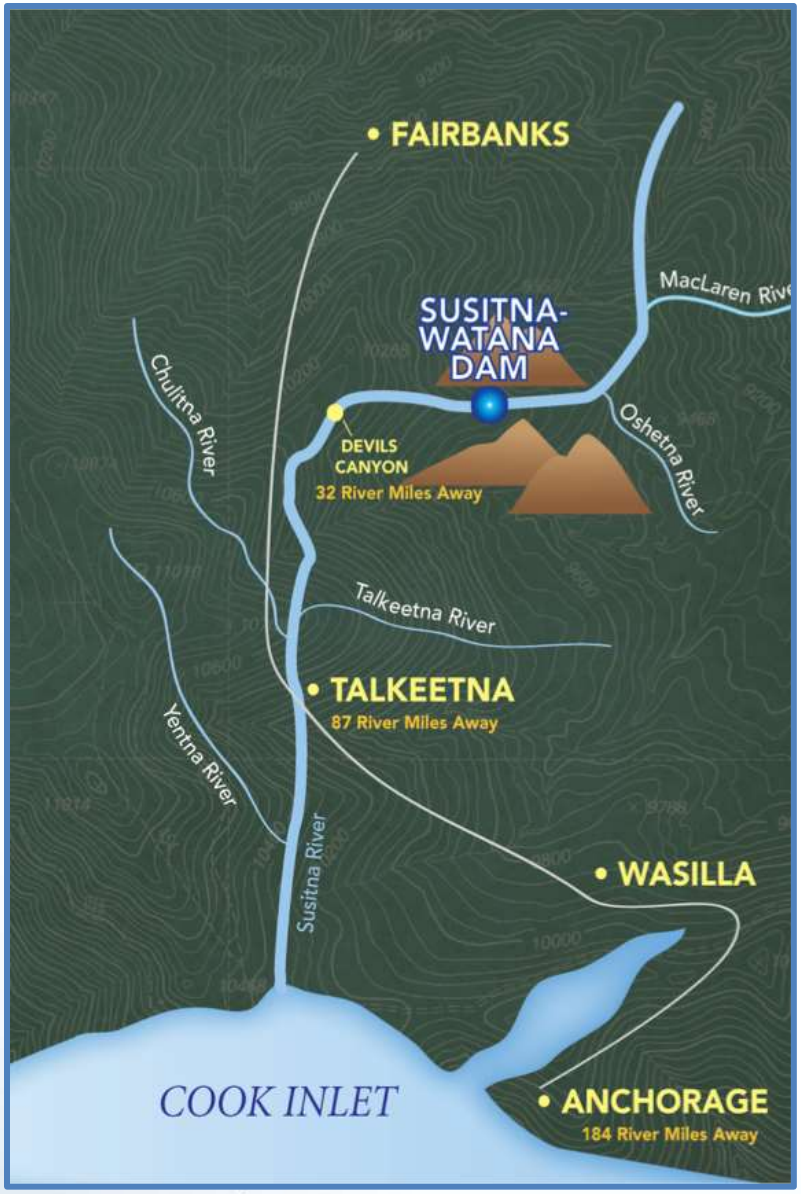


SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

Technical WorkGroup Meeting

Q4 2013 TWG

Groundwater Study Q4-2013, Q1-2014 Update

December 3, 2013

Prepared by
GW Scientific

Groundwater Study (GW) Objectives

- 7.5.4.1.1 Data Synthesis
- 7.5.4.1.2 Geohydrologic Process-Domains
- 7.5.4.2 Watana Dam/Reservoir
- 7.5.4.3 Upwelling/Springs Broad-Scale Mapping

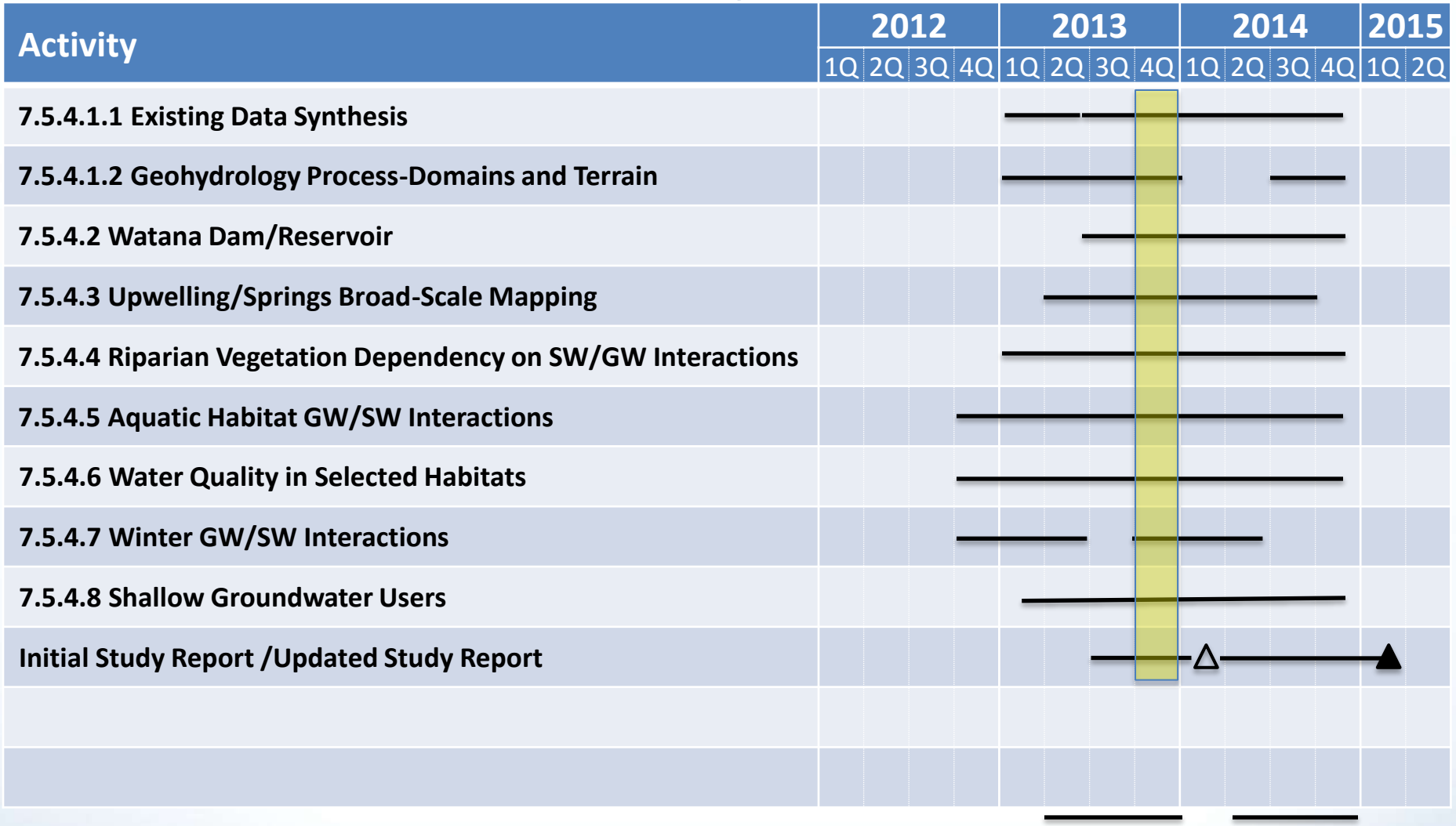
Lower end of Slough 11, FA-138 Gold Creek Focus Area, November 8, 2013. Water temperature data in Slough 11 and Upper Side Channel 11

Groundwater Study (GW) Objectives

- 7.5.4.4 Riparian GW/SW
- 7.5.4.5 Aquatic GW/SW
- 7.5.4.6 Water Quality in Selected Habitats
- 7.5.4.7 Winter GW/SW
- 7.5.4.8 Shallow Groundwater Users

FA-138 Gold Creek, Upper Side Channel 11, before main channel freeze-up conditions, November 8, 2013

GW Study Schedule



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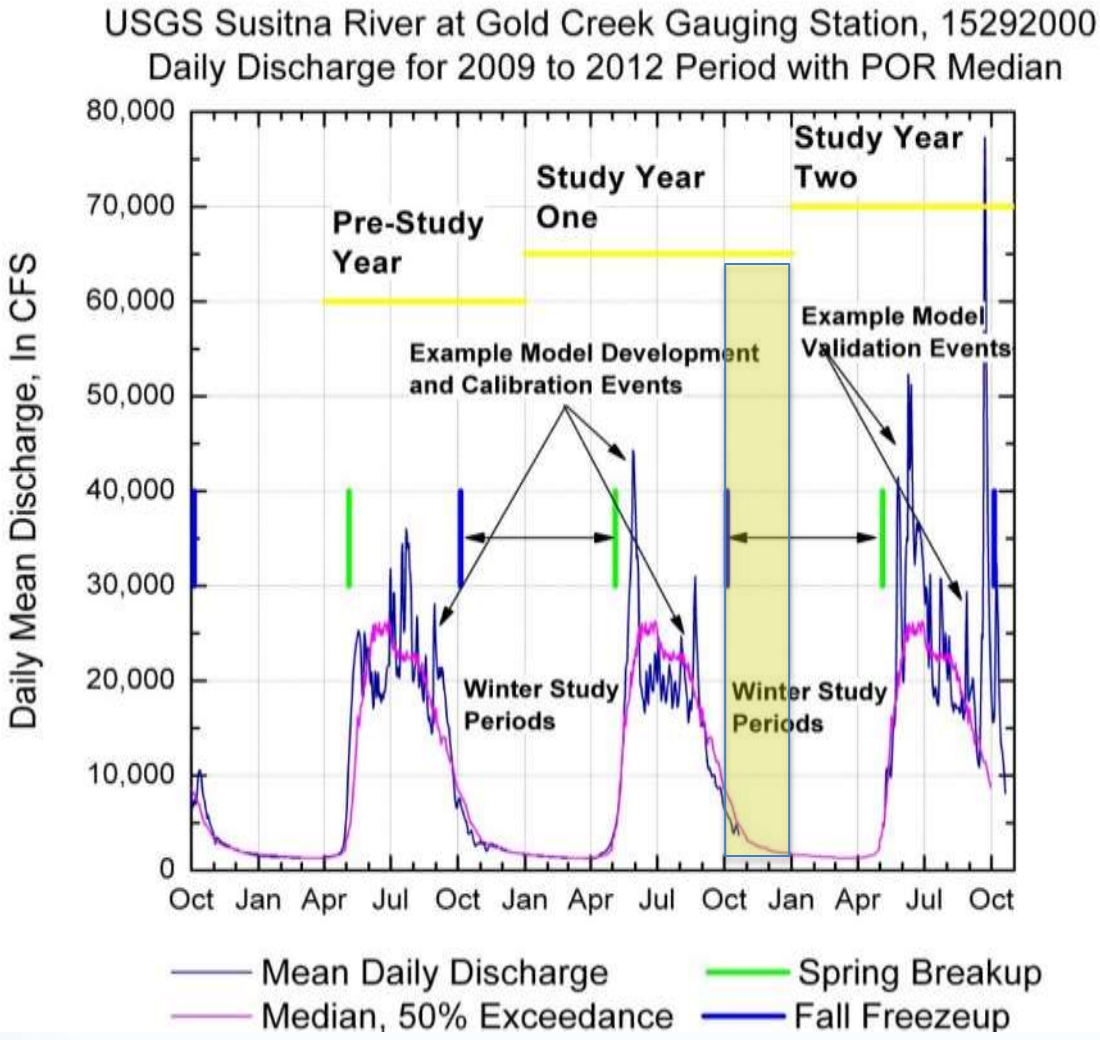
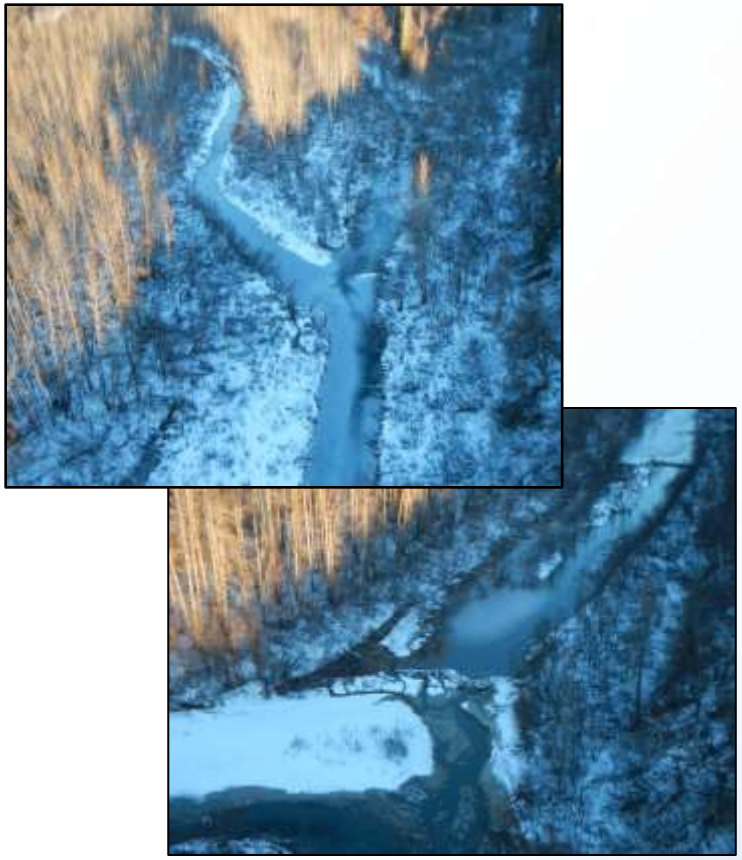
Planned Activity
Follow-up Activity
Initial Study Report
Updated Study Report

GW Hydrologic Study Schedule



GW 2013-Q4, 2014-Q1 Status

- 7.5.4.1.1 Data Synthesis
  - Review and summaries in Q4, Q1
- 7.5.4.1.2 Geohydrologic Process-Domains
  - Review and summaries in Q4, Q1
- 7.5.4.2 Watana Dam/Reservoir
  - Field Recon of Upper Reservoir – Q4
  - End of Season Conditions in Q4, Q1
- 7.5.4.3 Upwelling/Springs Broad-Scale Mapping
  - Thermal Infrared Imaging Coordination – Q4
  - Review and Summaries - Q4, Q12



FA-144 Slough 21, upper and lower sections of Slough 21 showing beaver dam controls, November 8, 2013

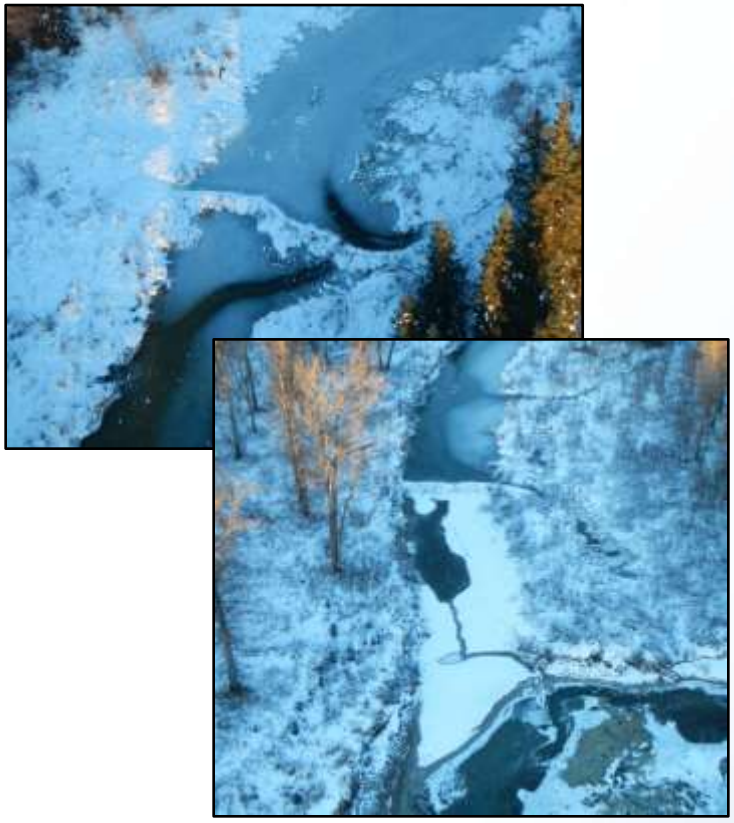
GW 2013-Q4, 2014-Q1 Status

- 7.5.4.4 Riparian GW/SW
  - Data Stations Completed in Q4
  - End of Summer, Early Winter Hydrology Observations in Q4
  - Data QC, Modeling, Analysis in Q1
- 7.5.4.5 Aquatic GW/SW
  - Data Stations Completed in Q4
  - End of Summer, Early Winter Hydrology Observations in Q4
  - Data QC, Modeling, Analysis in Q1

FA-144 Slough 21, upper section of Side Channel 21 are part of FA144 study activities, July 15, 2013, and November 8, 2013.

GW 2013-Q4, 2014-Q1 Status

- 7.5.4.6 Water Quality in Selected Habitats
  - Primary Activities Started Q4
  - Coordinated Winter Sampling in Q1
- 7.5.4.7 Winter GW/SW
  - 2013/14 Early Winter Trips in Q4
  - 2014 Winter Trips in Q1
- 7.5.4.8 Shallow Groundwater Users
  - Final 2013 Installations in Q4
  - Data QC, Analysis in Q1



FA-141 Indian River, side slough upstream of Indian River, upper and lower beaver dams, early winter November 8, 2013.

GW RSP 7.5.4.1.1 - Data Synthesis Highlights

- Continued Review of Literature Index Sources
  - ARLIS, UAF, Canadian, other
- Review of North Latitude Countries for Hydropower and Groundwater and Surface-Water Topics
- Coordination with Ice Processes Study

FA-128 Slough 8A, upper portion of Slough 8A, beaver pond looking downstream, November 8, 2013

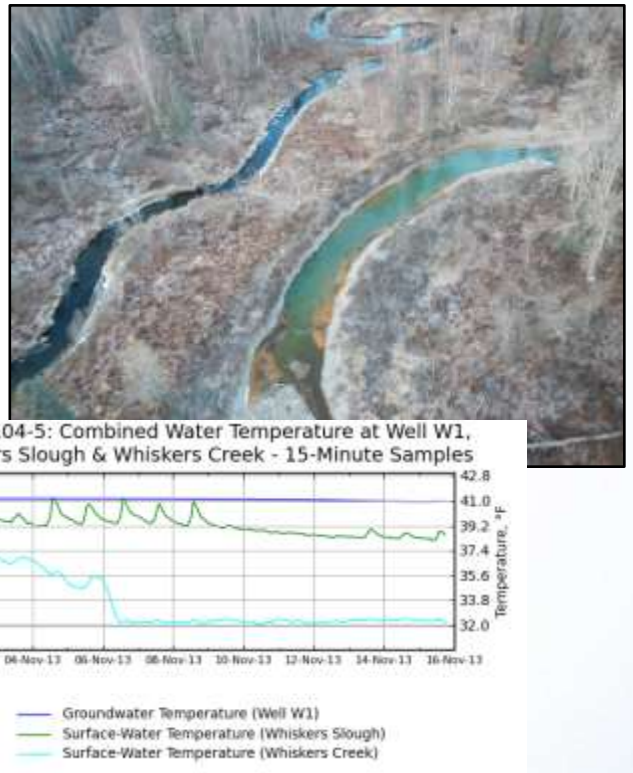
GW RSP 7.5.4.2 - Watana Dam/Reservoir Highlights

- Identification of 2013 End-of-Summer Conditions, Q4
- Field Visit to Upper End of Proposed Reservoir With IFS/Riparian to Document Riparian and Hydrology Conditions in Q4
- Review and Analysis in Q1

Proposed high-pool elevation area (marked by helicopter helmet) for reservoir, looking downstream, and upstream, armored bank conditions, November 8, 2013

GW RSP 7.5.4.3 - Upwelling/Springs Broad-Scale Mapping Highlights

- Interaction with Water Quality Studies for Fall Thermal Infrared Imaging, Q4
- Coordination with Ice Processes, IFS – Q1
- Data Analysis – Q1



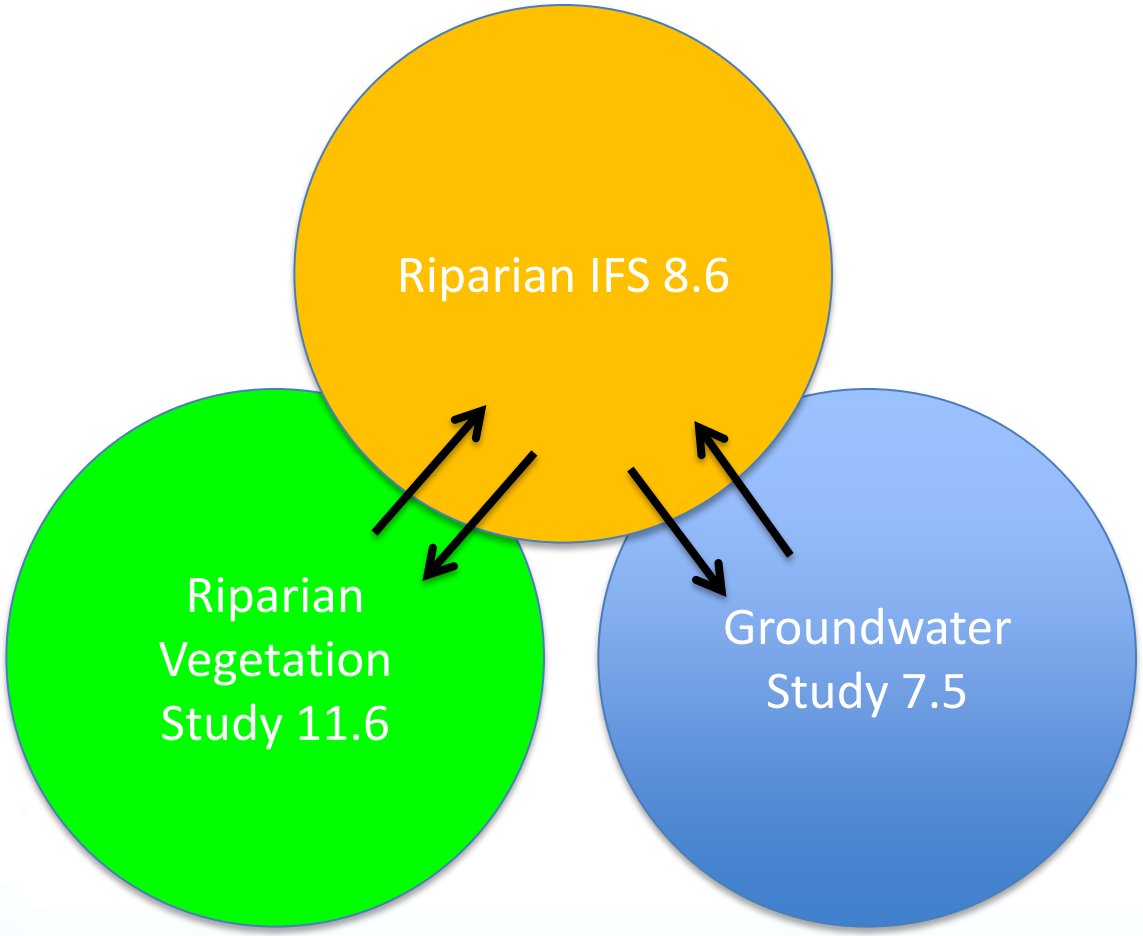
FA-104 Whisker Slough, Early winter view of Whisker Creek (left, darker) and Whisker Slough (right, clear), ESGFA104-5 (center of photo) well located between, temperature data, November 8, 2013

IFS Task3 Winter Gaging Q4 - GW 7.5.4.4 2013/14 Winter Coordination

- 2 Measurement Periods, Early February 2014 (Q1), Late March/Early April 2014
- Coordination with IFS, Ice Processes and Groundwater Studies, USGS
- Discharge, Stage, Ice Thickness and Elevation, Snow Cover, Frazil Ice

Geovera staff conducting RTK surveying at ESS40, GW Scientific and Brailey Hydrologic ice drilling, January 2013

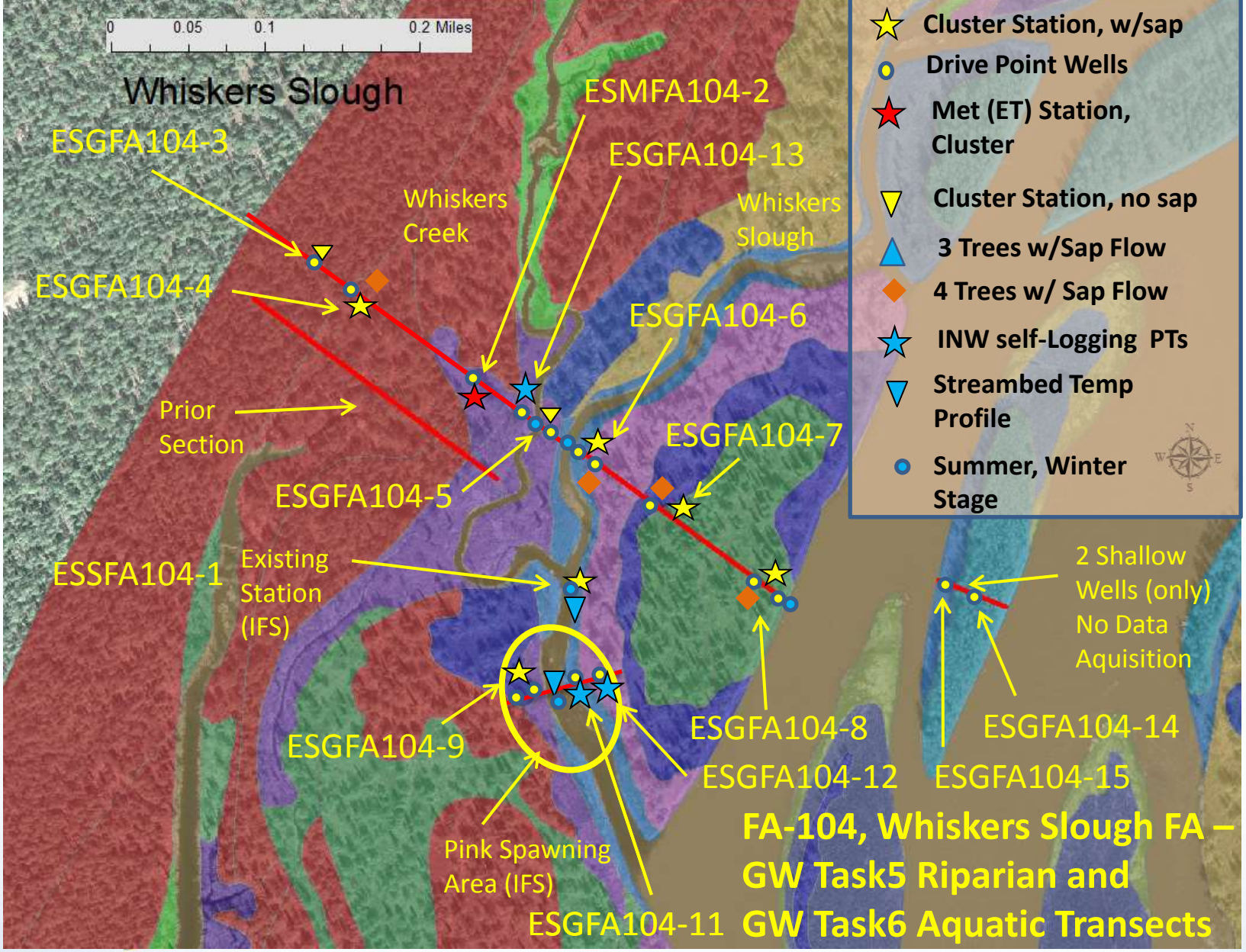
Integrated Riparian Groundwater (RIPGW) Studies

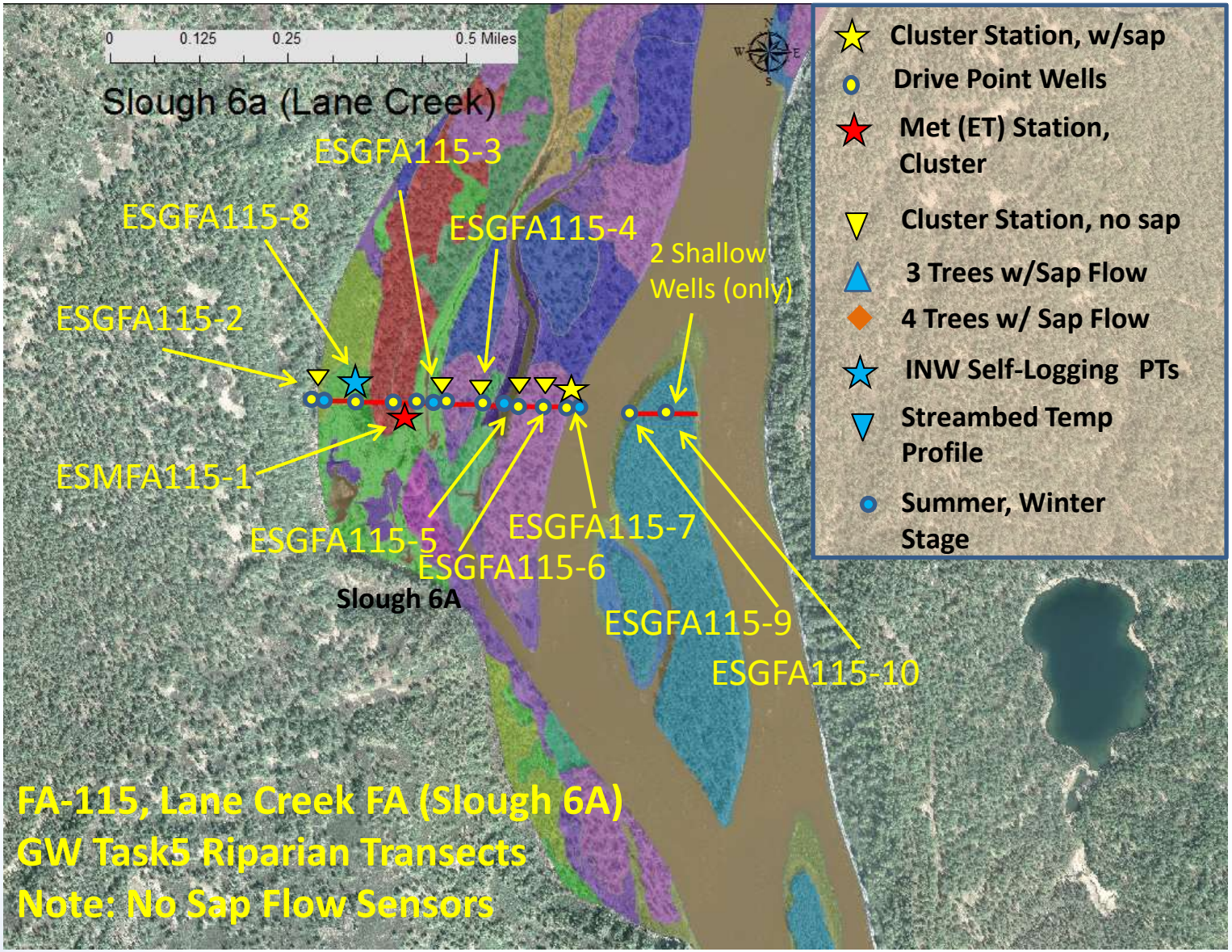


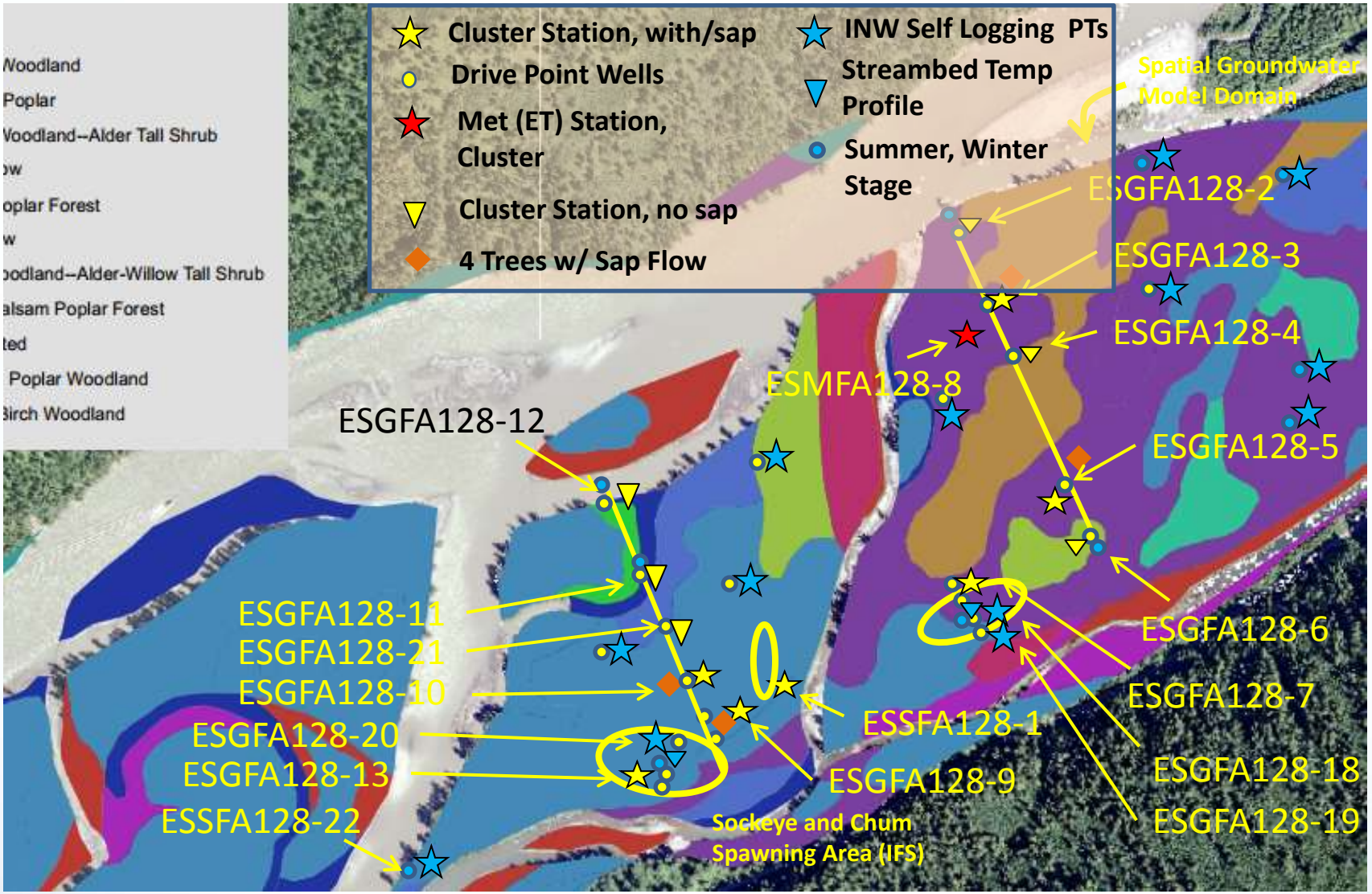
GW RSP 7.5.4.4 – Riparian GW/SW Highlights

- Q4 – End of Season Data Collection, Methods and Data QC
- Q1 – Data QC, Analysis, Groundwater Model Development

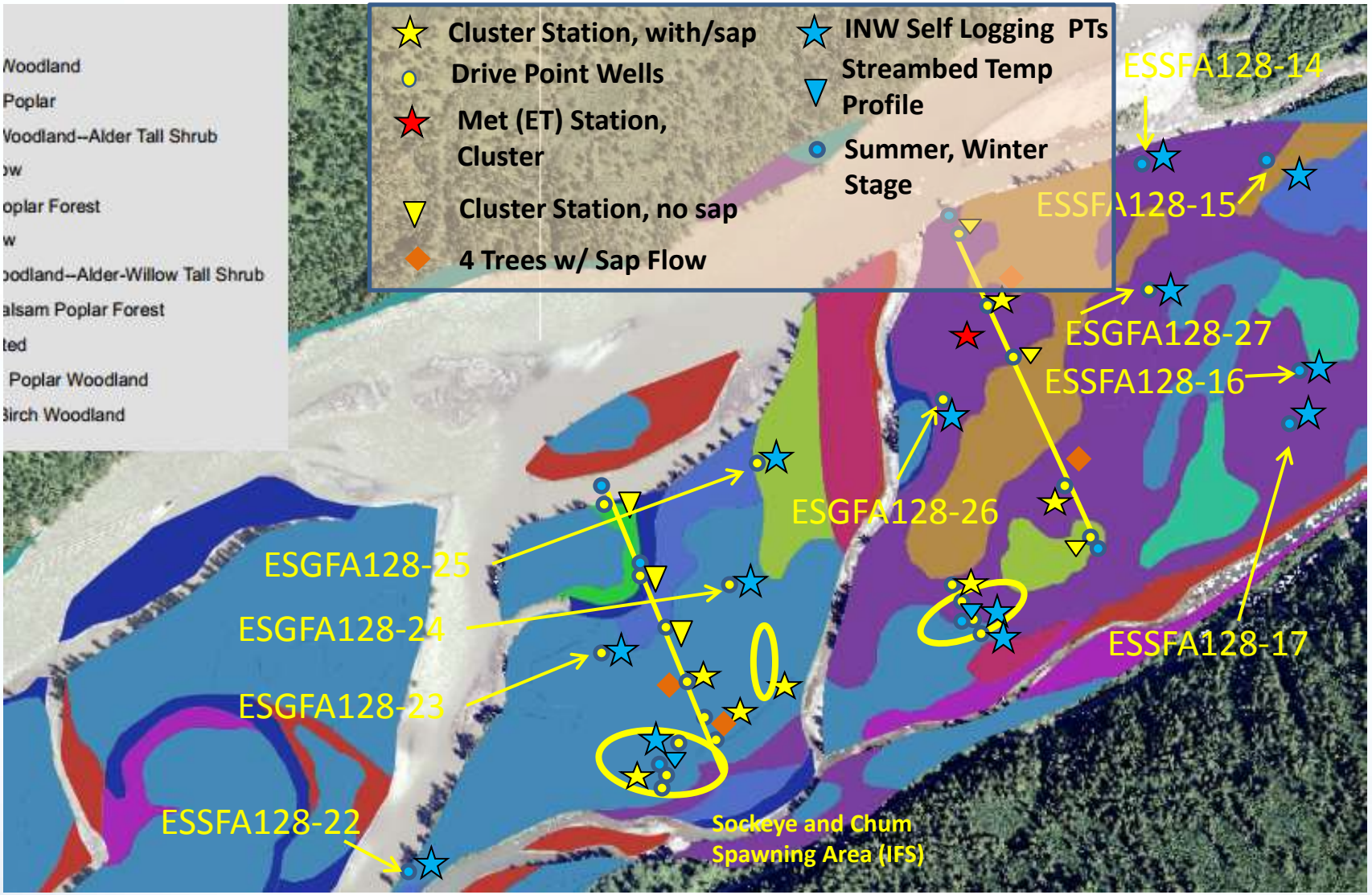
FA-104 Whisker Slough, Riparian IFS Study trees, prepared for winter period at sap-flow measurement locations, sensors will be reinstalled in spring, November 2, 2013


0 0.05 0.1 0.2 Miles
Whiskers Slough
ESGFA104-3
ESMFA104-2
ESGFA104-13
Whiskers Creek
Whiskers Slough
ESGFA104-4
ESGFA104-6
Prior Section
ESGFA104-7
ESGFA104-5
ESSFA104-1
Existing Station (IFS)
2 Shallow Wells (only) No Data Aquisition
ESGFA104-9
ESGFA104-8
ESGFA104-14
ESGFA104-12
ESGFA104-15
Pink Spawning Area (IFS)
ESGFA104-11
Cluster Station, w/sap
Drive Point Wells
Met (ET) Station, Cluster
Cluster Station, no sap
3 Trees w/Sap Flow
4 Trees w/ Sap Flow
INW self-Logging PTs
Streambed Temp Profile
Summer, Winter Stage
FA-104, Whiskers Slough FA – GW Task5 Riparian and GW Task6 Aquatic Transects


0
0.125
0.25
0.5 Miles
Slough 6a (Lane Creek)
ESGFA115-3
ESGFA115-8
ESGFA115-4
2 Shallow Wells (only)
ESGFA115-2
ESMFA115-1
ESGFA115-5
ESGFA115-7
ESGFA115-6
Slough 6A
ESGFA115-9
ESGFA115-10
Cluster Station, w/sap
Drive Point Wells
Met (ET) Station, Cluster
Cluster Station, no sap
3 Trees w/Sap Flow
4 Trees w/ Sap Flow
INW Self-Logging PTs
Streambed Temp Profile
Summer, Winter Stage
FA-115, Lane Creek FA (Slough 6A)
GW Task5 Riparian Transects
Note: No Sap Flow Sensors



Skull Creek Complex FA (Slough 8A) Aquatic and Riparian Stations



Skull Creek Complex FA (Slough 8A) Aquatic and Riparian Stations

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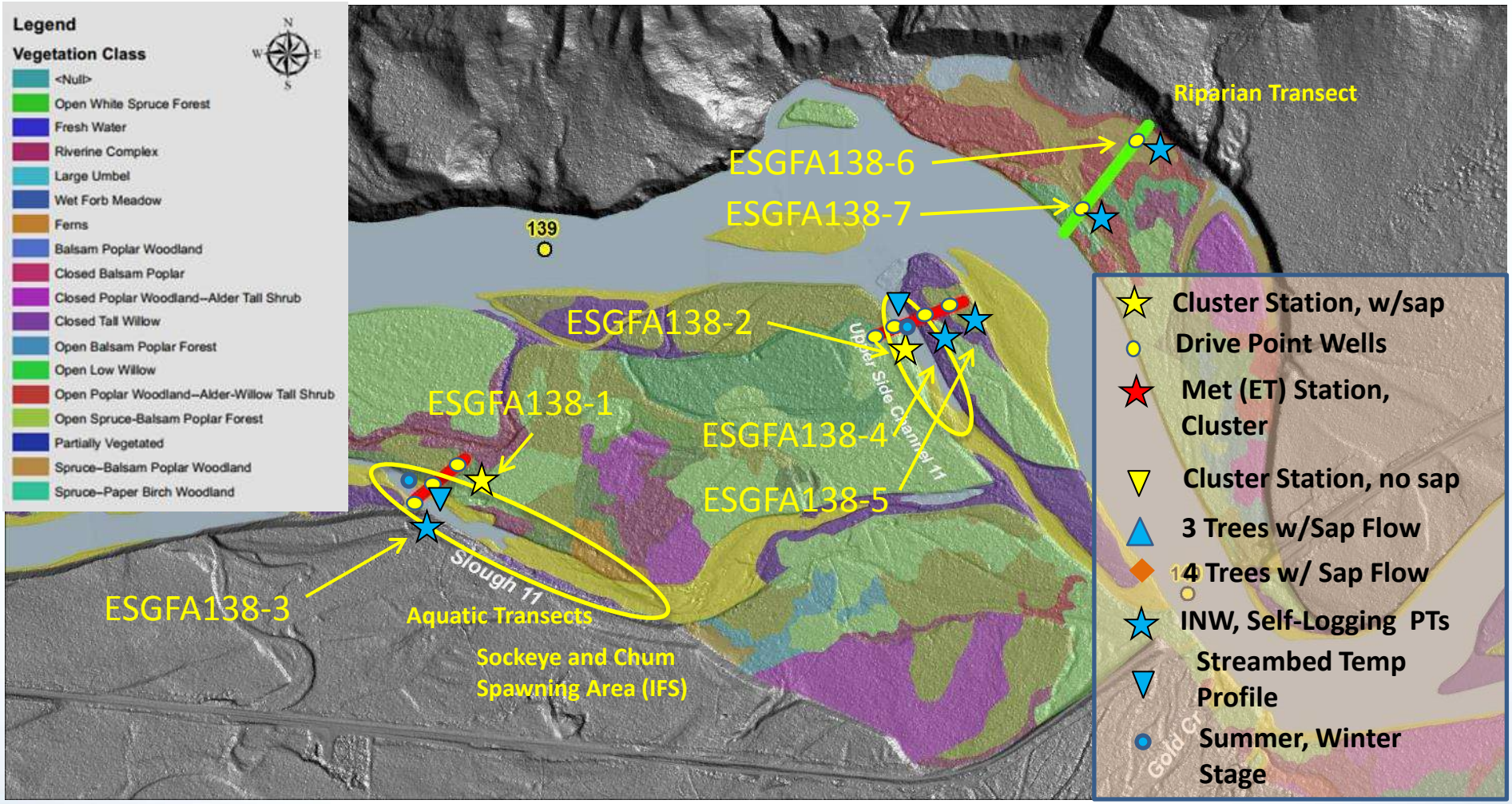
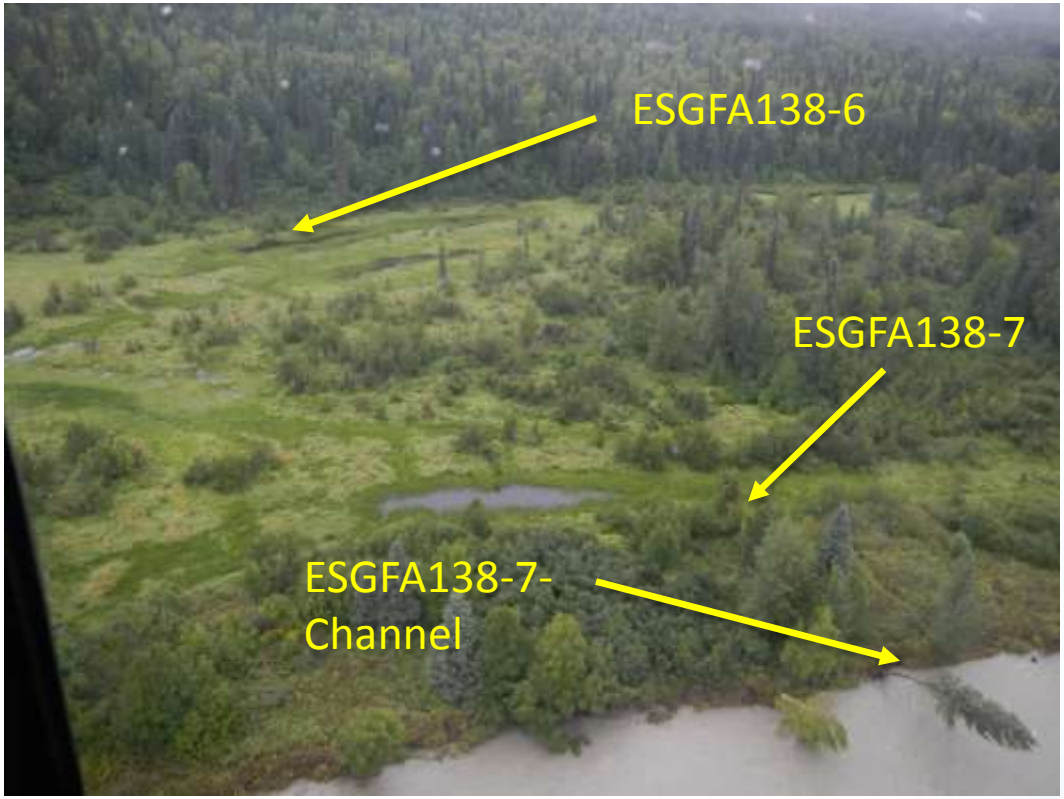


FA-138, Gold Creek Focus Area, GW Task6 Aquatic, Task5 Riparian Stations

SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

FA-138, Gold Creek Focus Area Upland Wetland Hydrology Observations

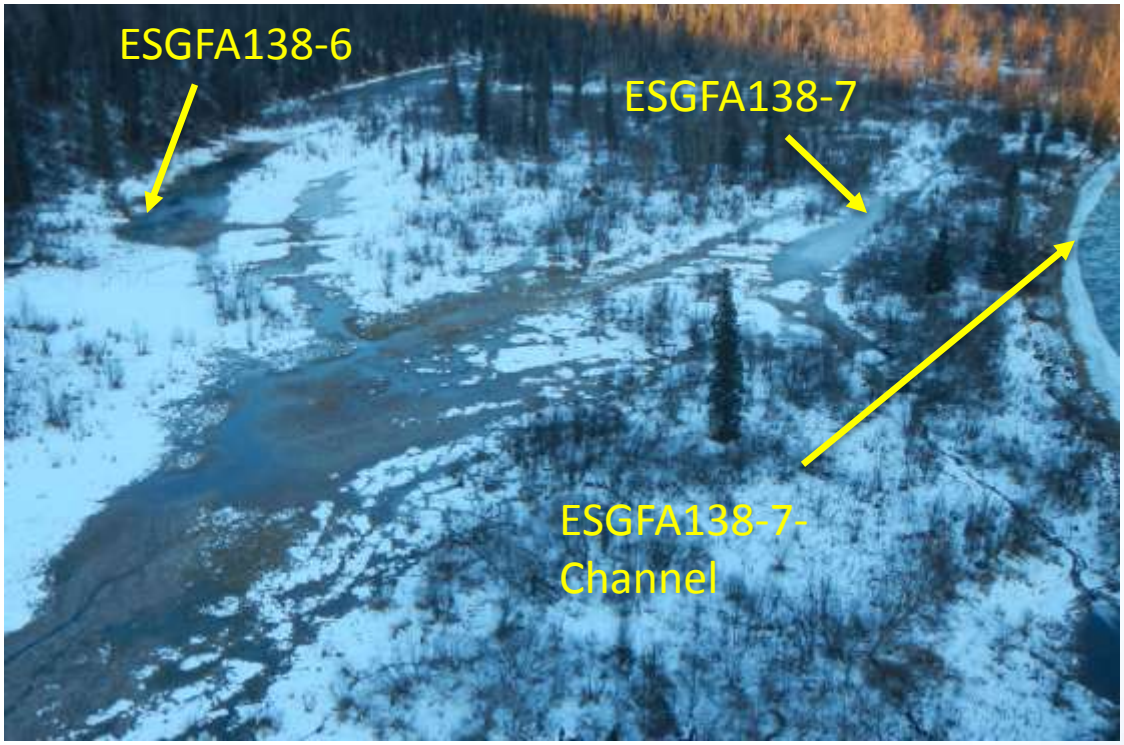
- How Are Upland Sloughs and Wetlands Impacted By River Stage Levels?
- How Does this Vary Over The Annual Hydrologic Cycle?
- At What Scale are GW/SW Interactions Significant?



FA-138, Gold Creek Focus Area, Right Bank Upland Sloughs and Wetlands, during heavy rainfall and precipitation flood peak on the Susitna River, August 22, 2013

FA-138, Gold Creek Focus Area
Upland Wetland Hydrology Observations

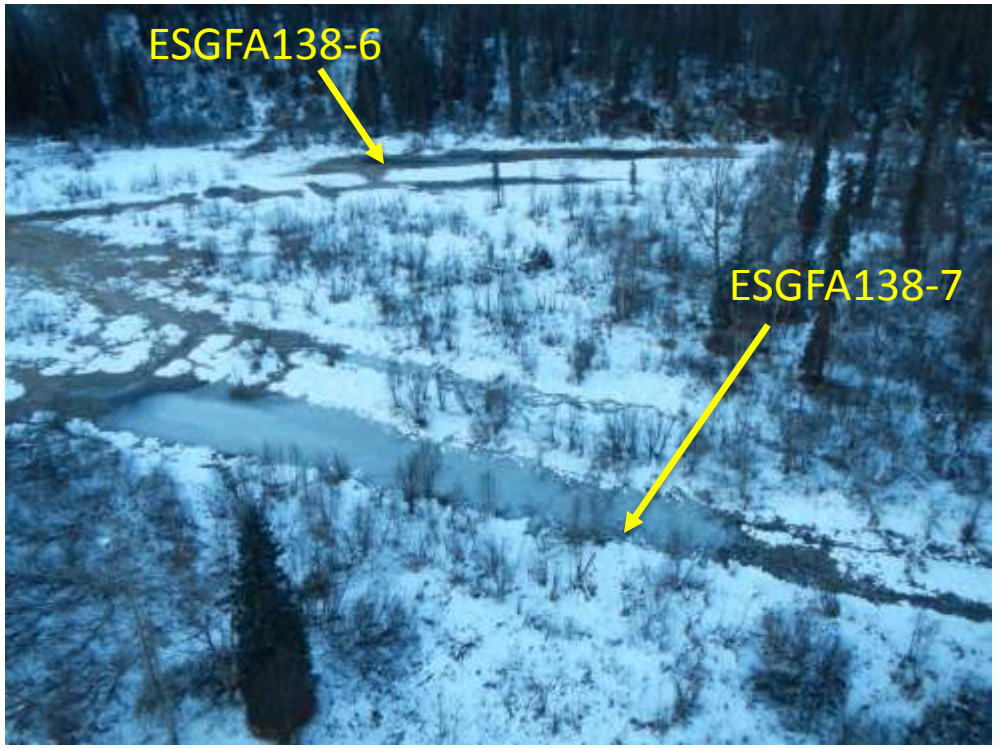
- Does Recharge From Groundwater Help Maintain Wetland Vegetation?
- What Winter Observations Help Understand This?
- What Snowmelt Transition Observations Help Understand This?



FA-138, Gold Creek Focus Area, Right Bank Upland abandoned beaver pond during periods of heavy rains, November 8, 2013

FA-138, Gold Creek Focus Area Upland Wetland Hydrology Observations

- Future Shallow Groundwater and Surface Water Level Monitoring
- Seasonal Observations
- Measuring Interactions (Or Lack Of) With River Stage Changes

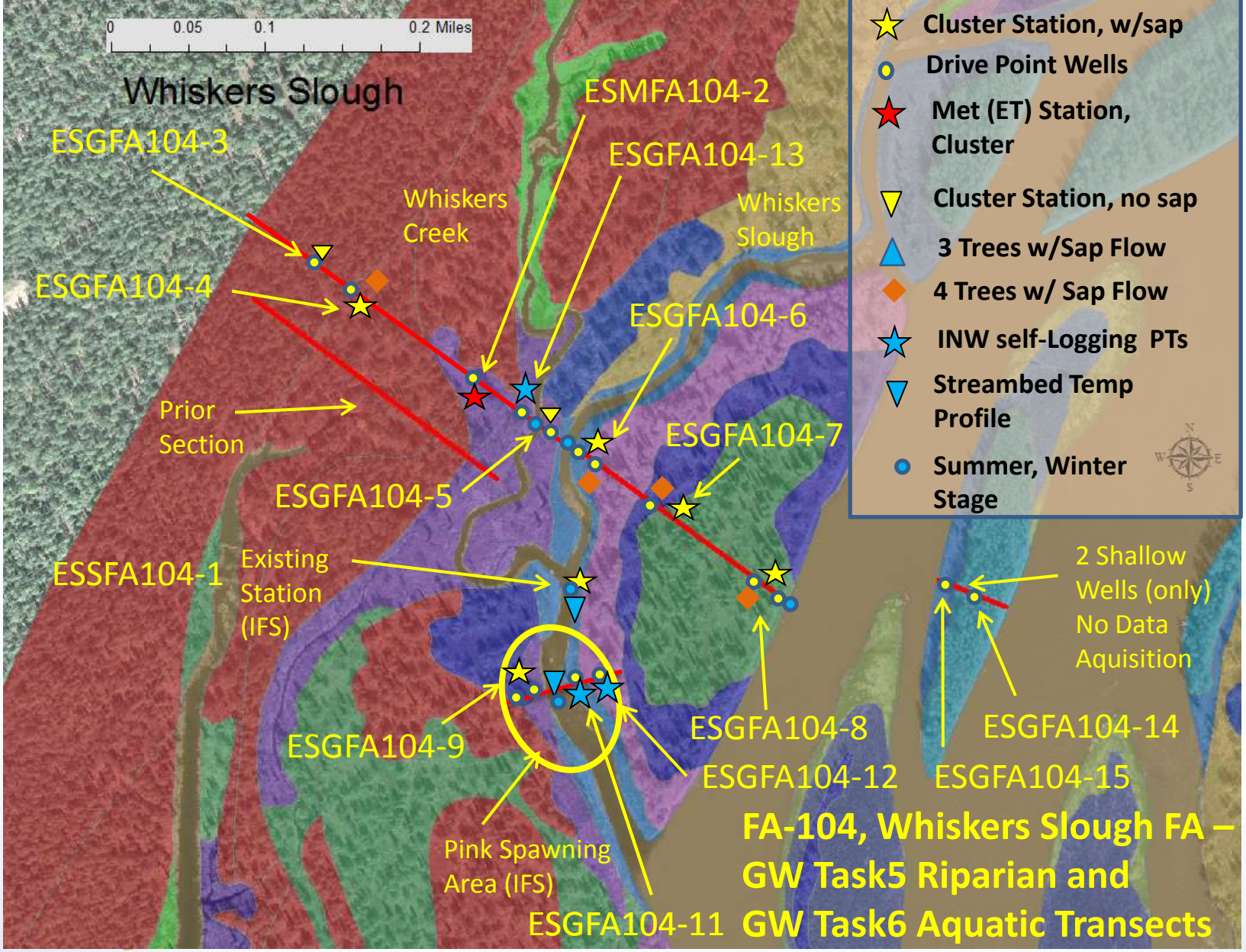


FA-138, Gold Creek Focus Area, Right Bank Abandoned Upland Sloughs and Wetlands, During Periods of Heavy Rain, August 22, 2013

GW RSP 7.5.4.5 – Aquatic GW/SW Highlights

- Q4 – Shallow GW Wells, Stations, Survey Control, End-of-Summer Data Collection complete
- Q1 – Data QC, Analysis, Groundwater Model Development

FA-104 Whisker Slough, came camera installation to record surface-water hydrology, snow, vegetation features, October 31, 2013


0 0.05 0.1 0.2 Miles
Whiskers Slough
ESGFA104-3
ESMFA104-2
ESGFA104-13
Whiskers Creek
Whiskers Slough
ESGFA104-4
ESGFA104-6
Prior Section
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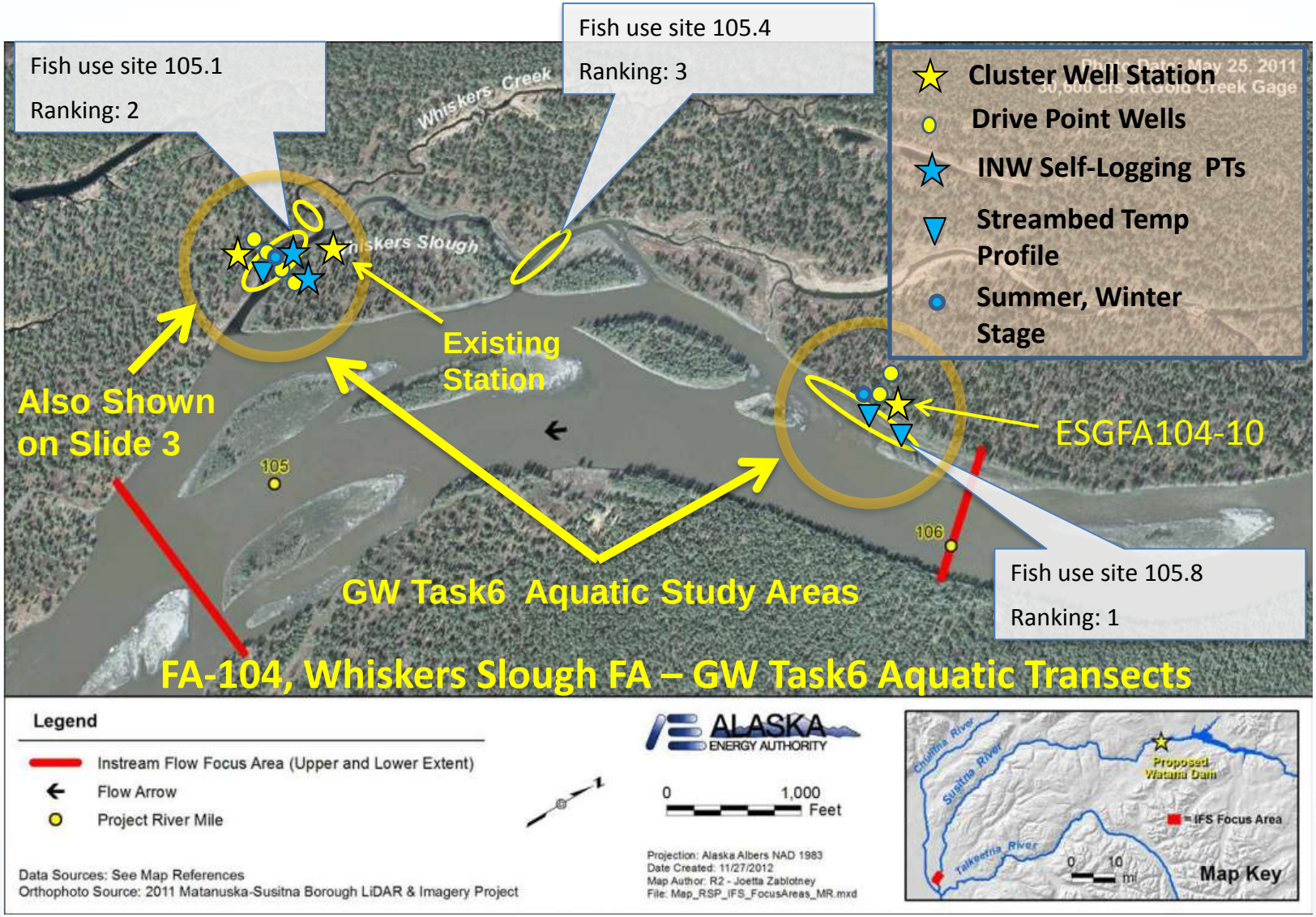
INW self-Logging PTs
Streambed Temp Profile
Summer, Winter Stage
FA-104, Whiskers Slough FA – GW Task5 Riparian and GW Task6 Aquatic Transects



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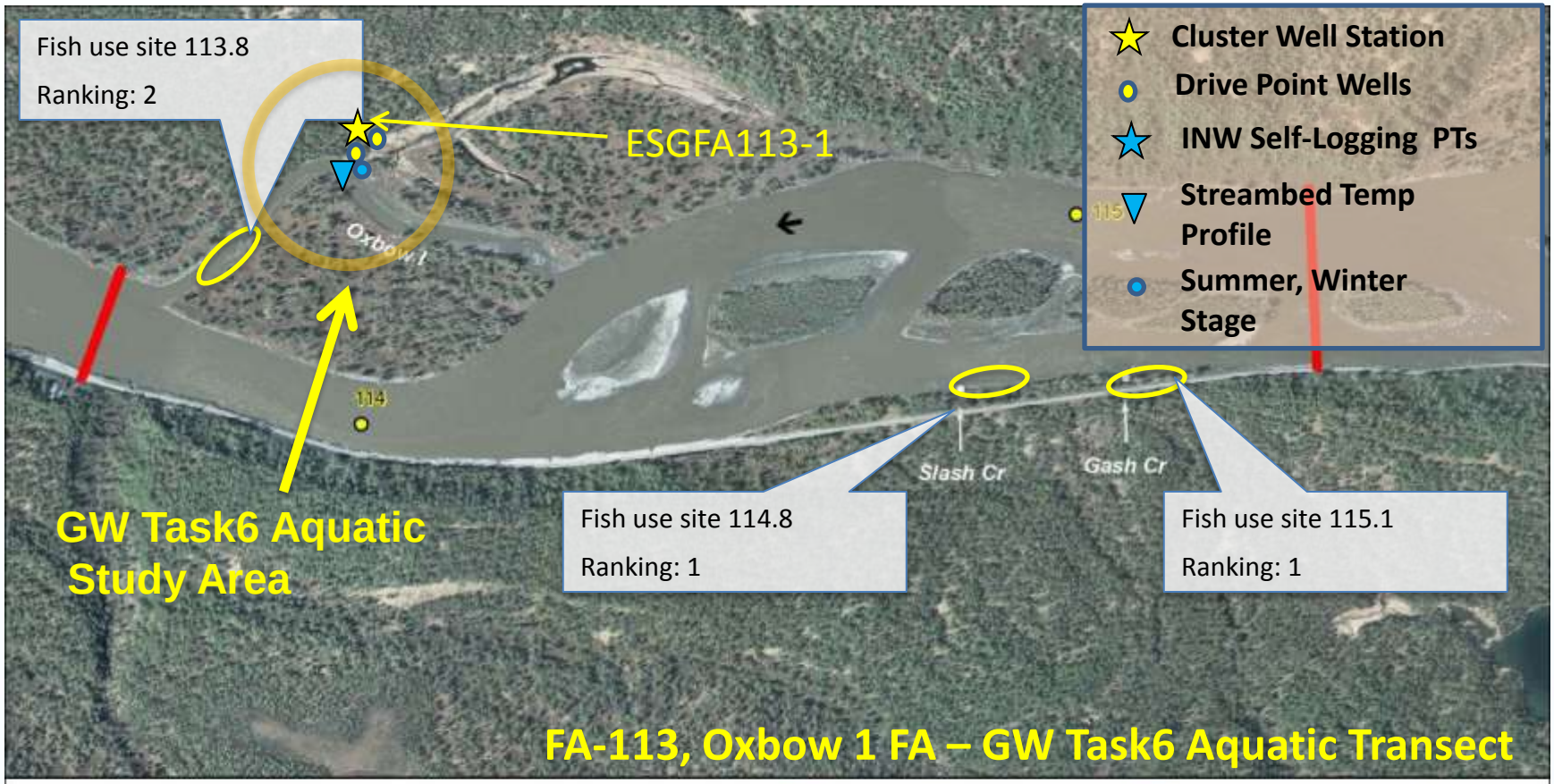
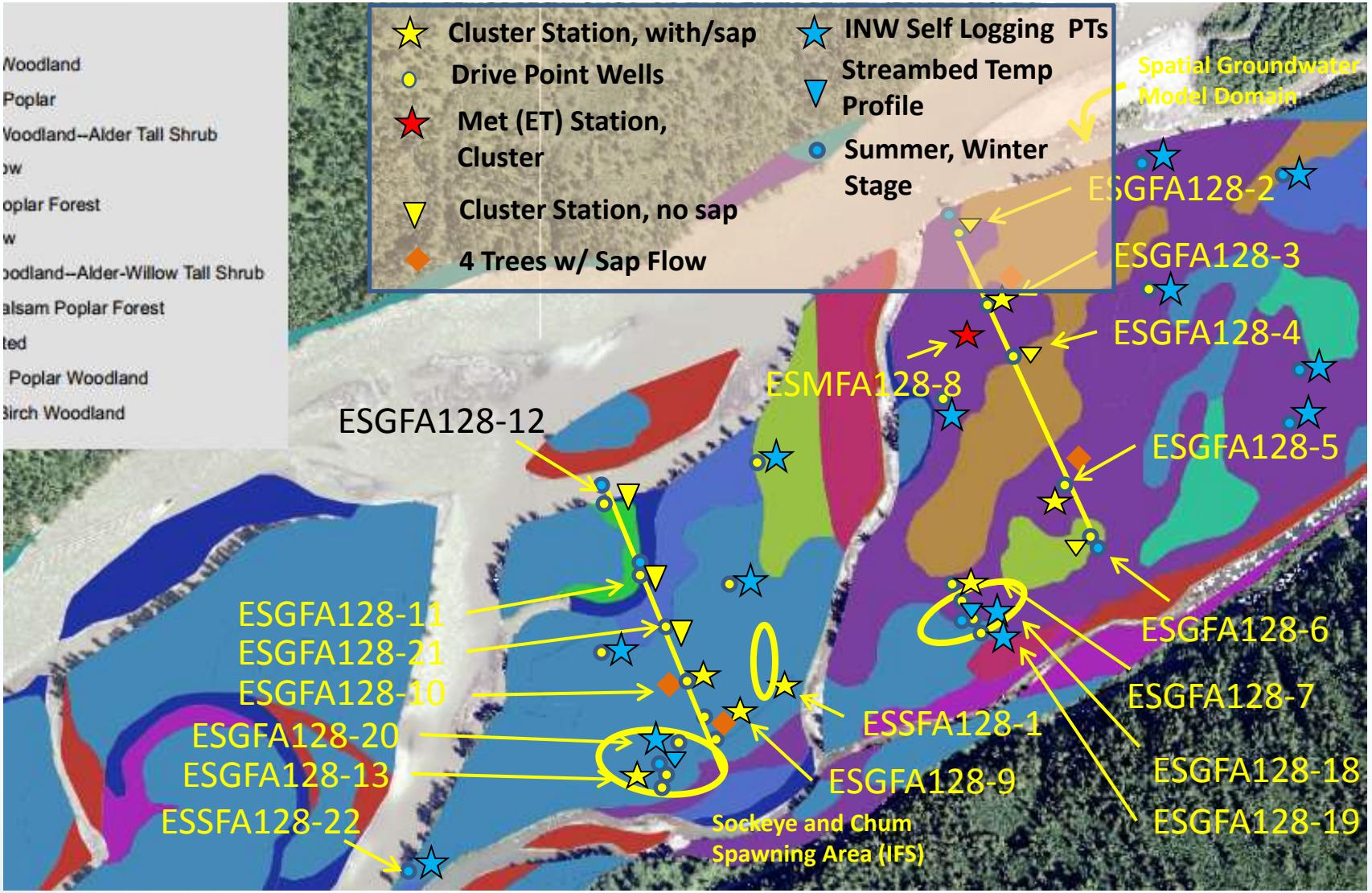
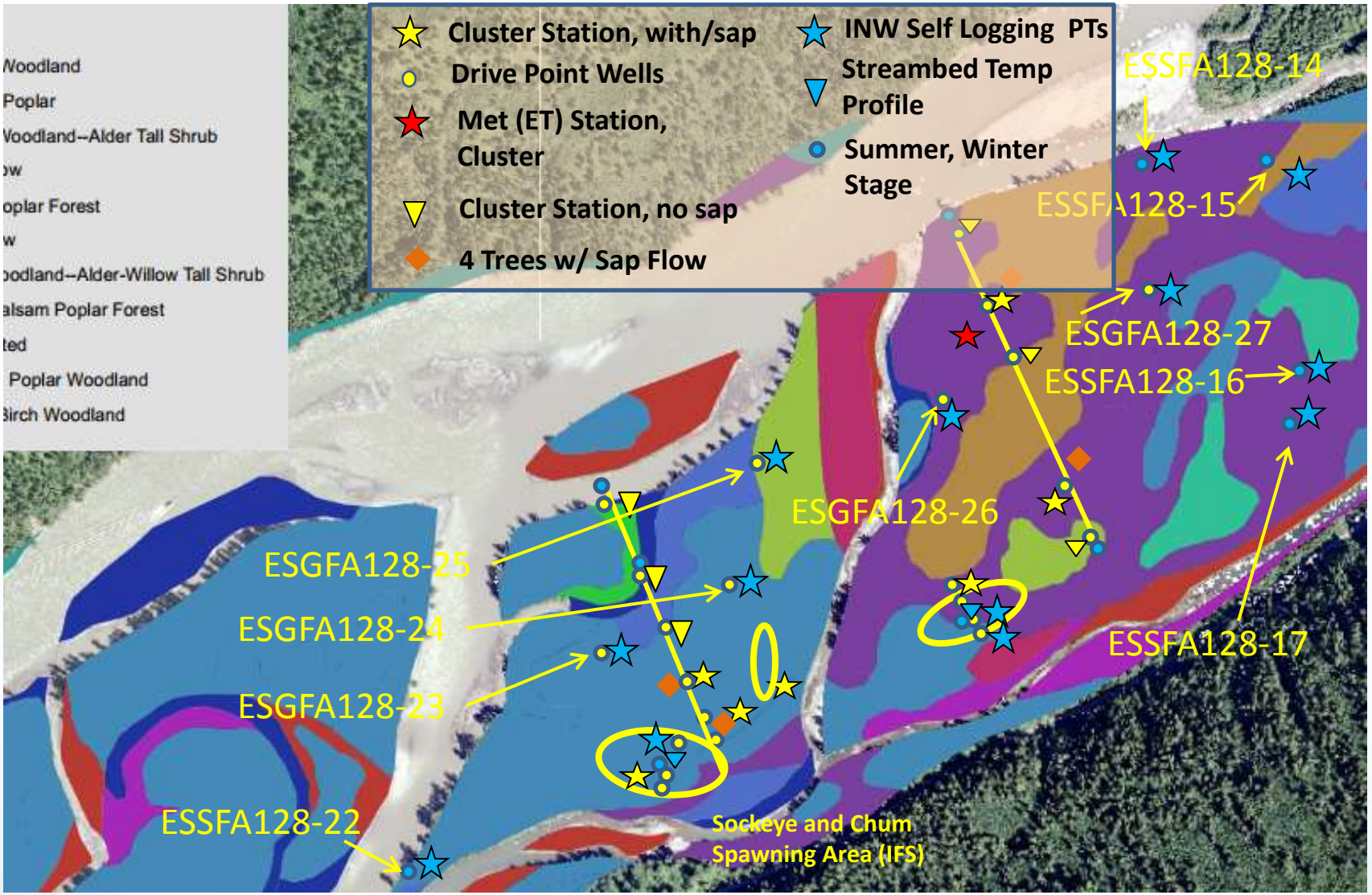


SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

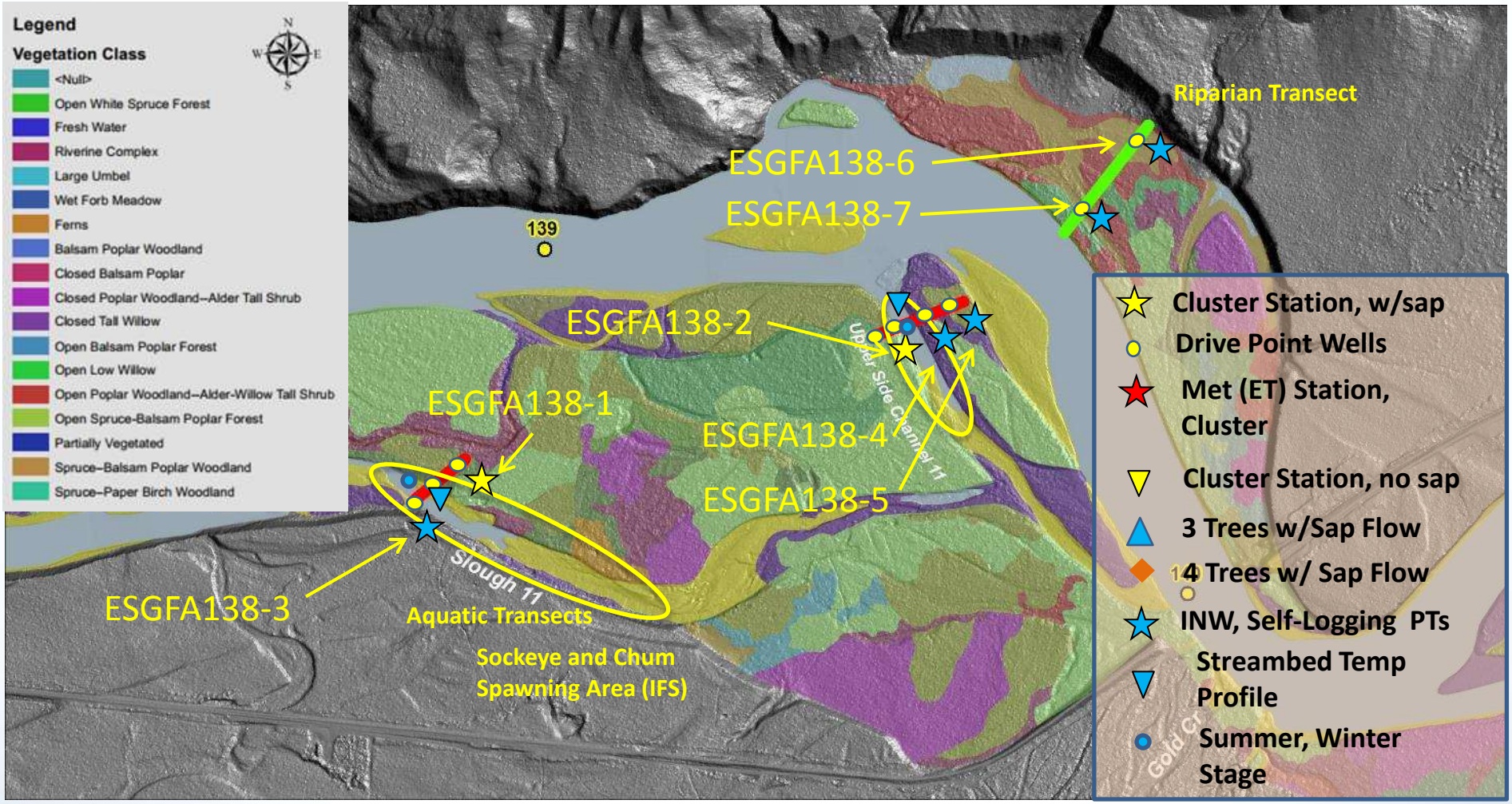


Skull Creek Complex FA (Slough 8A) Aquatic and Riparian Stations



Skull Creek Complex FA (Slough 8A) Aquatic and Riparian Stations

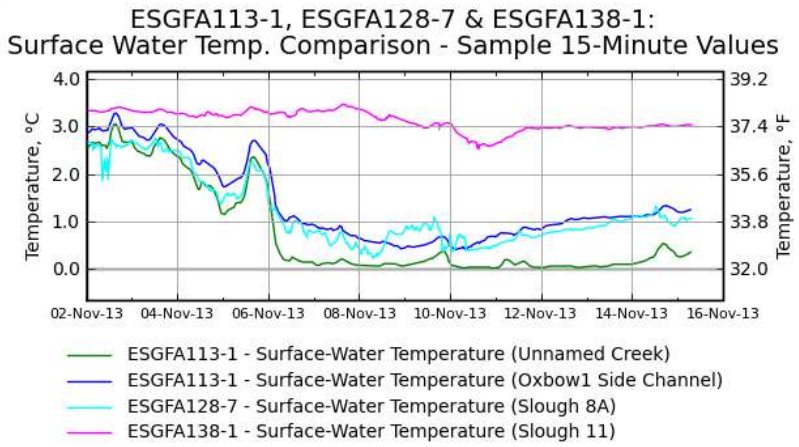
SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

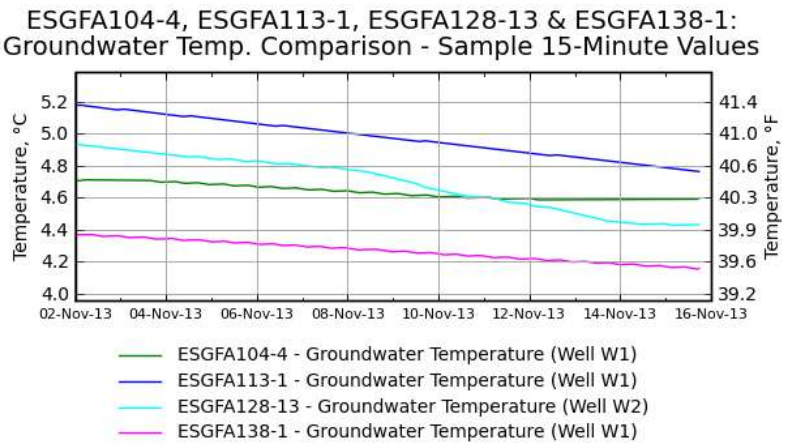


FA-138, Gold Creek Focus Area, GW Task6 Aquatic, Task5 Riparian Stations

SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

GW RSP 7.5.4.6 – Water Quality in Selected Habitats Highlights





Examples of empirical data collection across several Focus Areas, helping to characterization the natural ranges of groundwater and surface-water temperature variations throughout the annual hydrologic cycle.

- Q4 –Coordination with WQ, Winter Studies, Data QC
- Q1 – Data QC, Analysis, Coordination with Winter Studies

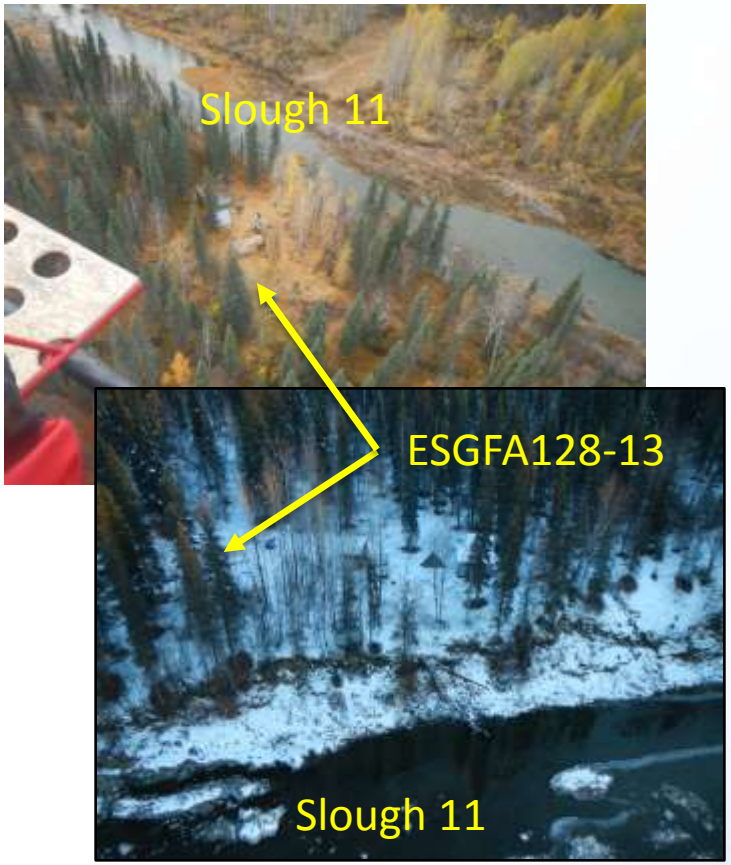
GW RSP 7.5.4.7 – Winter GW/SW Highlights

- Q4 – Start of 2013/14 Winter Studies
- Q4 – Begin Main Winter 2013/14 Observations
- Q1 – Monthly Trips to FA-104 Whisker Slough, FA-128 Slough 8A, FA-138 Gold Creek Focus Areas

FA-128 Slough 8A, Lower Section of Slough 8A, location of ESGFA128-13 station, surface-water icing conditions are affected by groundwater upwelling, November 8, 2013

GW RSP 7.5.4.8 – Shallow Groundwater Users Highlights

- Q4 – Completion of Station Installations for 2013 Objectives
- Q1 – Data QC and Analysis
- Three wells in FA-138 Gold Creek Focus Area will also help Focus Area Investigations



New residential well installed in FA138 Gold Creek area, adjacent to Slough 11, will be used by study, October 3 and November 8, 2013

GW RSP Variances

- No Variances Have Been Identified Through the Ongoing Summer and Earlier Winter 2013 Field Efforts

2013/14 Coordinated Winter Studies

- Coordinated IFS/Fish/GW Study Teams, Data
- Oct/Nov – Fall Freeze-up
- November – Early Fish/GW Observations
- Jan, Feb, Mar, April – Intensive Field Trips
- Spring 2014 Breakup

FA128 - Slough 8A beginning of breakup; Whiskers Slough side channel inlet, May 25, 2013

2013/14 Coordinated Winter Studies

- Three Main Focus Areas
  - FA138 Gold Creek
  - FA128 Slough 8A
  - FA104 Whiskers Slough
- Additional Sites in Vicinity in Each FA
- Synoptic Data Collection and Observations

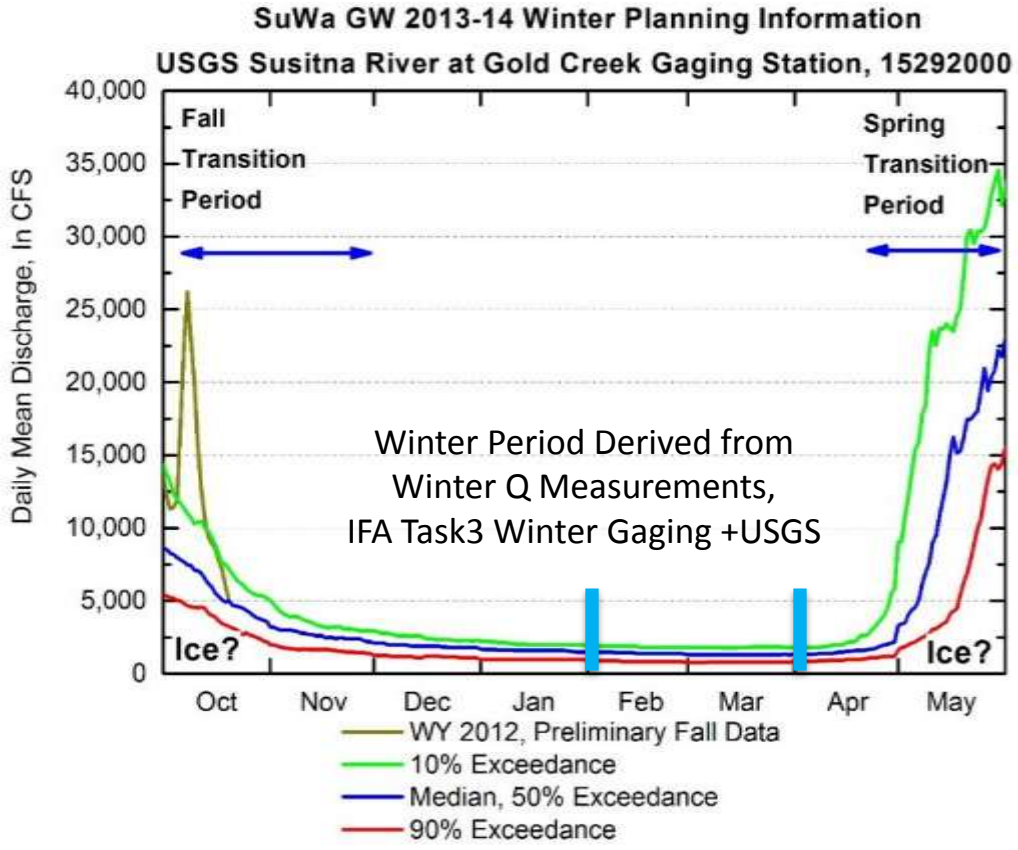
FA128 - Slough 8A beginning of breakup; Whiskers Slough side channel inlet, May 25, 2013

2013/14 Coordinated Winter Studies

- Additional Hydrology Data Collection, Automated Stations
  - FA113 – Oxbow1
  - FA115 – Slough 6A
- Additional Hydrology Data Collection, Manual Measurements
  - FA141 – Indian River
  - FA144 – Slough 21

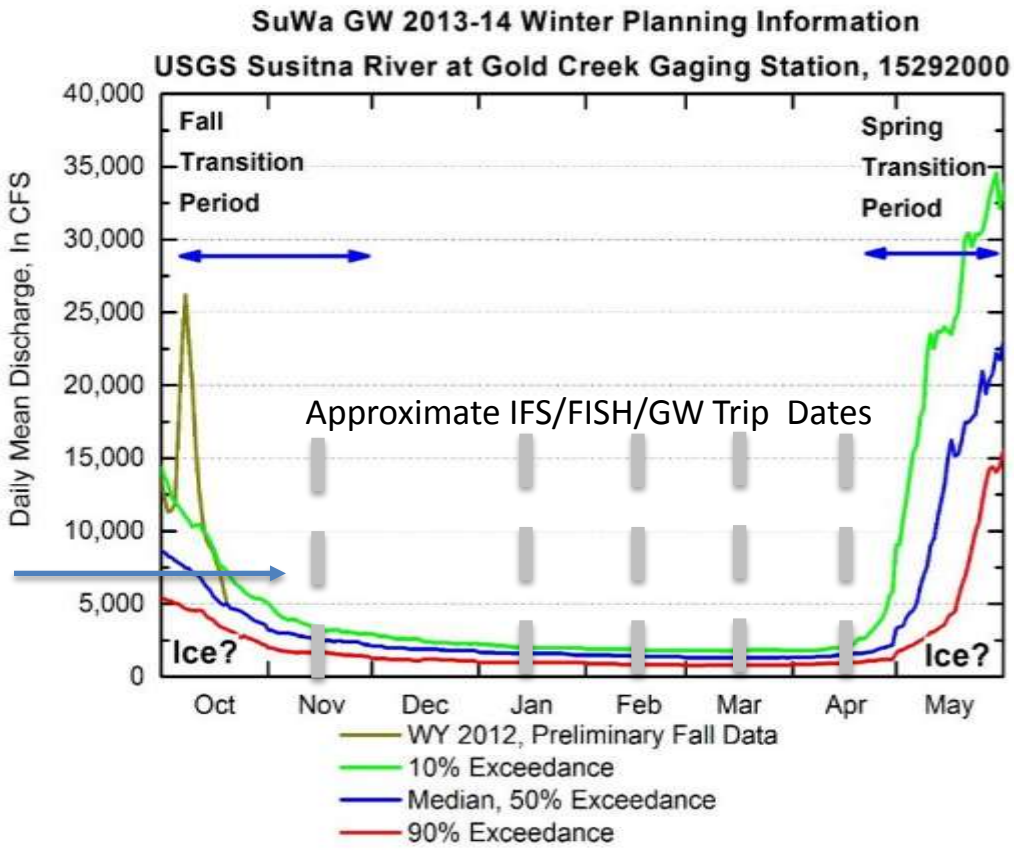
FA104 - Whiskers Slough, side channel inlet following major ice jam flooding, confluence of Whiskers Creek and Whiskers Slough, May 27, 2013

2013/14 Coordinated Winter Studies



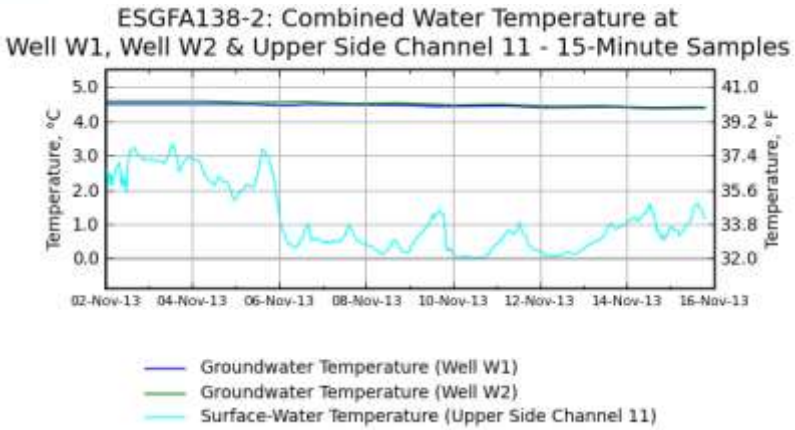
2013/14 Coordinated Winter Studies

November 5, 2013
7,000 to 6,500 cfs



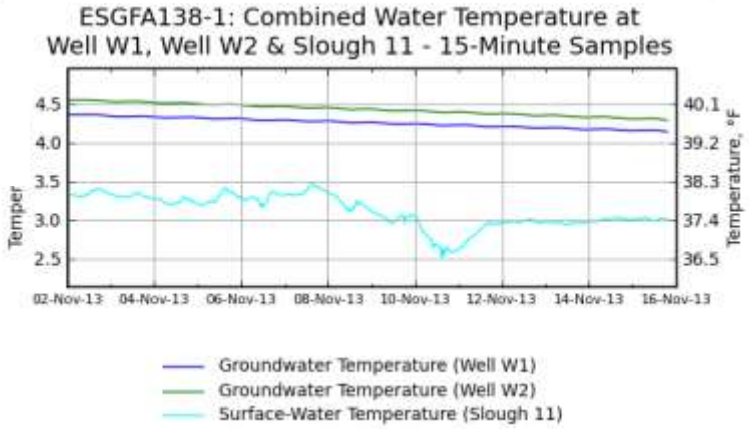
2013/14 Coordinated Winter Studies

- Winter Is Here – Data is Being Collected



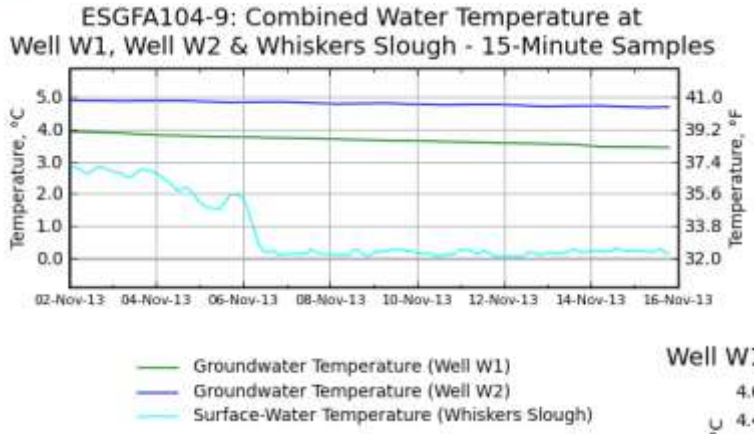
FA138 – Gold Creek
Upper Side Channel 11

Slough 11



2013/14 Coordinated Winter Studies

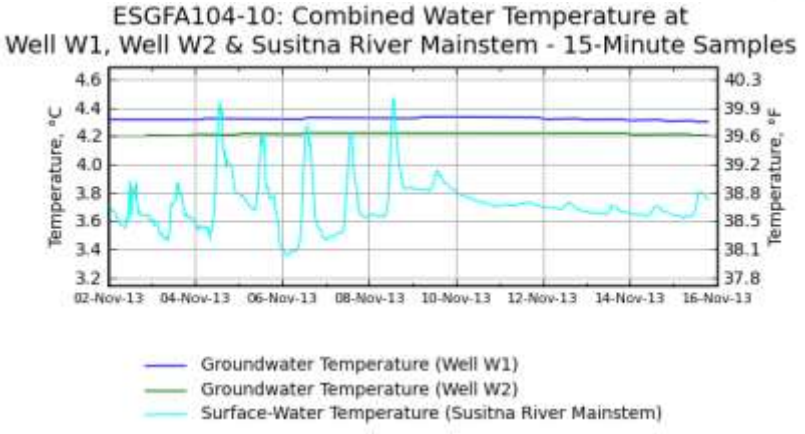
- Winter Is Here – Data is Being Collected



FA104 – Whiskers Slough

Whiskers Slough

Whisker Slough Side Channel



2013/14 Coordinated Winter Studies

- Streambed Temperature Profile Measurements

FA128 –Slough 8A, 9/28/13

FA138 –Gold Creek, 10/18/13

2013/14 Coordinated Winter Studies

- Early Winter Field Observations, Ice Cover Development

FA104 – Whiskers Slough, 10/29/13

FA104 – Whiskers Slough, 11/8/13

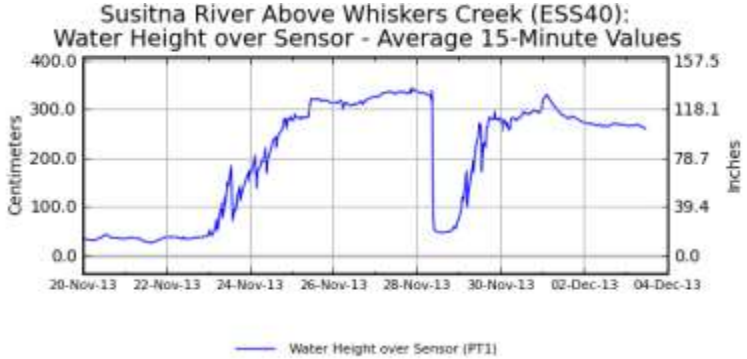
2013/14 Coordinated Winter Studies

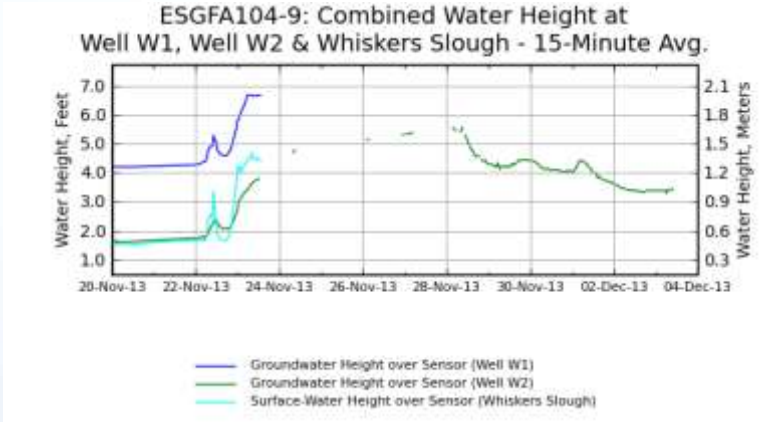
- Early Winter Field Observations, Ice Cover Development

FA104 –Whiskers Slough, 11/25/13

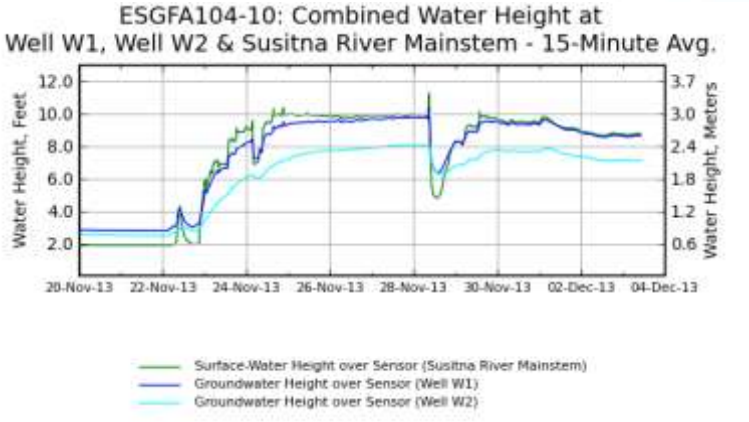
2013/14 Coordinated Winter Studies

- Early Winter Field Observations, Ice Cover, Jams





FA104 –Whiskers Slough



FA104 –Whiskers Side Channel

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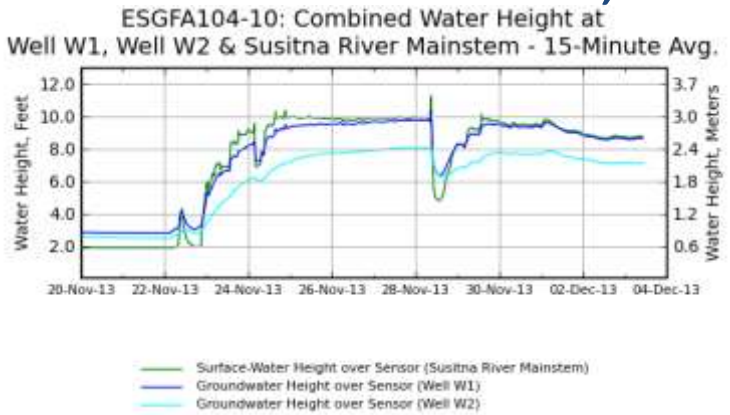
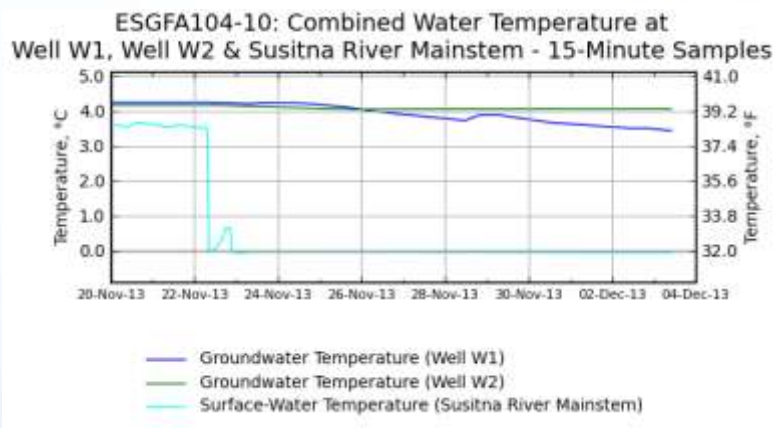
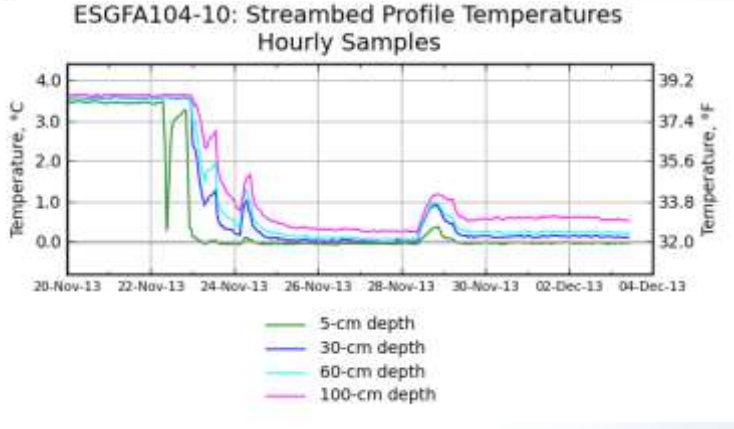
2013/14 Coordinated Winter Studies

- Early Winter Field Observations, Ice Cover, Jams



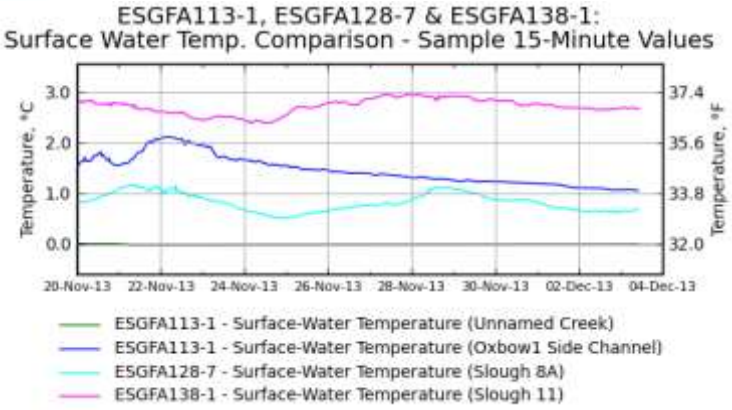


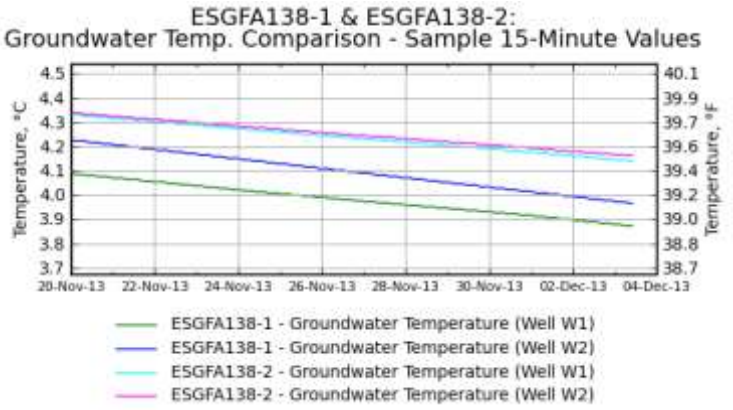


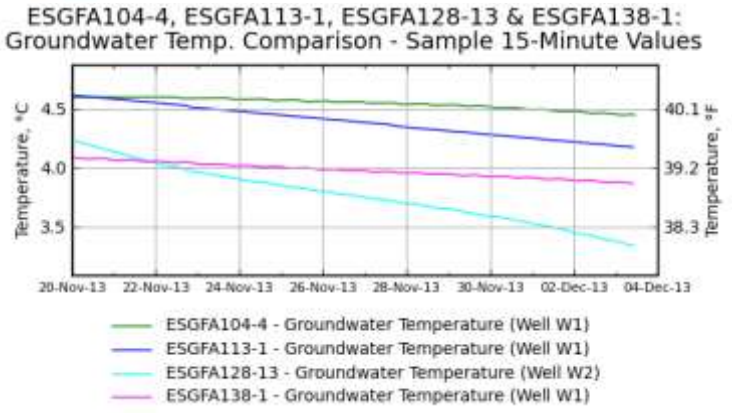
FA104 –Whiskers Side Channel

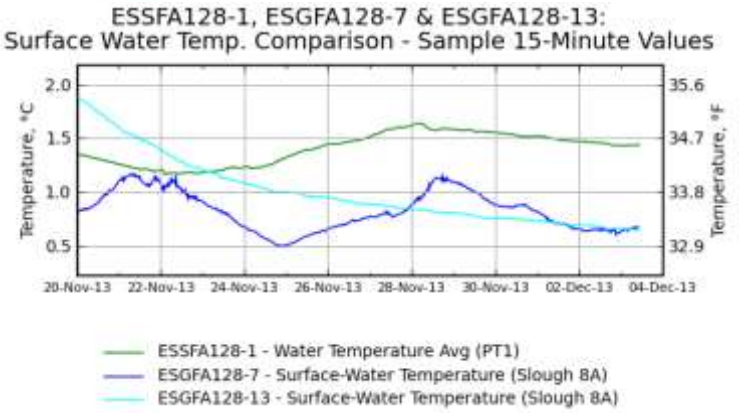
2013/14 Coordinated Winter Studies

- Early Winter Field Observations, Ice Cover, Jams









2013/14 Coordinated Winter Studies

- Early Winter Field Observations, Ice Cover, Jams

FA-104 –Whiskers Slough

11/21/13

>-20C

12/3/13 11:00

-15C

-10C

FA-128 – Slough 8A

SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

Groundwater Study

- Thank You!
- Questions?
- More information at:

  www.susitna-watanahydro.org

FA-128 Slough 8A, side channel camera installation to help record hydrology and ice process interactions, November 3, 2013