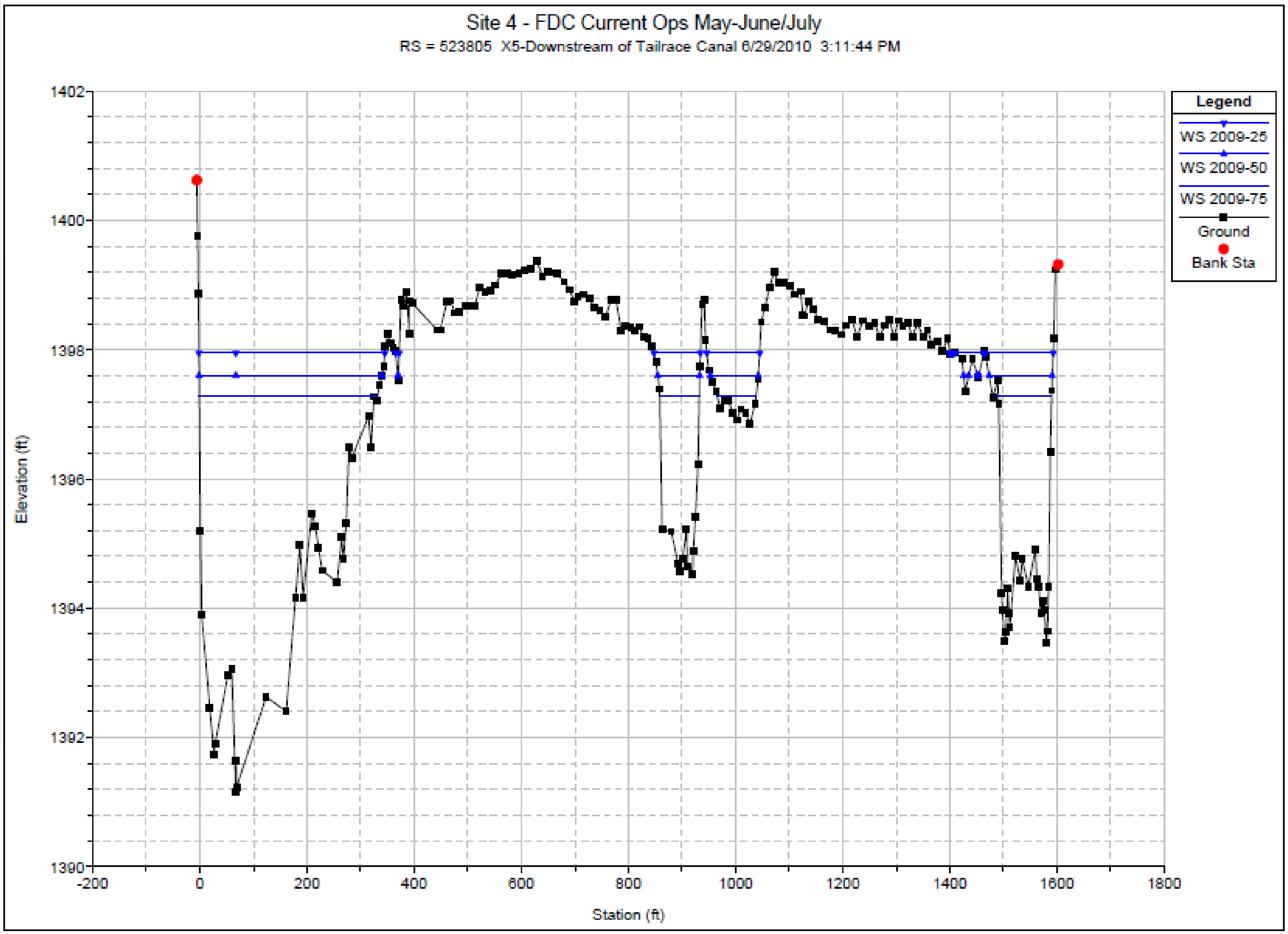
Flow Duration, Volume Duration, and Flood Flow Frequency Analysis

Results

- Summary of Results
- 25%, 50%, 75% Flow Exceedance Discharges

Daily Current OPs Loup Genoa (Gage)			
	2005 (Normal)	2006 (Dry)	2008 (Wet)
Percentile	Flow (cfs)	Flow (cfs)	Flow (cfs)
25%	1110	794	1540
50%	573	153	642
75%	112	47	173

Flow Duration



QUESTIONS?

1. Sedimentation

1. Sedimentation

Goals

- Determine the effect, if any, that Project operations have on stream morphology and sediment transport in the Loup River bypass reach and in the lower Platte River.
- In addition, compare the availability of sandbar nesting habitat for interior least terns and piping plovers to their respective populations and to compare the general habitat characteristics of the pallid sturgeon in multiple locations.

1. Sedimentation

Objectives

1. To characterize sediment transport in the Loup River bypass reach and in the lower Platte River through effective discharge and other sediment transport calculations.
2. To characterize stream morphology in the Loup River bypass reach and in the lower Platte River by reviewing existing data and literature on channel aggradation/degradation and cross sectional changes over time.

1. Sedimentation

Objectives (continued)

3. To determine if a relationship can be detected between sediment transport parameters and interior least tern and piping plover nest counts (as provided by the Nebraska Game and Parks Commission [NGPC]) and productivity measures.
4. To determine if sediment transport is a limiting factor for pallid sturgeon habitat in the lower Platte River below the Elkhorn.

1. Sedimentation

Objective

1. To characterize sediment transport in the Loup River bypass reach and in the lower Platte River through effective discharge and other sediment transport calculations.

Associated Tasks

- Sediment budget
- Effective discharge and other sediment transport calculations
- Regime Analysis

1. Sedimentation

Sediment Budget

- Utilized the adjusted sediment yield for the Loup River and its tributaries downstream of the Diversion Weir as well as downstream of the Tailrace Weir based on documented reductions from the Settling Basin.

1. Sedimentation

Sediment Budget

USGS Gage Number	Gage Name and Location	Annual Sediment Data (tons/year)
		Updated MRBC Average Annual Yield
Site 1	Subbasin Total Above Diversion Weir	4,180,000
	Sediment removed from Settling Basin	2,004,800
	Sediment passing down Loup Power Canal	700,000
	South Sand Management Area	560,000
Site 2	Loup River Downstream of the Diversion Weir	2,030,000
06793000	Loup River near Genoa, NE	2,030,000
06794500	Loup River at Columbus, NE	2,960,000
06774000	Platte River near Duncan, NE	1,870,000
Site 3	Platte River Upstream of the Tailrace Return	4,900,000
Site 4	Platte River Downstream of the Tailrace Return	5,250,000
Site 5	Platte River near North Bend	5,770,000
06796000	Platte River at North Bend, NE	5,770,000

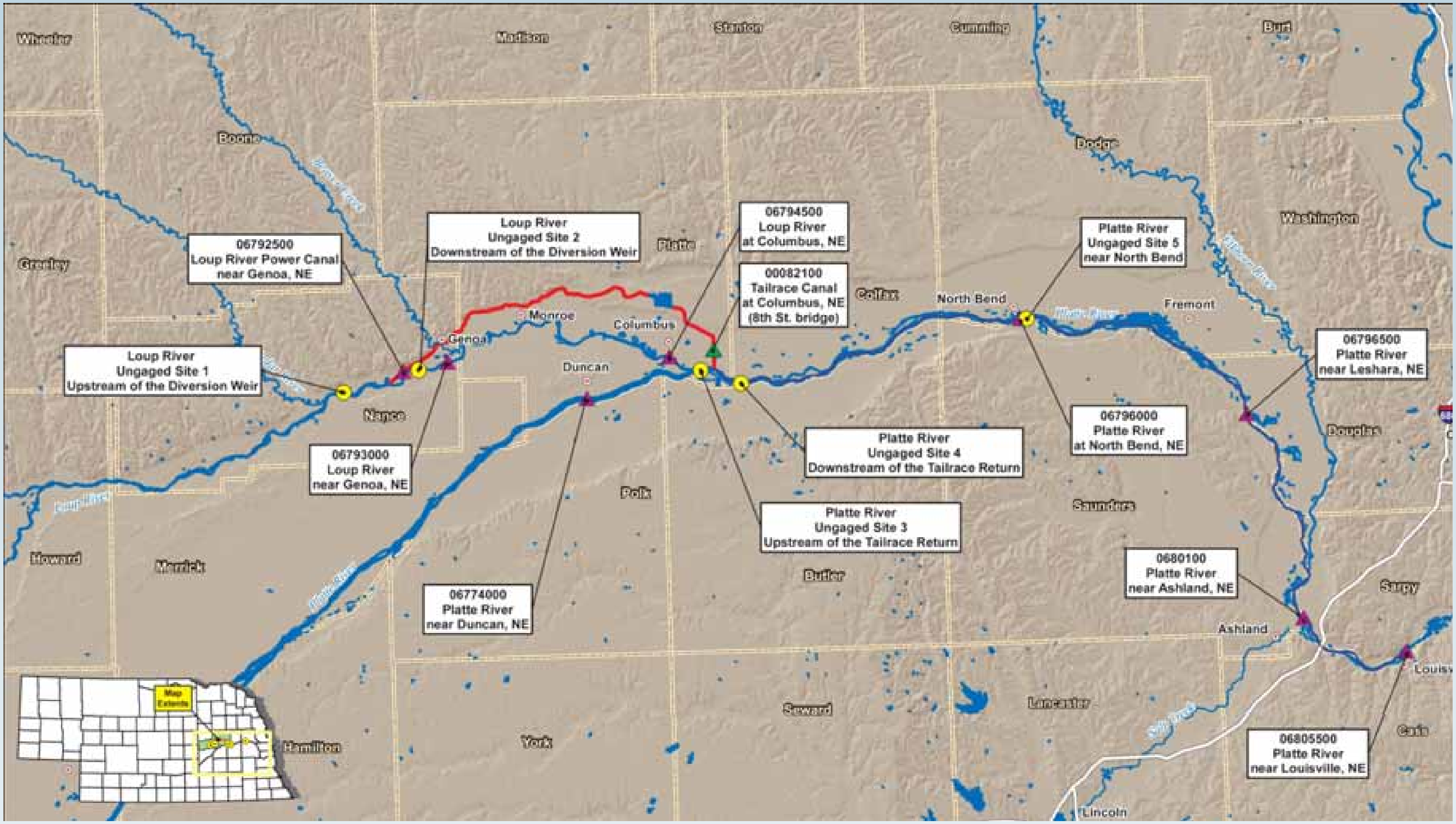
1. Sedimentation

Effective Discharge and Other Sediment Transport Calculations

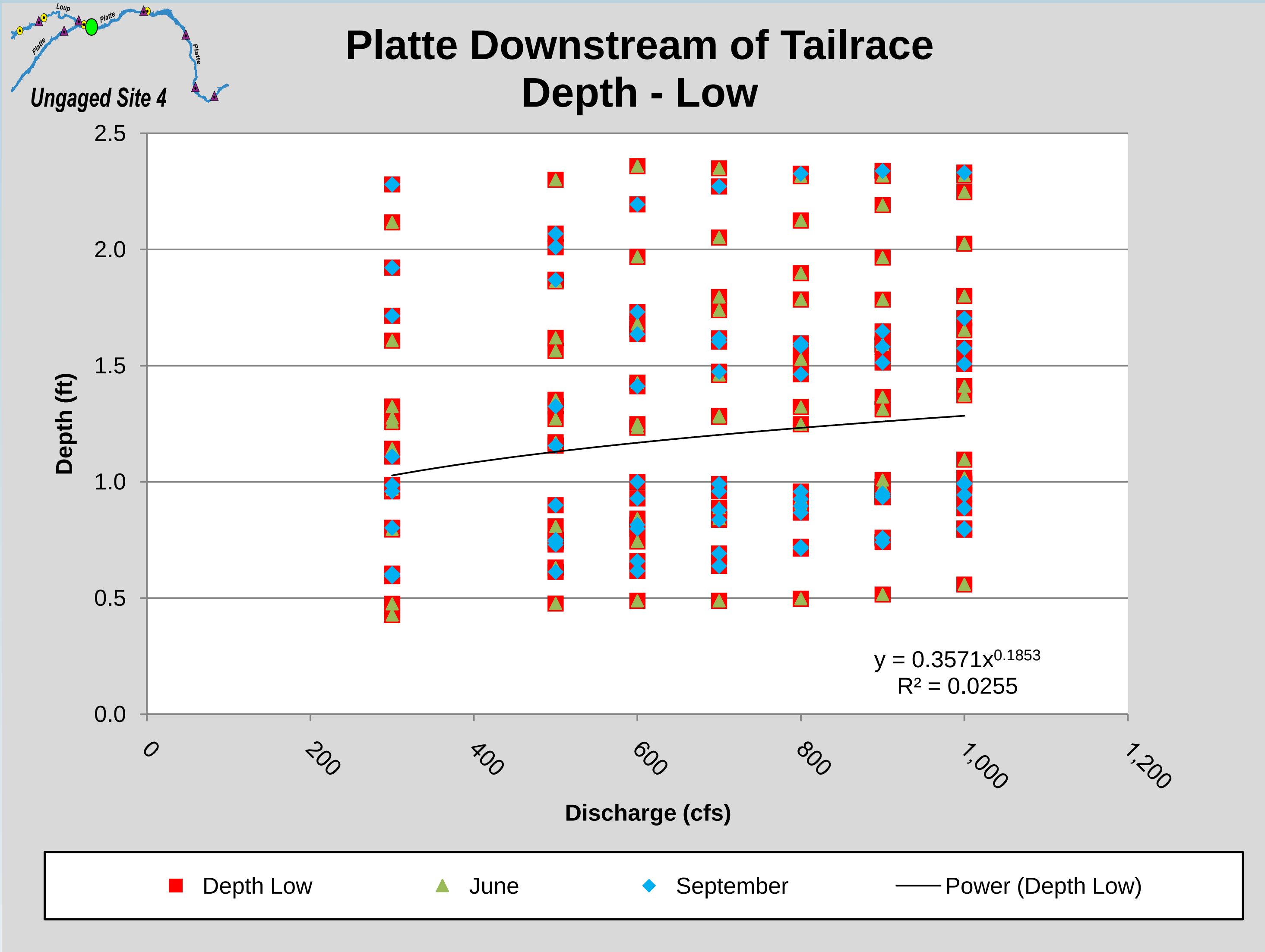
- Generate Sediment Discharge Rating Curves
- Generate Collective Sediment Discharge Curves
- Determine Sediment Transport Indicators
  - Effective Discharge
  - Total Sediment Transport
  - Dominant Discharge
- Regime Analysis

1. Sedimentation

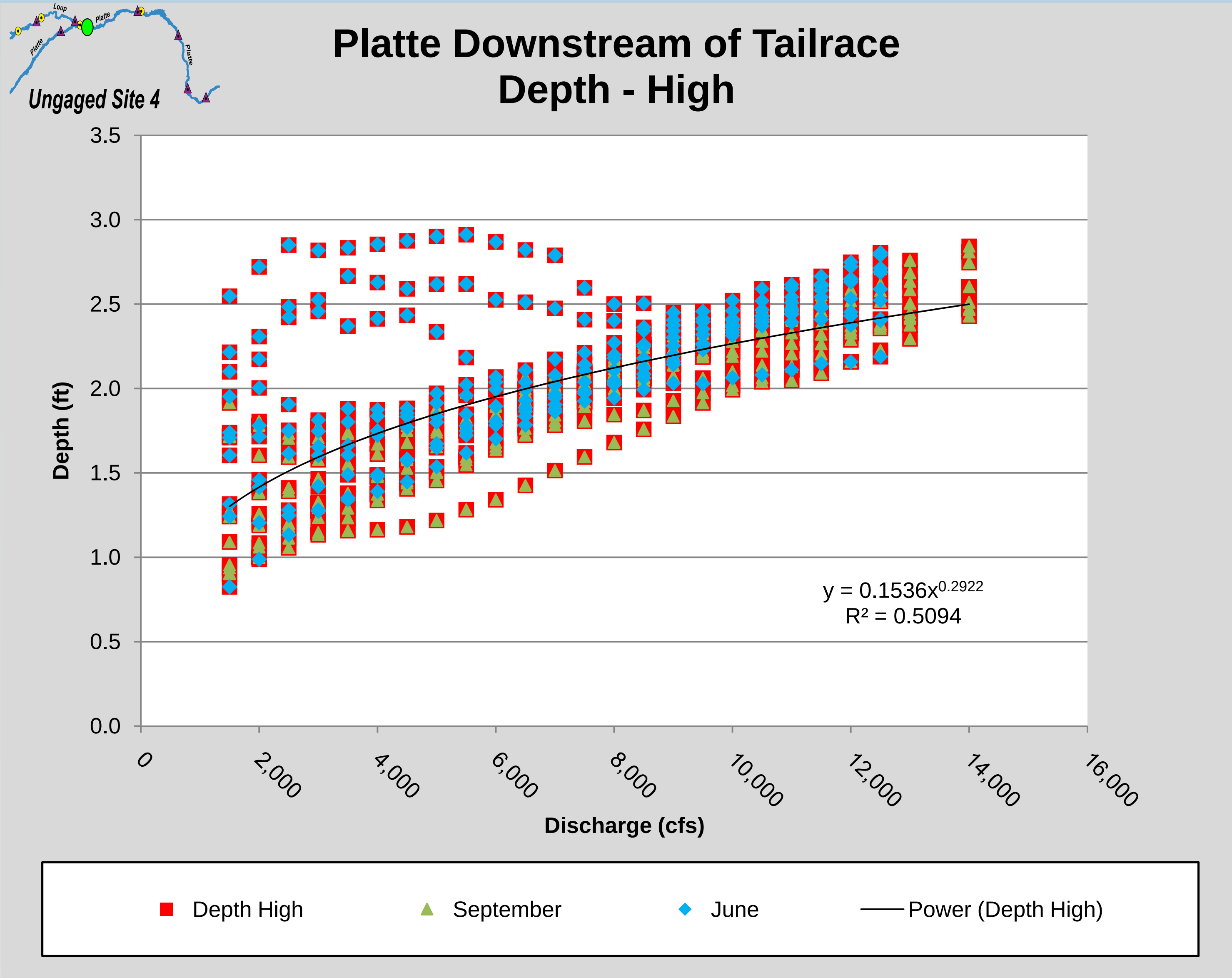
Study Sites



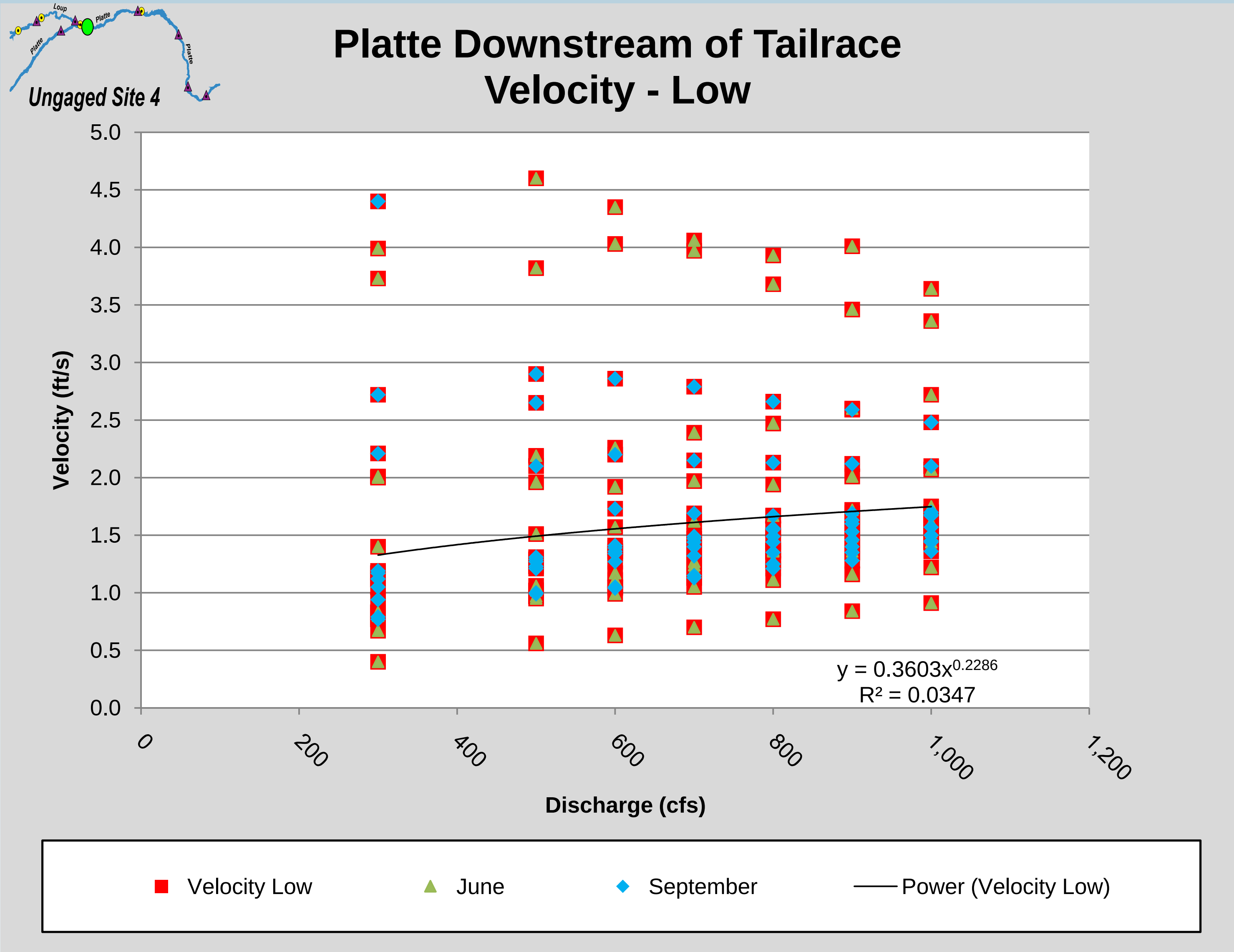
1. Sedimentation



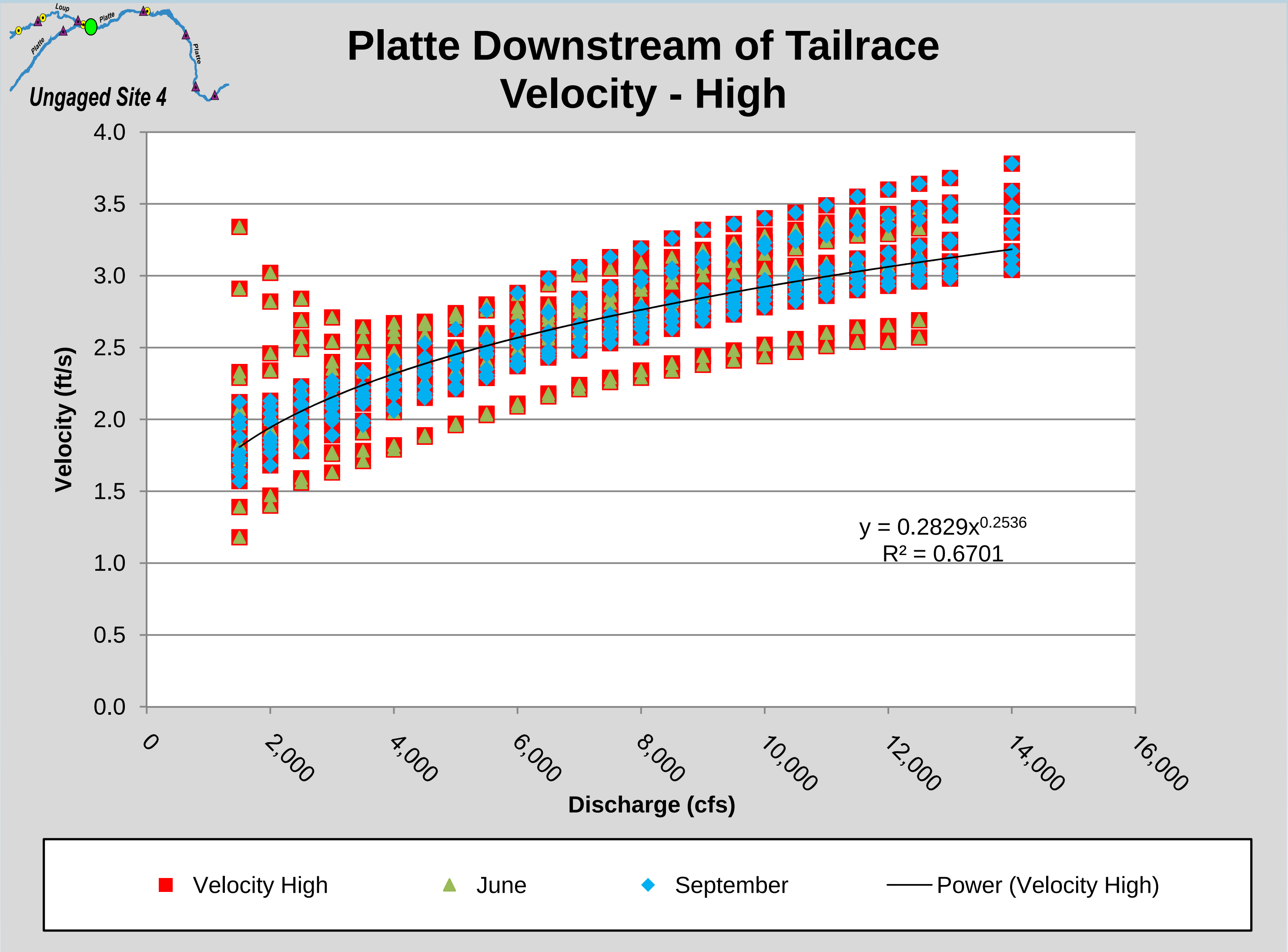
1. Sedimentation



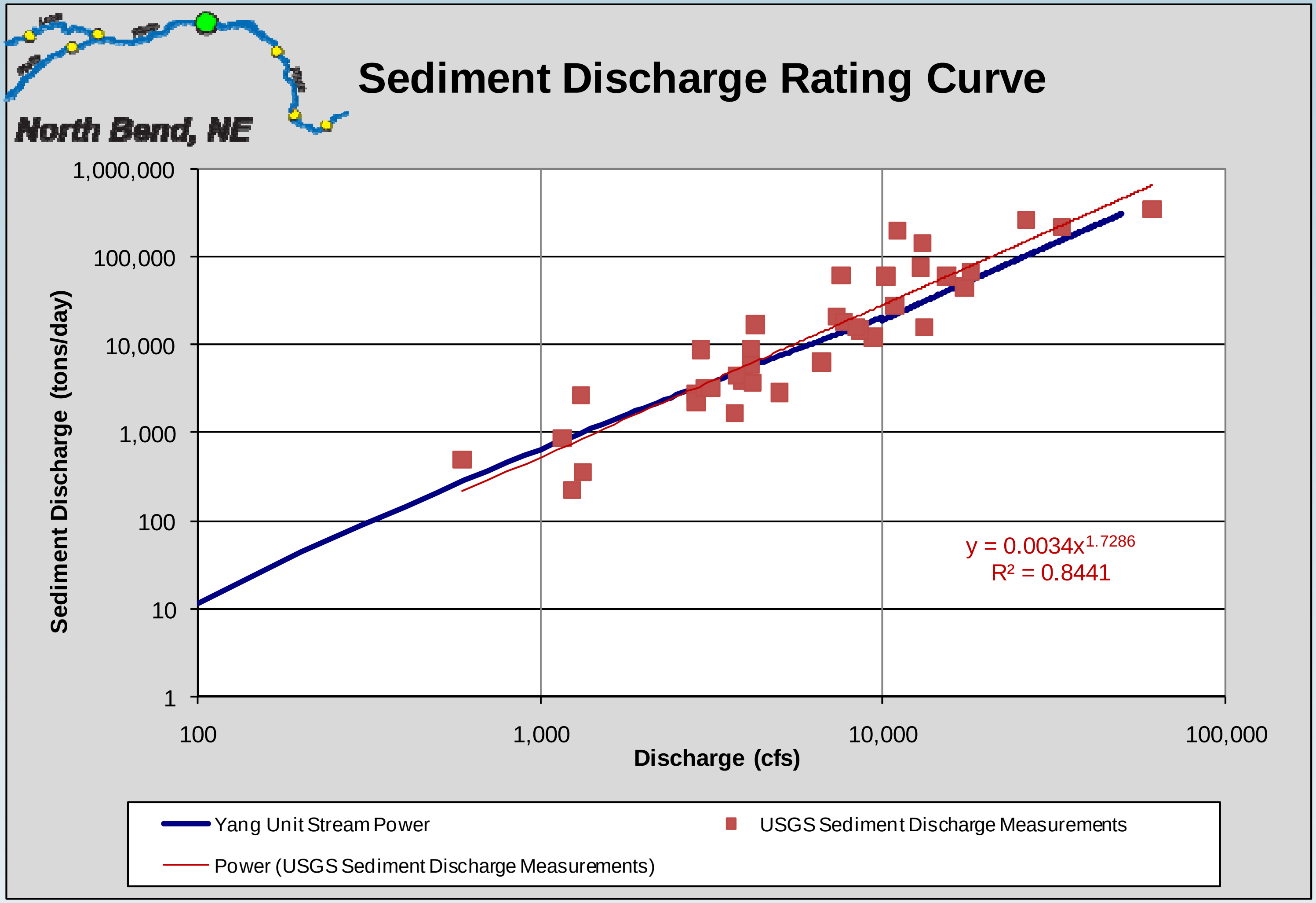
1. Sedimentation



1. Sedimentation



1. Sedimentation



1. Sedimentation

- Sediment Transport Indicators
  - Total Sediment Transport Capacity
  - Effective Discharge
  - Dominant Discharge

1. Sedimentation

Total Sediment Transport Capacity

- Total sediment carried for a period of interest based on the sediment discharge rating curve and the corresponding flow hydrograph.

1. Sedimentation

Effective Discharge

- Transports the largest fraction of the total sediment load
- Results in the average morphologic characteristics of the channel (the most important – channel shaping flow)
- Used to assess channel characteristics – width and depth
- Due to subjectivity, suggested for use in long term analysis (>year)

1. Sedimentation

Dominant Discharge

- Average flow that transports the same amount of sediment as the actual hydrograph
- Also used to assess channel characteristics - width and depth
- Can be used for shorter analysis periods (<year)

1. Sedimentation

Ungaged Sites - Sediment Transport Calculations

USGS Gage Number	Gage Name and Location	Mean Daily Discharge (cfs)	Effective Discharge (cfs)	Effective Discharge Range Low (cfs)	Effective Discharge Range High (cfs)	Dominant Discharge (cfs)
Site 1	Loup River Upstream of the Diversion Weir	2,910	3,100	2,930	3,250	2,930
Site 2	Loup River Downstream of the Diversion Weir	910	1,900	1,620	2,070	1,070
06793000	Loup River near Genoa, NE	920	1,700	1,620	1,840	1,150
06794500	Loup River at Columbus, NE	1,100	2,500	2,420	2,670	1,290
06774000	Platte River near Duncan, NE	1,400	2,900	2,800	2,990	1,565
Site 3	Platte River Upstream of the Tailrace Return	2,600	3,500	3,130	3,890	2,700
Site 4	Platte River Downstream of the Tailrace Return	4,640	4,900	4,710	5,120	4,760
Site 5	Platte River near North Bend	4,240	4,200	3,680	4,610	4,000
06796000	Platte River at North Bend, NE	4,240	3,900	3,680	4,140	4,440
06796500	Platte River at Leshara, NE	4,610	5,100	4,900	5,380	4,870
06801000	Platte River near Ashland, NE	7,400	8,000	7,650	8,440	7,365
06805500	Platte River at Louisville, NE	8,720	9,900	9,410	10,300	8,995

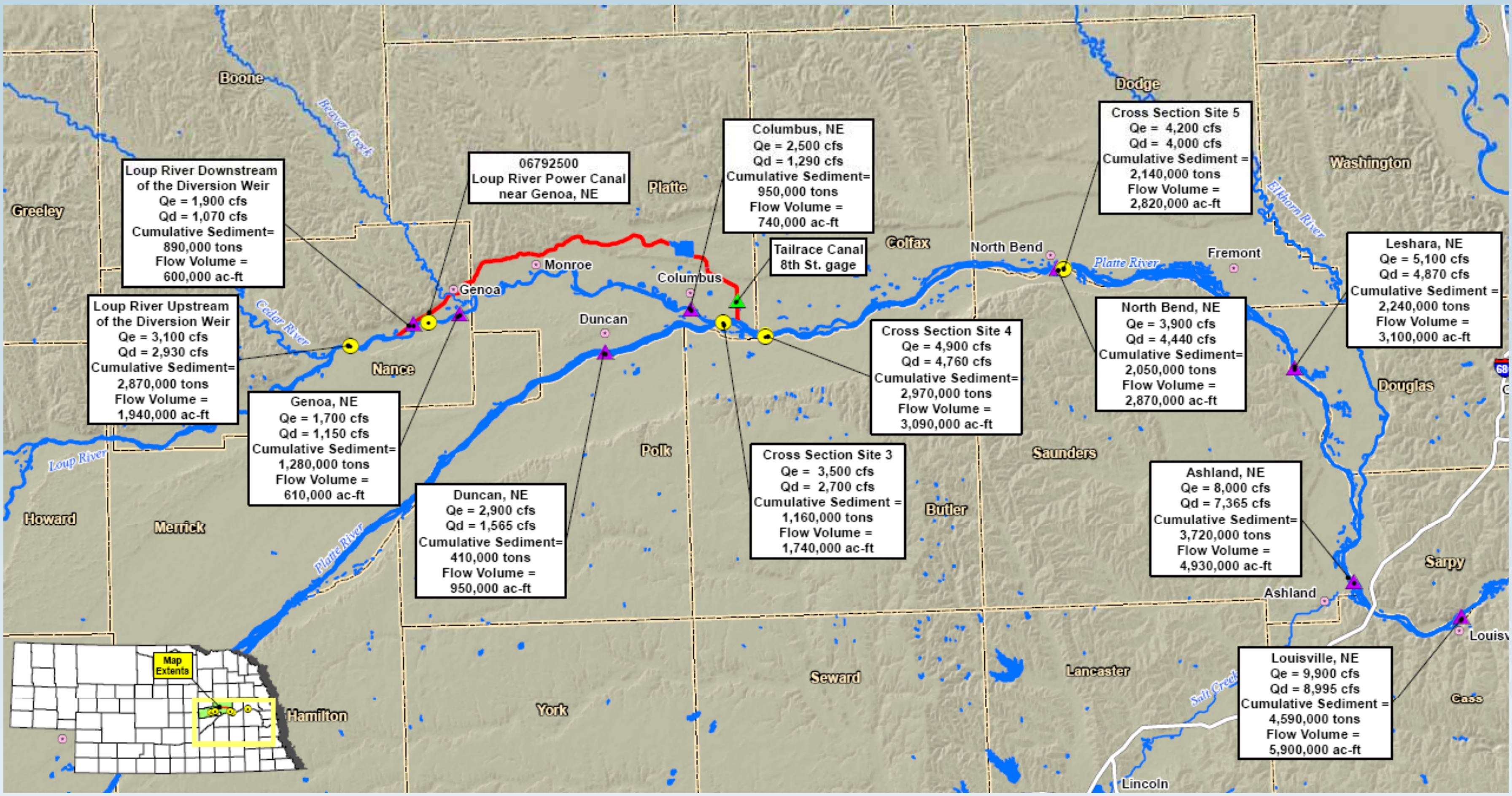
1. Sedimentation

Ungaged Sites - Capacity vs. Yield

USGS Gage Number	Gage Name and Location	Annual Sediment Data (tons/year)		
		Average 1985 to 2009 Capacities	2009 Capacity	MRBC Average Annual Yield
Site 1	Loup River Upstream of the Diversion Weir	NA	2,870,000	4,180,000
Site 2	Loup River Downstream of the Diversion Weir	NA	890,000	2,030,000
06793000	Loup River near Genoa, NE	1,760,000	1,280,000	2,030,000
06794500	Loup River at Columbus, NE	1,260,000	950,000	2,960,000
06774000	Platte River near Duncan, NE	747,000	410,000	1,870,000
Site 3	Platte River Upstream of the Tailrace Return	NA	1,160,000	4,900,000
Site 4	Platte River Downstream of the Tailrace Return	NA	2,960,000	5,250,000
Site 5	Platte River near North Bend	NA	2,026,000	5,770,000
06796000	Platte River at North Bend, NE	2,890,000	2,050,000	5,770,000
06796500	Platte River at Leshara, NE	2,800,000	2,240,000	5,850,000
06801000	Platte River near Ashland, NE	4,080,000	3,720,000	10,610,000
06805500	Platte River at Louisville, NE	4,930,000	4,590,000	12,780,000

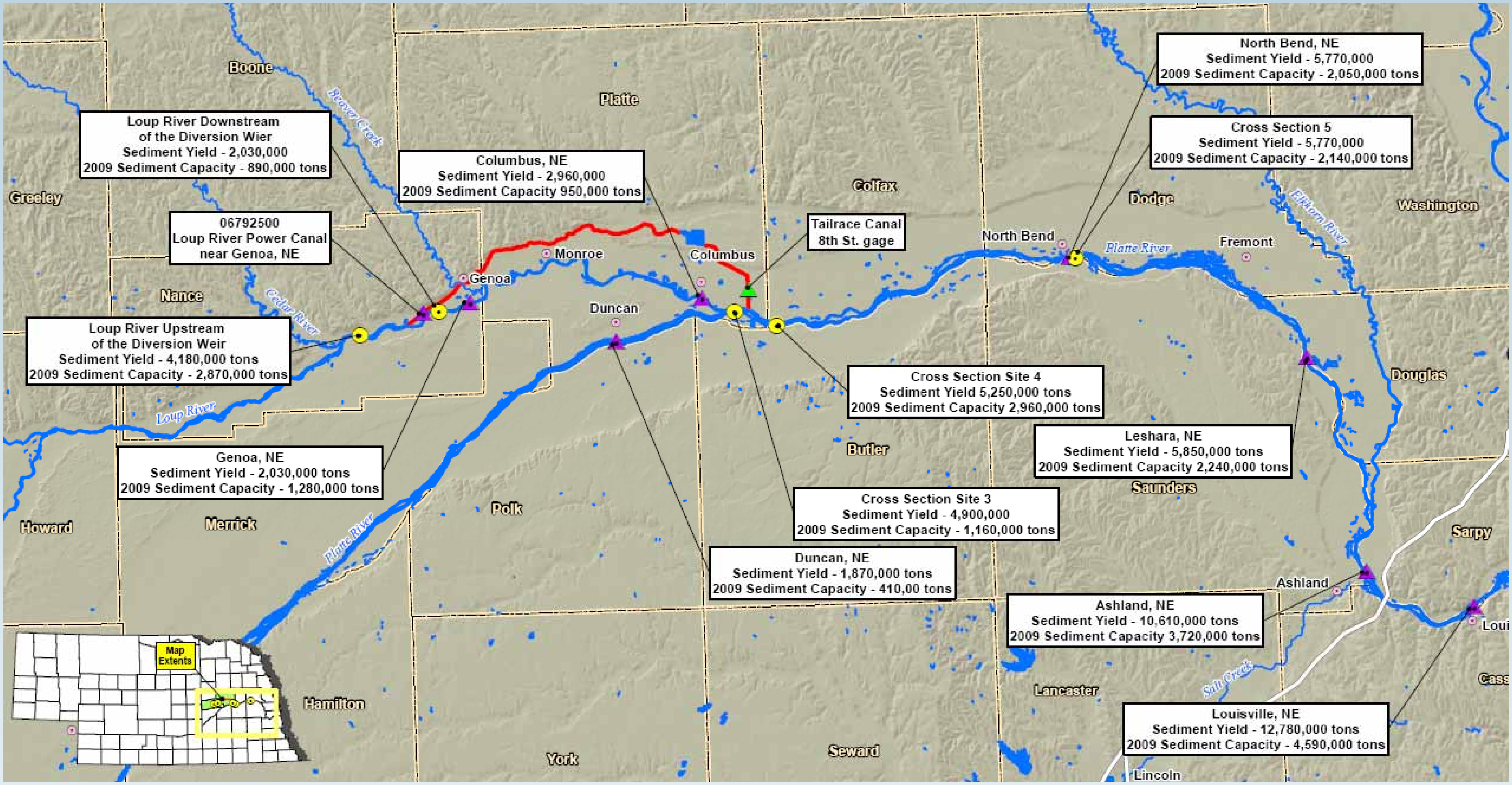
1. Sedimentation

Sediment Transport Spatial Analysis



1. Sedimentation

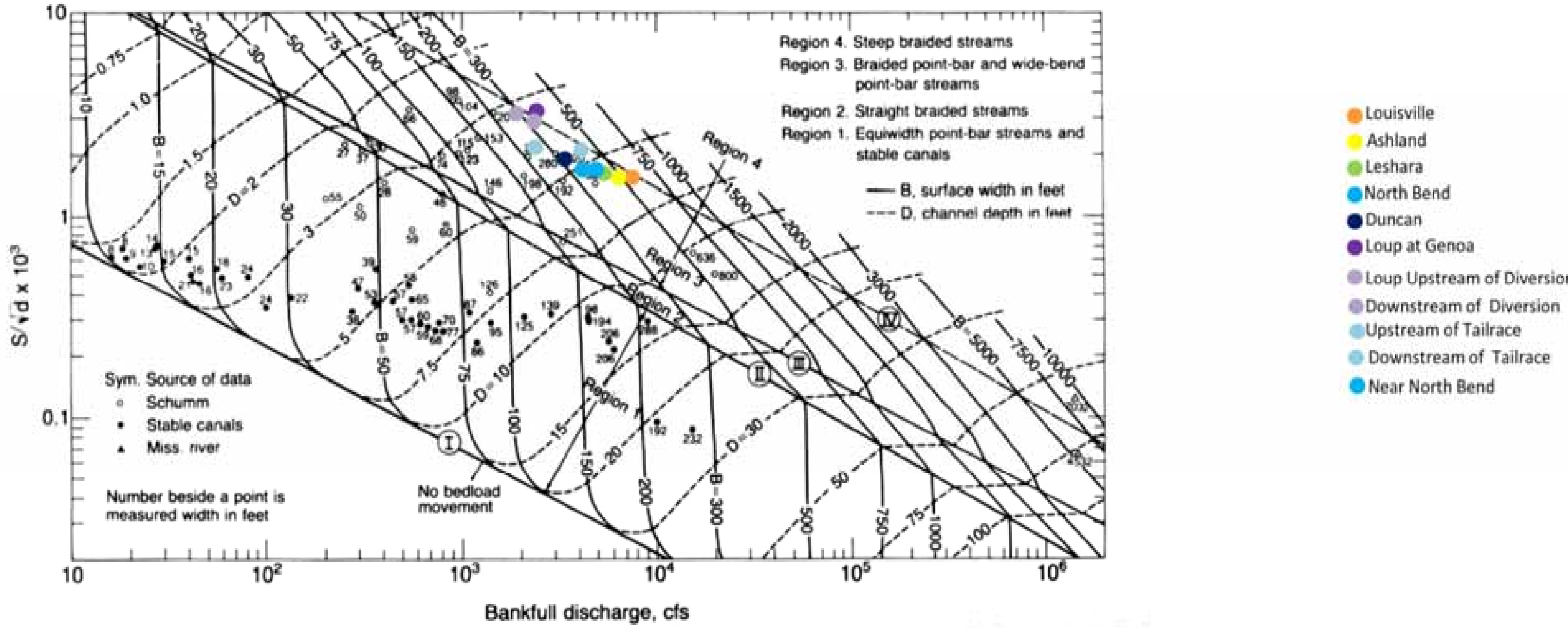
Capacity vs. Yield Spatial Analysis



1. Sedimentation

Regime Analysis

Chang's (1985) Regime Morphology Chart for Sand Bed Rivers

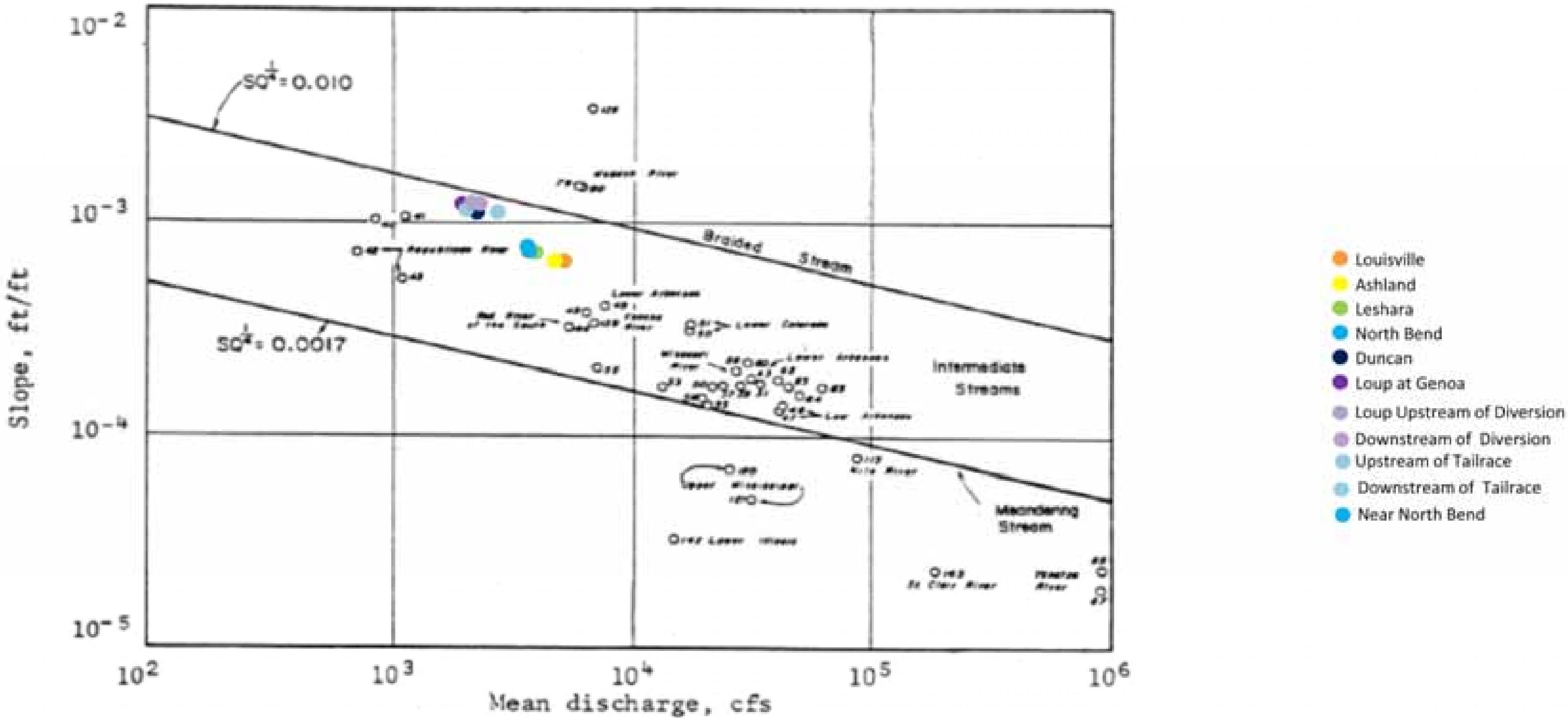


Regime channel bed geometry for sand bed rivers, from Chang (1985). For the historic Platte River channel (1900), the bankfull discharge was about 10,000 cfs, the median grain size was about 0.4 mm, and the slope was 0.00126. Therefore, the term $[(S/d^{0.5})1000]$ was equal to 2.0. For the present Platte River channel (2000), the bankfull discharge is about 4,000 cfs, the median grain size near Overton, Nebraska is about 1.5 mm, and the slope is still 0.00126. Therefore, the term $[(S/d^{0.5})1000]$ is now equal to 1.0. Based on the classification by Chang (1985), the Platte River evolved from a steep braided channel (Region 4) to a braided point-bar and wide bend point-bar channel (Region 3).

1. Sedimentation

Regime Analysis (Cont.)

Lane's (1957) Regime Morphology Chart for Sand Bed Rivers



Lane's (1957) regime diagram for sandbed streams based on slope and mean discharge, taken from Richardson, et al. (1990). Red points shown are for the central Platte River with a slope of 0.0026 ft/ft and a mean discharge of 3,700 cfs for the year 1900, and a mean discharge of 2,100 cfs for the year 2000.

1. Sedimentation

Conclusions:

- Both rivers at all locations studied are clearly not supply limited.
- Spatial analysis of effective and dominant discharge reveal that they increase in a downstream direction in a manner consistent with natural river processes.
- The effective discharge, and associated river morphology, has not changed since 1928.

1. Sedimentation

Conclusions (cont.):

- Sediment transport calculations show that the channel geometries are in “regime”. Nothing appears to be constraining either the Loup or Platte River from maintaining the hydraulic geometry associated with the effective discharges.
- The combinations of slopes, sediment sizes, and effective discharges result in all locations being well within the braided river morphologies, with none being near any thresholds of transitioning to another morphology.

1. Sedimentation

Objective

2. To characterize stream morphology in the Loup River bypass reach and in the lower Platte River by reviewing existing data and literature on channel aggradation/degradation and cross sectional changes over time.

Associated Tasks

- Utilize existing literature to characterize stream morphology.

1. Sedimentation

Conclusions:

- Literature and analysis clearly indicates that both rivers are in dynamic equilibrium with no indications of aggradation or degradation or channel geometry changes over time.
- Literature and calculations demonstrate that the Loup River bypass reach and the lower Platte River are in regime and well seated within regime zones classified as braided streams.

QUESTIONS?

12. Ice Jam Flooding on the Loup River

2010 Ice Jam at Lake Oconee

2010 Ice Jam at N-39 Bridge

12. Ice Jam Flooding on the Loup River

Goal

- Evaluate the impact of Project operations on ice jam flooding on the Loup and Platte rivers between Fullerton and North Bend.
- To develop an ice jam and/or breakup predictive model (limited to examination of Project effects), as well as identify operational or structural measures to mitigate or minimize Project effects on ice jam formation and subsequent flooding, if it is demonstrated that operation of the Project materially impacts ice jam formation on the Loup and Platte rivers.

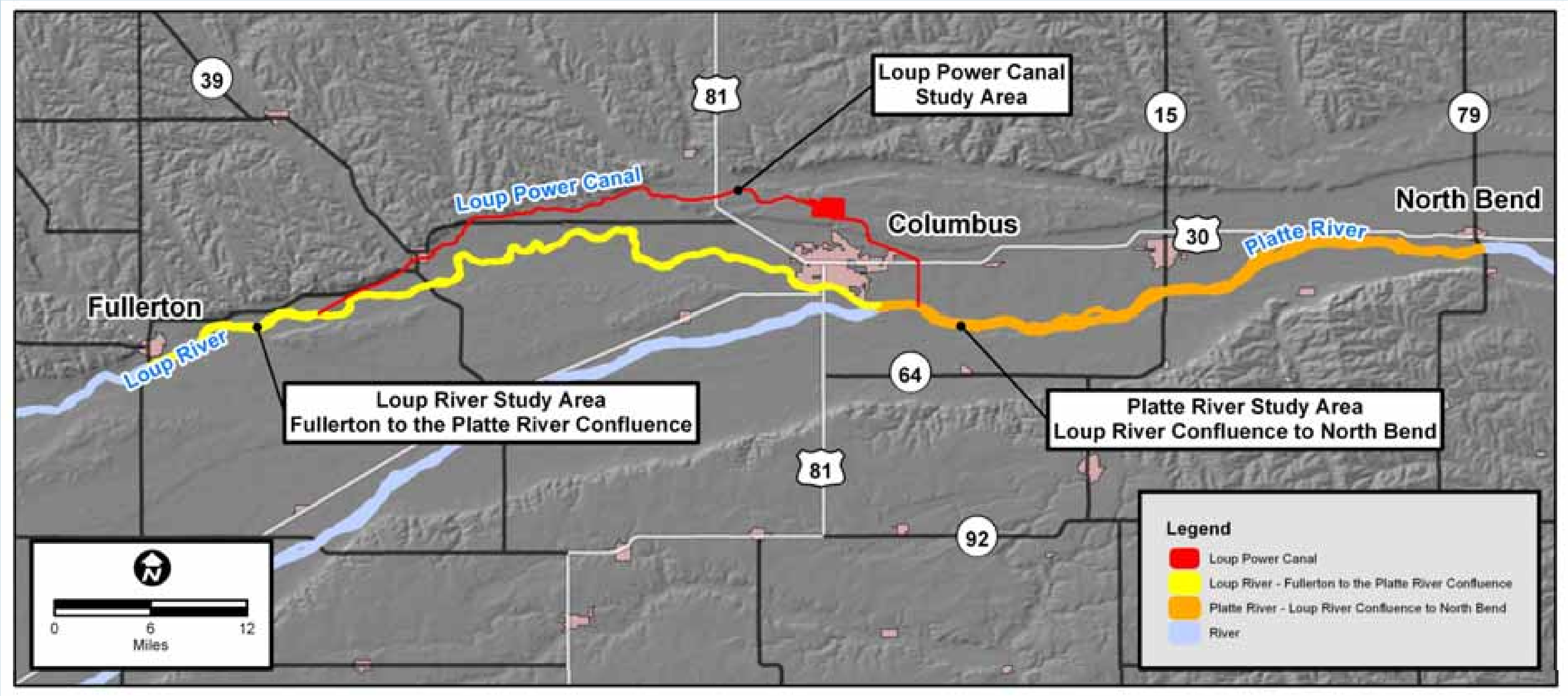
12. Ice Jam Flooding on the Loup River

Objectives

1. To evaluate the effect of Project operations on hydrology, sediment transport, and channel hydraulics on the ice processes in the Loup and Platte rivers.
2. To develop an ice jam and/or predictive model to evaluate Project effects.
3. To identify structural and nonstructural methods for the prevention and mitigation of ice jams, should it be demonstrated that operation of the Project materially impacts ice jam formation on the Loup and Platte Rivers.

12. Ice Jam Flooding on the Loup River

Study Area



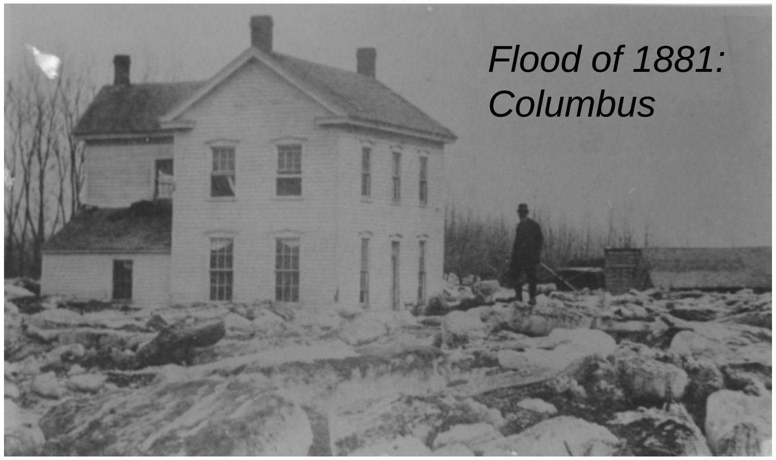
12. Ice Jam Flooding on the Loup River

Objective

1. To evaluate the effect of Project operations on hydrology, sediment transport, and channel hydraulics on the ice processes in the Loup and Platte rivers.

Associated Tasks

- History of Ice Jams
- Hydrology and Sedimentation
- Ice Formation



Flood of 1881: Columbus

12. Ice Jam Flooding on the Loup River

Objective

2. To develop an ice jam and/or predictive model to evaluate Project effects.

Associated Tasks

- Ice Transport
- Ice Affected Hydraulics

12. Ice Jam Flooding on the Loup River

Objective

3. To identify structural and nonstructural methods for the prevention and mitigation of ice jams, should it be demonstrated that operation of the Project materially impacts ice jam formation on the Loup and Platte Rivers.

Associated Tasks

- Identification of Methods for Prevention and Mitigation of Ice Jams

12. Ice Jam Flooding on the Loup River

Methodology – Objective 1 (Evaluate Project operation effects)

- History of Ice Jams
  - A review of all available records was conducted to determine when significant and minor flood events occurred.
  - Period of Record Analyzed to Determine if Statistical Basis Exists to Indicate if District Operations have Significant Effect on Occurrence/Severity of Events

12. Ice Jam Flooding on the Loup River

- History of Ice Jams (continued)
  - Significant Loup River Basin Ice Jam Floods
    - March 1848/1849 – Multiple deaths
    - March 1881 – Multiple deaths
    - February 1905 – Bridge destroyed
    - February 1907 – 4 deaths
    - March 1910 – RR lines damaged, bridge destroyed
    - March 1912 – Bridges destroyed
    - March 1936 – Multiple evacuations
    - February 1941 – Rainfall affected
    - February 1948 - $72,000 damages in Columbus
    - March 1960 – One death, $236,000 damages
    - March 1969 – Highest stage (at time) at Columbus
    - February 1971 – Rainfall affected
    - March 1993 – Highest stage recorded at Columbus, considerable damage

12. Ice Jam Flooding on the Loup River

- History of Ice Jams (continued)
  - Probability of Significant Ice Jam Formation Has Remained Same, or Decreased

Documented Significant Ice Jam Floods Before and After 1937

	Documented Ice Jam Floods	Documented Runoff Floods
1848-1936 (88 years)[1]	7	3
1893-1936 (43 years)[2]	5	3
1937-2010 (73 years)	5	3

Note[1]: Inconsistent record before late 1800's. More undocumented events may have occurred between 1848 and late 1800's.

Note[2]: 1893-1936 was used as period of record before construction of Canal.

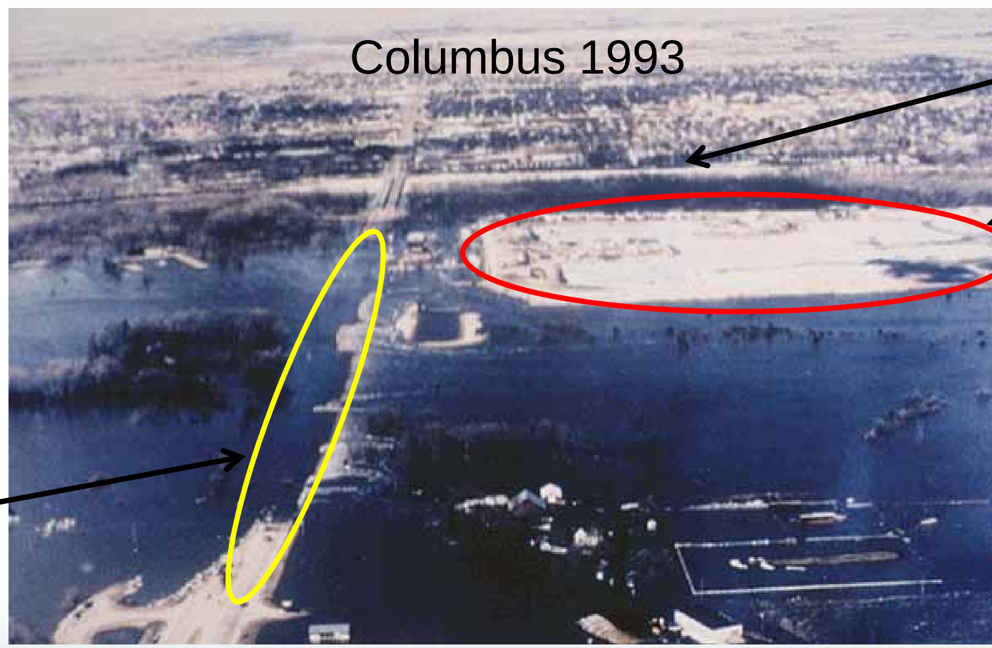
12. Ice Jam Flooding on the Loup River

- History of Ice Jams (continued)
  - Decrease in Probability Cannot be Credited to District Operations;
  - Decrease in Probability Does Discount Idea that District operations have increased frequency of ice jams;
  - Since District Operations began, every year with a significant Loup River ice jam has seen significant ice jam flooding on one or more other large Nebraska rivers;
  - Perception levels change over time, making comparisons of minor flooding difficult;
  - Ice-affected flood stage at Genoa in 22 of last 50 years, corresponds well w/ frequency of ice jam flood occurrence on natural streams (every 2-3 years);

12. Ice Jam Flooding on the Loup River

- History of Ice Jams (continued)
  - Floodplain development may contribute to severity of individual ice jams:

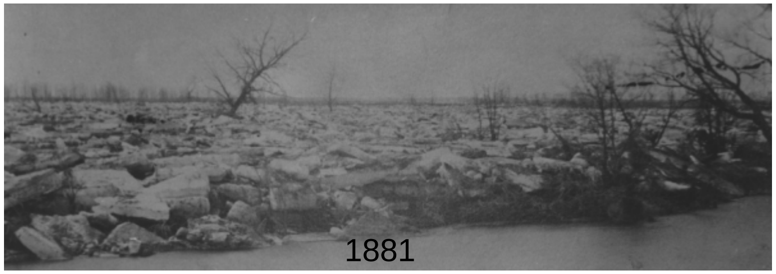
<u>EXAMPLES</u>
No evaluation of these specific items at this site



12. Ice Jam Flooding on the Loup River

Methodology – Objective 1 (Evaluate Project operation effects)

- Hydrology and Sedimentation
  - Hydrology and Sedimentation Studies Conducted by Others
  - Results Used as Input to Various Ice Studies as Needed


1881


1993

12. Ice Jam Flooding on the Loup River

Results – Objective 1 (Evaluate Project operation effects)

- Hydrology and Sedimentation
  - Hydrology and Sedimentation Study Results Presented Separately, Not Covered Here
  - Results Used as Input to Various Ice Studies as Needed
    - No discernable difference in channel geometry due to differences in sediment transport or flow regimes

12. Ice Jam Flooding on the Loup River

Methodology – Objective 1 (Evaluate Project operation effects)

- Ice Formation
  - Hydrometeorologic data utilized to determine ice production;
  - Estimate Ice Cover thickness growth
  - If difference in ice regime attributable to differences in discharge, 2 ice regimes used in Hydraulic Model studies

12. Ice Jam Flooding on the Loup River

Results – Objective 1 (Evaluate Project operation effects)

- Ice Formation
  - Hydrometeorologic data
    - Average of 11 Accumulated Freezing Degree Days (AFDD) Before Large Flows Bypassed into Bypass Reach;
    - Average of 108 AFDD Required to Produce Stable Ice Cover, Comparable to Ice Cover Formation on Natural Streams;
    - 60% of Ice Jams Occur in Years with AFDD>1,000;
    - AFDD>1,000 has ~20% Occurrence of Happening in a Specific Year

$$FDD = (32 - T_{ave})$$

$$AFDD = \sum_{i=0}^{n} FDD_i$$

12. Ice Jam Flooding on the Loup River

- Ice Formation (continued)
  - Hydrometeorologic data
    - AFDD varies cyclically on 25-35 yr basis:

Peak AFDD 30-Year Average

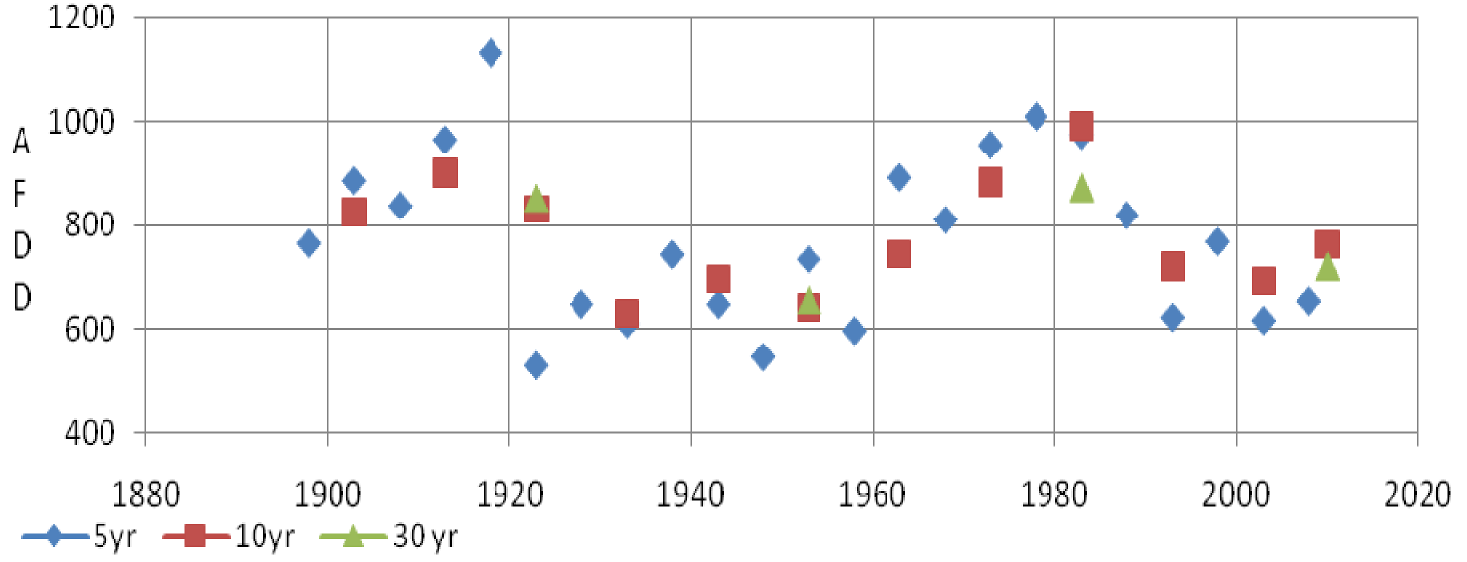
	Genoa	Columbus	St. Paul
1894 – 1923	822	853	-
1924 – 1953	656	<u>655</u>	614
1954 – 1983	831	872	809
1984 – 2010	<u>636</u>	721	<u>600</u>

Note: No St. Paul data available before 1900. Calculated 1st 30 yr. average beginning in 1924.
The 1984-2010 average does not contain a full 30 year record.
The highest peak AFDD 30 yr. average is bolded and the lowest peak AFDD 30 yr. average is underlined

12. Ice Jam Flooding on the Loup River

- Ice Formation (continued)
  - Hydrometeorologic data
    - AFDD > 1,000 ~ 30% Probability in High AFDD Periods
    - AFDD > 1,000 ~ 10% Probability in Low AFDD Periods

Figure 2.2. 5, 10, 30 Year AFDD Averages 1894-2010 at Columbus



12. Ice Jam Flooding on the Loup River

- Ice Formation (continued)
  - Hydrometeorologic data
    - AFDD > Average ~60% of Years in High AFDD Periods;
    - AFDD > Average ~35% of Years in Low AFDD Periods;
    - If Ice Jams Are More Likely to Form in Years w/AFDD > 1,000, then Ice Jams are Roughly 3 Times More Likely in High AFDD Periods;
    - Project Operations Began in Middle of Period of Low AFDD, *MAY* have led to perception that Project Operations were a factor in increased ice jam formation when High AFDD Period Began;
    - Only 1 Year with Below Normal AFDD Had Significant Ice Jam (Rainfall Event)
    - AFDD > 1,000 Indicates ~20% Chance of Ice Jam Forming, *BUT* AFDD > 1,000 Coupled with Below Normal Temperatures Preceding Peak AFDD <u>and</u> Above Normal Temperatures Following Peak AFDD Indicates ~50% Chance of Ice Jam Forming

12. Ice Jam Flooding on the Loup River

- Ice Formation (continued)
  - Hydrometeorologic data
    - Years with High Snow Accumulation Usually Correlate with High Discharges
      - Does not Correlate with Occurrence of Ice Jams
    - 80% of Ice Jams Occurred in Years with Above Normal Snowfall;
    - 60% of Ice Jams Occurred in Years with Snowfall in 20th Percentile or Higher;
    - Rainfall During Snowmelt Seems to Increase Probability of Ice Jam Formation

12. Ice Jam Flooding on the Loup River

- Ice Formation (continued)
  - Hydrometeorologic data
    - Other Trends Analyzed:
      - Annual AFDD Shows Slight Downward Trend, Not Statistically Significant;
      - Monthly AFDD Show Varying Trends, Not Statistically Significant;
      - Date of Annual Maximum AFDD Trends Same is Value of Annual Maximum AFDD;
      - However, Variability of Date of Maximum AFDD has markedly increased over last 20 years

12. Ice Jam Flooding on the Loup River

Results – Objective 1 (Evaluate Project operation effects)

- Ice Formation
  - Estimate Ice Cover thickness growth
    - Empirical Equations Validated against Field Measurements

$$t = C \times \sqrt{AFDD}$$

where: t = ice thickness, in
AFDD = Accumulated Freezing Degree Days, °F
C = Empirical Coefficient

12. Ice Jam Flooding on the Loup River

- Ice Formation (Continued)
  - Estimate Ice Cover thickness growth

Typical C Values for modified Stefan Equation

Ice cover condition	C
Windy lake w/o snow	0.8
Average lake w/ snow	0.5-0.7
Average river w/ snow	0.4-0.5
Sheltered small river	0.2-0.4

12. Ice Jam Flooding on the Loup River

- Ice Formation (Continued)
  - C values computed as 0.4 – 0.7, average of 0.56
  - Initial Ice Thickness Values Computed as 4-6 inches
  - Range in Computed Ice Thicknesses for Historic Jams Seems Consistent with Available Anecdotal Evidence
  - No measurable difference in ice regimes attributable to Project Operations

12. Ice Jam Flooding on the Loup River

Methodology – Objective 2 (Ice Jam Predictive Model)

- Ice Transport
  - Assess if 2-D Modeling of select reaches of interest may demonstrate differences in the formation of ice under with and without power canal conditions
- Ice Affected Hydraulics
  - Assess if differences in flow and channel regimes between the with and without flow diversions may lead to differences in water surface profiles in the study reach.
  - Assess if the flow and channel regime differences lead to differences in ice cover and ice jam formation, as these may lead to additional differences in water surface profiles

12. Ice Jam Flooding on the Loup River

Methodology – Objective 2 (Ice Jam Predictive Model)

- Ice Transport
  - The two-dimensional DynaRICE ice-hydraulic numerical model has been successfully used to simulate ice transport through various channels and hydraulic structures as well as ice jam initiation.
  - DynaRICE (DR) hydraulic models were constructed for two areas of interest:
    - Upstream and downstream of the Power Canal Headworks on the Loup River;
    - The section of the Loup River that passes through Columbus.

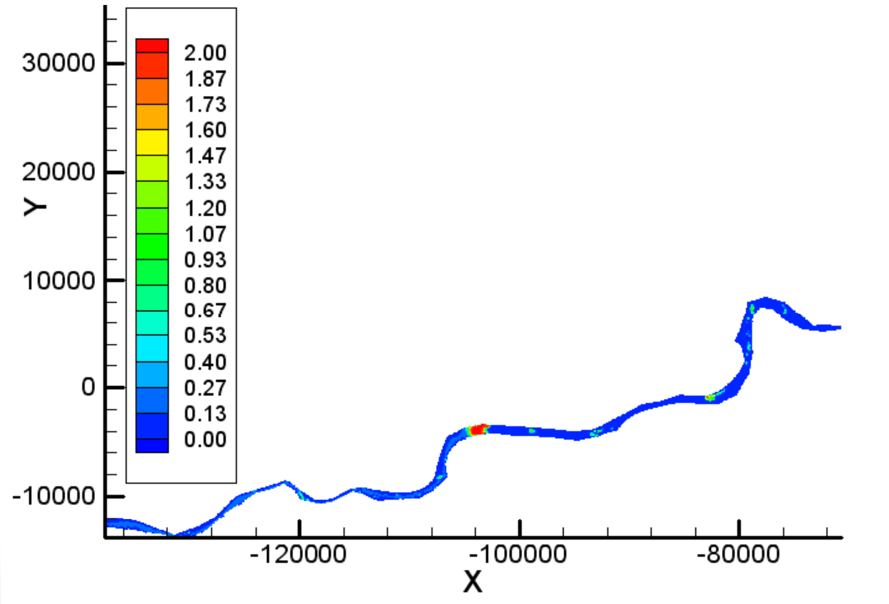
12. Ice Jam Flooding on the Loup River

Results – Objective 2 (Ice Jam Predictive Model)

- Ice Transport
  - Reach U/S and D/S of Headworks shows Freeze-up jam occurring in bend just D/S of Genoa gage, with thin ice cover proceeding U/S quickly to Headworks for both High and Moderate flows;
  - Jams likely to occur under no-diversion condition (all flow into Bypass Reach), and diversion of flow reduces the amount of ice available in Bypass Reach for jam formation;
  - Model unstable at Low Flows (little flow in Bypass Reach), due to coarseness of bathymetry

12. Ice Jam Flooding on the Loup River

- Ice Transport (continued)
  - DynaRICE model shows jam formation in close proximity to HEC-RAS model for similar flows, and HEC-RAS shows approx. same locations for ice jams at lower flows



DynaRICE Freezeup Locations

HEC-RAS Freezeup Locations

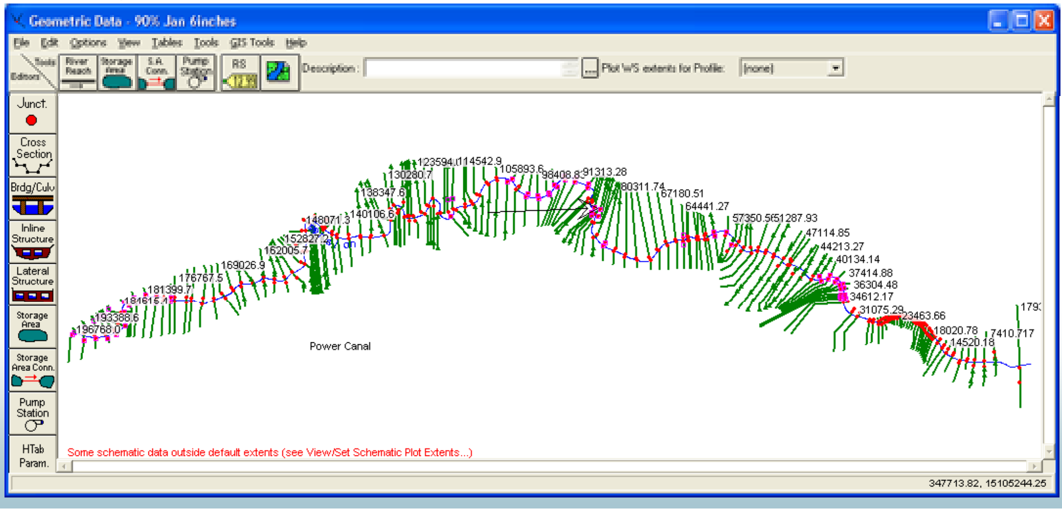
12. Ice Jam Flooding on the Loup River

- Ice Transport (continued)
  - For Columbus reach, DynaRICE demonstrates that significant ice can build up during break-up conditions, with or without diversion into Power Canal;
  - DynaRICE model indicates that diversion of flows into Power Canal serves to reduce the size of a jam at Columbus and thus the water surface elevation and potential for flooding.
  - Proposed DynaRICE domain from U/S Tailrace to BNRR Bridge needs much more geometry data to be viable model; however, no significant differences in ice regime found, so no modeling needed;
  - Additional bathymetry may improve model stability in both reaches; however, it is not clear that DynaRICE would predict measurable differences in ice cover formation, given that HEC-RAS does not show differences in water velocities under low-flow conditions.

12. Ice Jam Flooding on the Loup River

Methodology – Objective 2 (Ice Jam Predictive Model)

- Ice Affected Hydraulics
  - Georeferenced HEC-RAS model constructed from just D/S of Loup Power Canal Headworks to just U/S of UPRR bridge west of Columbus, based on 2010 channel surveys;
  - HEC-2 model incorporated into HEC-RAS geometry to extend model reach to approx. 1 mile D/S of Loup-Platte confluence;
  - Overbank geometry extracted from 10m DEM;



12. Ice Jam Flooding on the Loup River

- Ice Affected Hydraulics (continued)
  - Model calibrated to Genoa rating curve, as well as measured water surface elevations taken during channel surveys;
  - Calibrated model used to verify parameters from Sediment Transport study for open water under assumptions of Effective and Dominant Discharge for Current Operating Plan and No-Diversion
  - Ice Formation modeled with 10-, 25-, 50-, 75-, and 90% by duration flows (Nov, Dec, and Jan) and Freeze-up with 10% Dec flow for with- and without diversion

12. Ice Jam Flooding on the Loup River

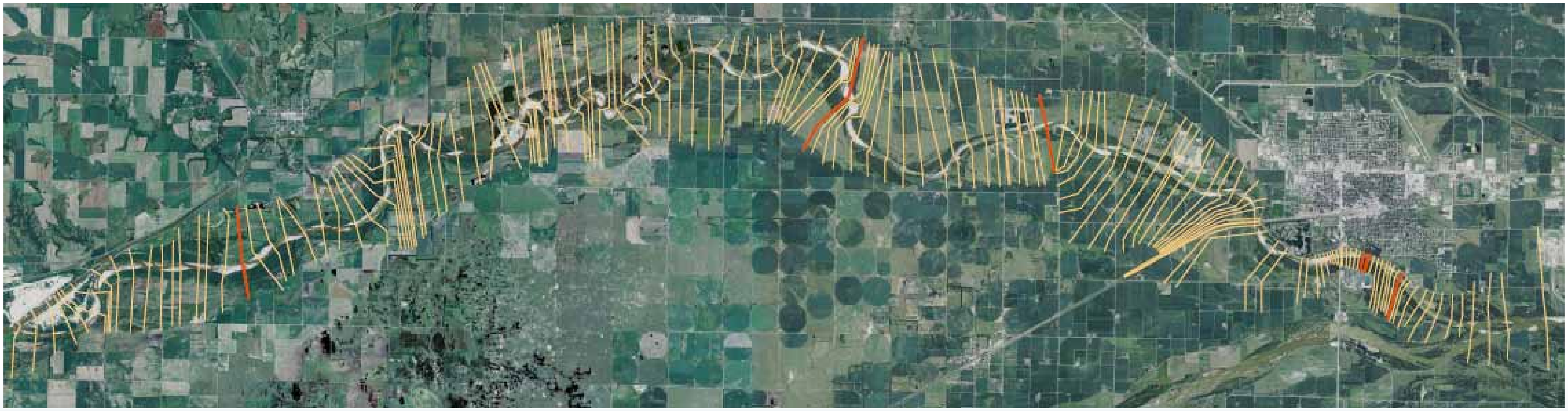
- Ice Affected Hydraulics (continued)
  - Pre-Breakup Jam Period modeled with 10-, 25-, 50-, 75-, and 90% by duration flows (Feb) with- and without diversion
    - Ice thickness based on average AFDD and 1-standard deviation above average AFDD and average C;
    - Use resulting ice volumes to compute ice volume available for breakup ice jams
  - Modeled Breakup Jam Floods with 2-, 5-, 10-, 20-, and 50-year Discharges
    - Volume taken from 50% of the 50% by duration flow ice volume

12. Ice Jam Flooding on the Loup River

- Ice Affected Hydraulics
  - 9 Locations Identified as Most Likely to Form Freeze-up Jam in HEC-RAS
  - No-Diversion Produces Higher Stages due to Greater Flow and Greater Volume of Ice
  - Ice cover, freeze-up jam and open water very similar regardless of flow
    - Ice volume affected by flow (i.e. higher flows produce more ice)

12. Ice Jam Flooding on the Loup River

- Ice Affected Hydraulics
  - Same Reaches of River Identified as Having Too High Velocity to Promote Stable Ice Cover, Regardless of Discharge
    - Implies Frazil Ice Production within Bypass Reach is Roughly the Same regardless of Diversion (or lack thereof)



12. Ice Jam Flooding on the Loup River

- Ice Affected Hydraulics
  - 8 Locations Identified as Most Likely to Form Breakup Jam in HEC-RAS
  - HEC-RAS does not “self-predict” jam below Highway 81 Bridge
    - Other locations correspond with reported jam locations
  - No-diversion Flows Produce Higher Stages due to Higher Flows and Greater Ice Volume

12. Ice Jam Flooding on the Loup River

Methodology and Results – Objective 3

- Identification of Methods for Prevention and Mitigation of Ice Jams
  - Since No Impacts Due to Project Operation were identified, no identification of methods for prevention and mitigation of Ice Jams is warranted, per study scope.

12. Ice Jam Flooding on the Loup River

Summary of Results and Conclusions

- Review of Flood History Indicates that Ice Jam Frequency has NOT increased since commencement of Project Operations;
- Review of Climatological Data and Hydraulic Models Does NOT show a Difference in Occurrence of Minor Ice Jam Flooding;
- Climatic Variability and Floodplain Development May Lead to Increase in Flood Risk with Time;
- Project Operations have NOT measurably changed the Loup River ice regime, nor increased the risk of Significant Ice Jam Flooding.

QUESTIONS?