

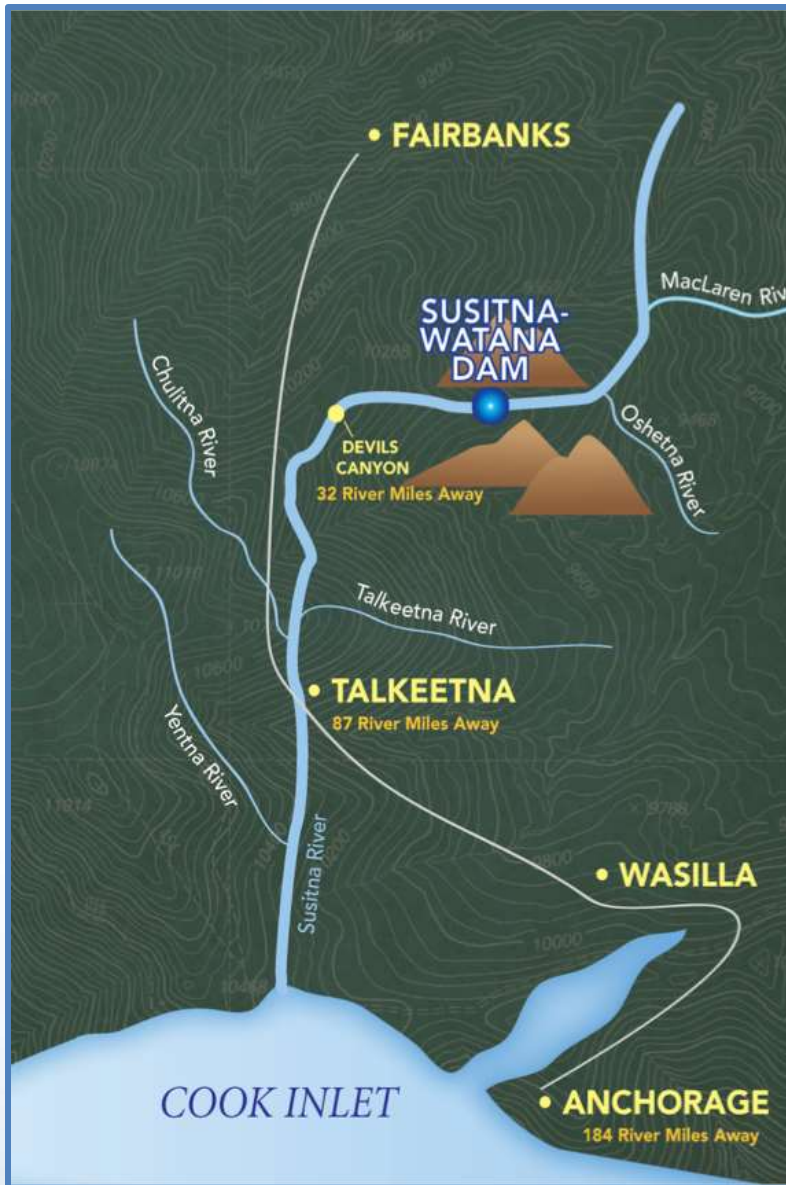
Technical Team Meeting

Riverine Modeling Proof of Concept

Groundwater Study Modeling & Analysis

April 15-17, 2014

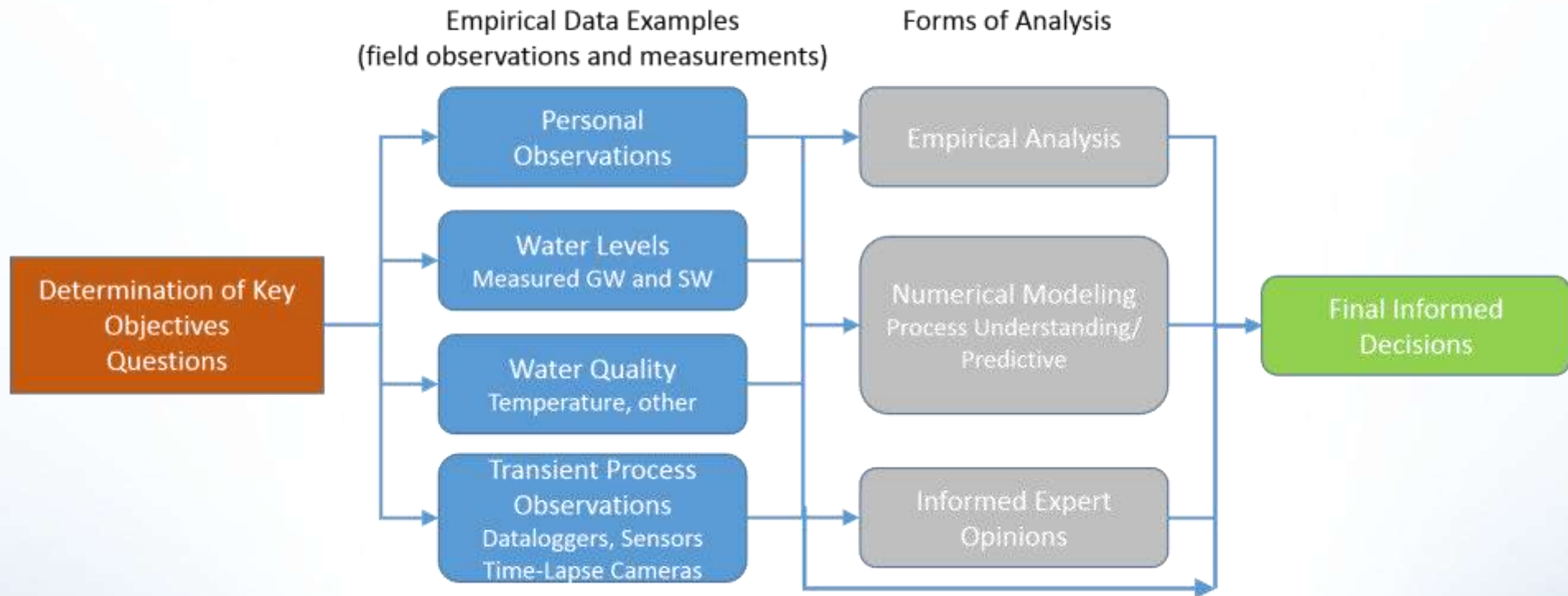
Prepared by
GW Scientific



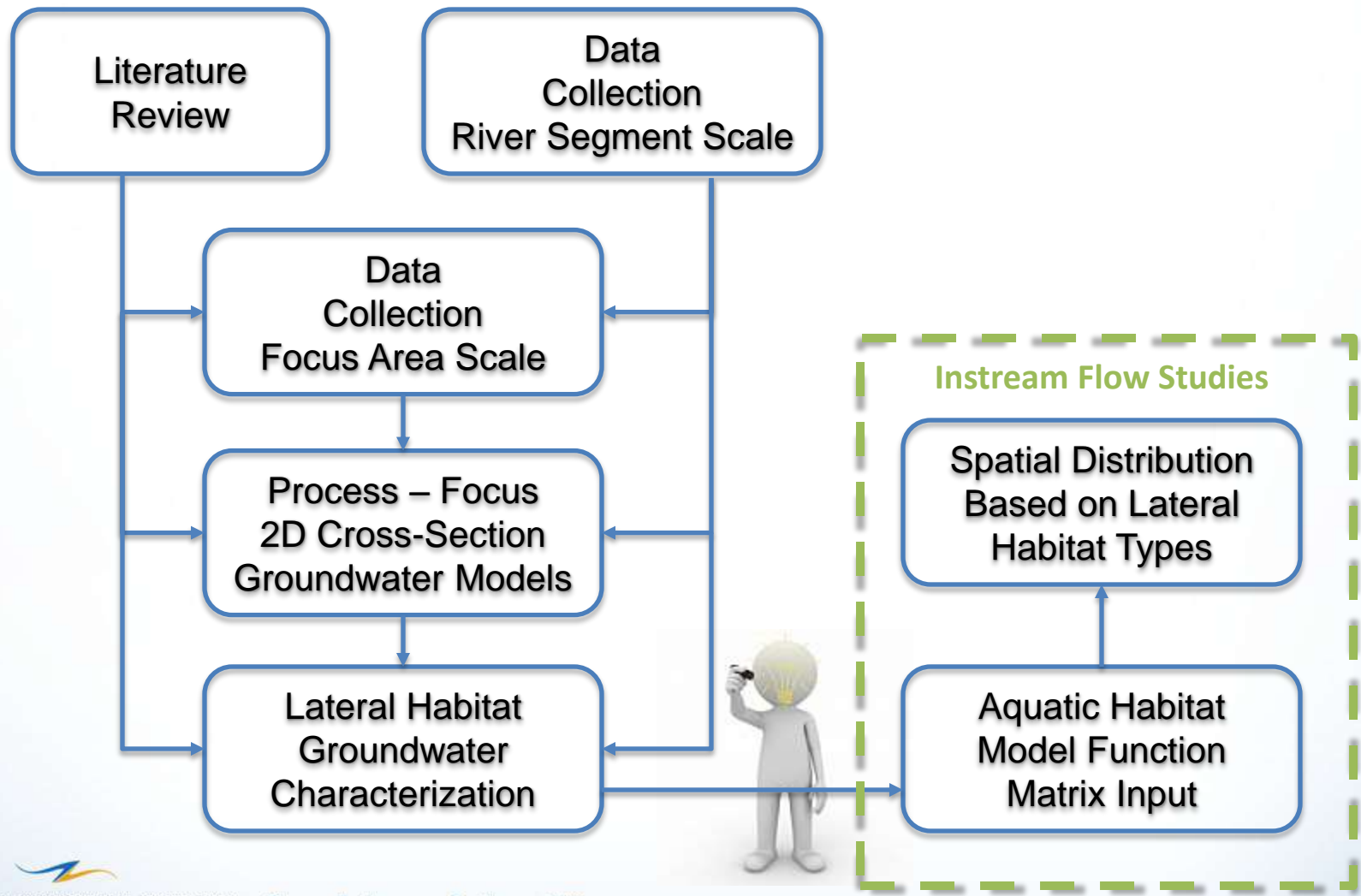
 **SUSITNA-WATANA HYDRO** *Clean, reliable energy for the next 100 years.*

Groundwater Study Analysis Approach

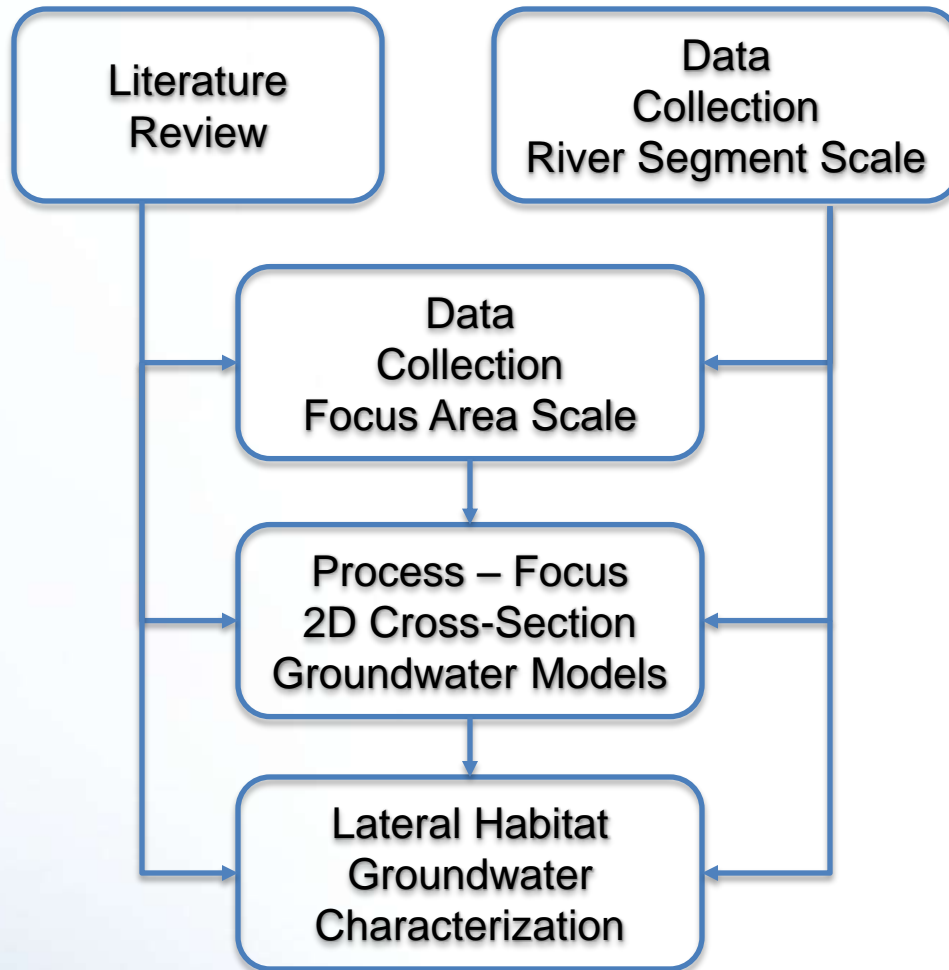
Study Process from Objectives to Final Informed Decisions



Groundwater Study Analysis Process



Focus Area Example: FA-128 (Slough 8A)



Data Collection on Annual Basis

- Winter and Summer
- Time-Series Information on Transects
- Additional Manual Measurements
- Spatial Data Sets – Thermal Imaging, Aerial Images (Winter, Summer)

Conceptual Models

- Helps Define the Hydrologic System – Groundwater, Surface Water, Atmospheric

Numerical Models

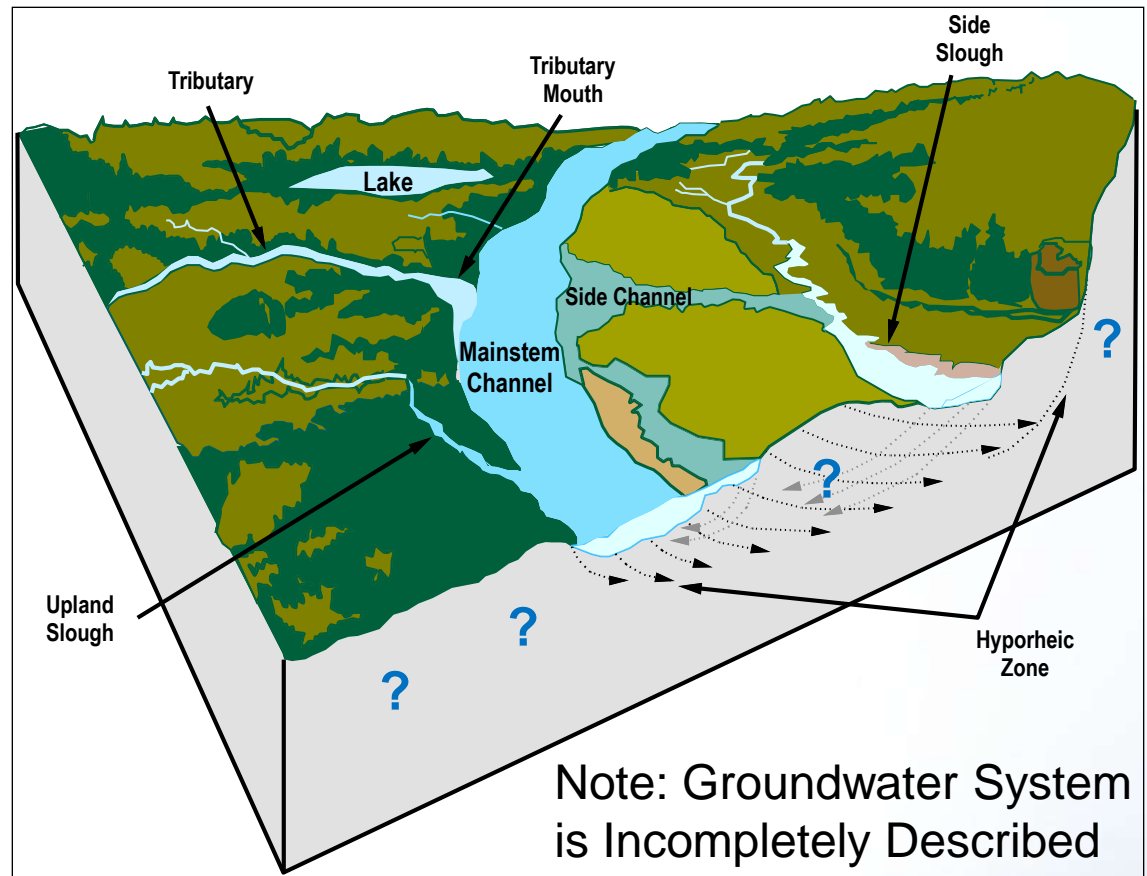
- Provide Process Understanding and Cause/Effect Analysis, Transient Analysis

Groundwater Study Modeling

- Why Model?
 - Understand processes we can not easily see place
 - Bracket the range of processes interactions
 - Use in combination of other data and studies to guide reasonable estimates of groundwater conditions and potential changes outside the range of natural variability
 - To address specific questions

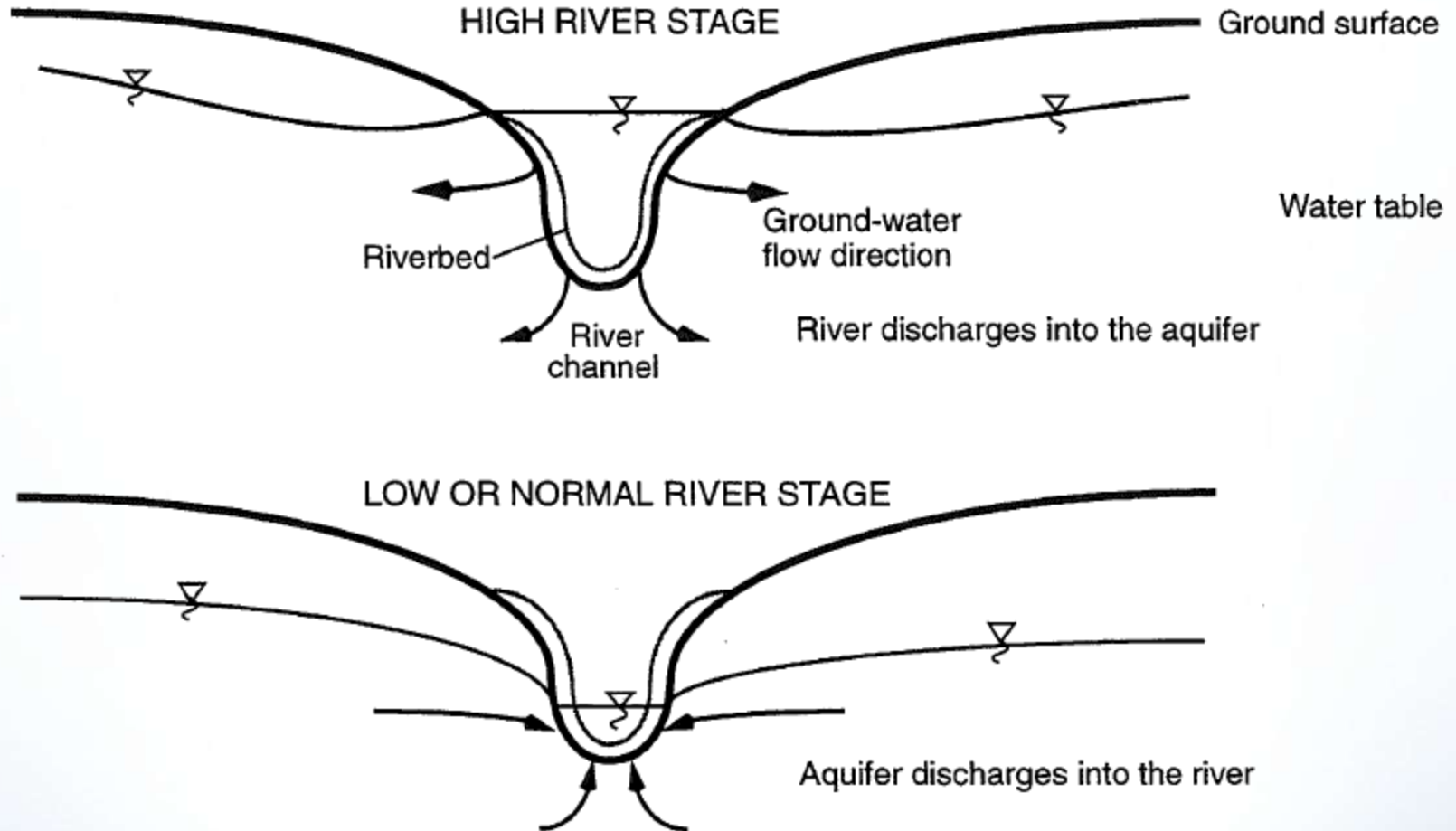
Aquatic and Riparian Resources

- Inter-Related
- Impacts on Riparian = Impacts on Aquatic
- Groundwater Questions Have Many Overlaps



Habitat types identified in the middle reach of the Susitna River during the 1980s studies (adapted from ADF&G 1983; Trihey 1982).

Groundwater/Surface-Water Interaction Processes



FA-128 (Slough 8A) Hydrology Features



FA 128 (Slough 8A) - Focus Area Groundwater Upwelling Features

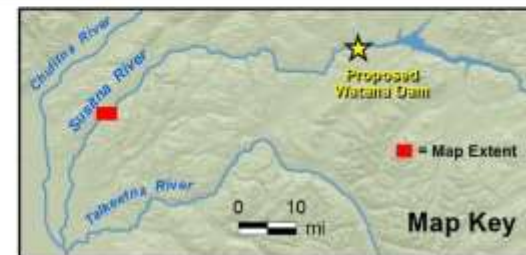
- Project River Mile
- ↘ Susitna Flow Direction
- FA 128 Side Channel/Slough Hydrological Features

Orthophoto Source: 2011 Matanuska-Susitna Borough LiDAR & Imagery Project Data Sources: See Map References



0 1,500 Feet

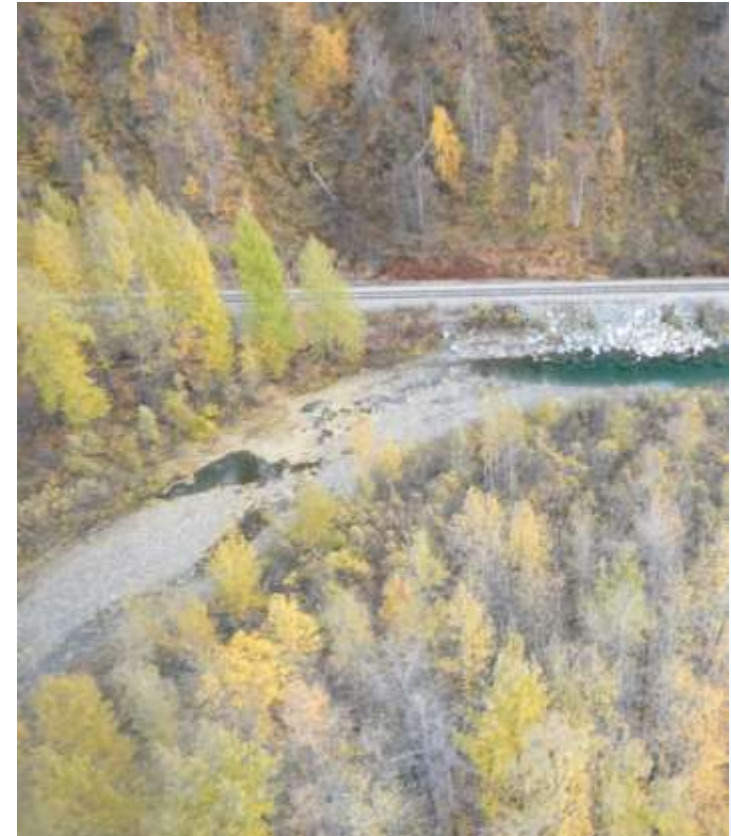
Projection: AK SP Zone 4 NAD 1983
Date Created: 3/27/2014
Map Author: GWS - Cari Ruffino
File: POC FA128.mxd



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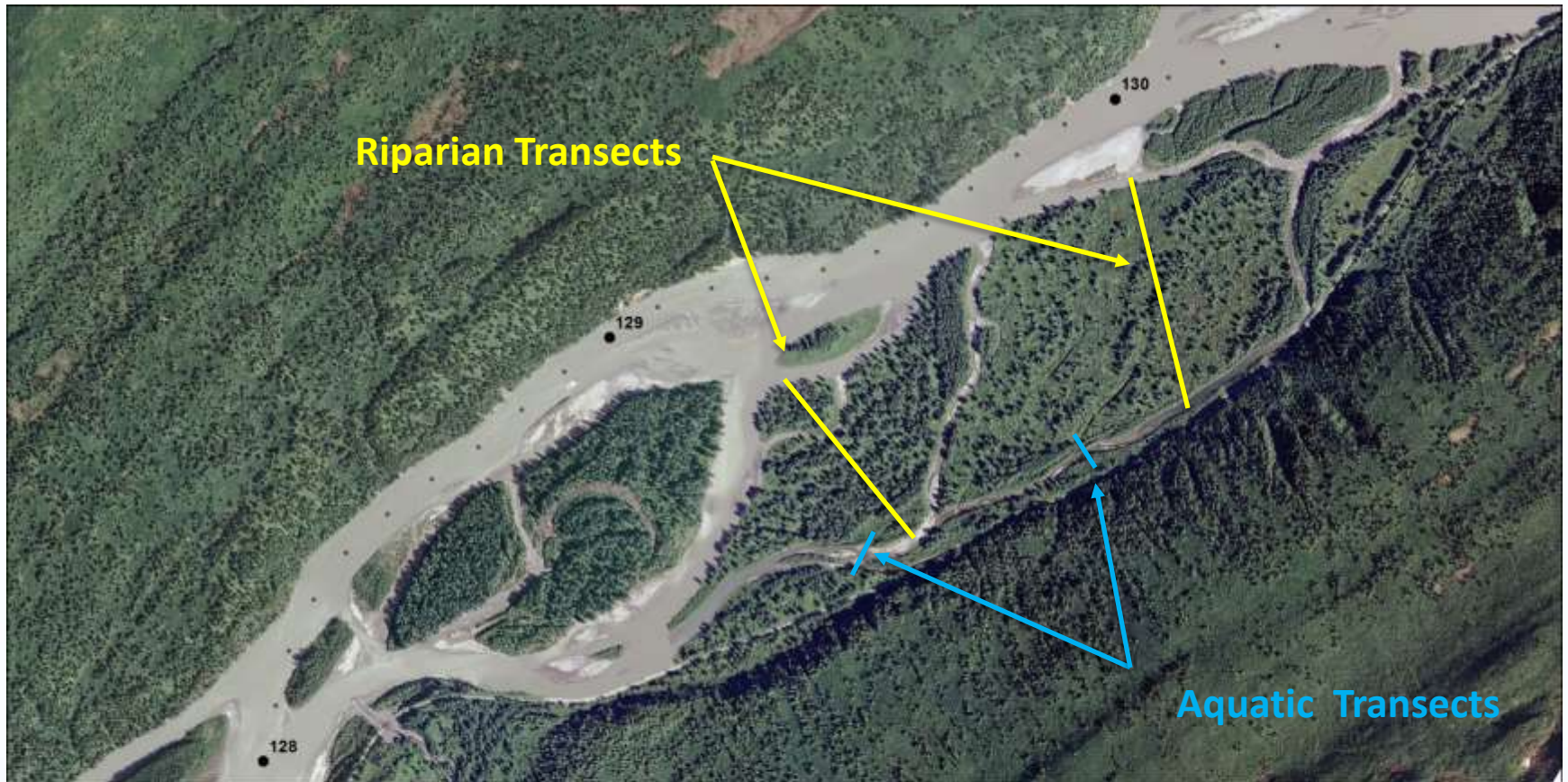
FA-128 (Slough 8A) Hydrology Features (A-G)

- A, B, C - Inlets to Upper Side Channel 8A
- D - Inlet to Transitional Channel/Slough 8A
- E - Inlet to Middle Side Channel 8A
- F – Outlet of Middle Side Channel 8A
- G – Confluence of Middle Side Channel 8A and Slough 8A



FA-128 – (Slough 8a), Upland Slough, Upstream End, October 3, 2013

FA-128 (Slough 8A) Analysis Transects



FA 128 (Slough 8A)



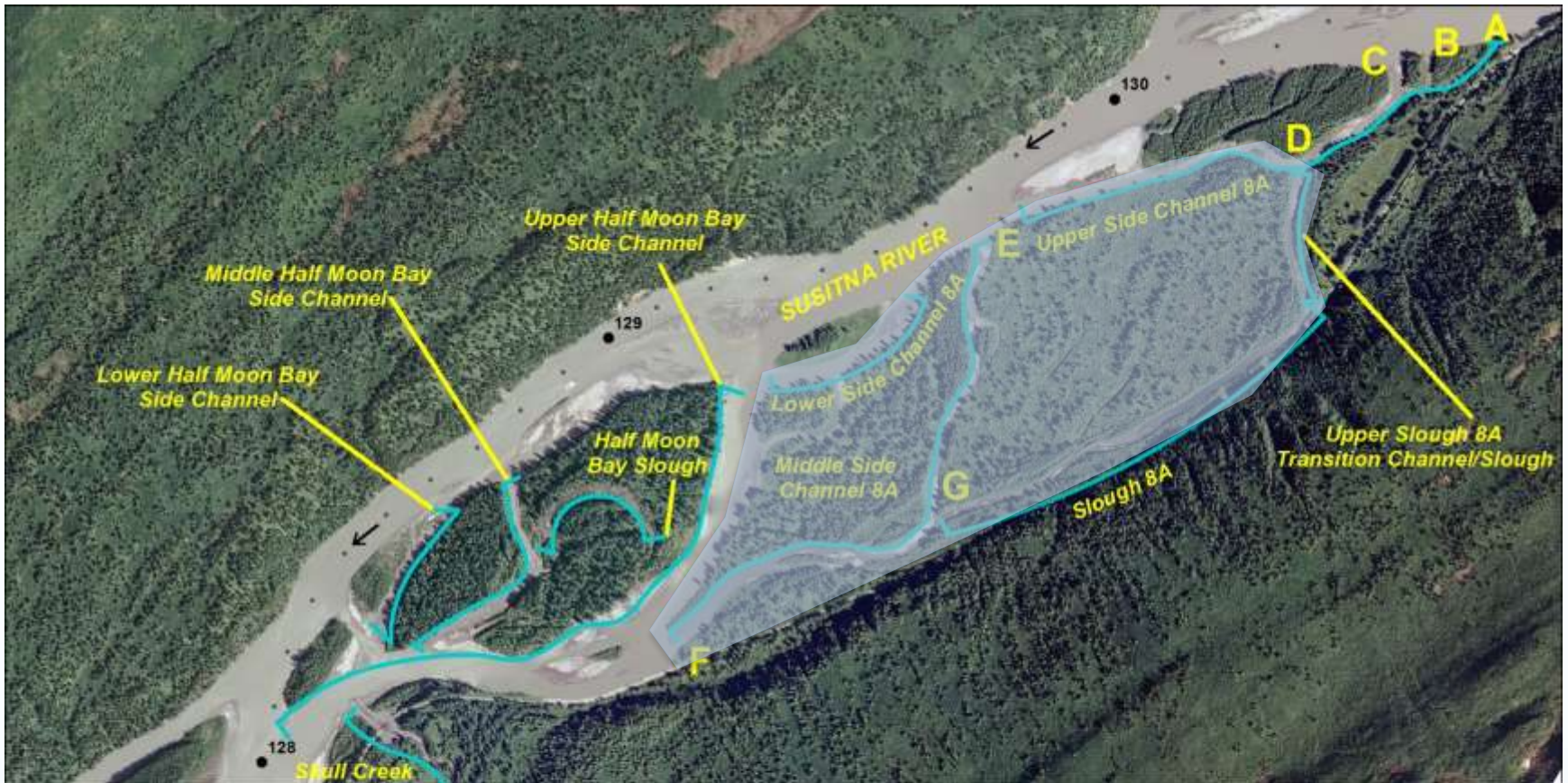
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Date Created: 3/27/2014
Map Author: GWS - Cari Ruffino
File: FA 128 Blank.mxd



● Project River Mile
Orthophoto Source: 2011 Matanuska-Susitna Borough LiDAR & Imagery Project Data Sources: See Map References

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FA-128 (Slough 8A) Primary Analysis Area



FA 128 (Slough 8A) - Focus Area Groundwater Upwelling Features

- Project River Mile
- ↘ Susitna Flow Direction
- FA 128 Side Channel/Slough Hydrological Features

Orthophoto Source: 2011 Matanuska-Susitna Borough LiDAR & Imagery Project Data Sources: See Map References

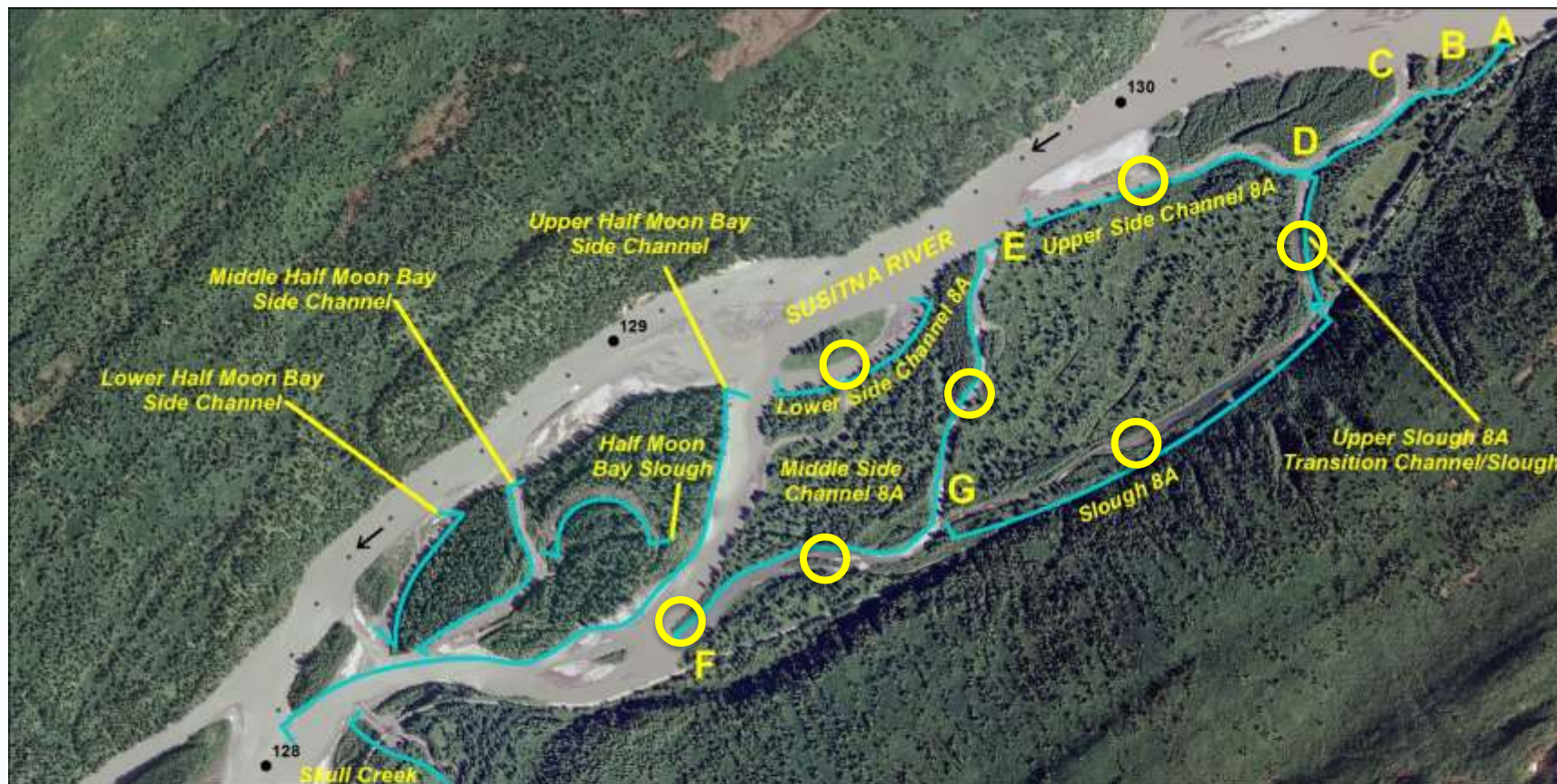


Projection: AK SP Zone 4 NAD 1983
 Date Created: 3/27/2014
 Map Author: GWS - Cari Ruffino
 File: POC FA128.mxd



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FA-128 (Slough 8A) Key Hydrologic Boundaries



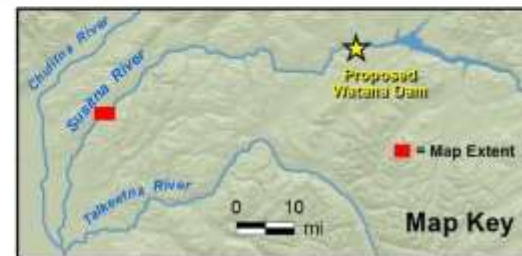
FA 128 (Slough 8A) - Focus Area Groundwater Upwelling Features

- Project River Mile
- ↘ Susitna Flow Direction
- FA 128 Side Channel/Slough Hydrological Features

Orthophoto Source: 2011 Matanuska-Susitna Borough LiDAR & Imagery Project Data Sources: See Map References

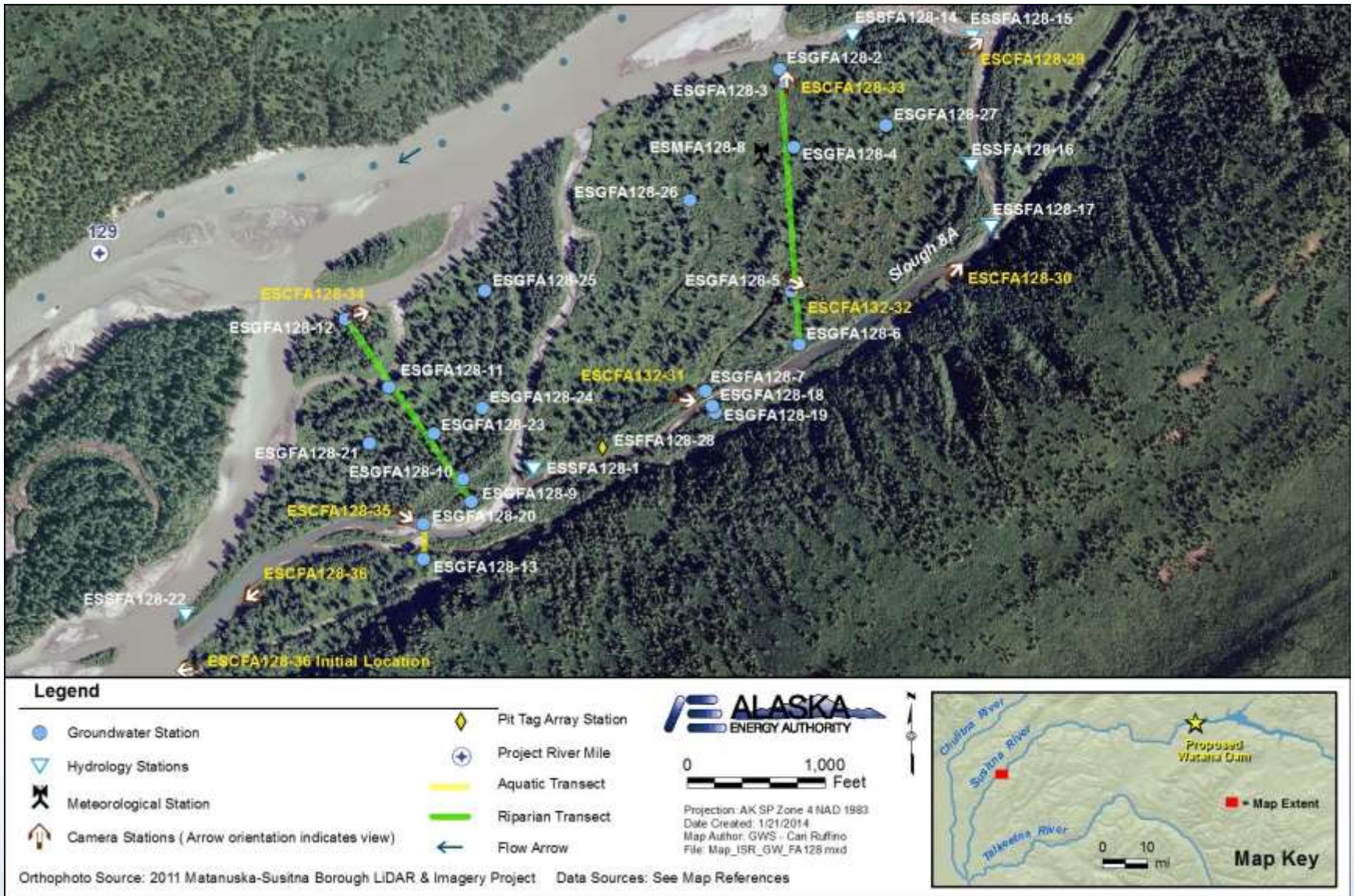


Projection: AK SP Zone 4 NAD 1983
 Date Created: 3/27/2014
 Map Author: GWS - Cari Ruffino
 File: POC FA128.mxd



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FA-128 (Slough 8A) Data Stations



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FA-128 (Slough 8A) Survey Control



Legend

- ⊗ RTK Survey Control Point
- Elevation Control Points - Level Loop Surveys
- ⊕ Project River Mile
- ← Flow Arrow

Orthophoto Source: 2011 Matanuska-Susitna Borough LIDAR & Imagery Project Data Sources: See Map References



0 1,000 Feet

Projection: AK SP Zone 4 NAD 1983
Date Created: 1/21/2014
Map Author: GWS - Carl Ruffino
File: Map_ISR_GW_FA128_TBM.mxd



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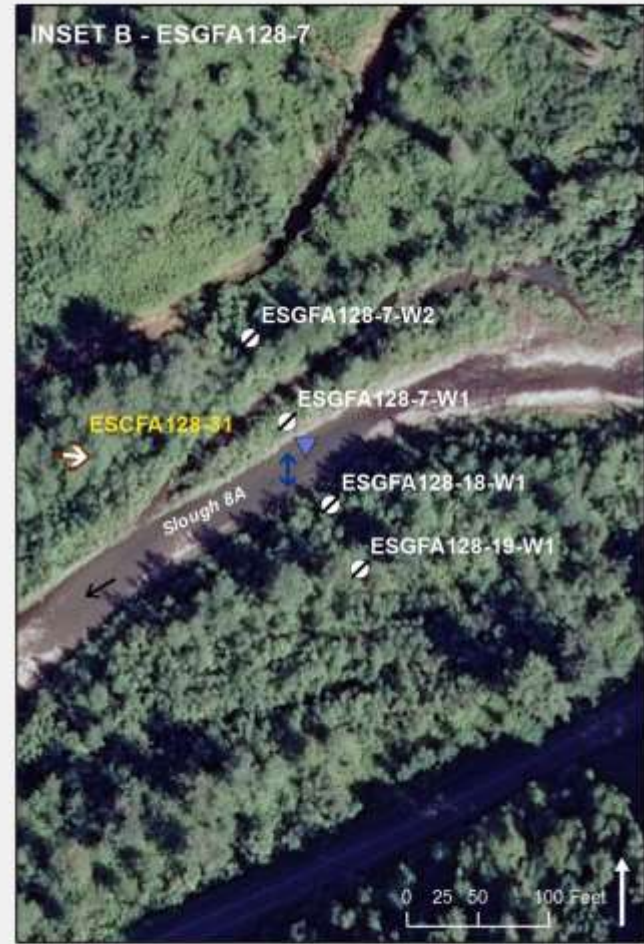
FA-128 (Slough 8A) Groundwater Wells



Legend					
Well - Water Level, Temperature Surface-Water Stage Soil/Streambed Temperature Profile Location Meteorological Station	Flow Arrow Camera (Arrow orientation indicates view.) Project River Mile				
<p>Orthophoto Source: 2011 Matanuska-Susitna Borough LIDAR & Imagery Project Data Sources: See Map References</p>					

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FA-128 (Slough 8A) Aquatic Transect Stations



Legend

- Well - Water Level, Temperature
 - Surface-Water Stage
- Soil/Streambed Temperature Profile String
 - Camera Stations (Arrow orientation indicates view)
- Flow Arrow

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GW/SW Examples – Aerial Images

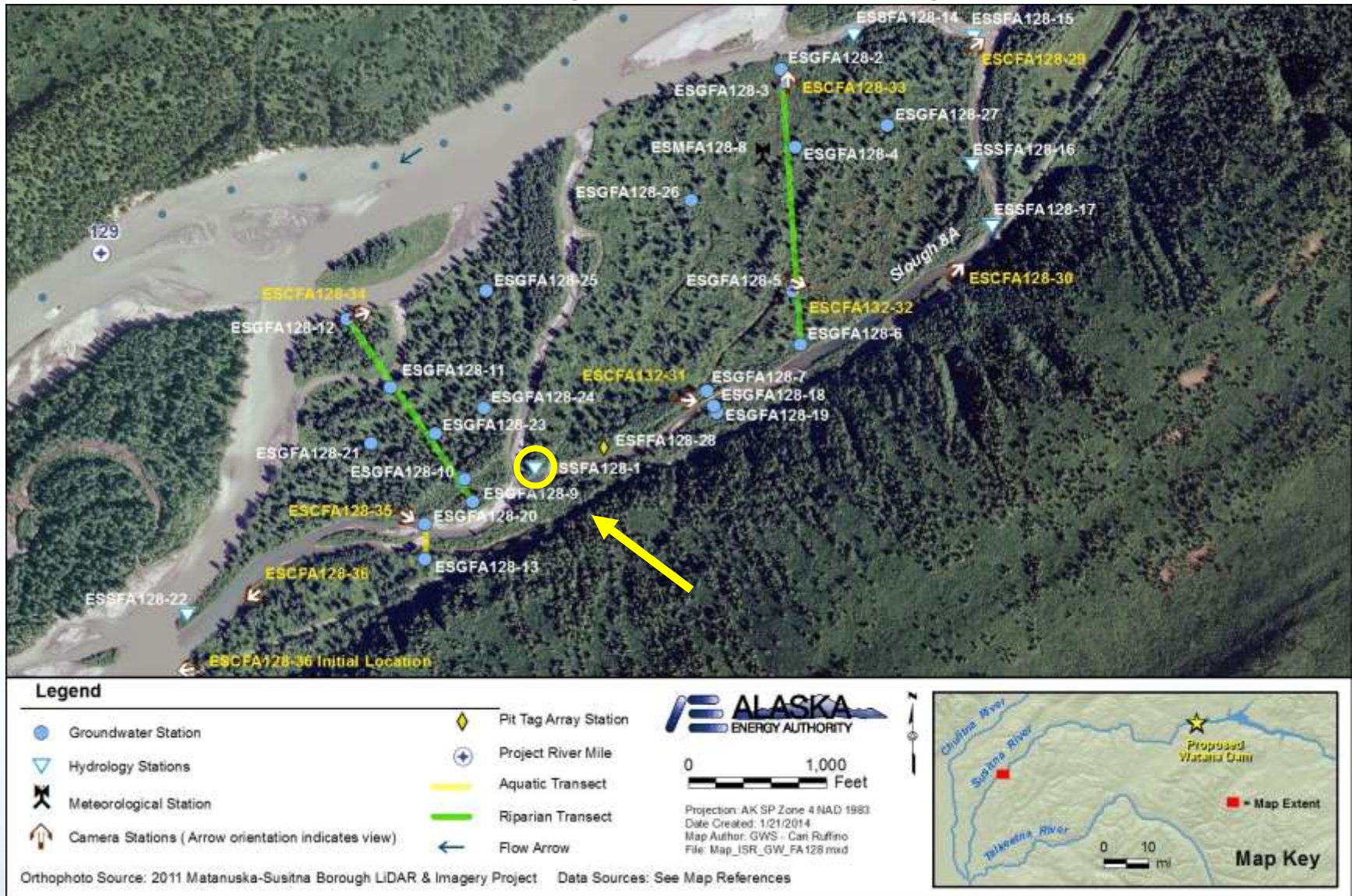


FA-128 – (Slough 8A), Junction of Middle Side Channel 8A and Slough 8A, June 12, 2013
Susitna River at Gold Creek (12:20) = 35,900 CFS



FA-128 – (Slough 8A), Junction of Middle Side Channel 8A and Slough 8A, October 3, 2013
Susitna River at Gold Creek (15:45) = 9,130 CFS

ESSFA128-1 Example - Time-Lapse Cameras

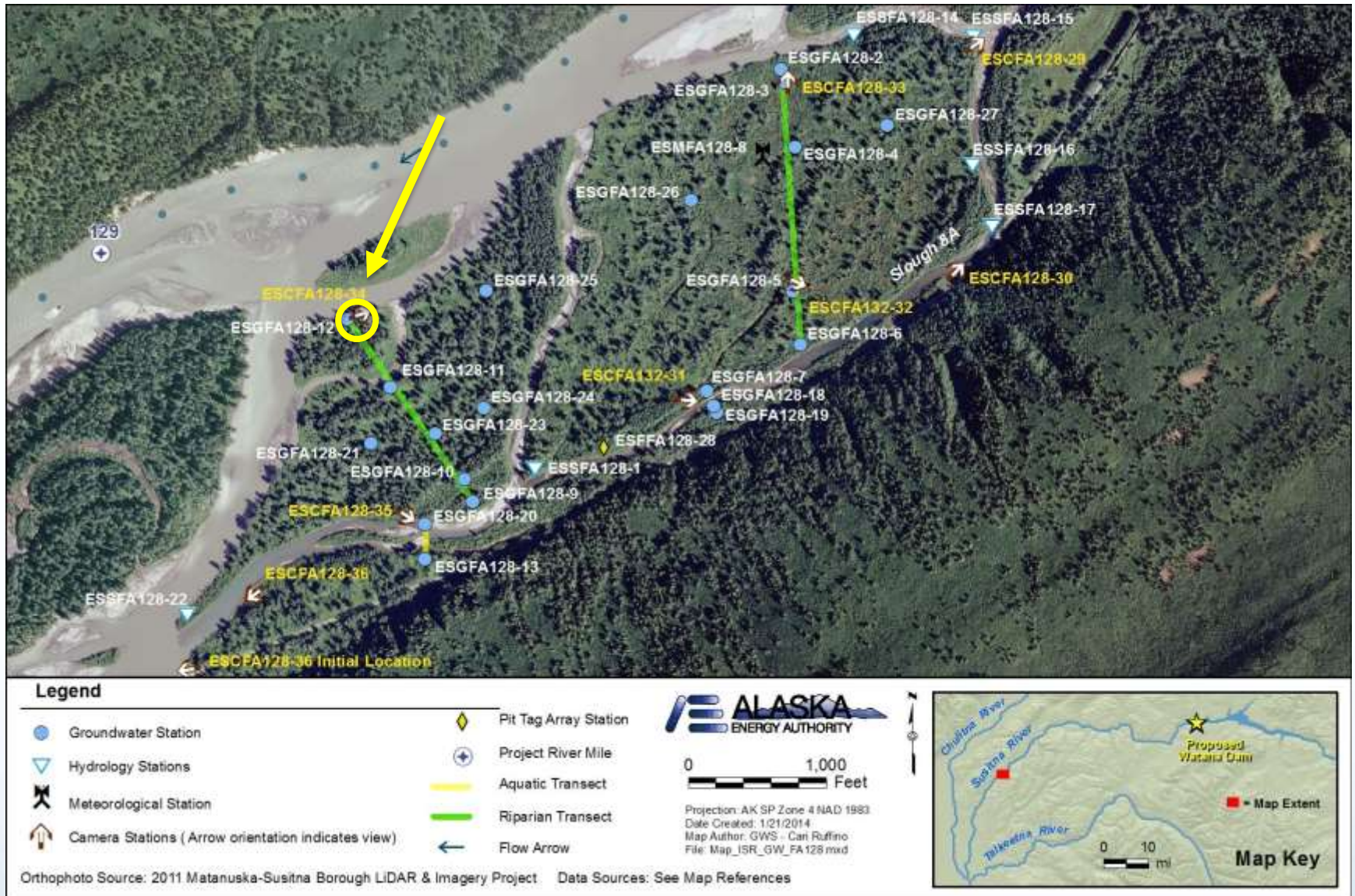


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ESSFA128-1 Example - Time-Lapse Cameras

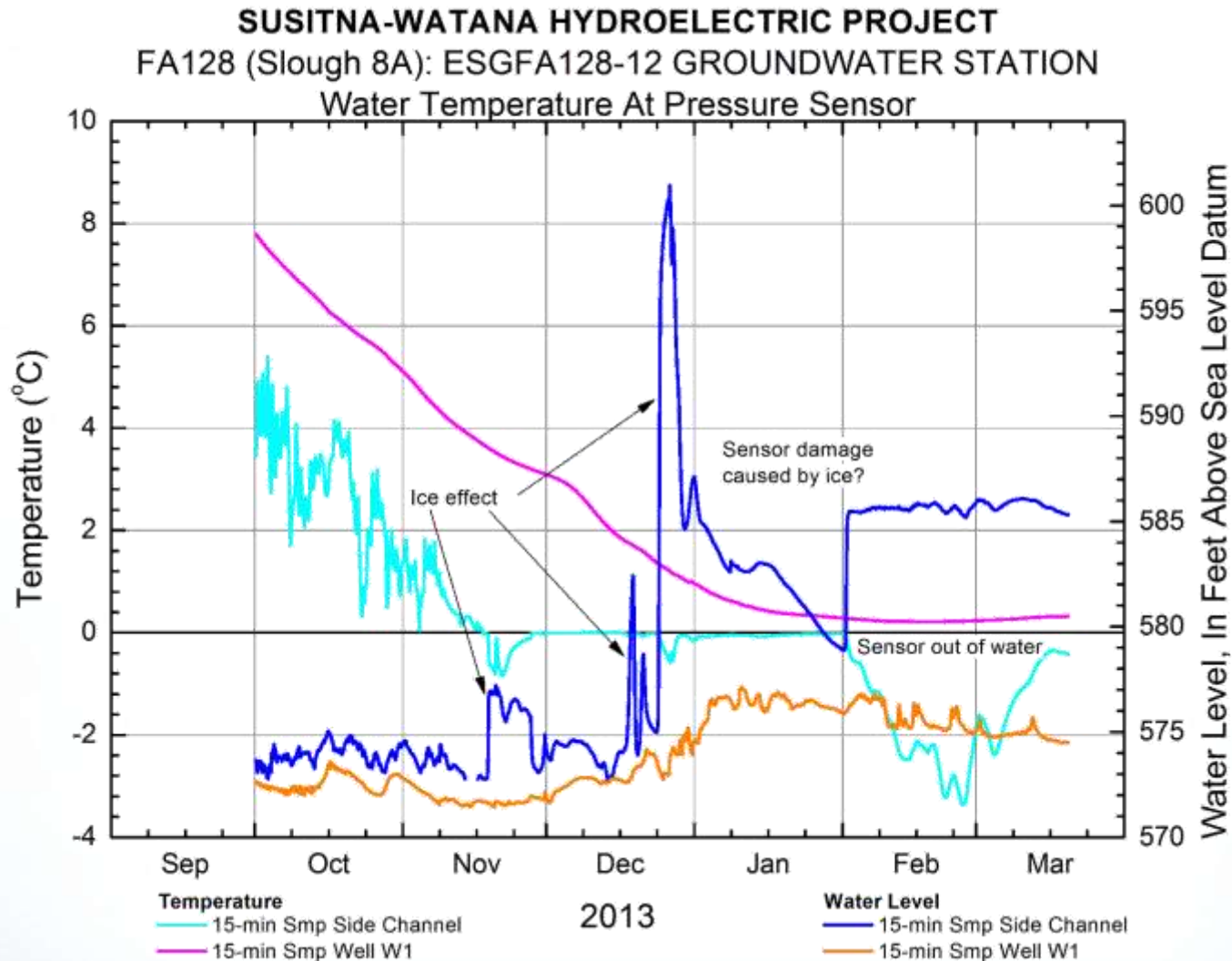


ESGFA128-12 Example – Temperature, Water Level

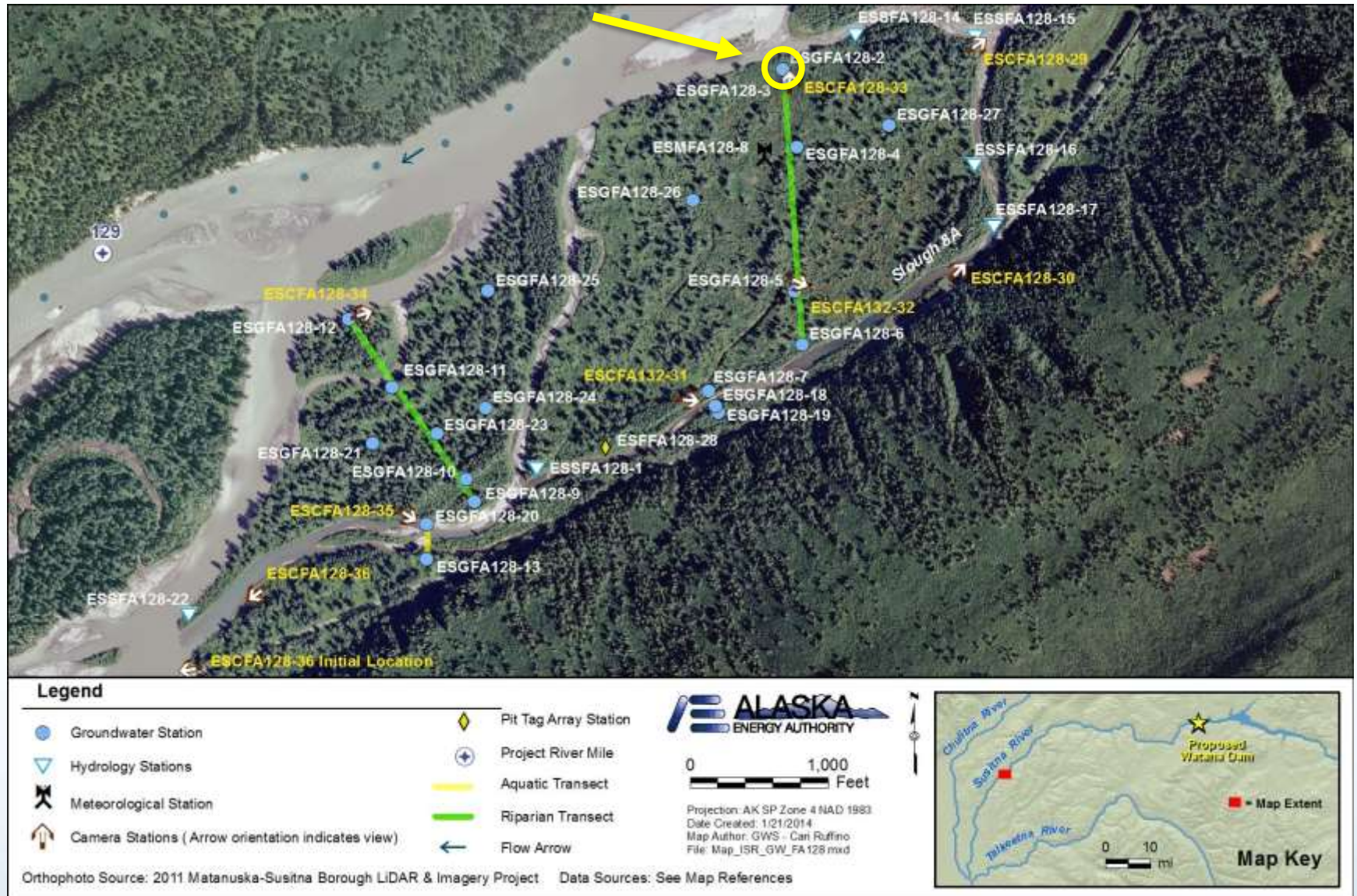


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ESGFA128-12 Example – Temperature, Water Level



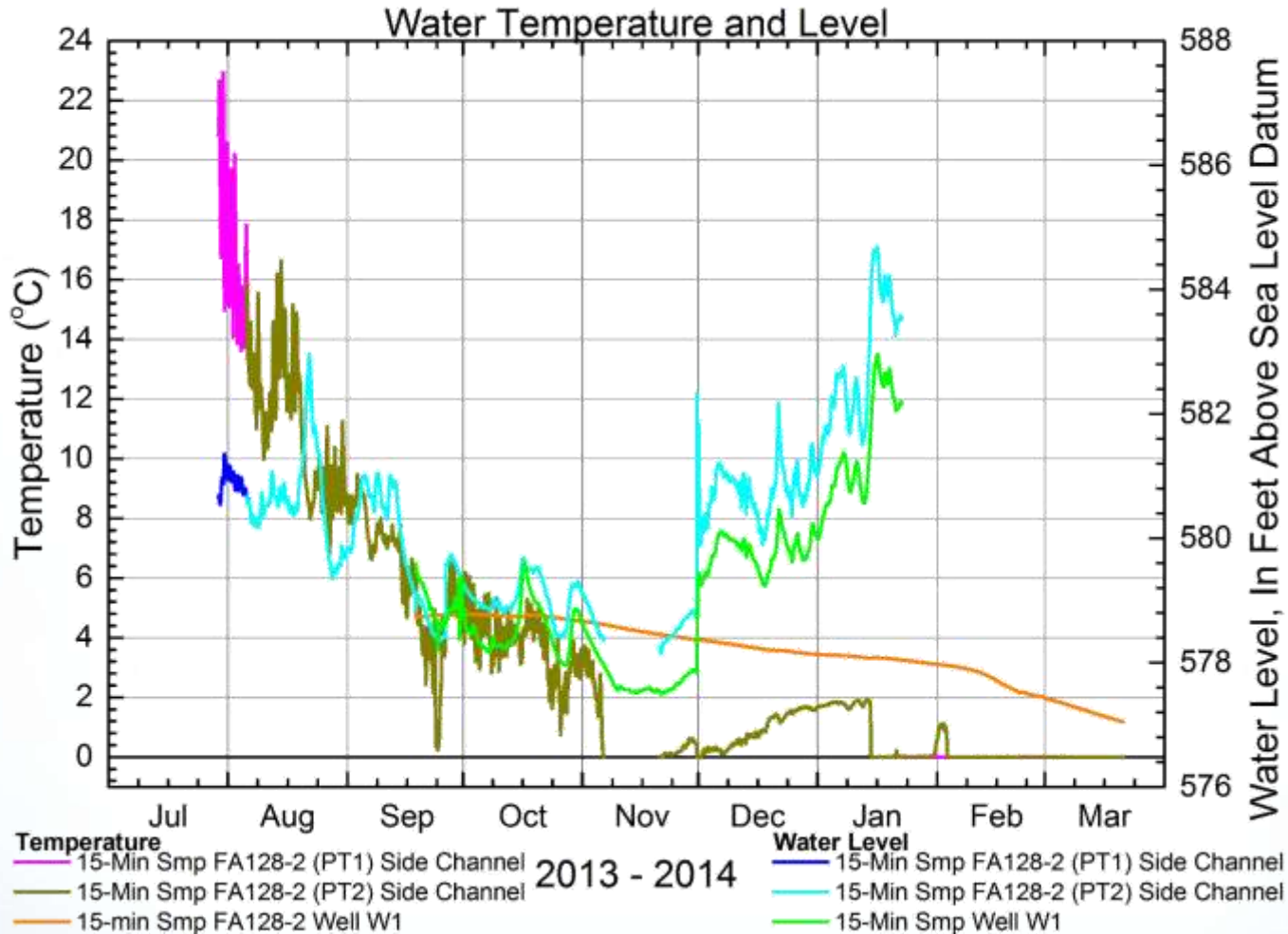
ESGFA128-2 Example – Temperature, Water Level



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ESGFA128-2 Example – Temperature, Water Level

SUSITNA-WATANA HYDROELECTRIC PROJECT FA128 (Slough 8A): ESGFA128-2 GROUNDWATER STATION



ESSFA128-1, ESGFA128-6,-13 Example – Water Level

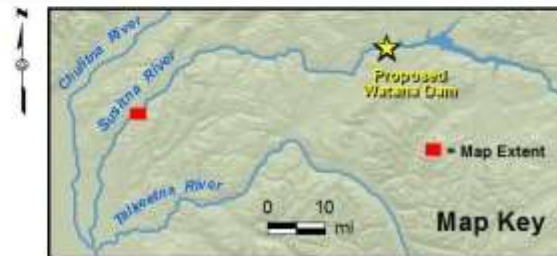


Legend

- Groundwater Station
- Hydrology Stations
- Meteorological Station
- Camera Stations (Arrow orientation indicates view)
- Pit Tag Array Station
- Project River Mile
- Aquatic Transect
- Riparian Transect
- Flow Arrow



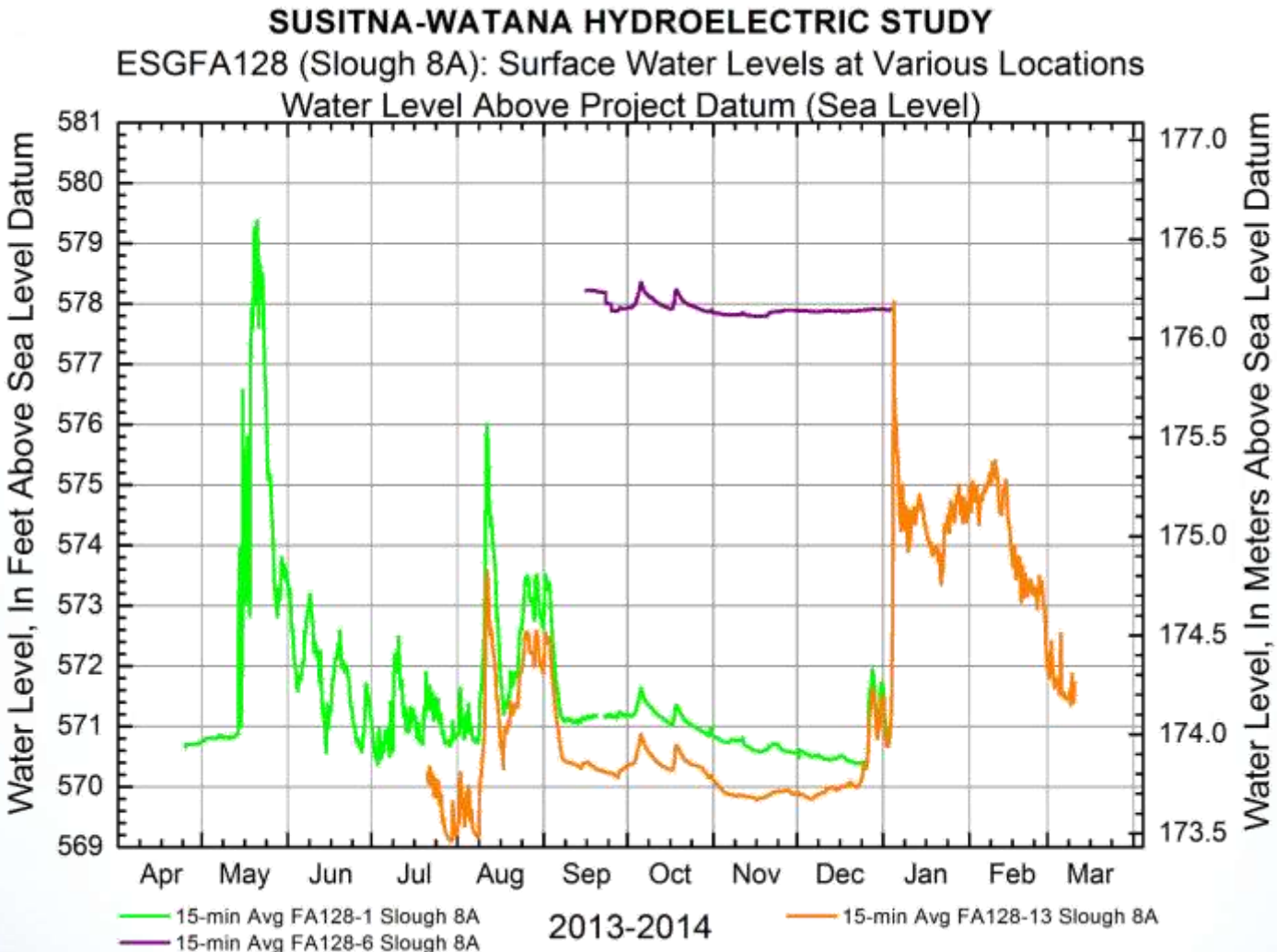
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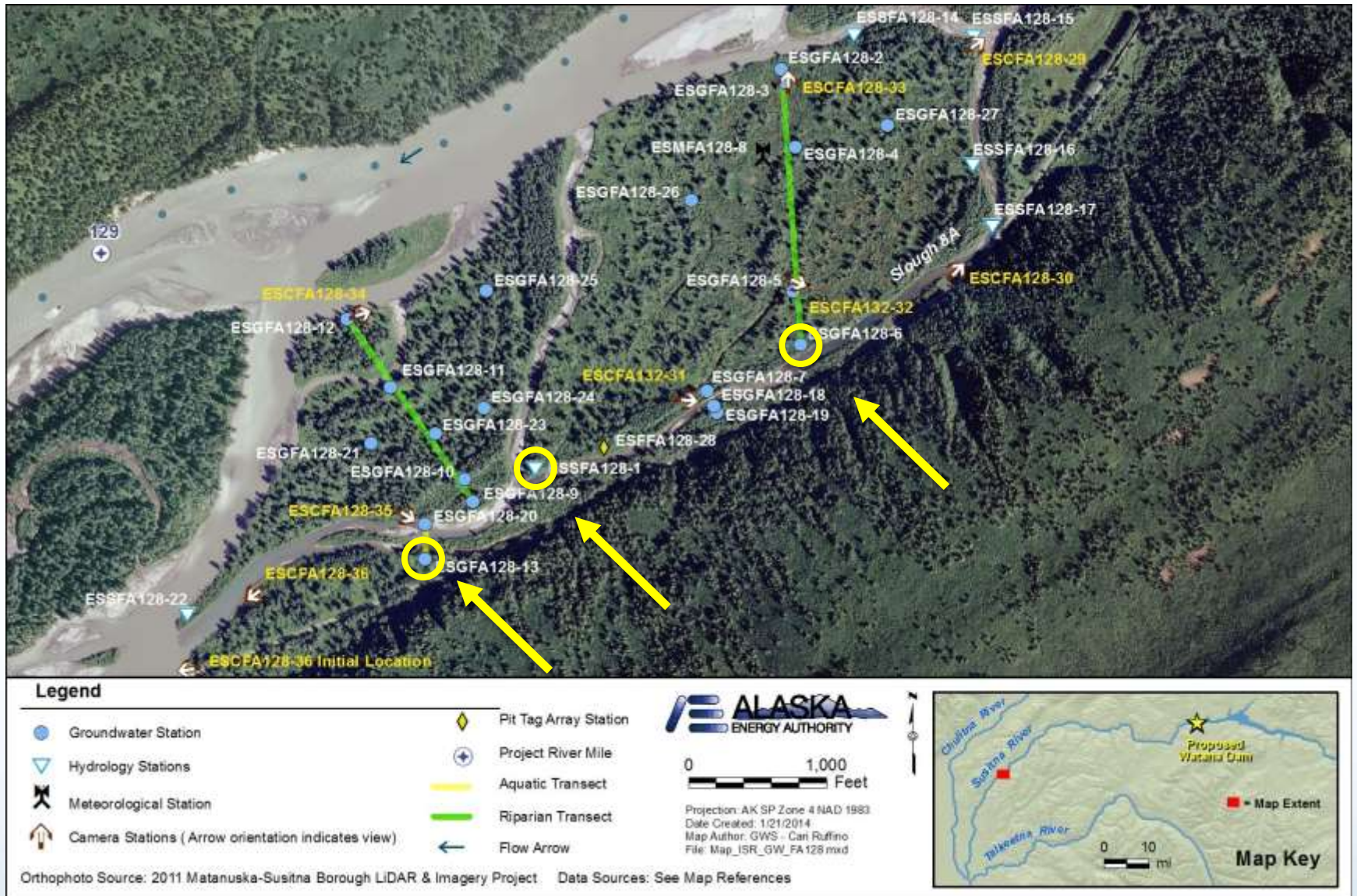
Orthophoto Source: 2011 Matanuska-Susitna Borough LIDAR & Imagery Project Data Sources: See Map References

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ESSFA128-1, ESGFA128-6,-13 Example – Water Level

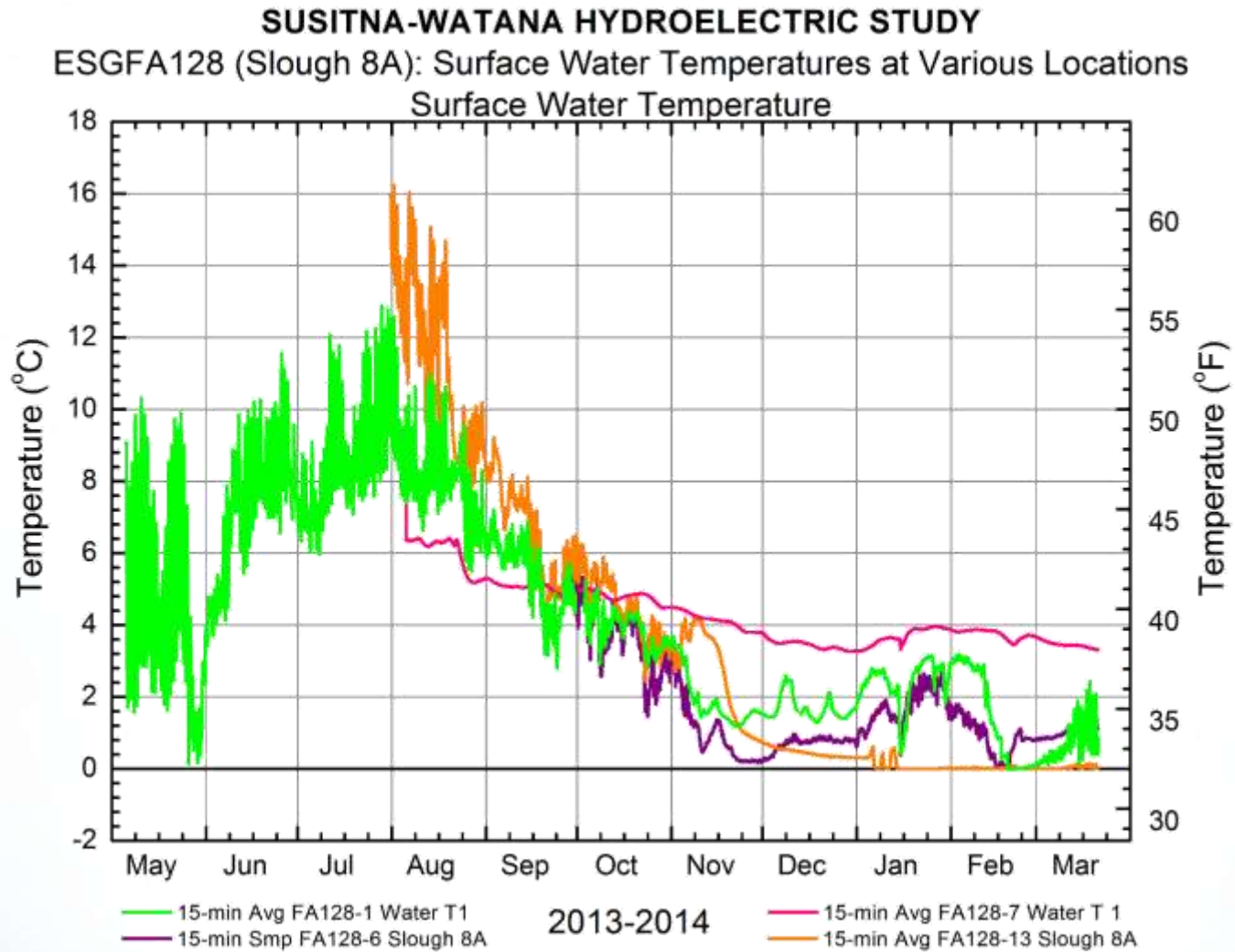


ESSFA128-1, ESGFA128-6,-7,-13 Example –Temp

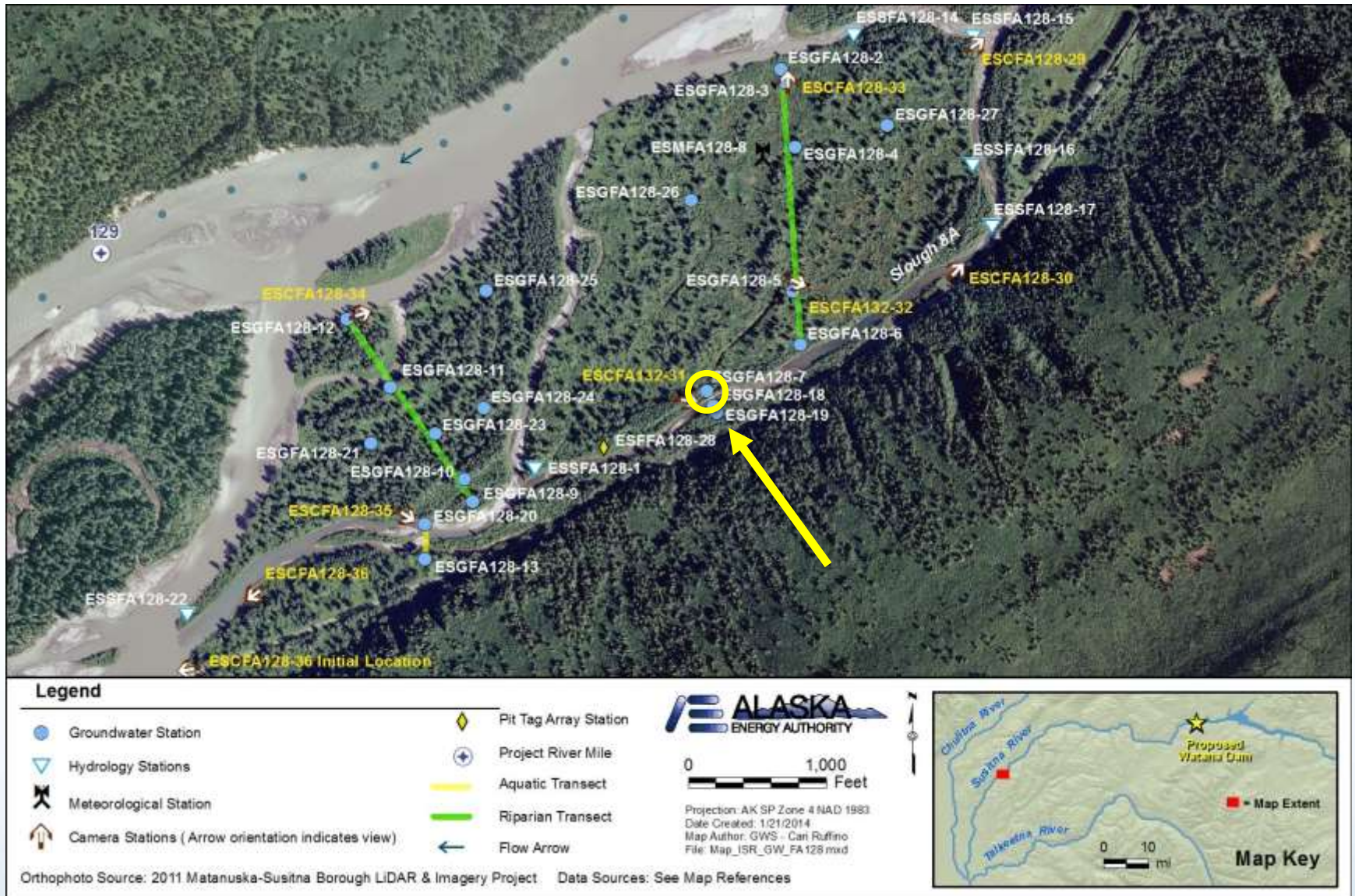


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ESSFA128-1, ESGFA128-6,-7,-13 Example –Temp

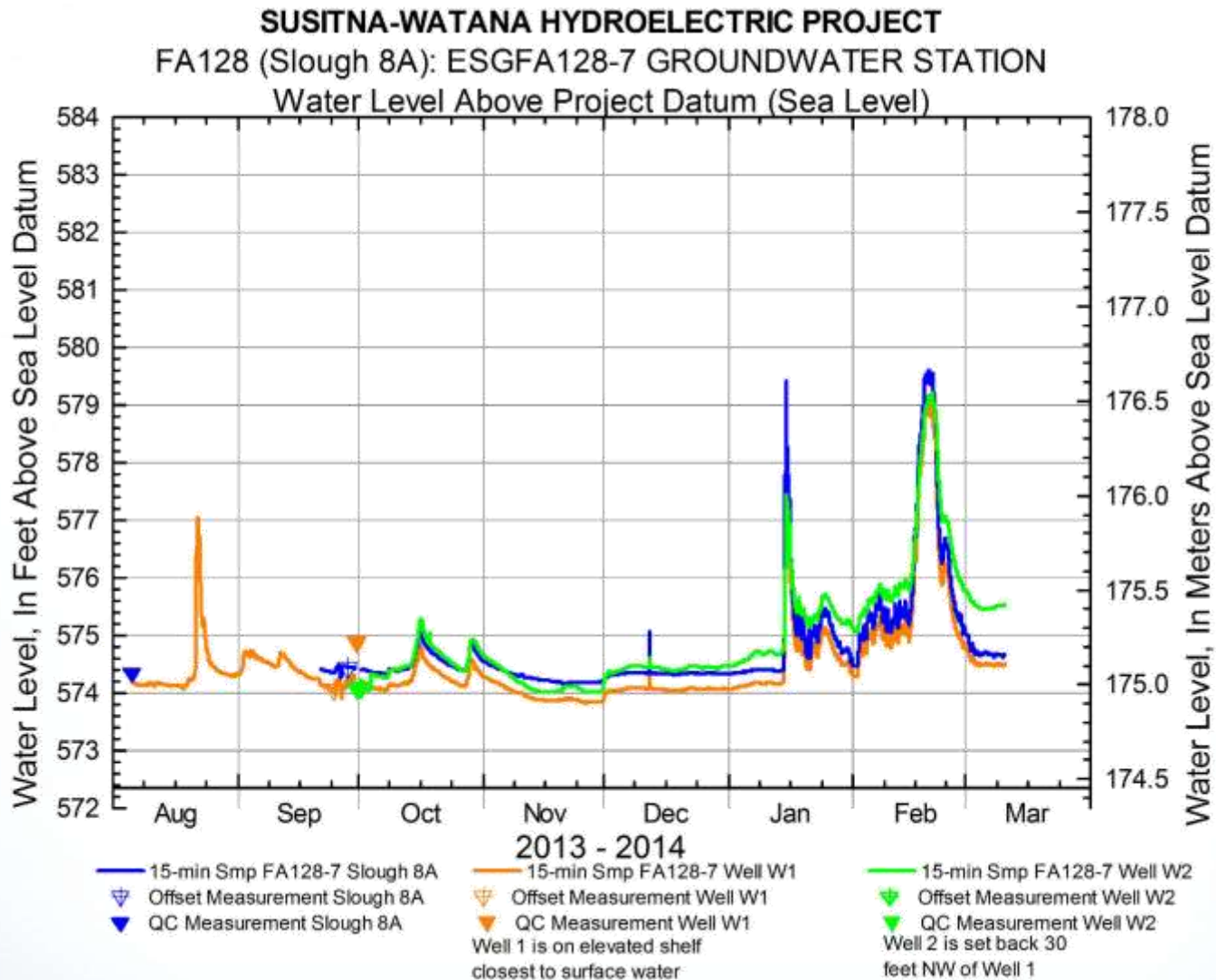


ESGFA128-7 Example – Water Level, Temperature



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ESGFA128-7 Example – Water Level



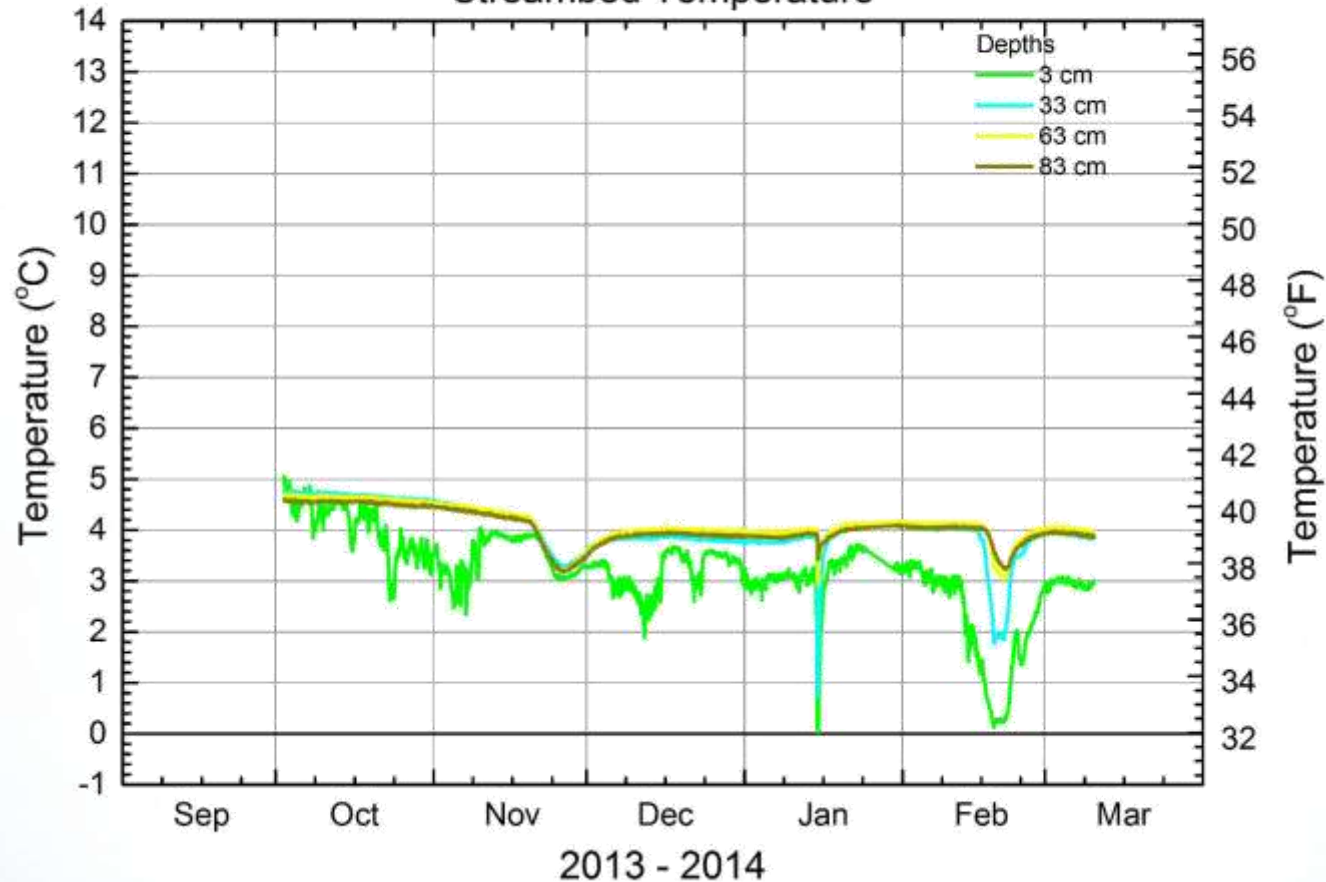
ESGFA128-7 Example – Temperature

SUSITNA-WATANA HYDROELECTRIC PROJECT
FA128 (Slough 8A): ESGFA128-7 GROUNDWATER STATION
Water Temperature At Pressure Sensor



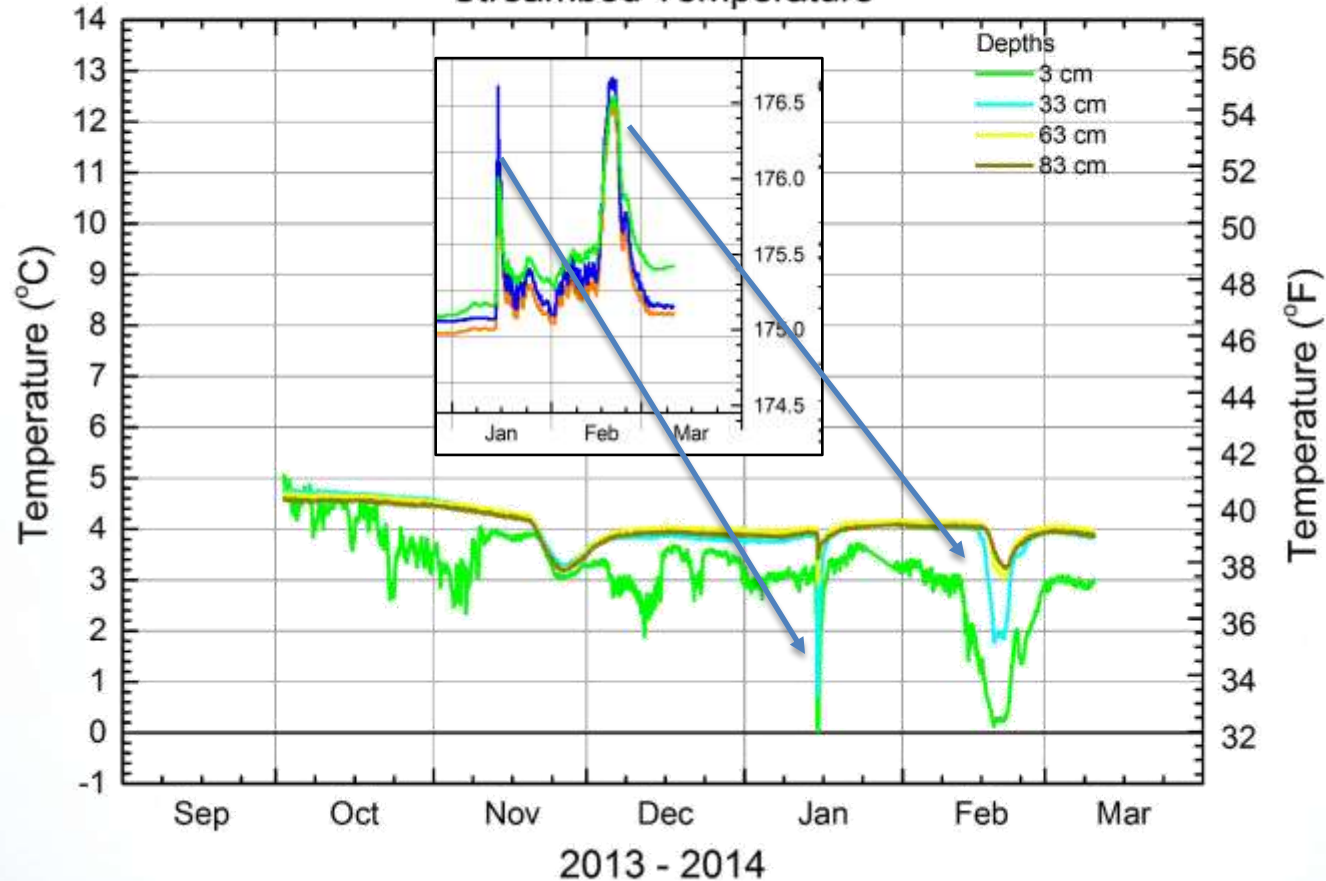
ESGFA128-7 Example – Streambed Temperatures

SUSITNA-WATANA HYDROELECTRIC PROJECT
FA128 (Slough 8A): ESGFA128-7 GROUNDWATER STATION
Streambed Temperature



ESGFA128-7 Example – Streambed Temperatures

SUSITNA-WATANA HYDROELECTRIC PROJECT
FA128 (Slough 8A): ESGFA128-7 GROUNDWATER STATION
Streambed Temperature



GW/SW FA-128 (Slough 8A) Upwelling Data



FA 128 (Slough 8A) - Focus Area Groundwater Upwelling Features

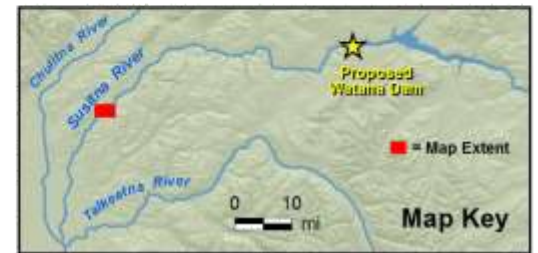
HSC Positive VHG Measurement

- June
- July
- August
- September

- TIR 2012
- TIR 2013
- Susitna Flow Direction
- Project River Mile



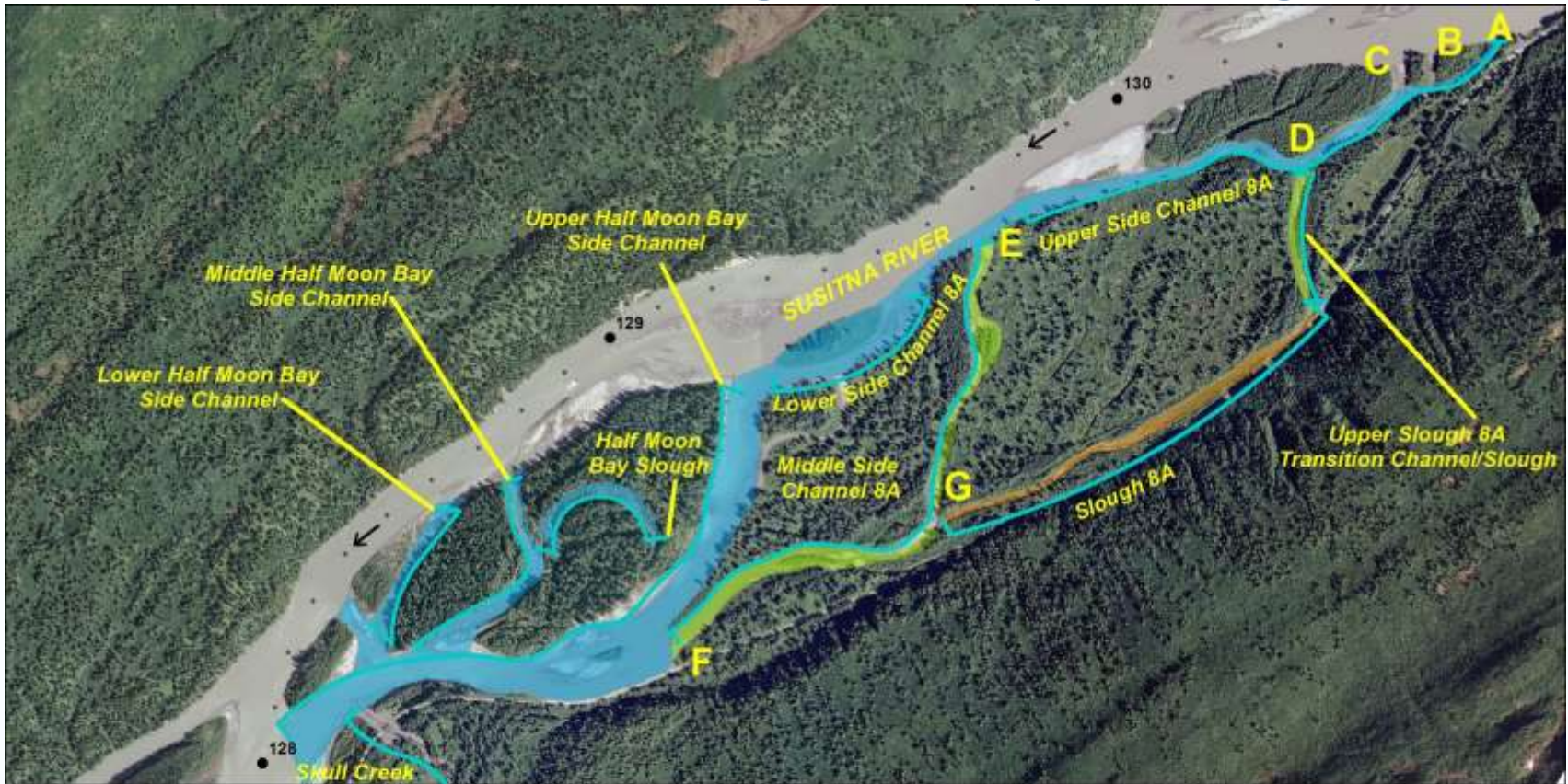
Projection: AK SP Zone 4 NAD 1983
 Date Created: 3/31/2014
 Map Author: GWS - Carl Ruffino
 File: POC_FA_128_TIRVHG_HSC.mxd



Orthophoto Source: 2011 Matanuska-Susitna Borough LiDAR & Imagery Project Data Sources: See Map References

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GW/SW FA-128 (Slough 8A) Upwelling Zones



FA 128 (Slough 8A) - Focus Area Groundwater Upwelling Features

- Project River Mile
- ↘ Susitna Flow Direction
- Light Blue: Riverine Dominated
- Green: Riverine, Upland Transitional
- Orange: Upland Dominated
- Thick Blue Line: FA 128 Side Channel/Slough Hydrological Features

Orthophoto Source: 2011 Matanuska-Susitna Borough LIDAR & Imagery Project

Data Sources: See Map References



Projection: AK SP Zone 4 NAD 1983
 Date Created: 3/31/2014
 Map Author: GWS - Carl Ruffino
 File: POC FA128_Upwelling Edits.mxd



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Focus Area Example: FA-128 (Slough8A)

- Aquatic Section FA128-2DM1 – Slough 8A
 - Upland Dominated, groundwater inflow, warm
- Aquatic Section FA128-2DM2 – Middle Side Channel 8A (Lower)
 - Both lateral groundwater inflow (warm) and mainstem surface water (cold – winter; warm – summer)
 - Riverine, Upland Transitional



FA-128 – (Slough 8a), Upland Slough, location of aquatic transect FA1282DM1, October 29, 2013

Focus Area Example: FA-128 (Slough8A)

- Aquatic Section FA128-2DM1 – Slough 8A
 - Upland Dominated, groundwater inflow, warm
- Aquatic Section FA128-2DM2 – Middle Side Channel 8A (Lower)
 - Both lateral groundwater inflow (warm) and mainstem surface water (cold – winter; warm – summer)
 - Riverine, Upland Transitional

**Groundwater Upwelling Trends
Matrix Input Table – Example Only**

Month	Slough Lateral Habitat	Side Channel Lateral Habitat
Oct	Up, Increasing	Up, Increasing
Nov	Up, Increasing	Up, Increasing
Dec	Up, Increasing	Up, Increasing
Jan	Up, Increasing	Up, Increasing
Feb	Up, Increasing	Up, Increasing
Mar	Up, Stable	Up, Stable
Apr	Up, Stable	Up, Stable
May	Up, Stable	Up, Stable
June	Down, Increasing	Down, Increasing
Jul	Down, Increasing	Up, Increasing
Aug	Down, Stable	Up, Stable
Sept	Reversing	Up, Decreasing

Next Steps

- Continued Empirical Data Collection
- GW/SW Process Numerical Modeling (Year 2)
- Empirical Relationship Development
- Upscaling



FA-128 (Slough 8A), Slough 8A and Middle Side Channel 8A junction on October 29, 2013