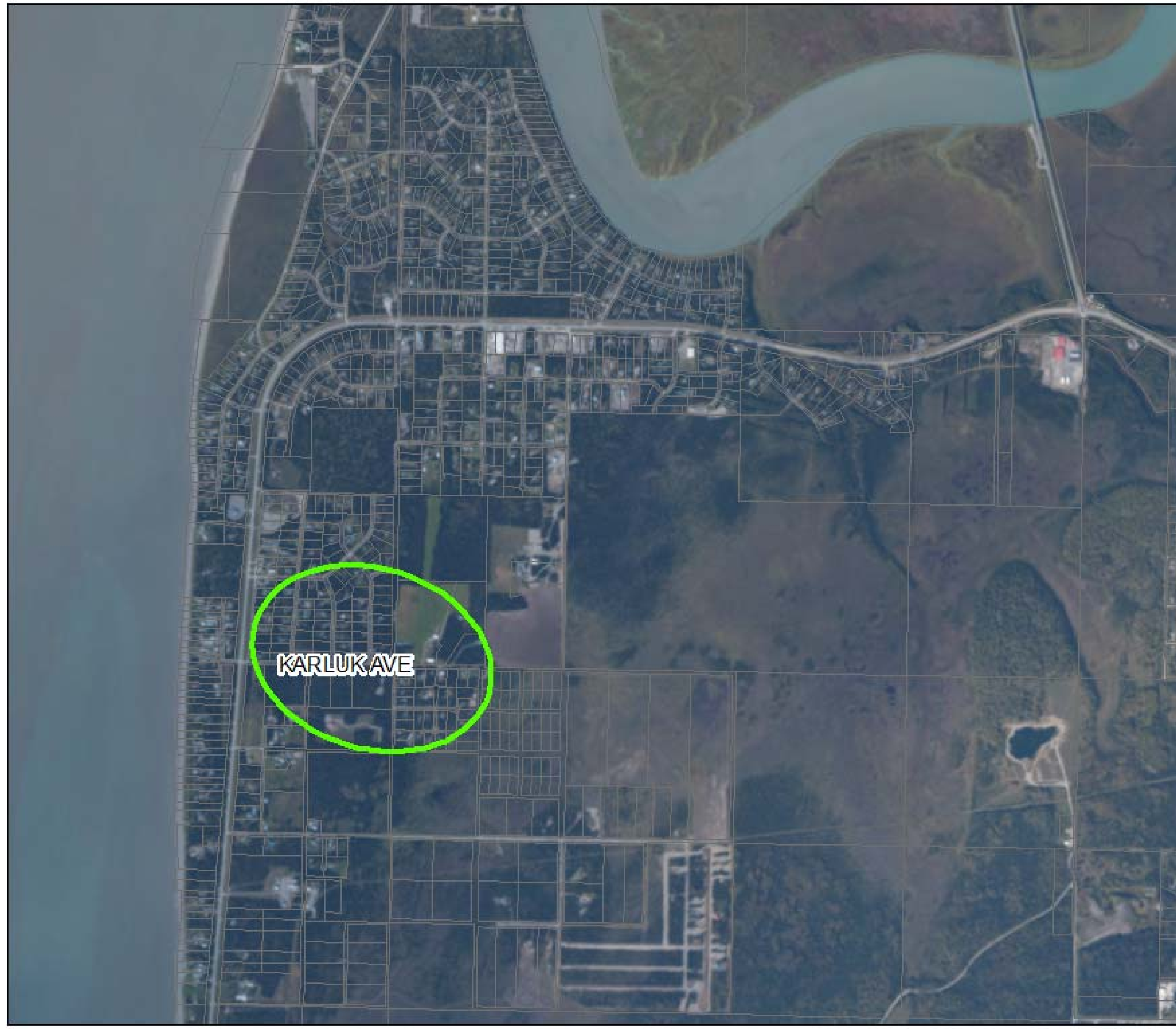
CONTEXT OF WATER MOVEMENTS IN THE KARLUK AVENUE AREA

Presentation of observations by Marcus Mueller

KARLUK AVENUE AREA

~ 90 Properties
~ $8.9 Million in Improvement Value
~ 2 Miles of KPB Maintained Roads

- Part of the area impacted by 2013 High Water Event



Applicable Authorities

- Emergency Management
- Roads
- Land Management
- Planning

Note: The Borough Does Not Have A General Purpose Water Management or Drainage Authority. The borough's water management scope is therefore incidental applications of the authorities listed above. "Drainage Districts" are a common general purpose form of authority to construct, operate, maintain and fund drainage improvements serving geographic areas on a continuous basis.

Major Points

- Natural drainage course for area water is primarily below-ground.
- Below-ground water movement is to the Cook Inlet.
- Surface Drainage courses to the Cook Inlet are not found in this area.
- Creation of a surface drainage course to the Cook Inlet is unlikely to be found within the borough's existing authority and funding.
- Ditching of wetlands leads to flooding.
- Returning ground water to the ground is practical.
- Emergency pipelining to tidewater was low-impact and effective.

Quick Tour of Karluk During the 2013 Flooding


10/29/2013

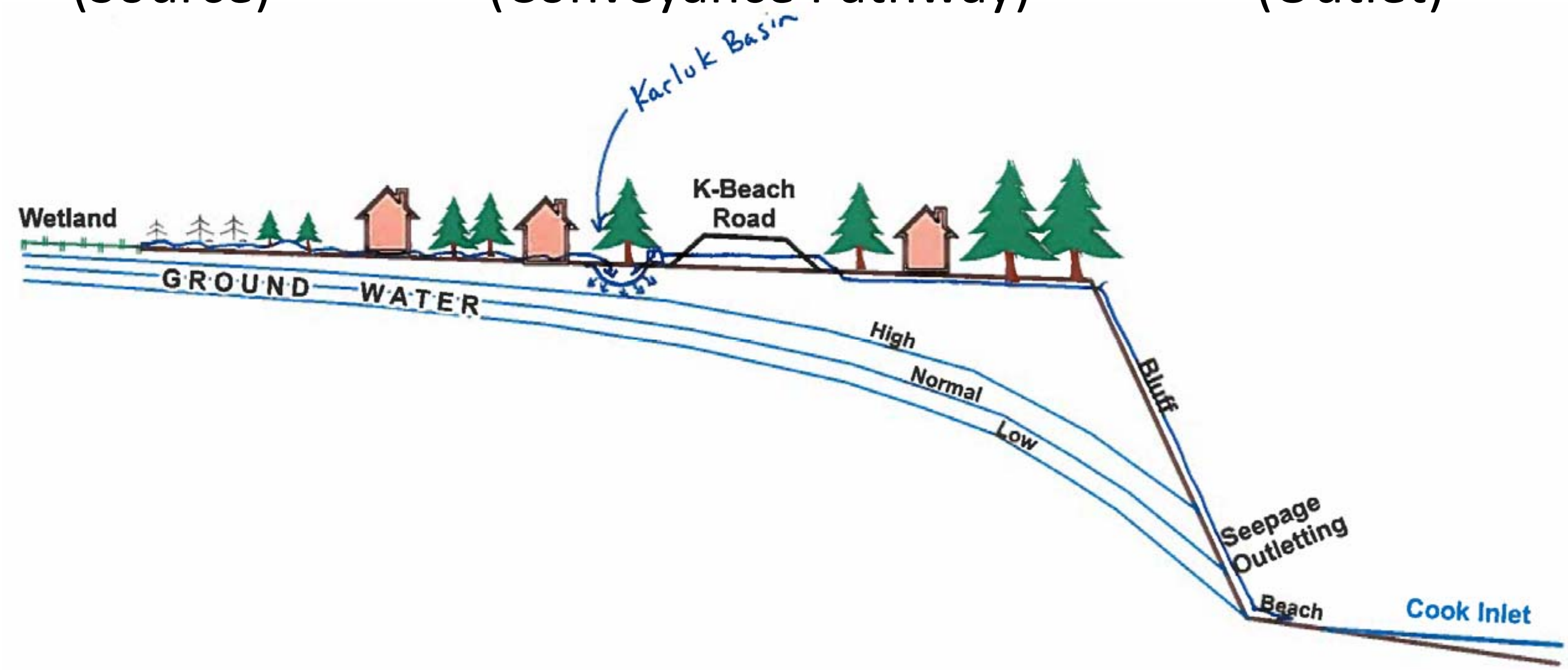

11/01/2013


10/29/2013

Beginning
(Source)

Middle
(Conveyance Pathway)

End
(Outlet)



Water Source

- Groundwater charge
- Rainwater Swell
- Wetland Drainage

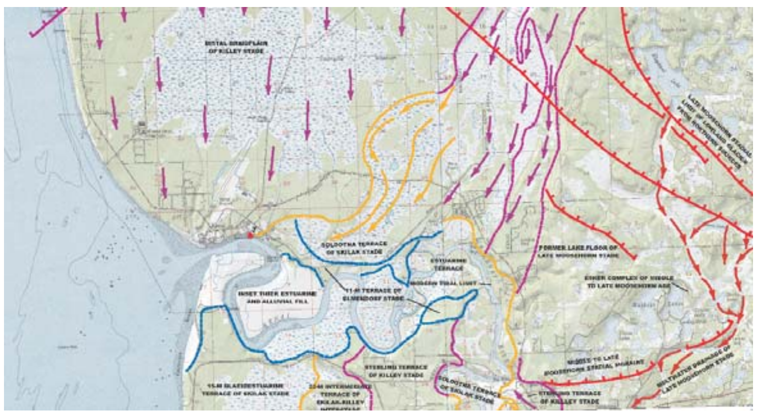
Wetland drainage is relatively new on the landscape. It takes several forms. It is a conversion of slow moving water to fast moving surface water. Wetland drainage can have unmitigated and unmanaged downstream effects.

Water Storage – Area, Time, Volume

- Broad wetland containing peat soils over lakebed sands acts as a large water storage feature positioned inland and upslope of a forested edge along the Cook Inlet.
- Peat soil formation is indication of persistent saturation near the surface soils over a long period of time.
- Peat soils hold many times more water than the same thickness of loam soil, also peat soils tend to be many times thicker than loam soils.

Water Conveyance Pathway

- Water conveyance from the broad peatland-wetland is primarily underground with the underlying sand layer being a broad conduit. The sand layer can be consistently observed in well logs, the sand profile observable from the beach, and is further supported by the description of the landform as a proglacial lakebed in the geological records compiled by Reger etal. Sands are generally known to have high hydraulic conductivity.



<table>
<tr><td>K (cm/s)</td><td>10^{2}</td><td>10^{1}</td><td>$10^{0}=1$</td><td>10^{-1}</td><td>10^{-2}</td><td>10^{-3}</td><td>10^{-4}</td><td>10^{-5}</td><td>10^{-6}</td><td>10^{-7}</td><td>10^{-8}</td><td>10^{-9}</td><td>10^{-10}</td></tr>
<tr><td>K (ft/day)</td><td>10^{5}</td><td>10,000</td><td>1,000</td><td>100</td><td>10</td><td>1</td><td>0.1</td><td>0.01</td><td>0.001</td><td>0.0001</td><td>10^{-5}</td><td>10^{-6}</td><td>10^{-7}</td></tr>
<tr><td>Relative Permeability</td><td colspan="4">Pervious</td><td colspan="3">Semi-Pervious</td><td colspan="6">Impervious</td></tr>
<tr><td>Aquifer</td><td colspan="5">Good</td><td colspan="4">Poor</td><td colspan="4">None</td></tr>
<tr><td>Unconsolidated Sand & Gravel</td><td colspan="2">Well Sorted Gravel</td><td colspan="3">Well Sorted Sand or Sand & Gravel</td><td colspan="4">Very Fine Sand, Silt, Loess, Loam</td><td colspan="4"></td></tr>
<tr><td>Unconsolidated Clay & Organic</td><td colspan="4"></td><td colspan="2">Peat</td><td colspan="3">Layered Clay</td><td colspan="4">Fat / Unweathered Clay</td></tr>
<tr><td>Consolidated Rocks</td><td colspan="4">Highly Fractured Rocks</td><td colspan="3">Oil Reservoir Rocks</td><td colspan="2">Fresh Sandstone</td><td colspan="2">Fresh Limestone, Dolomite</td><td colspan="2">Fresh Granite</td></tr>
</table>

Source: modified from Bear, 1972

Water Outlet

- Out-letting of water released by the peatland wetland downward into the sand layer occurs broadly and continuously and it exits the system along the beach and bluff of the Cook Inlet as well as along the banks of the Kenai River. This out-letting is observable from those shores in the form of seepage.
- Stream (surface) channelization has largely not occurred in the history of the landform as evidenced by the lack of natural cuts connected to the ocean.
- The lack of surface channels coupled with the prevalence of near shore seepage indicates that underground outletting balances the typical range of water volumes carried in the system.

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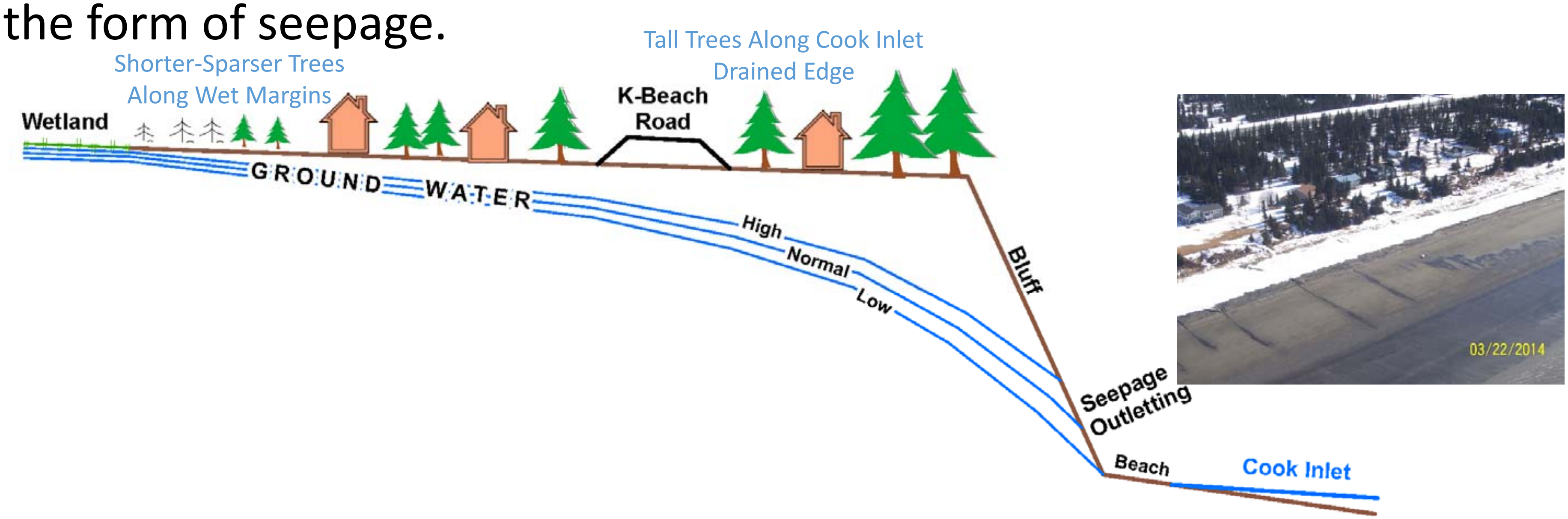

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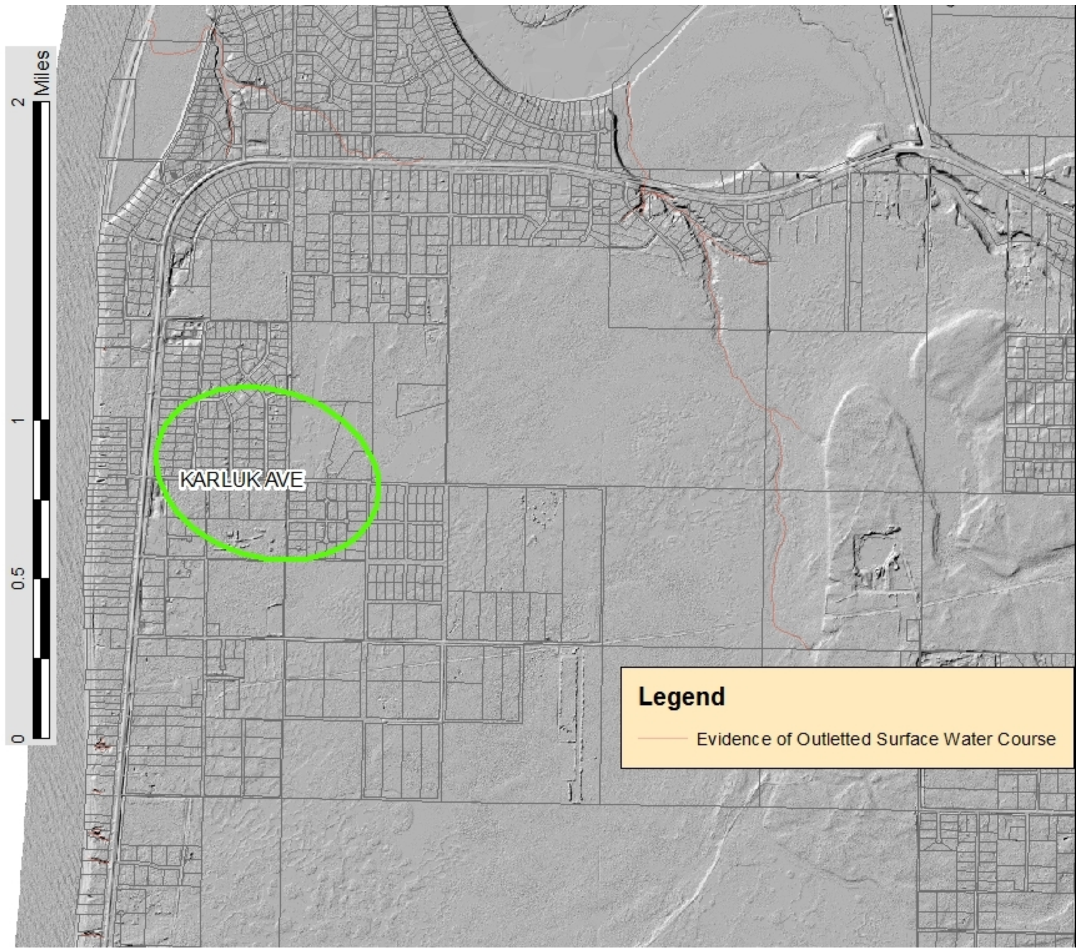

Miles
2
1
0.5
0
KARLUK AVE
Legend
Evidence of Outletted Surface Water Course

- The lack of surface channels coupled with the prevalence of near shore seepage indicates that underground outletting balances the typical range of water volumes carried in the system.

Conclusion:
Long History of Water System Balance

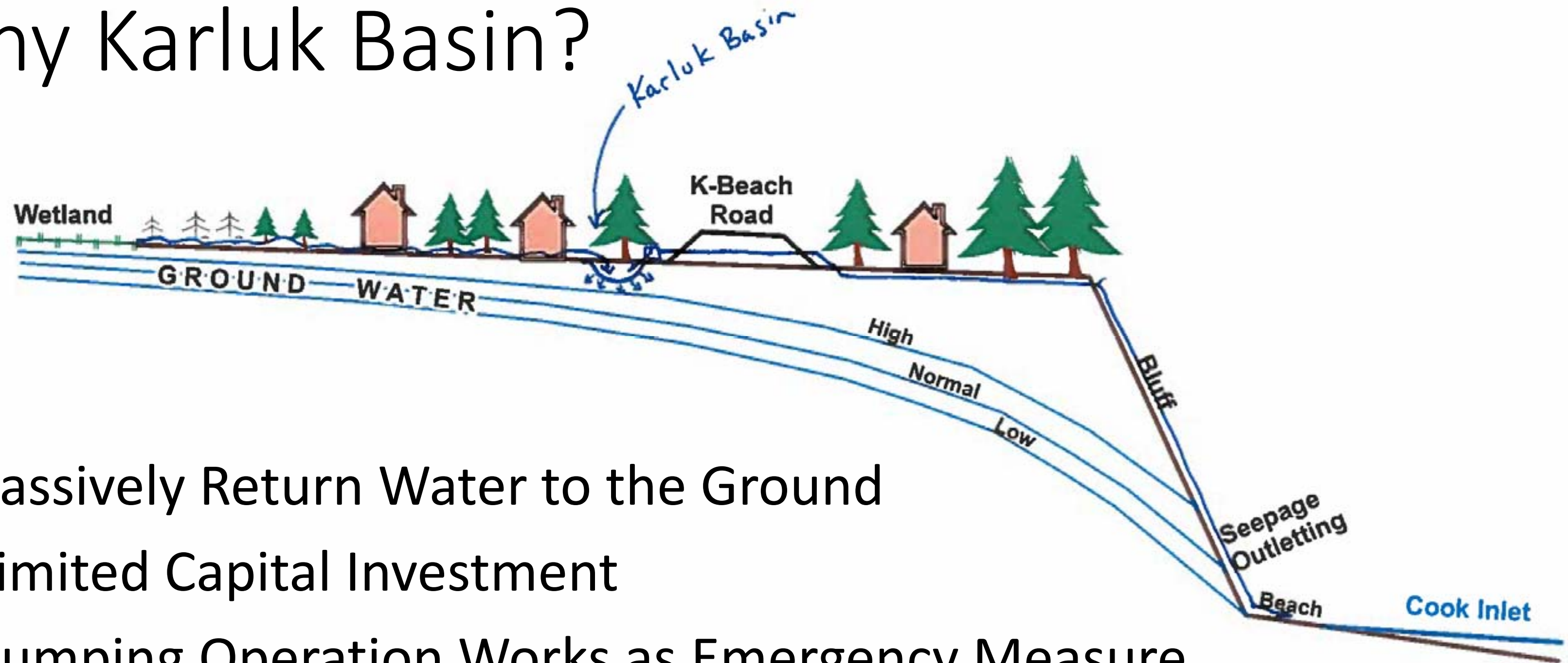
Myths

- Flooding occurred because K-Beach Road is acting like a dam
- More ditches & culverts will solve the flooding problem
- Draining the wetland will solve the problem

Thoughts about creating a surface outlet

- An Open System
  - Securing an adequate width along the bluff would be challenging and expensive
  - The sandy soils would be challenging to stabilize and would be prone to headcutting
  - Maintenance and repair costs could be challenging to manage
- A Closed System
  - Expensive to install but would minimize footprint and maximize stability
- Ultra-Flat grades would necessitate either deep or flat ditches
- No culverts crossing K-Beach are positioned to carry water at a ditchline elevation.
- Unclear who would do it.

Why Karluk Basin?



- Passively Return Water to the Ground
- Limited Capital Investment
- Pumping Operation Works as Emergency Measure

West end of Karluk looking East (Basin on Right)

Mid Draw Down

Outlet Overview

3,000,000 Gal Removed
(9-acre feet)

Outlet Flow at Tidewater

Beach Approach

Condition Afterward

Kicking the Can

- Would be to run Karluk Ditchline past the Keohane Property to the End of Karluk, aka to the DOT Right-of-way, referred to as the common enemy water doctrine, or dump-water-problems-on-your-neighbor. However, Alaska does not honor the common enemy water law.

THANK YOU

ARE THERE QUESTIONS?