Addressing challenges of declining North Slope production

Northern Energy Science and Technology Fair
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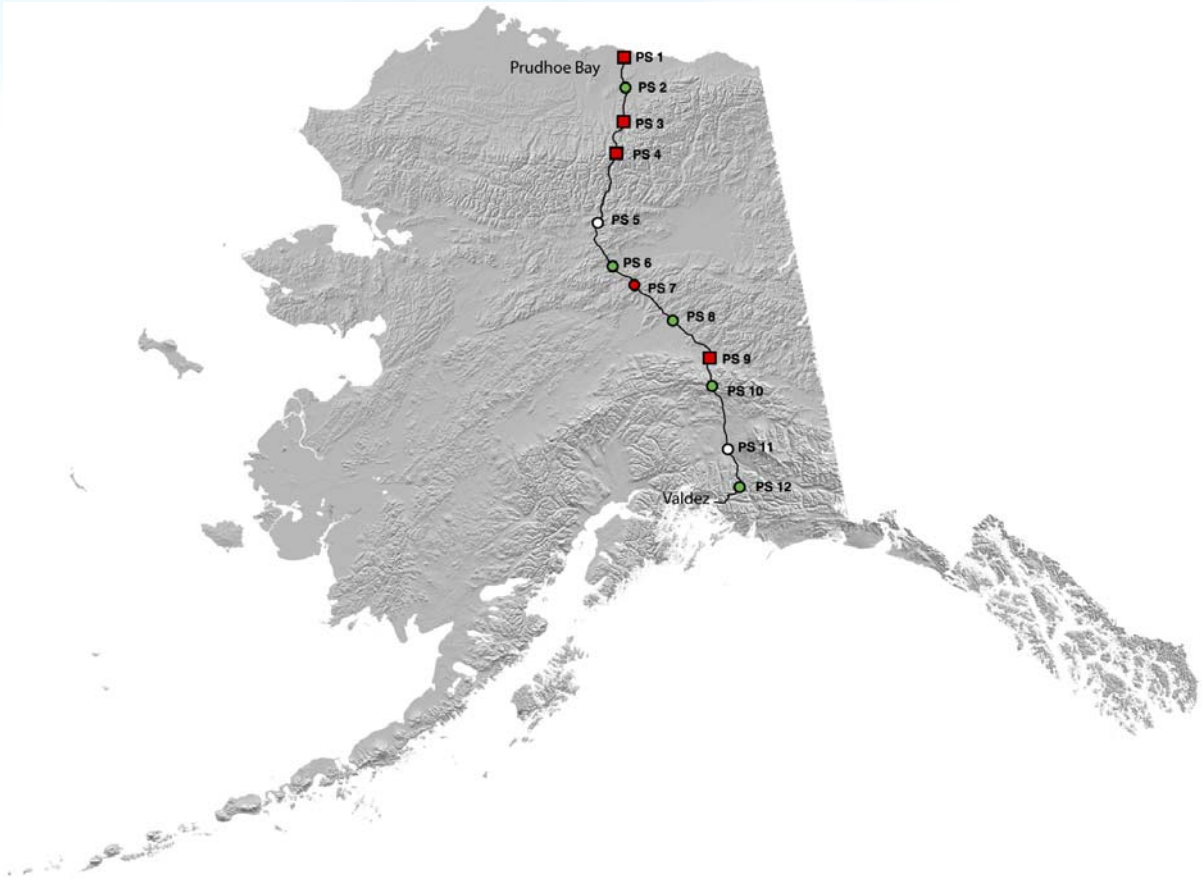
Outline

- TAPS overview
  - Alyeska at a glance
  - Pipeline facts
  - Pipeline throughput
- Declining flow
- TAPS historical throughput
- January temperature profiles
- Low flow Impact Study
  - Water & ice
  - Wax deposition & precipitation
  - Frost heave
- Low flow mitigative measures
- Questions?

Alyeska at a glance

- Alyeska Pipeline Service Company was incorporated August 14, 1970 to design, build, operate and maintain the pipeline, pump stations and the Valdez Marine Terminal.
- Alyeska personnel and contractors continually monitor and operate the Trans Alaska Pipeline System – or TAPS – so that oil flows safely, efficiently and in an environmentally sound manner.
- On average, there are about 2,000 TAPS employees – a combination of Alyeska employees and various contractors.
- Alyeska is owned by five oil pipeline companies.

TAPS Map


Prudhoe Bay
PS 1
PS 2
PS 3
PS 4
PS 5
PS 6
PS 7
PS 8
PS 9
PS 10
PS 11
PS 12
Valdez

Pipeline facts

- Some 420 of the 800-mile-long pipeline is elevated on 78,000 supports, called “vertical support members.” It is designed this way because the ground is permafrost
- The pipeline crosses the Brooks, Alaska and Chugach mountain ranges
- TAPS’ highest point is 4,739 feet at Atigun Pass in the Brooks Range
- The pipe has an outside diameter of 48 inches and approximately half-inch-thick walls

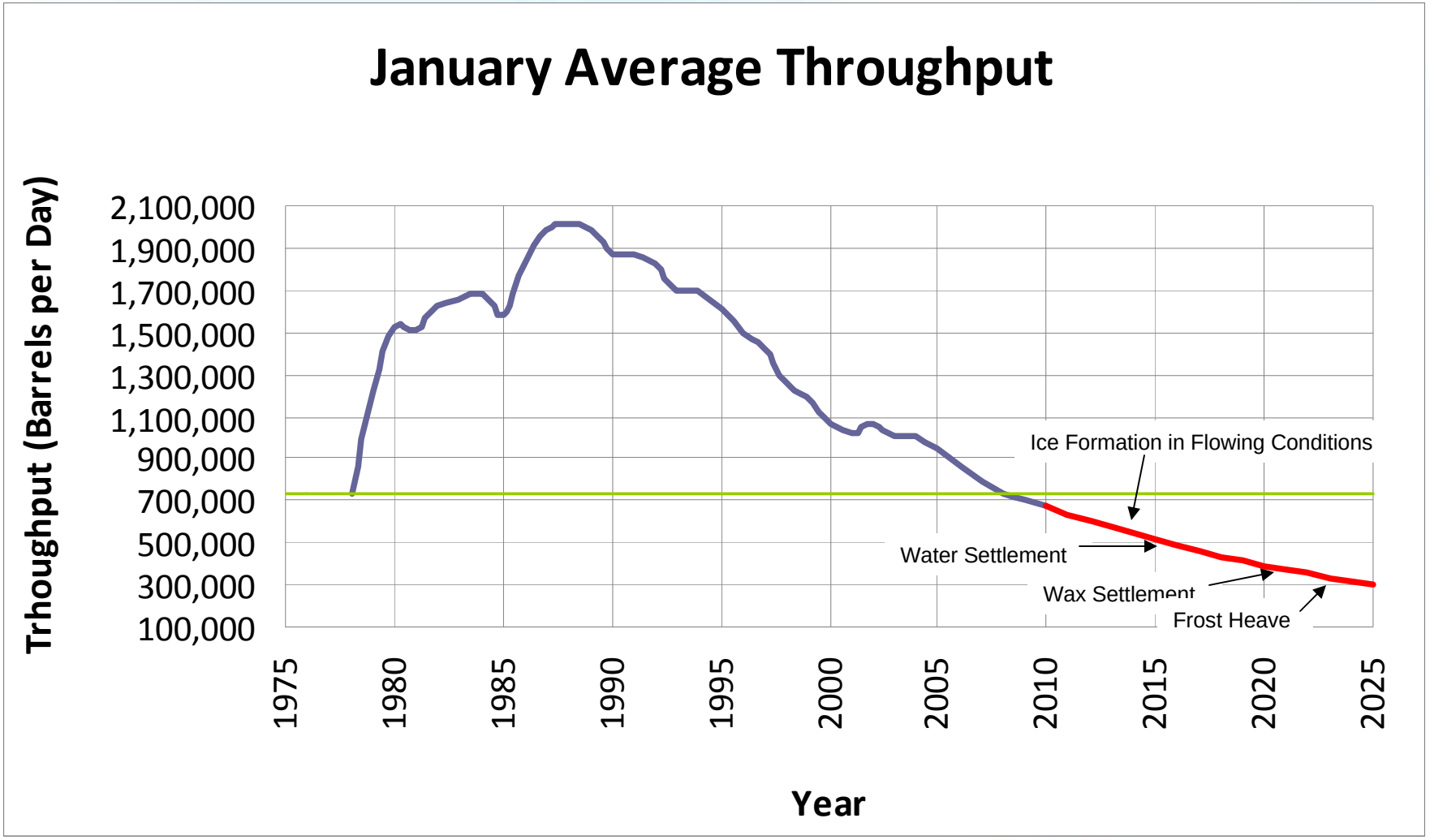
Pipeline throughput

- TAPS carries approximately 11 percent of the nation's domestic oil production
- Current daily throughput is approximately 560,000 barrels per day (July 2012)
- Since startup in June 1977, TAPS has:
  - transported more than 16 billion barrels of crude oil
  - loaded more than 20,000 tankers at the Valdez Marine Terminal

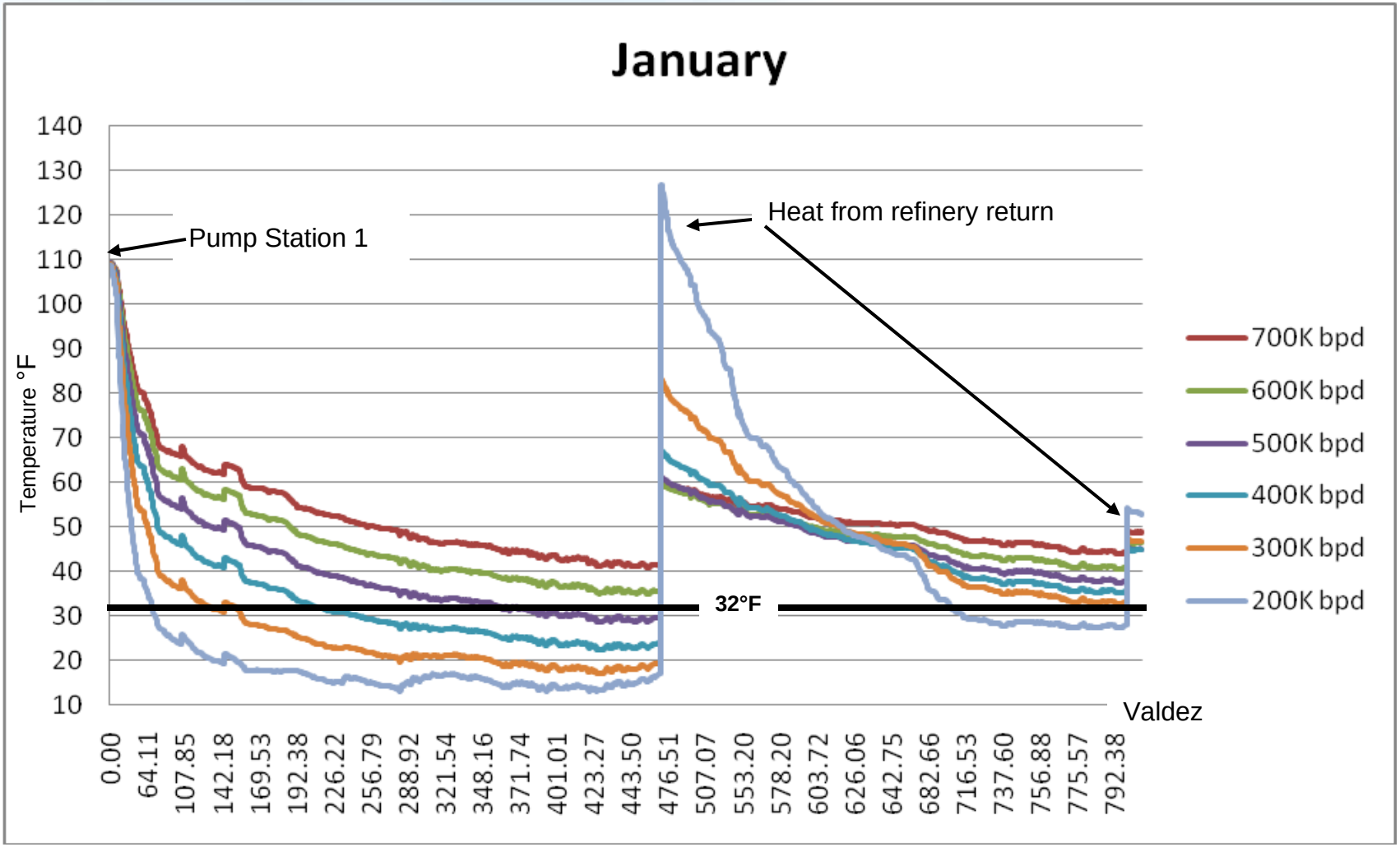
Declining flows

- TAPS is facing significant technical challenges related to lower flow rates:
  - Slower velocities and longer transit times
    - At 600,000 barrels/day, >15 days PS1 to Valdez
    - At 300,000 barrels/day, >30 days PS1 to Valdez
  - Lower temperatures
  - Less turbulence with lower flow rates
    - Water and crude oil solids settle out of the crude oil

TAPS Historical Throughput

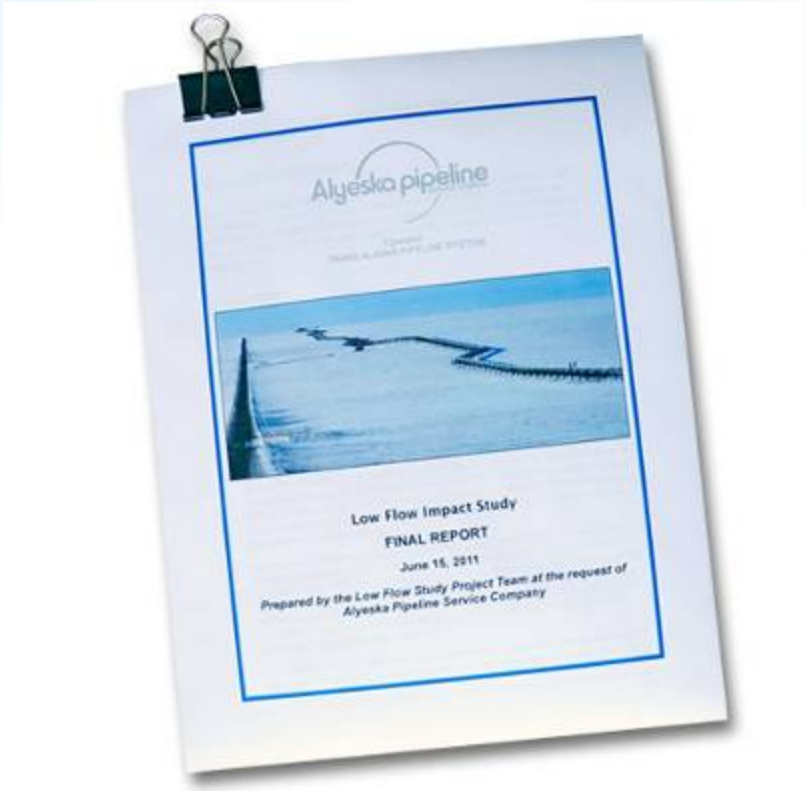


January Temperature Profiles



Low Flow Impact Study

- Study initiated in 2008 and completed 2011
- Study components
  - Literature review
  - Testing
  - Model validation and development
  - Analysis
  - Mitigation evaluation

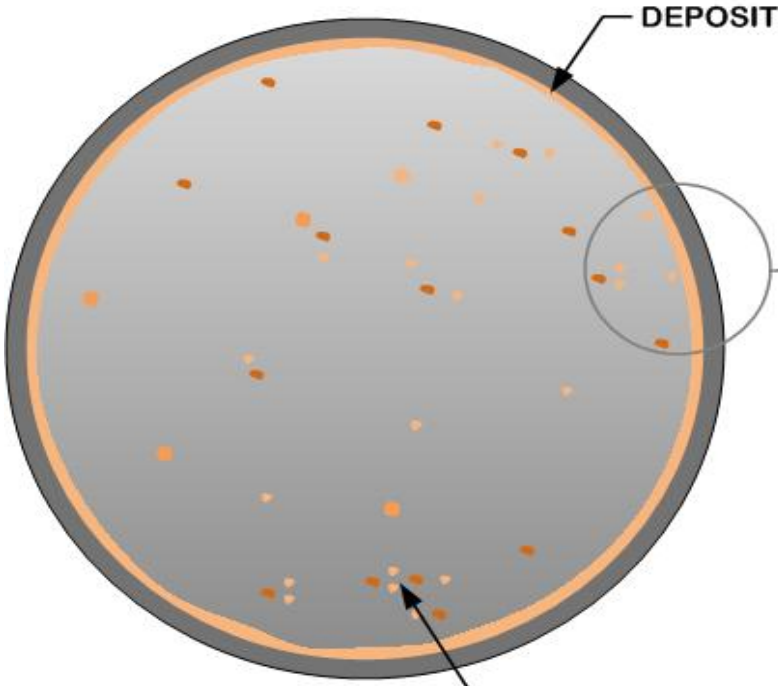


Low flow: water & ice

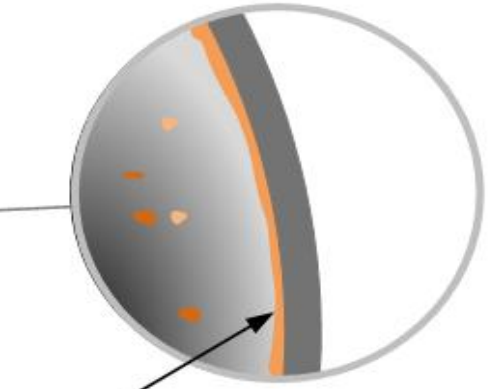
- Water separation and accumulation at low points during flowing conditions (water begins to hold-up just below 500,000 BPD)
- Ice forms under flowing conditions
- Water accumulates and freezes at low points during extended winter shutdowns
- Ice formed from TAPS water has variable strength, with some ice comparable to sea ice

Ice formation in flow loop

Low flow: wax deposition & precipitation



- **Temperature Dependent**
  - No wax precipitated above wax appearance temperature
  - Lower temperatures precipitate more wax



- No deposition above wax appearance temperatures - northern pipeline areas
- Higher deposition in below - ground areas
- Less deposition as temperature declines

Low flow: wax issues

- Inability to obtain continuous data from instrumented pigs due to increased wax deposition
  - Instrumented pig failure in 2006 due to wax accumulation
- Internal corrosion issues
  - Corrosion can potentially begin under wax deposits and in routinely wetted areas
- Problems with wax solids clogging mainline pump and metering strainers

Wax received by scraper pig

Low flow: frost heaves

- Pipe can accommodate 12 inches of frost heave:
  - Thirty-three belowground sections totaling 9 miles identified with high potential for frost heave issues
  - The frost heave issue initiates at approximately 350,000 BPD when the average annual crude temperature is below 32 ºF
  - Without mitigation, frost heave is predicted to reach 12 inches at approximately 300,000 BPD

Low flow mitigation

- Ice formation in flowing conditions
  - Crude oil heating (station recycle, fired heaters, waste heat recovery)
- Ice formation in shutdown conditions
  - Enhanced insulation
- Water holdup
  - Regular pigging
  - Water specification and enforcement measure change
  - Regular injection of corrosion inhibitors and biocides
- Wax deposition and precipitation
  - Regular pigging
  - Additional pig trap(s)
  - Solids handling facilities
  - Regular injection of wax crystal modifiers
- Frost heave
  - Crude oil heating

Questions?