

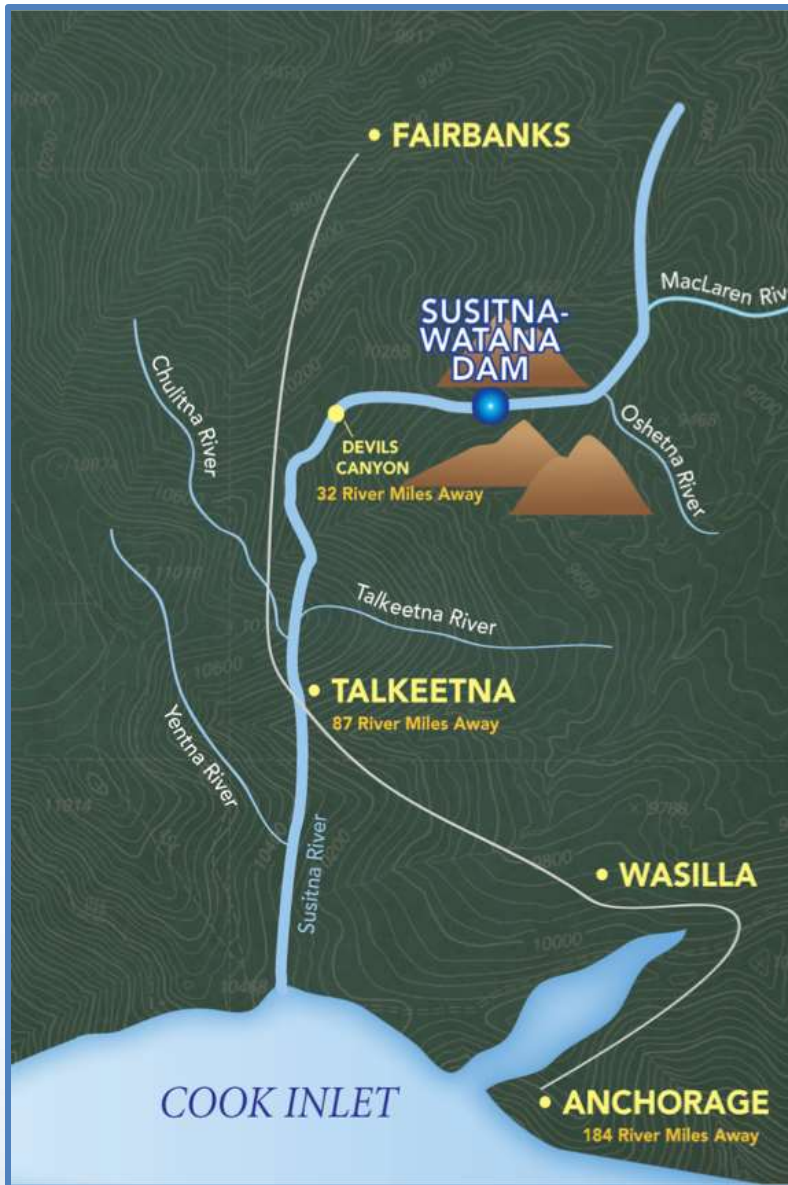


# SUSITNA-WATANA HYDROELECTRIC PROJECT

## Water Resources Technical Work Group Meeting 2nd Quarter 2013 Ice Processes

June 26, 2013

Prepared by HDR Alaska, Inc.



# Ice Processes Presentation Outline

## 2013 1<sup>st</sup> and 2<sup>nd</sup> Quarter Study Results Summary

- Freeze-up
- Thickness, Elevation, Discharge
- Open Leads
- Breakup Progression and Ice Jams
- Lower River HEC-RAS Model

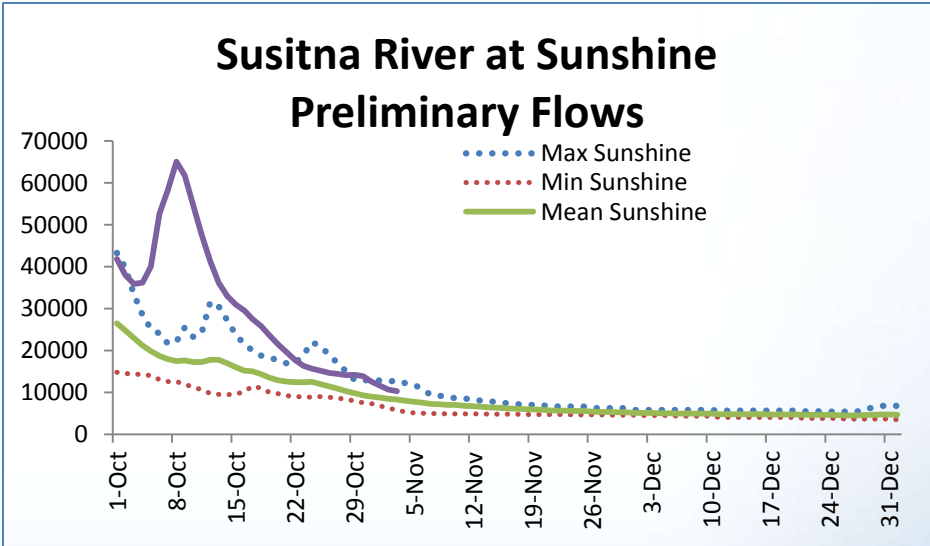
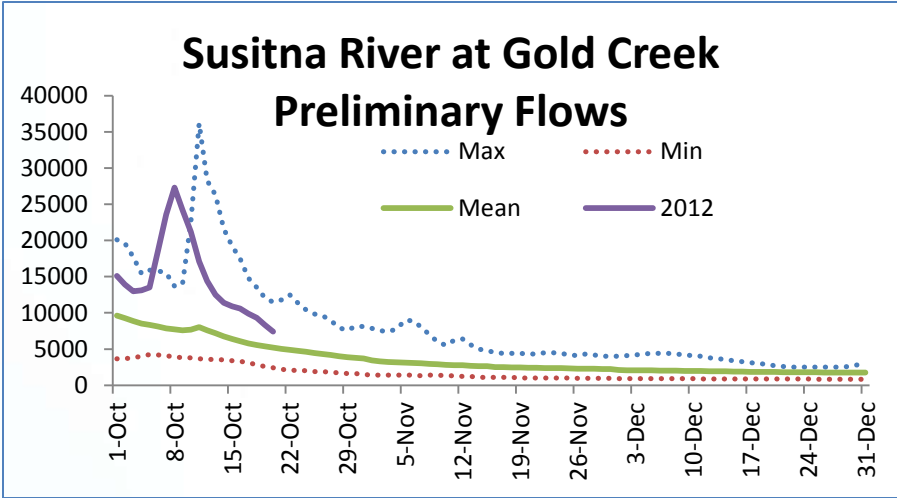


## 2012-2013 Freeze-up Conditions

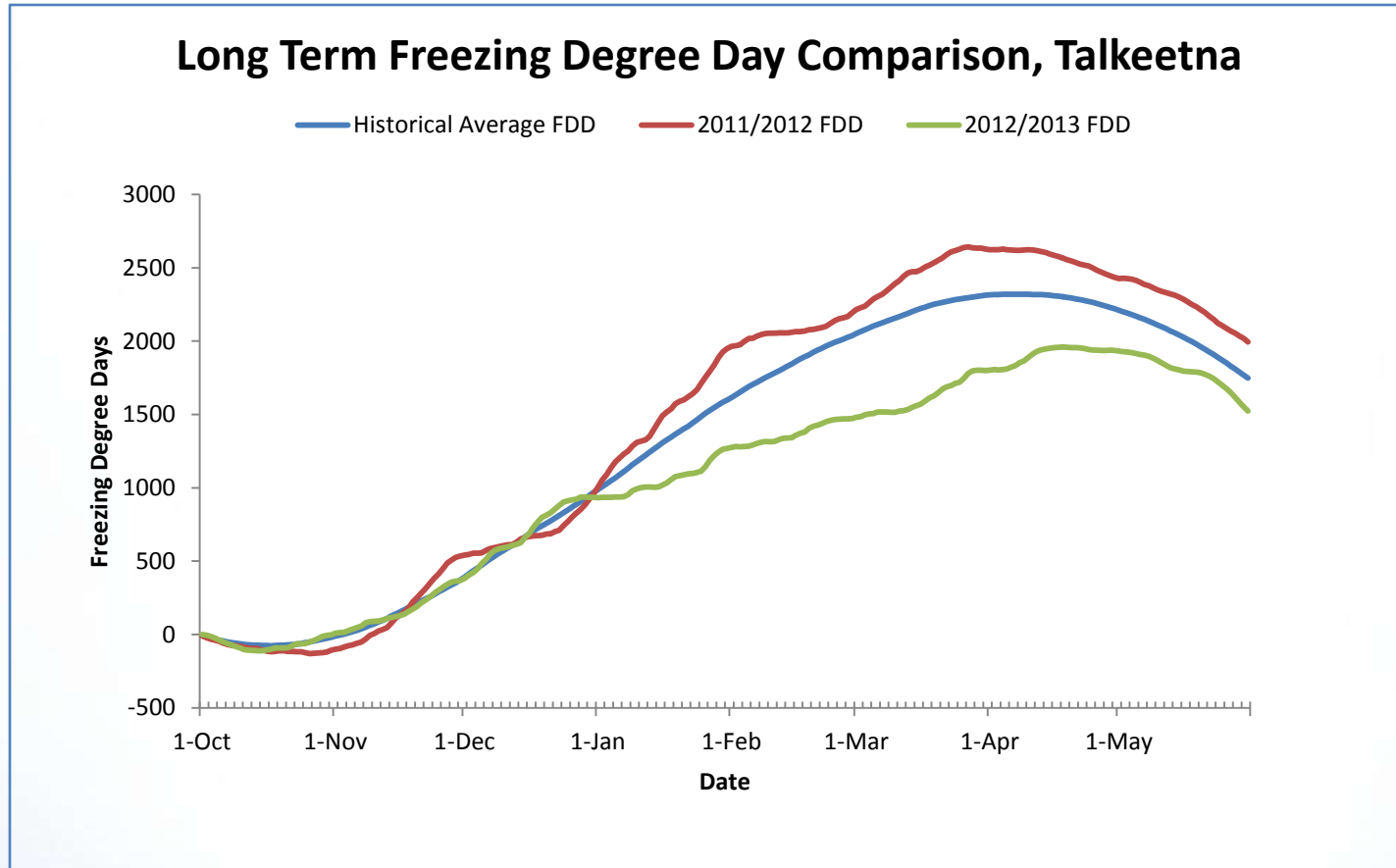
- Higher than average flows during early ice formation dropping to normal winter flows
- Temperatures in November average, warmer December and January
- In the Lower River, a continuous ice cover progressed from tidewater upstream to PRM 121.
- In the Middle River, a second bridge at PRM 124 initiated ice cover to the mouth of Devils Canyon. Multiple bridges formed between Portage Creek and the proposed dam site.
- In the Upper River, a continuous ice cover progressed from PRM 194 to the Oshetna River.



# 2012 Freeze-up Flows



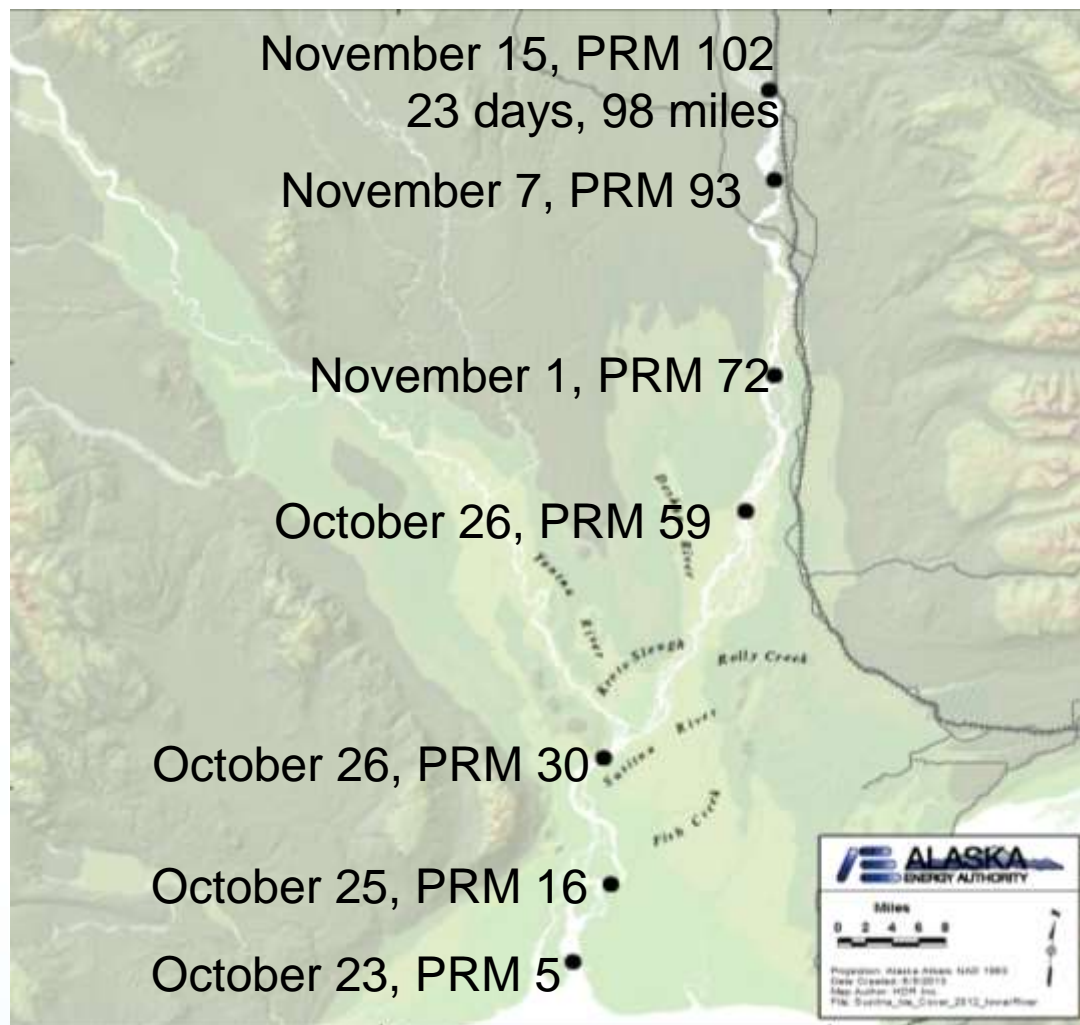
# 2012-2013 Winter Temperature



# Bridges near Tidewater, October 23, 2012



# Lower River Ice Cover Progression, 2012-2013



# 2012 Freeze-up Observations – Lower River

Ice cover progressed rapidly at first then slowed

- 11-12 miles/day up past the Yentna River,
- 7 miles/day past Sunshine Station,
- 4 miles/day to Talkeetna.

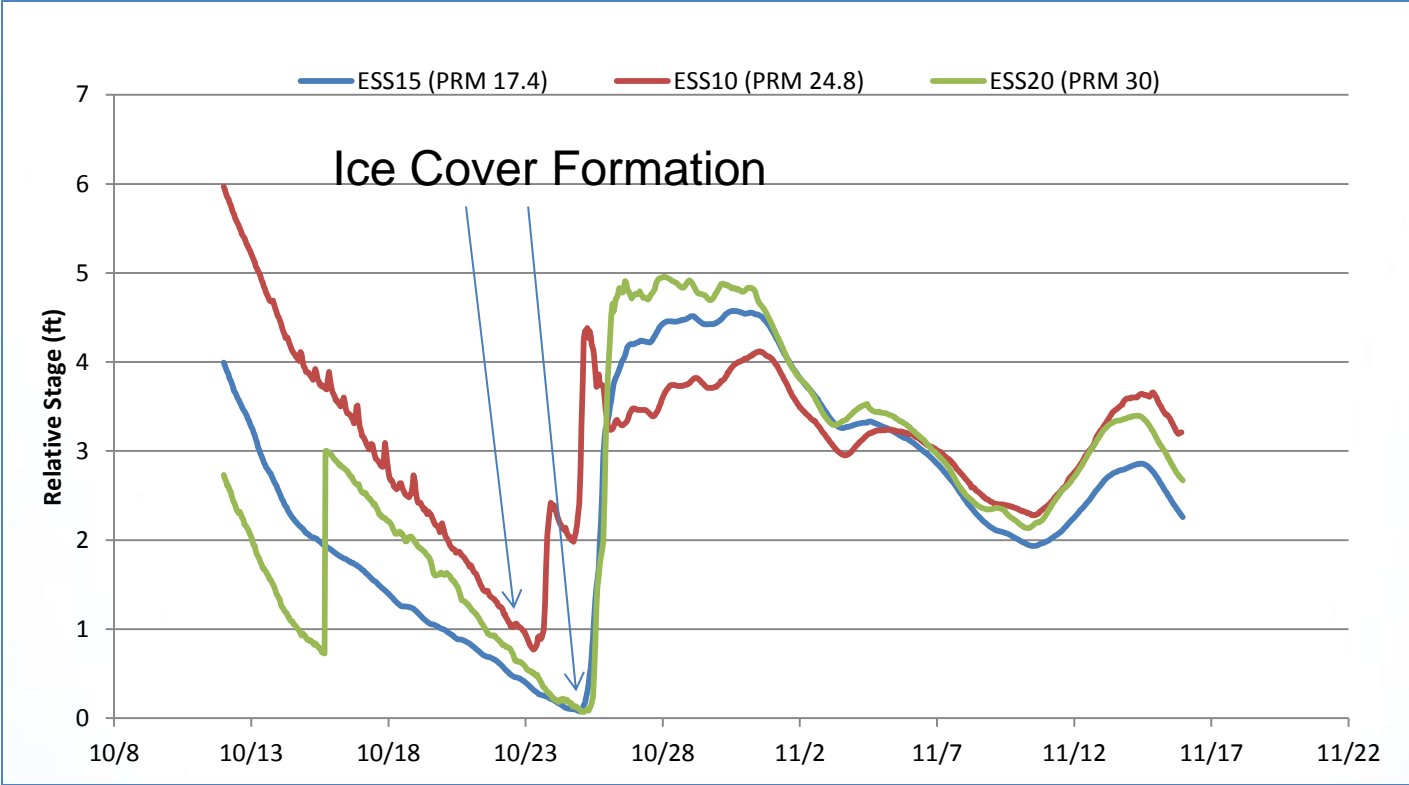
The thalweg filled with ice first, then flow was diverted to other channel braids.



Ice cover leading edge, PRM 72



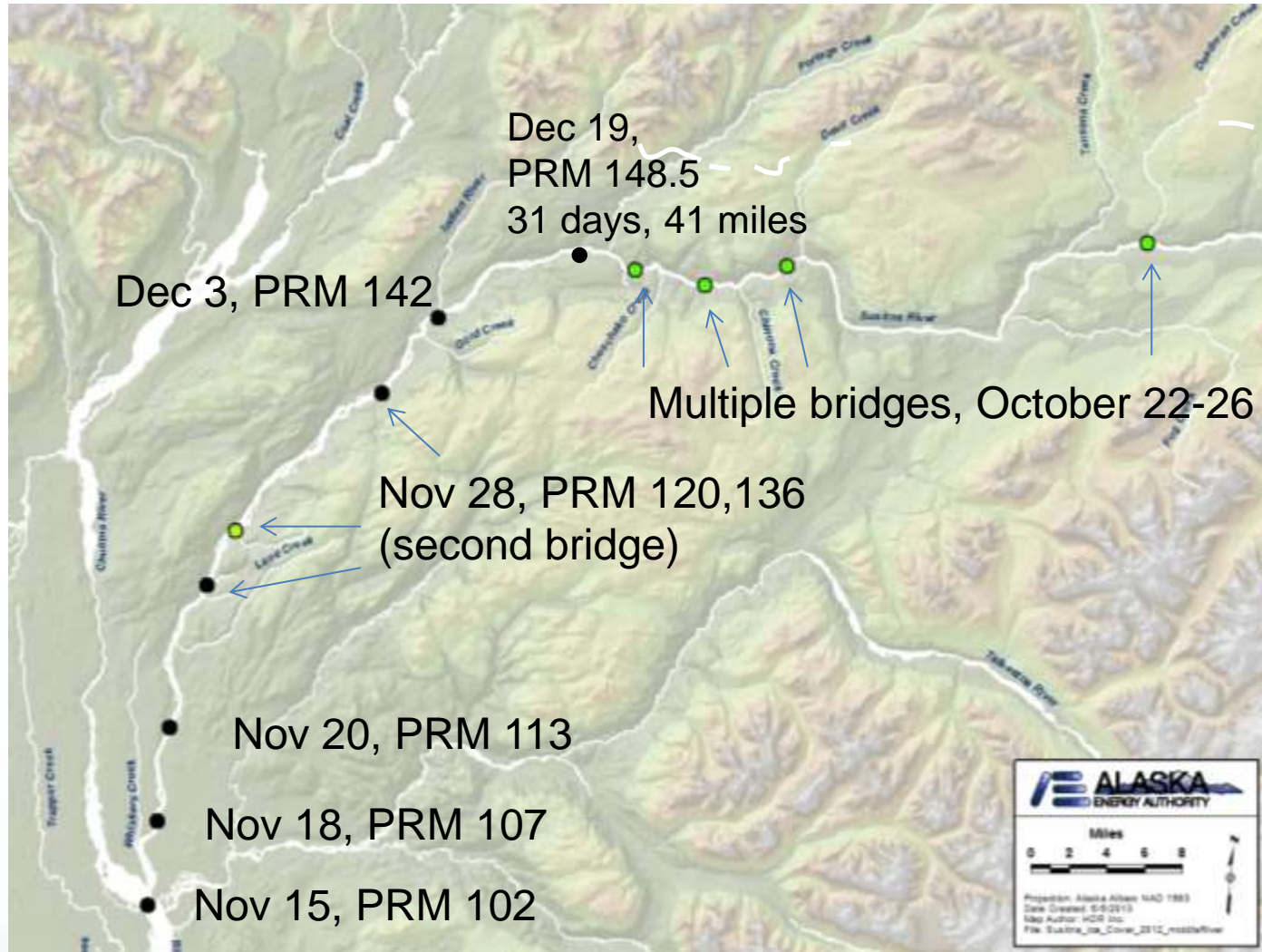
# 2012 Freeze-up Observations – Lower River Staging



# 2012 Freeze-up Flooding Talkeetna Area, Nov 15<sup>th</sup>



# 2012 Freeze-up Progression – Middle River



## 2012 Freeze-up Observations – Middle River

- The ice cover progressed continuously from tidewater up to PRM 120.
- A secondary bridge formed November 28 at PRM 124, and the ice cover continued to progress by accumulation up to Portage Creek.
- The Middle River above Portage Creek did not have a continuous ice cover progression. Multiple bridges formed throughout the fall, and area between bridges froze over by a combination of border ice growth and frazil accumulation up to proposed dam site
- Staging during ice cover progression filled most side channels and sloughs that had been dry prior to ice cover formation.
- Velocity leads and thermal leads developed shortly after ice cover progression.



# 2012 Freeze-up Observations – PRM 105, Whiskers Slough Area, Nov 7, 2012



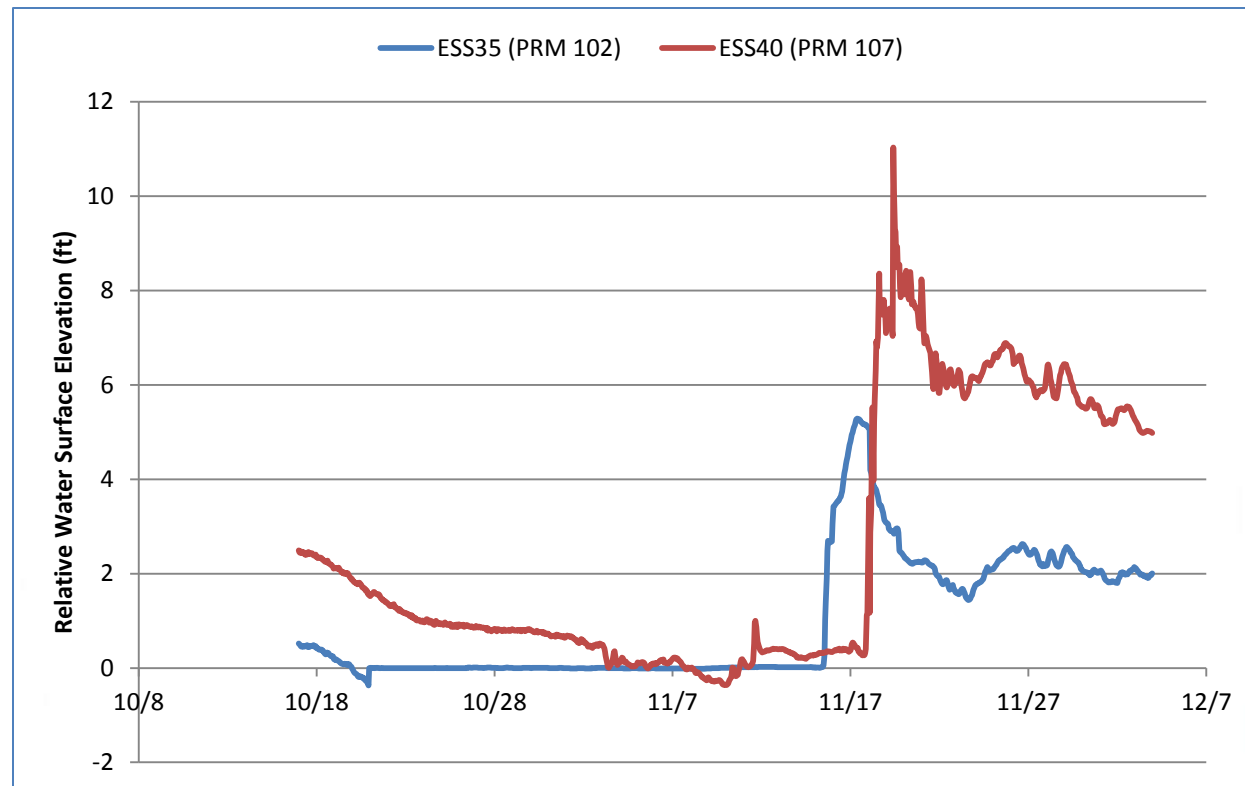
## 2012 Freeze-up Observations – PRM 105, Whiskers Slough Area, Nov 15, 2012



# 2012 Freeze-up Observations – PRM 105, Whiskers Slough Area, Dec 3, 2012



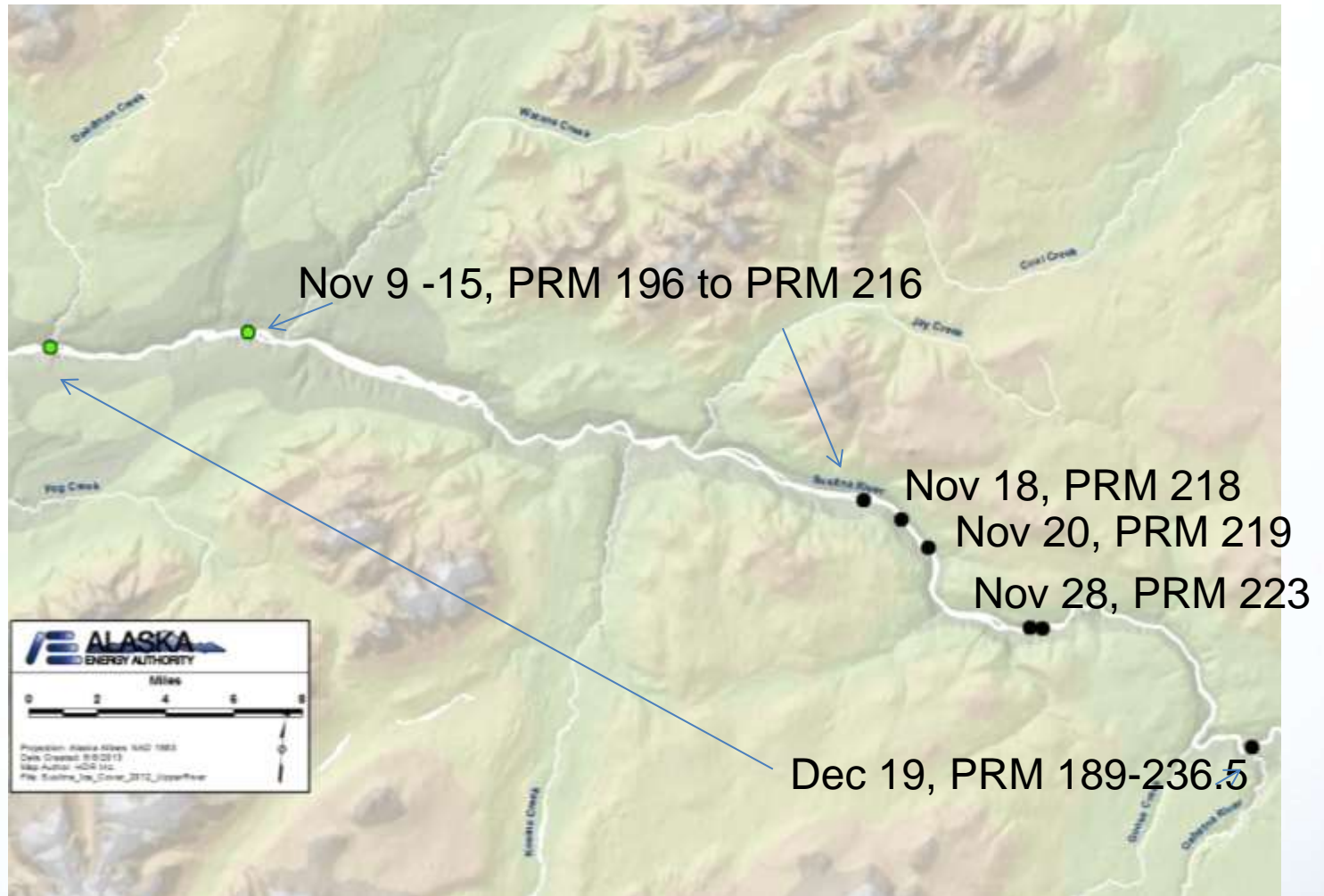
# 2012 Freeze-up Observations – Middle River Staging



Only two pressure transducers survived freeze-up in the Middle River.



# 2012 Freeze-up Progression – Upper River



# 2012 Freeze-up Observations – Upper River



Above, Upper River ice bridge,  
PRM 196.6, November 15<sup>th</sup>



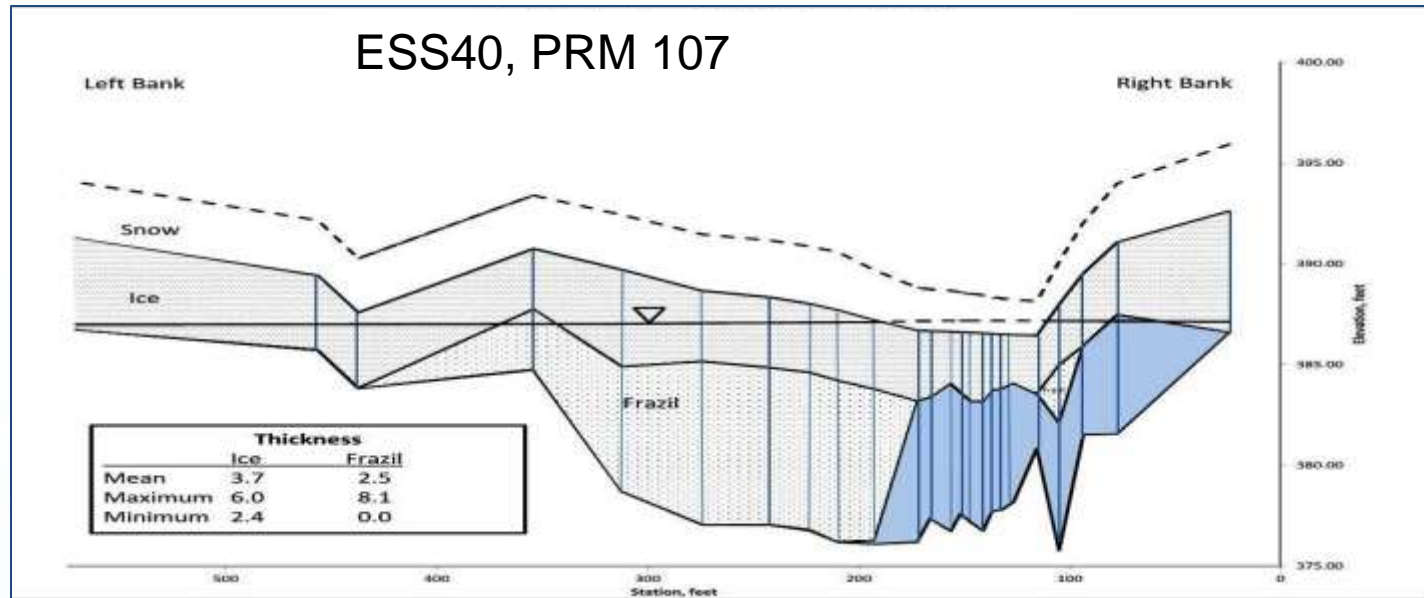
Right, Upper River ice front,  
PRM 217.5, November 15<sup>th</sup>

# 2012 Freeze-up Observations – Upper River



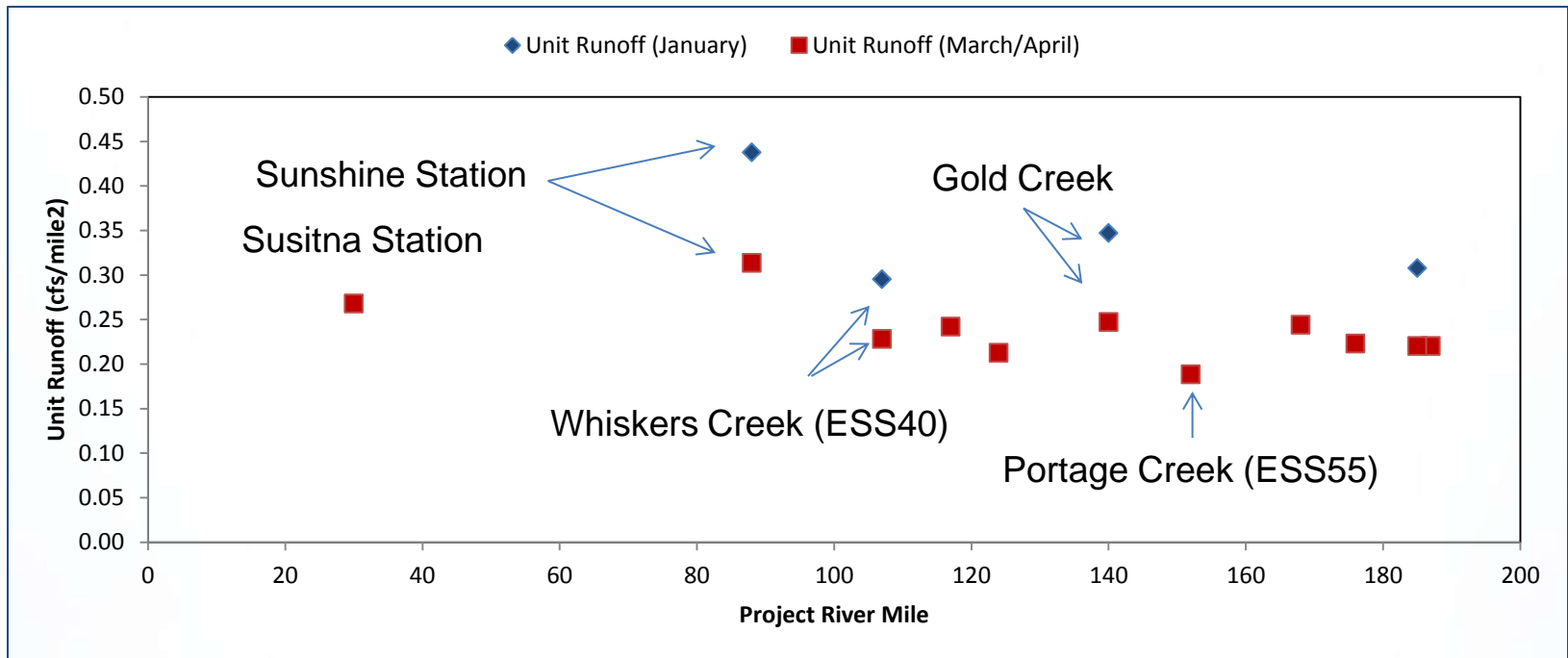
Kosina Creek Confluence, December 9, 2012. Dark ice is from Kosina Creek ice jam blowout.

# Ice Covered Conditions – Thickness, Elevation, Q



- Ice thickness, elevation and water surface elevations taken at 13 locations; discharge (Q) taken at 11 locations (between all studies) in the winter of 2013
- Mean solid ice thickness was around 3.5 feet
- Frazil ice thicknesses up to 27 feet
- Frazil accumulations found in scour pools, below the solid ice, and on the bed.
- 3/7 stage at ESS40 was 7 feet, Q was 1,430 cfs. 3/7 stage was equivalent to stage on 9/27. On this day, Q was 20,000 cfs at Gold Creek, without ice cover.

# Ice Covered Conditions – Winter Discharge Profile



- Winter discharges were consistent with USGS discharges measured in the past.
- Runoff per unit area (URO) varied along the river, with higher URO at Sunshine at Susitna Station, and lower URO at Portage Creek. There also appeared to be consistently higher URO at Gold Creek than near Whiskers Slough.

## 2013 Open Leads

Watching progression of leads throughout winter was informative – velocity leads tended to fill in from the bottom up with flowing frazil, while thermal leads tended to remain static or open up more.



# 2013 Open Leads – Lower River



PRM 45 Thermal Lead – Side Channel. Visible gravel and wavy edges.



PRM 35 Velocity Lead – straight edges



# 2012 and 2013 Open Lead Comparison, Slough 8A





# 2012 and 2013 Open Lead Comparison, PRM 142



2012

Velocity Lead

Thermal Lead



2013

Thermal Lead

Velocity Lead

## 2013 Open Leads – Upper River



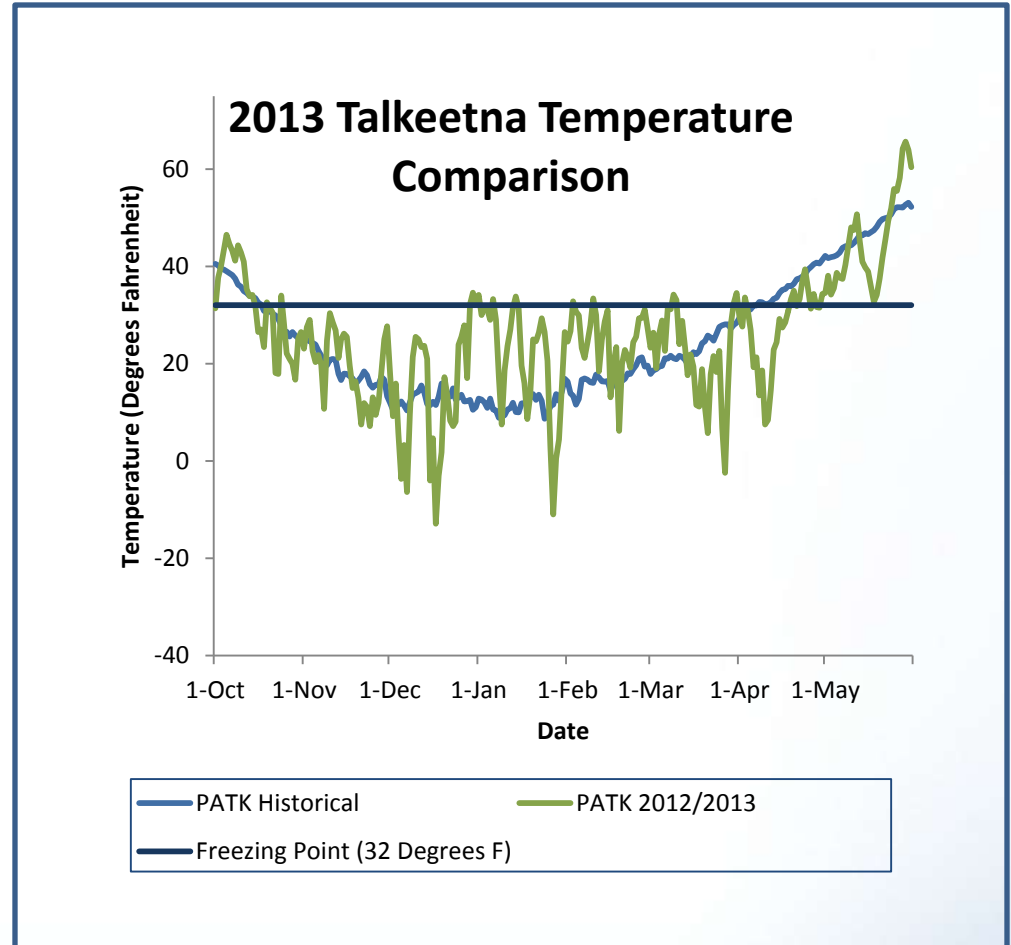
PRM 215 – smooth ice indicates former leads that have frozen over.

PRM 230 – Open lead downstream of Goose Creek. Many leads were associated with tributaries in the Upper River.



# 2013 Breakup Conditions

- Record cold spring
- Additional snowfall in April and May
- Progression not entirely downstream to upstream
- Largest jams in Upper River
- Followed immediately by extreme snowmelt flooding in Middle Su



# 2013 Breakup Observations – Lower River

Large tributaries broke up first.

- Alexander Creek and Deshka River broke up between May 11 and May 14.
- The Yentna River broke up May 19.

Susitna River below Yentna broke up on May 21.

Jams persisted between Sunshine and Deshka Landing until May 25.



Jam at mouth of Alexander Slough,  
5/14/2013

Mouth of Deshka River,  
5/14/2013



# 2013 Breakup Observations – Yentna River, 5/19



R44, 30 ft long

# 2013 Breakup Observations – Lower River

No apparent flooding was associated with breakup. Main flow moved to another braid where there were ice blockages.



← May 19, PRM 93



May 26, PRM 75 →

## 2013 Breakup Observations – Middle River

- Major jams occurred Memorial Day weekend (May 25-27) during rapid warming. The biggest jams with flooding into the vegetation were at Whiskers Slough (extending up to PRM 113), PRM 131-134, PRM 134-136, and PRM 180-181.
- Several sloughs were overtopped or affected by ice jams during breakup, but not all of them. Sloughs that had ice flow into them included Whiskers Slough and Slough 9. Slough 8A, Slough 11, and Slough 21 had ice flow into side channels but not enter the sloughs.



## 2013 Breakup – Whiskers

May 25 – water flowing into Whiskers from jam in main channel



May 26 – ice remaining in Whiskers Slough





# 2013 Breakup – Whiskers, May 29



# 2013 Breakup Observations – PRM 131



# 2013 Breakup Observations – Slough 9



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## 2013 Breakup Observations – Slough 9



# 2013 Breakup – Upper River



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# 2013 Breakup – Upper River



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# Ice Process Studies: 3rd Quarter Activities, 2013

- River1D model development and open-water calibration
- Lower River HEC-RAS models with ice cover
- Literature review on effects of existing hydropower projects on ice cover

