# Hydrologic Issues Related to the Pebble Project, Alaska

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EPA Headquarters, Office of Wetlands, Oceans, and Watersheds (OWOW)



ED_00006500006176 EPA-7609-0002010_0001

# Outline

1. Physical Setting
   - Surficial geology: Extent of low-permeability materials
   - Permeability measurements
   - Implications for mining impacts
2. Groundwater and Surface Water Hydrology
   - Hydraulic gradients
   - Surface water-groundwater interactions
   - Interbasin transfers
   - Implications for mining impacts
3. Ongoing Work
   - Integrated surface water-groundwater modeling
   - Coupled to atmospheric processes
   - Evaluate pre-mine and post-mine conditions
4. Summary



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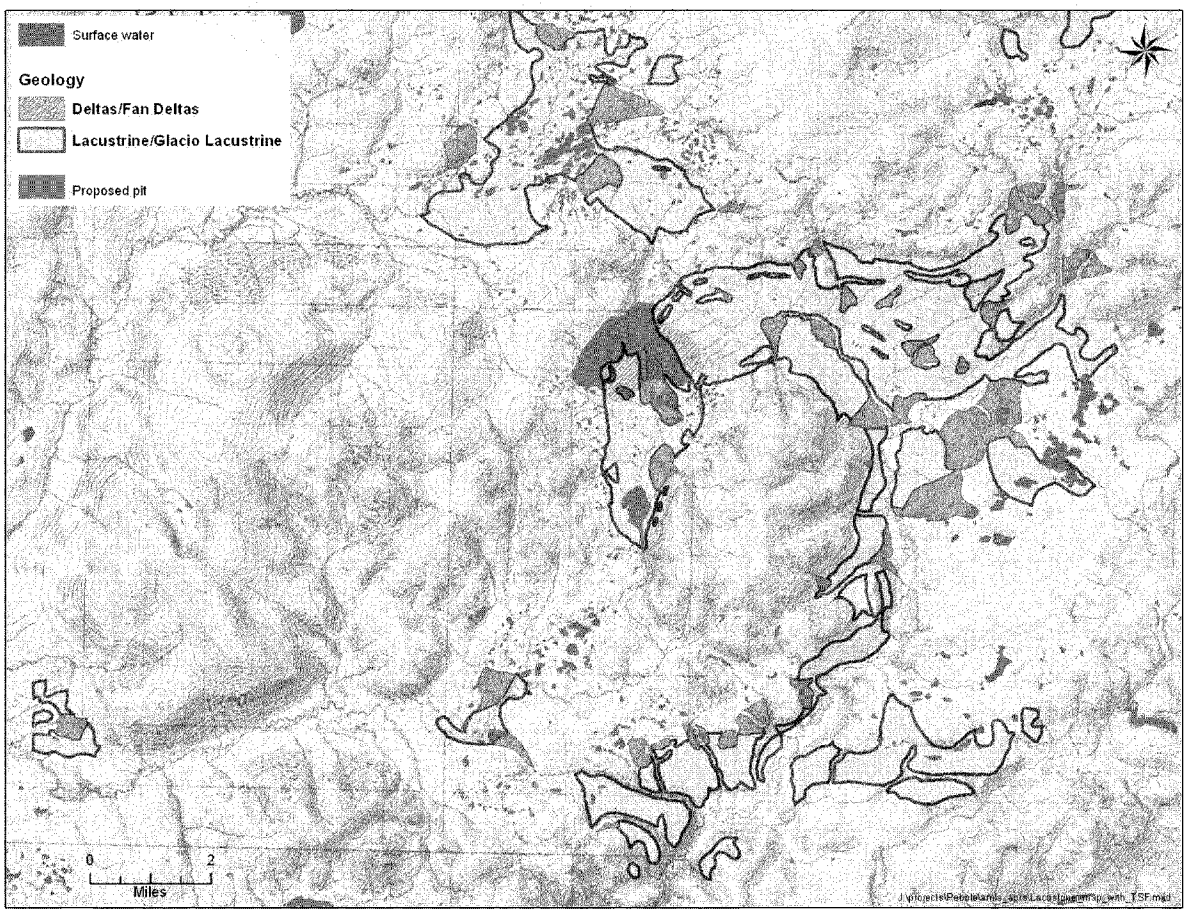
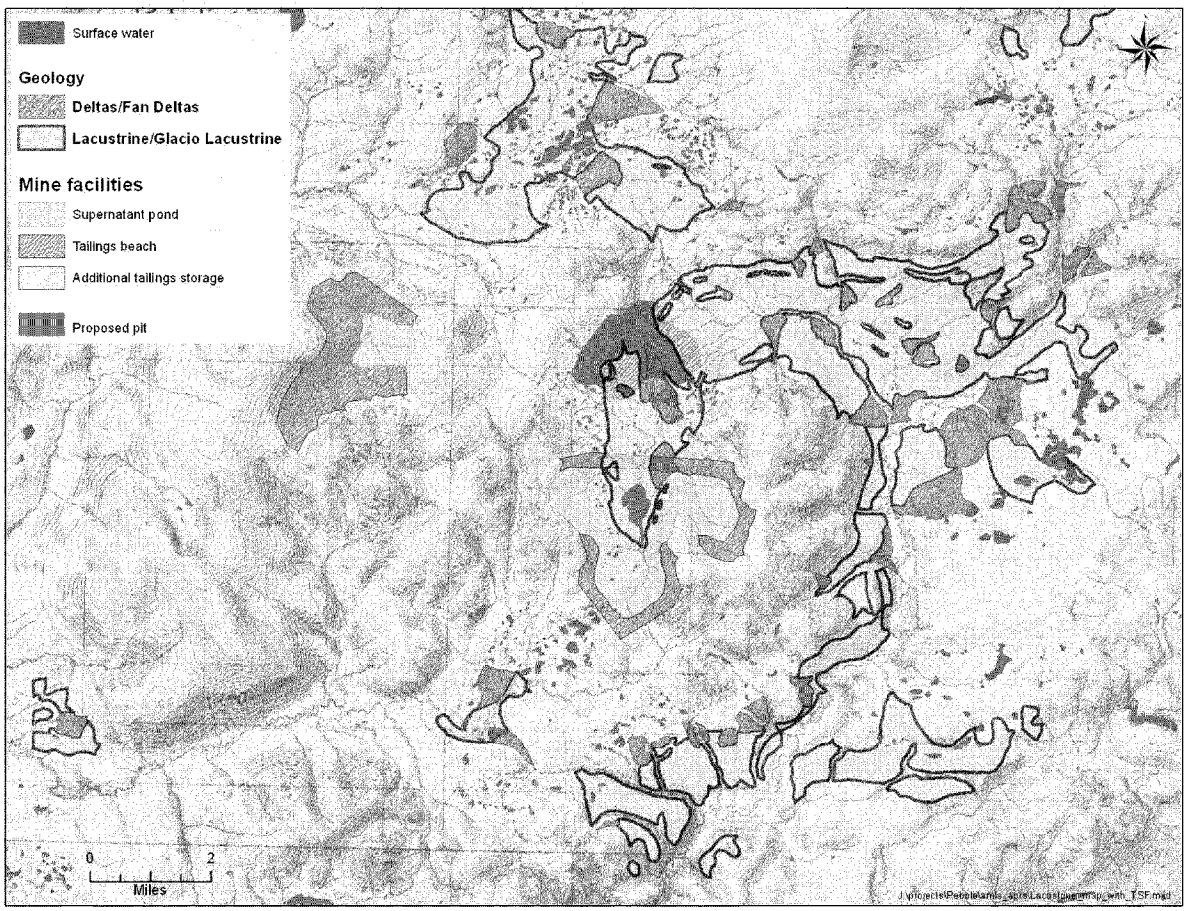
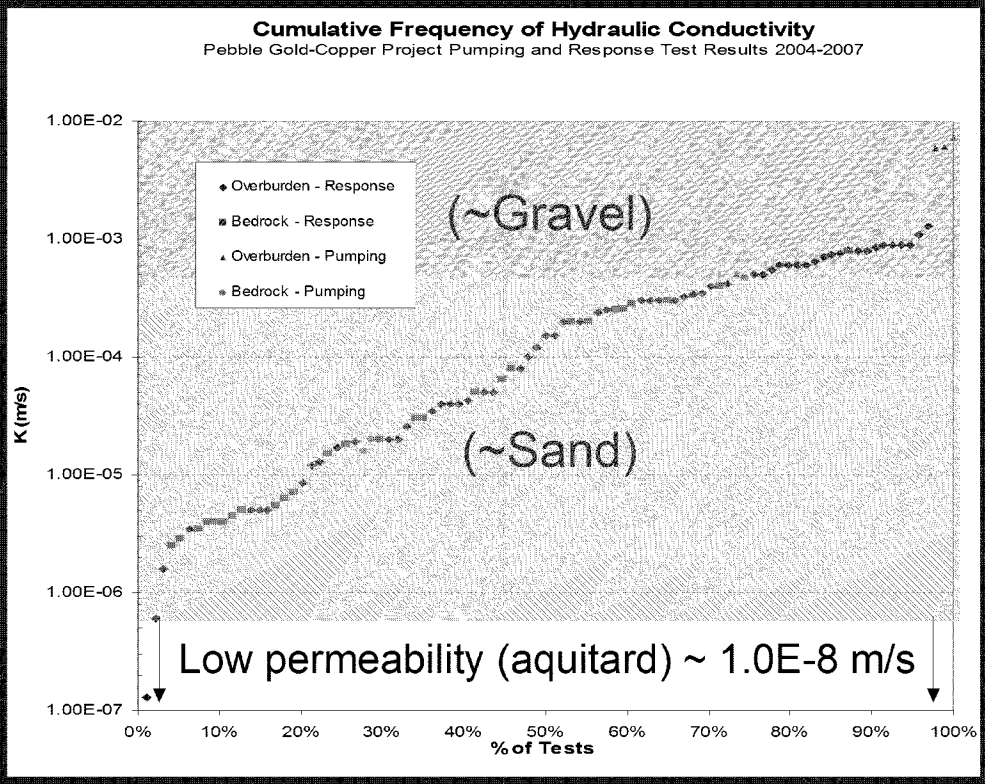
# Extent of Low-permeability Deposits




Surface water
Geology
Deltas/Fan Deltas
Lacustrine/Glacio Lacustrine
Mine facilities
Supernatant pond
Tailings beach
Additional tailings storage
Proposed pit
0
2
Miles

# Hydraulic Tests: Very High Permeabilities throughout Tested Materials




Smith and McCreadie, 2008

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# Physical Setting – Implications for Mining

- Limited extent of low-permeability materials at the surface
  - Surface impoundments will be leaky
- Very high permeability sand and gravel throughout mine area
  - Groundwater will flow quickly and freely



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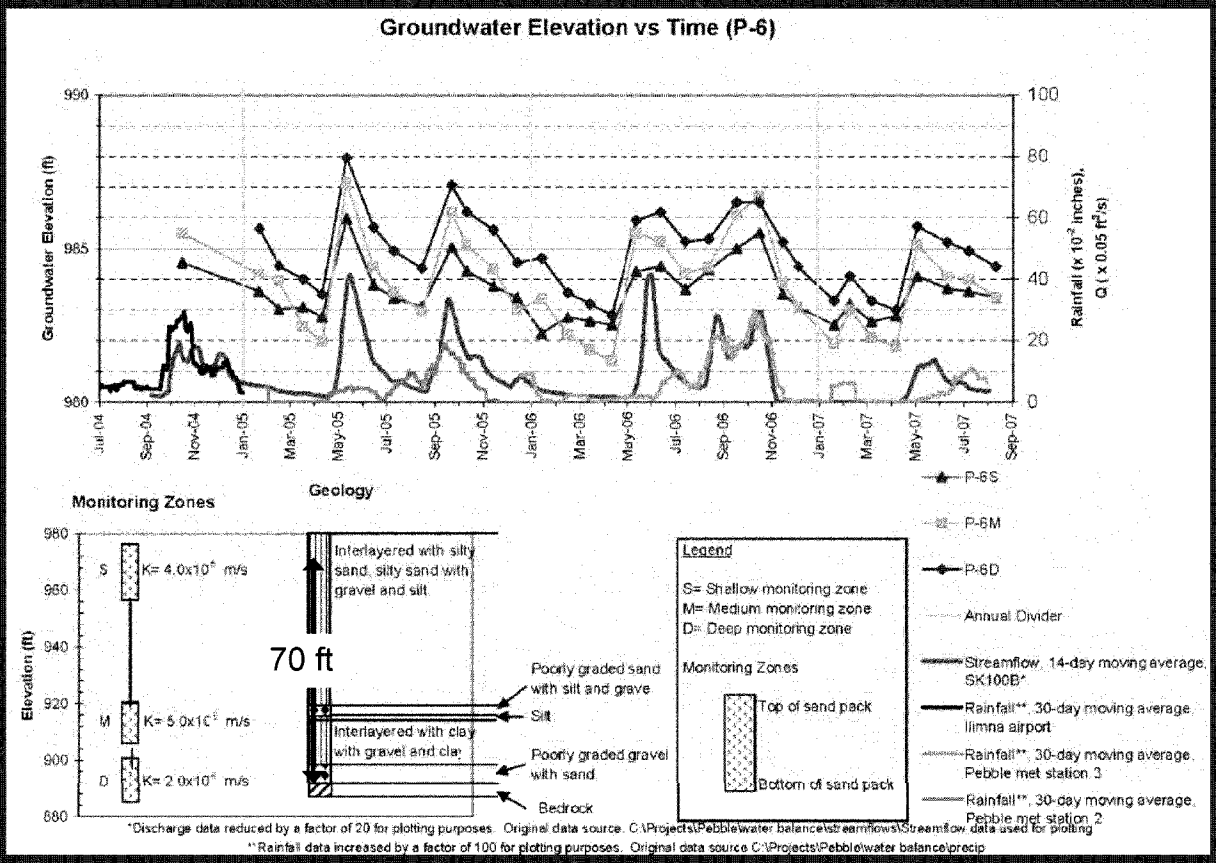


Shallow, medium, and deep groundwater respond together along with seasonal changes in streamflow near the pit. Moderate upward gradient.




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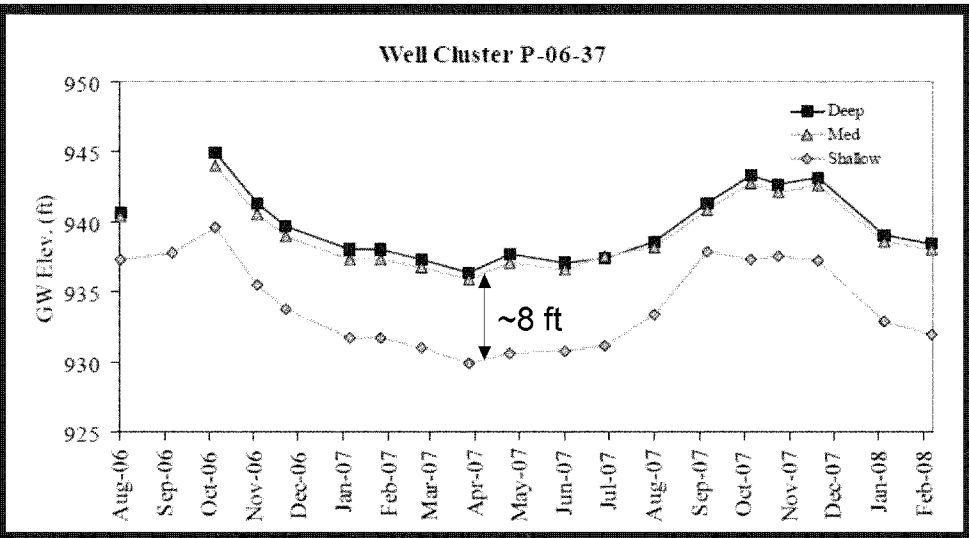
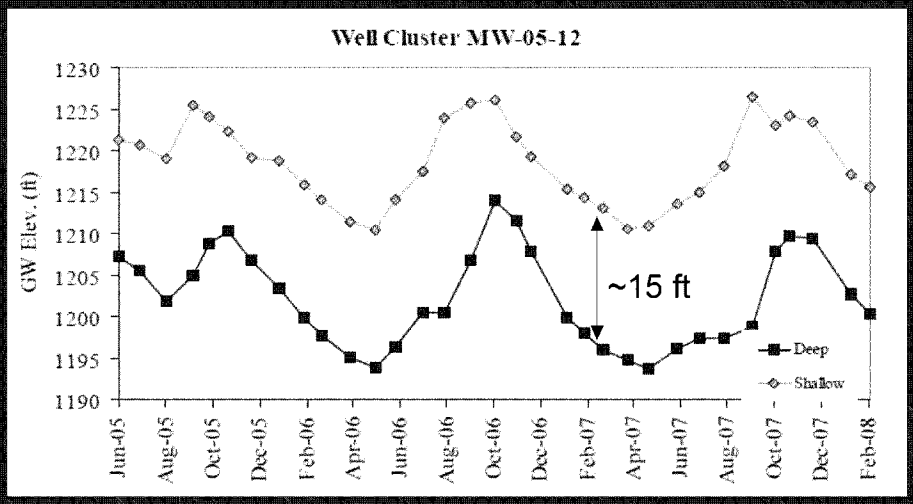



Upward Gradient
(deep GW > shallow GW)

Downward Gradient
(shallow GW > deep GW)



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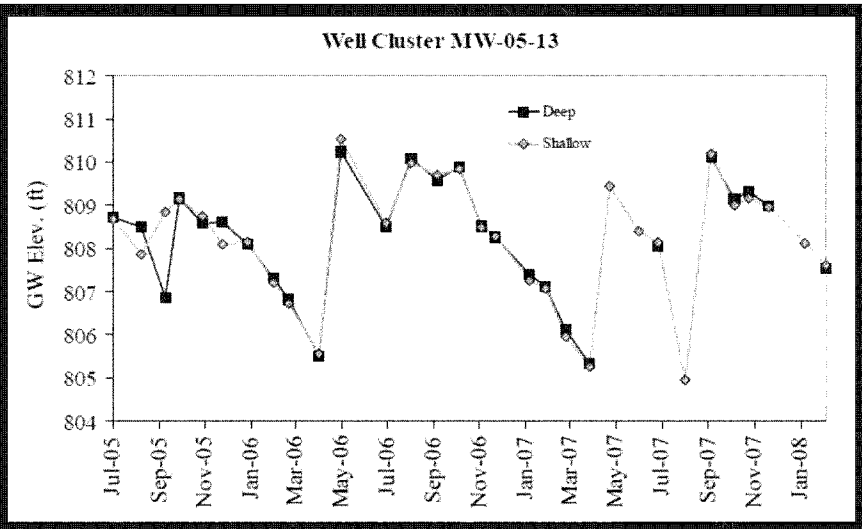
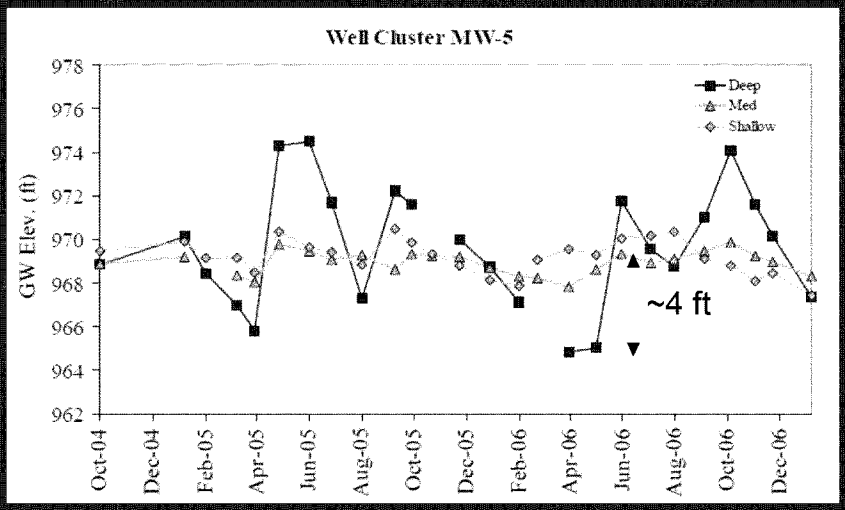



Negligible Gradient
(total communication between shallow and deep GW)

Seasonally Variable Gradient
(aquifers are separated, but deep GW is fed by surface)



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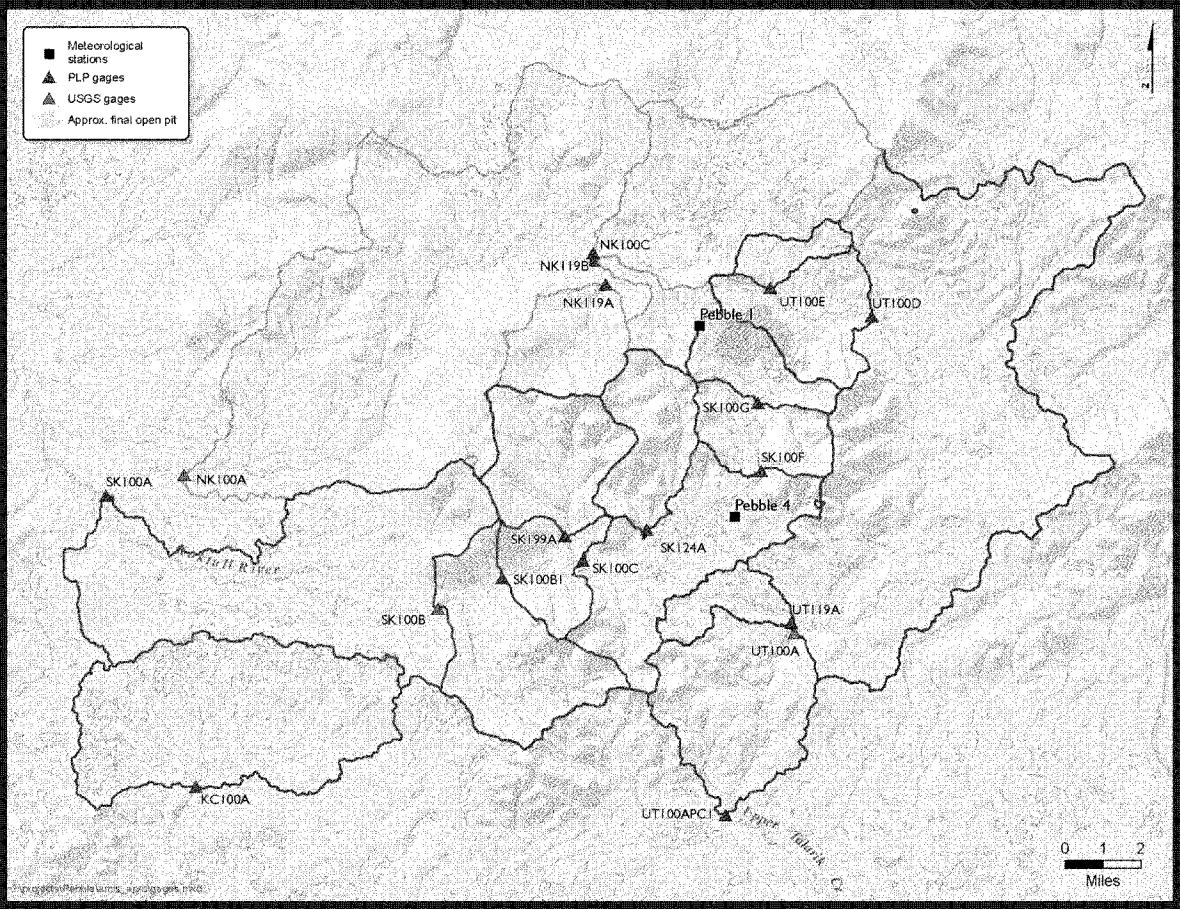
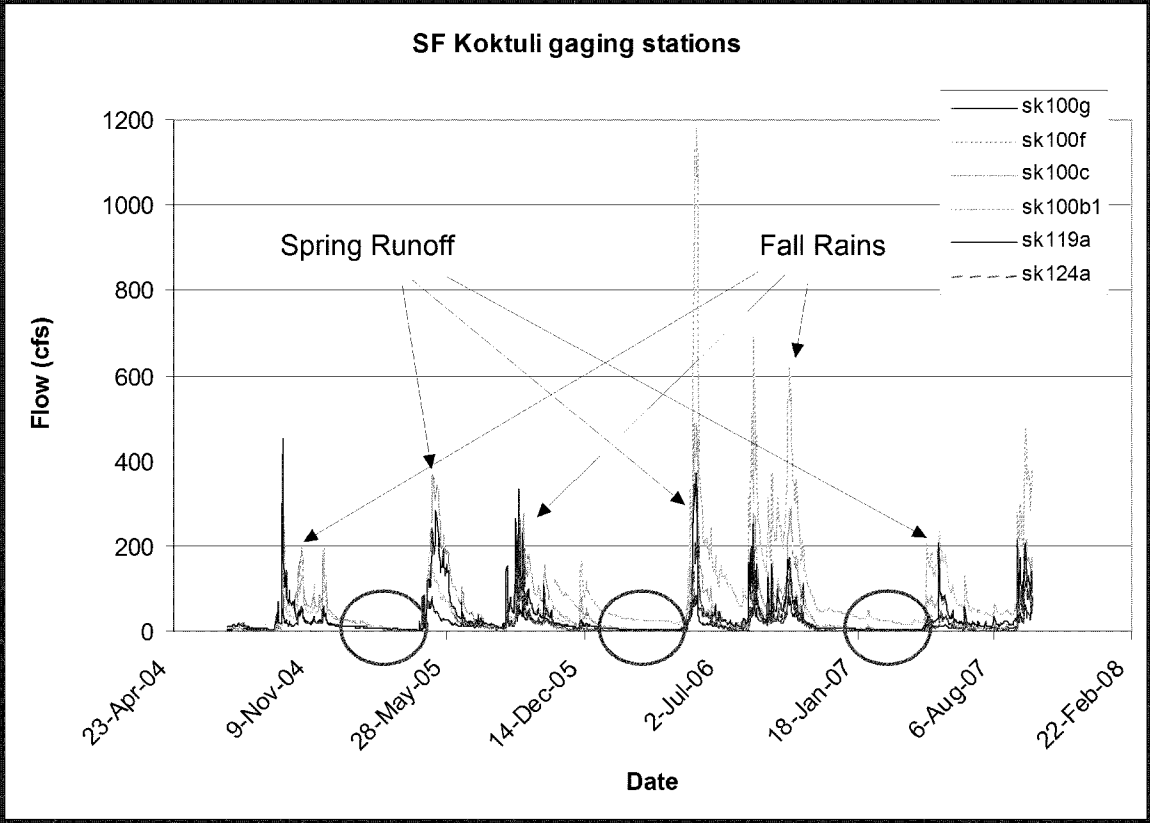
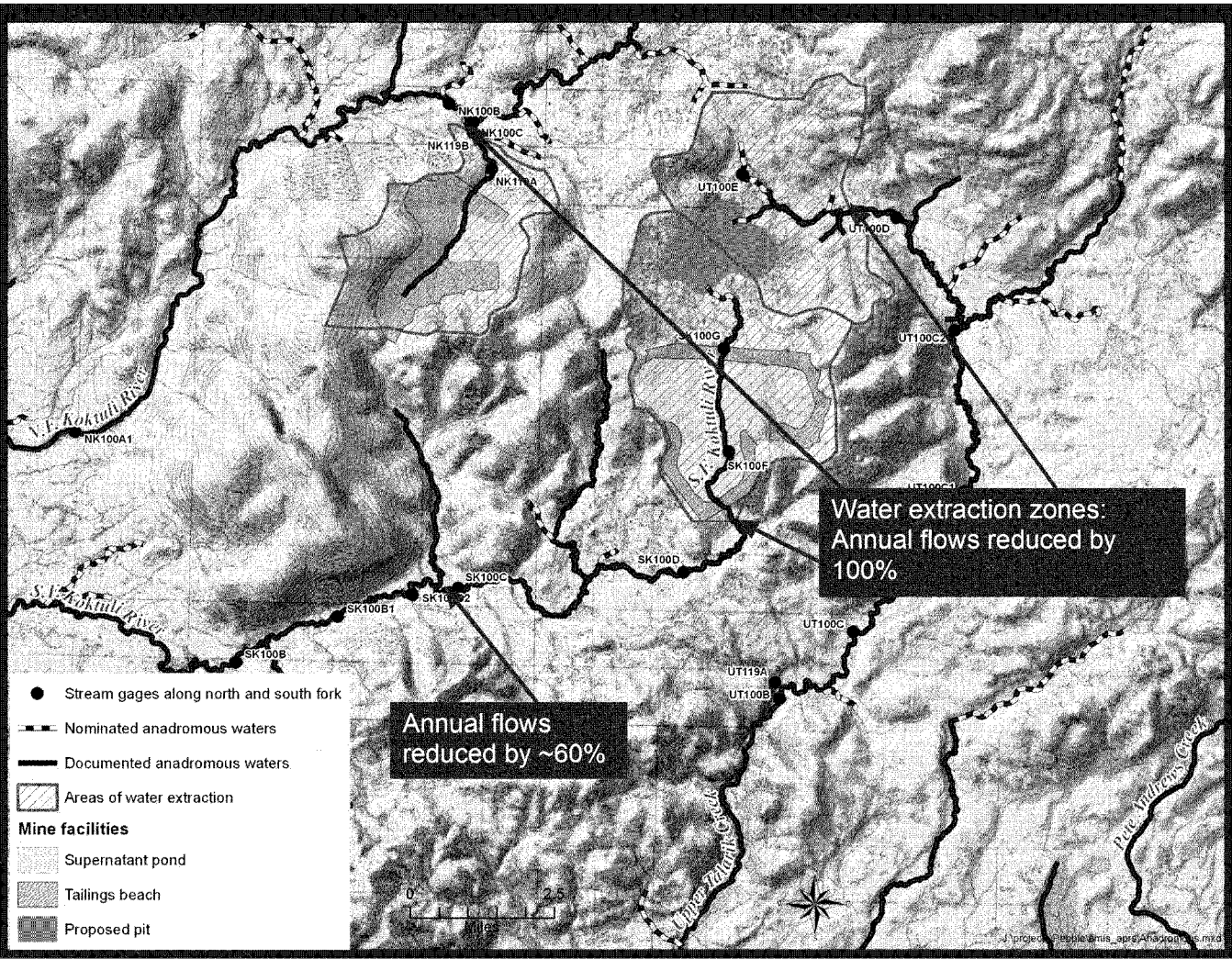
# Stream Gages and Met Stations

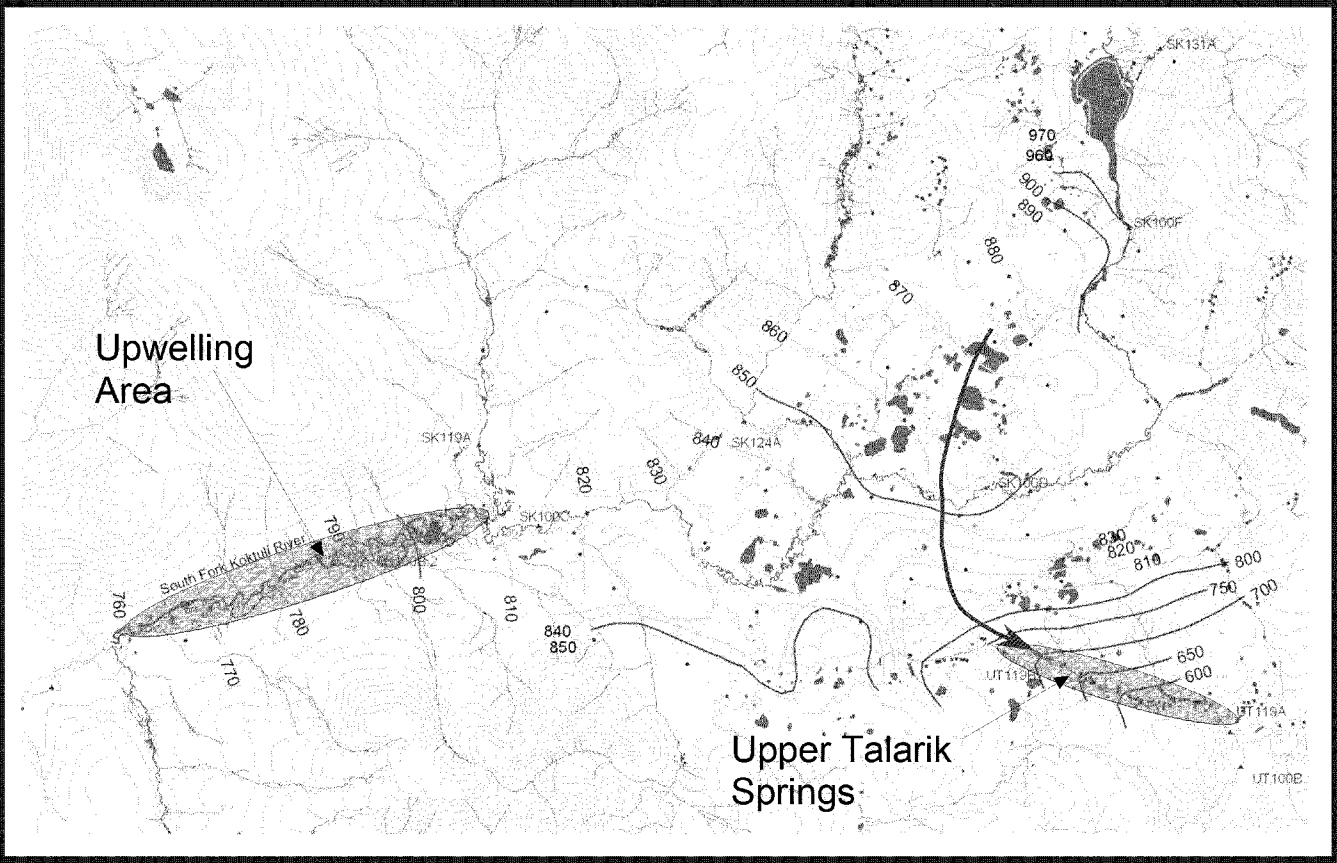


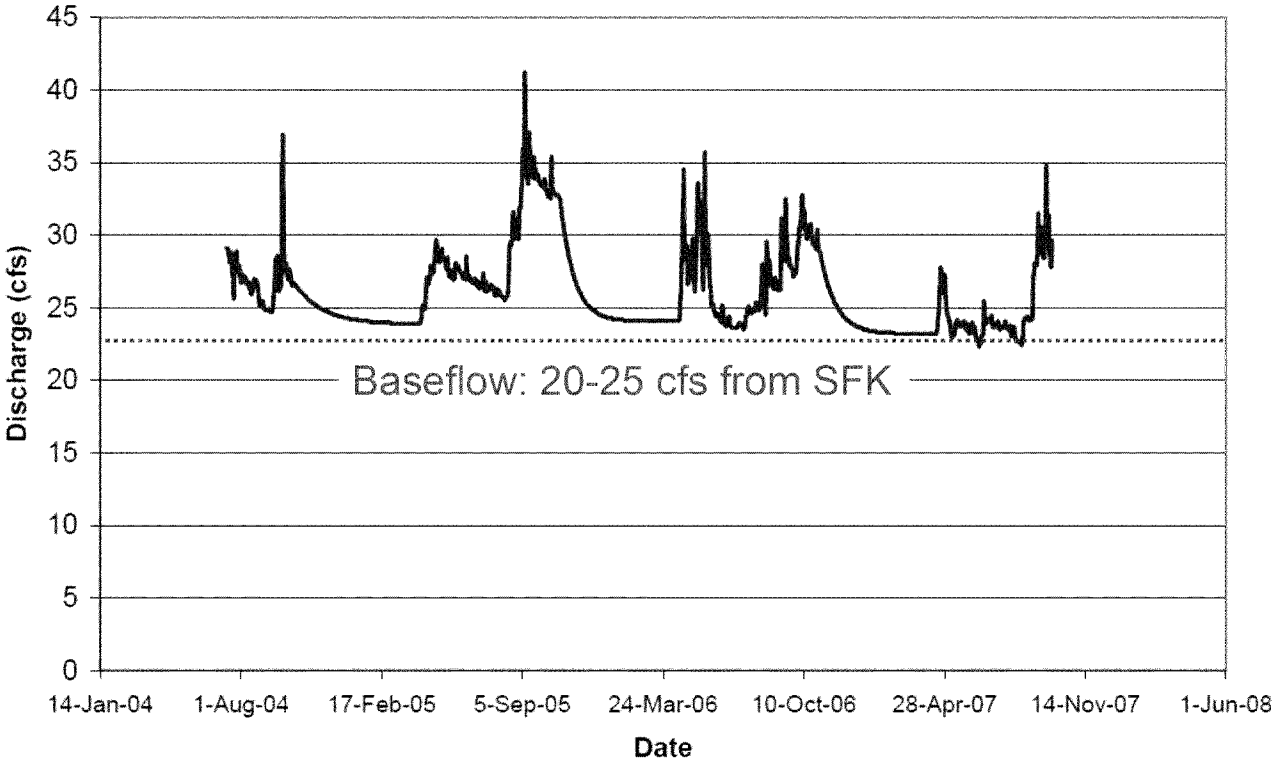
# Streamflow Records: 2004–2007




High seasonality to surface water flow, with very low (to zero) flows in late summer


NK100B
NK100C
NK119B
NK119A
UT100E
UT100D
UT100C2
SK100G
N.F. Koktuli River
NK100A1
S.F. Koktuli River
SK100F
Water extraction zones: Annual flows reduced by 100%
SK100D
SK100C
SK100B1
SK100B
UT100C
UT119A
UT100B
Annual flows reduced by ~60%
Upper Talarik Creek
Pete Andrews Creek
Stream gages along north and south fork
Nominated anadromous waters
Documented anadromous waters
Areas of water extraction
Mine facilities
Supernatant pond
Tailings beach
Proposed pit
0
2.5
Miles


Upwelling Area
Upper Talarik Springs
South Fork Koktuli River
SK131A
SK100F
SK119A
SK124A
SK100C
SK100B
UT119A
UT100B
970
960
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
700
650
600


UT 119A Hydrograph
Discharge (cfs)
45
40
35
30
25
20
15
10
5
0
Baseflow: 20-25 cfs from SFK
14-Jan-04
1-Aug-04
17-Feb-05
5-Sep-05
24-Mar-06
10-Oct-06
28-Apr-07
14-Nov-07
1-Jun-08
Date

# Groundwater and Surface Water Hydrology: Implications for Mining

- Groundwater elevations vary seasonally
  - Water is flushed in and out of the ground seasonally
- Surface water flows are highly seasonal
  - Natural ability to dilute contamination varies through the year
- SF Koktuli loses ALL of its flow to groundwater and into the Upper Talarik in late summer
  - Contamination of SF Koktuli would also affect springs in Upper Talarik



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   - Interbasin transfers
   - Implications for mining impacts
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   - Integrated surface water-groundwater modeling
   - Coupled to atmospheric processes
   - Evaluate baseline and post-mine conditions
4. Summary



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# Ongoing Work – Motivation

- Available data indicate that surface water and groundwater are very closely linked at Pebble
- Models such as MODFLOW may not simulate coupled SW-GW interactions realistically
- Need to evaluate mine impacts in a fully coupled system



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# Ongoing Work – Goals

- Simulate fully coupled atmosphere-surface water-groundwater system under baseline conditions
  - Calibrate to observed GW and SW data
- Evaluate impacts of potential mining scenarios
  - Changes in hydrographs
  - Downstream changes in water quantity
  - Downstream changes in water quality due to mining



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# Hydrologic Model: DHI MikeSHE/Mike11

- Fully coupled GW-SW-Atmosphere model
- Inputs
  - Topography, stream network
  - Subsurface geology
  - Rainfall, ET, wind at 3-hour increments (NOAA NARR data)
- Outputs
  - Rainfall-runoff response and hydrographs
  - Groundwater elevations and storage



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# Summary

- Site geology is very “leaky”
  - Very few low permeability materials
  - Difficult to contain mining wastes
- Groundwater and surface water are closely coupled
  - Groundwater elevations and gradients change seasonally
  - Streams lose water to the ground that flows freely between basins
- Ongoing modeling study
  - Coupled atmosphere-surface water-groundwater model
  - Sub-daily timestep
  - Best chance of simulating potential mining impacts



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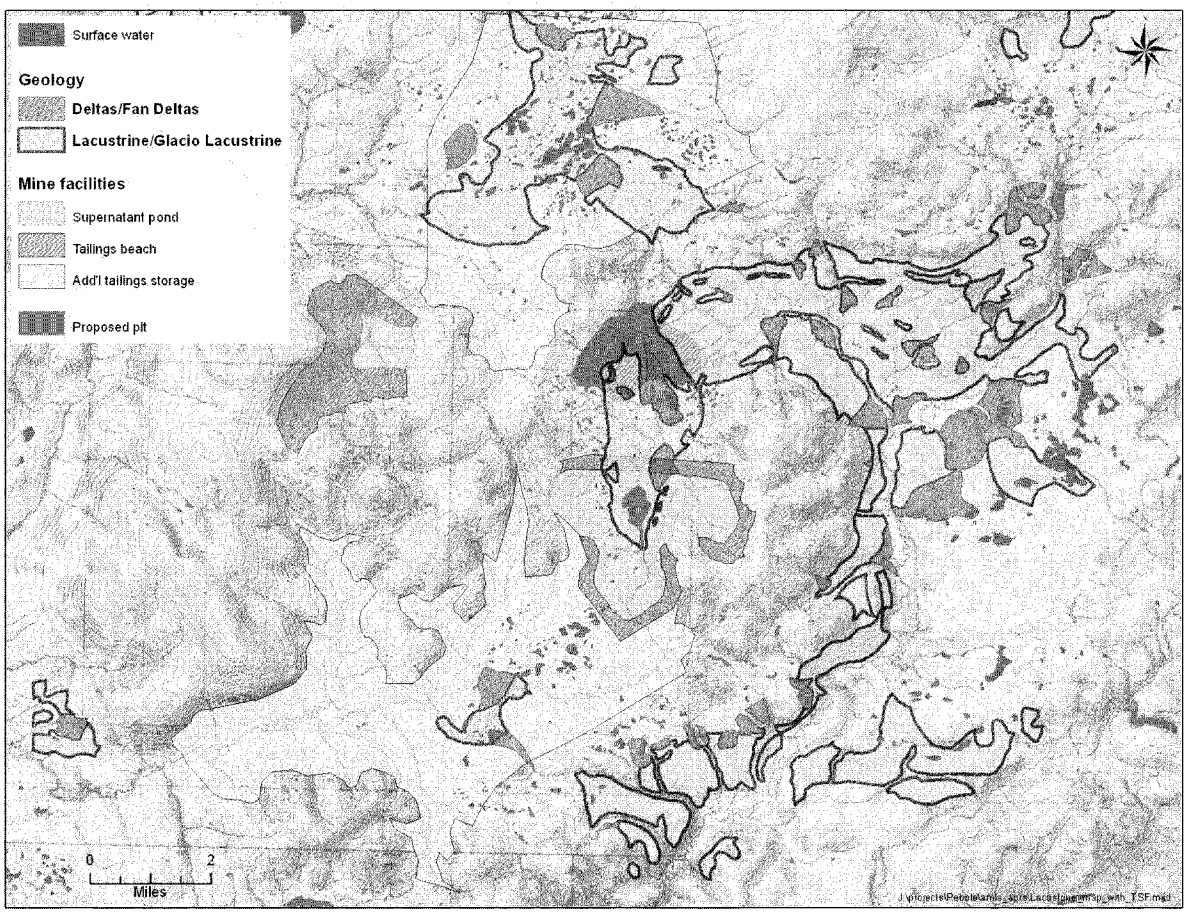
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Add'l tailings storage
Proposed pit
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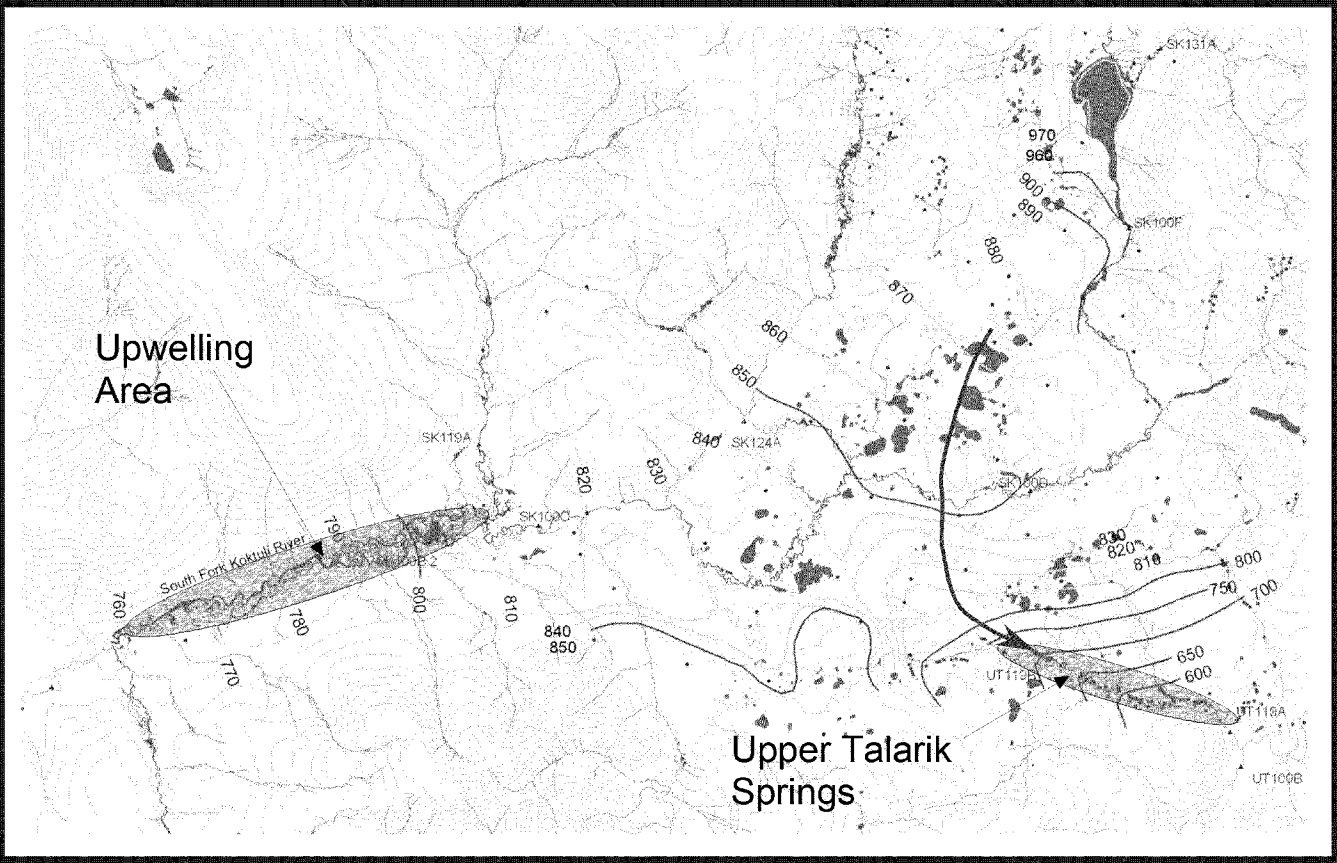
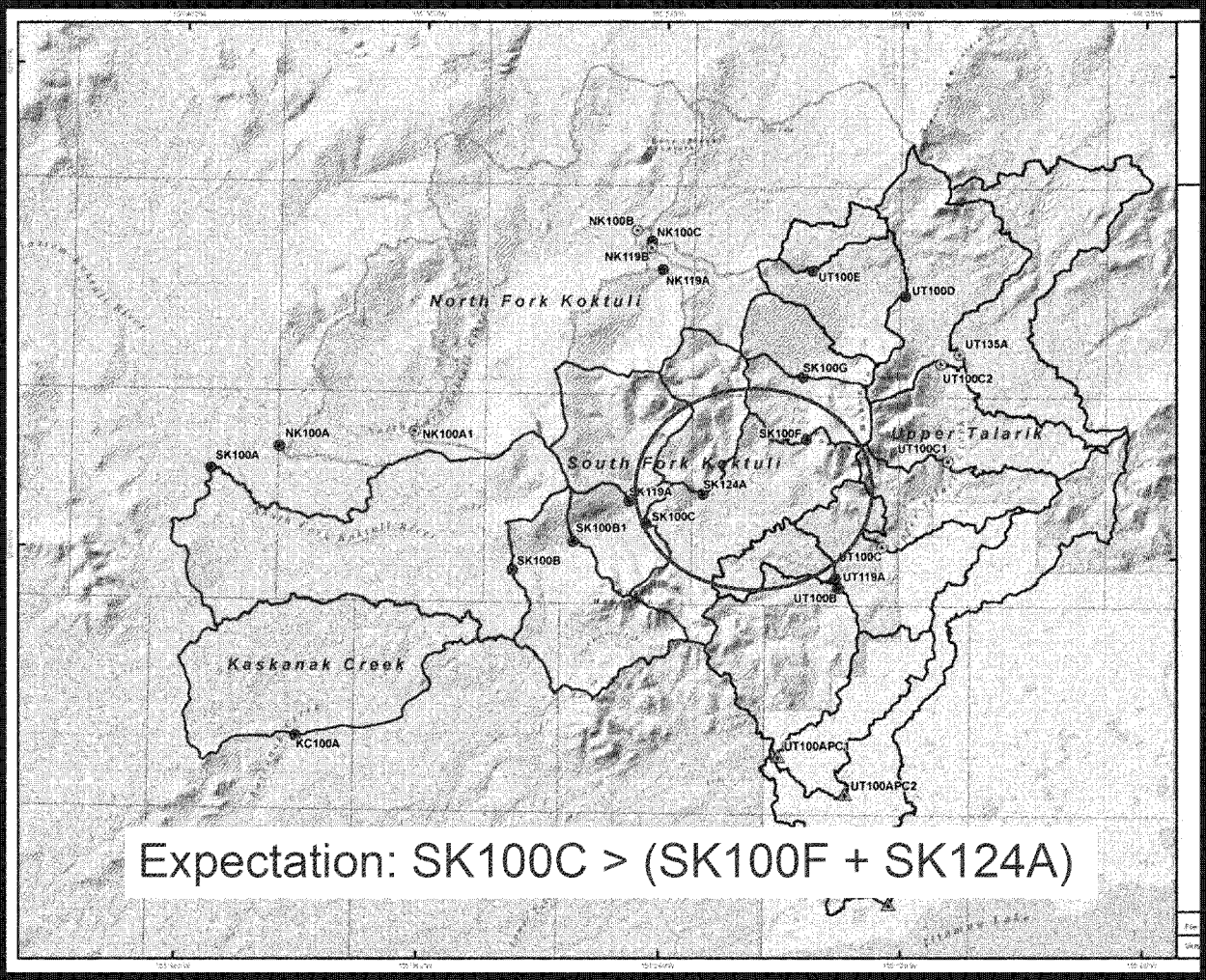
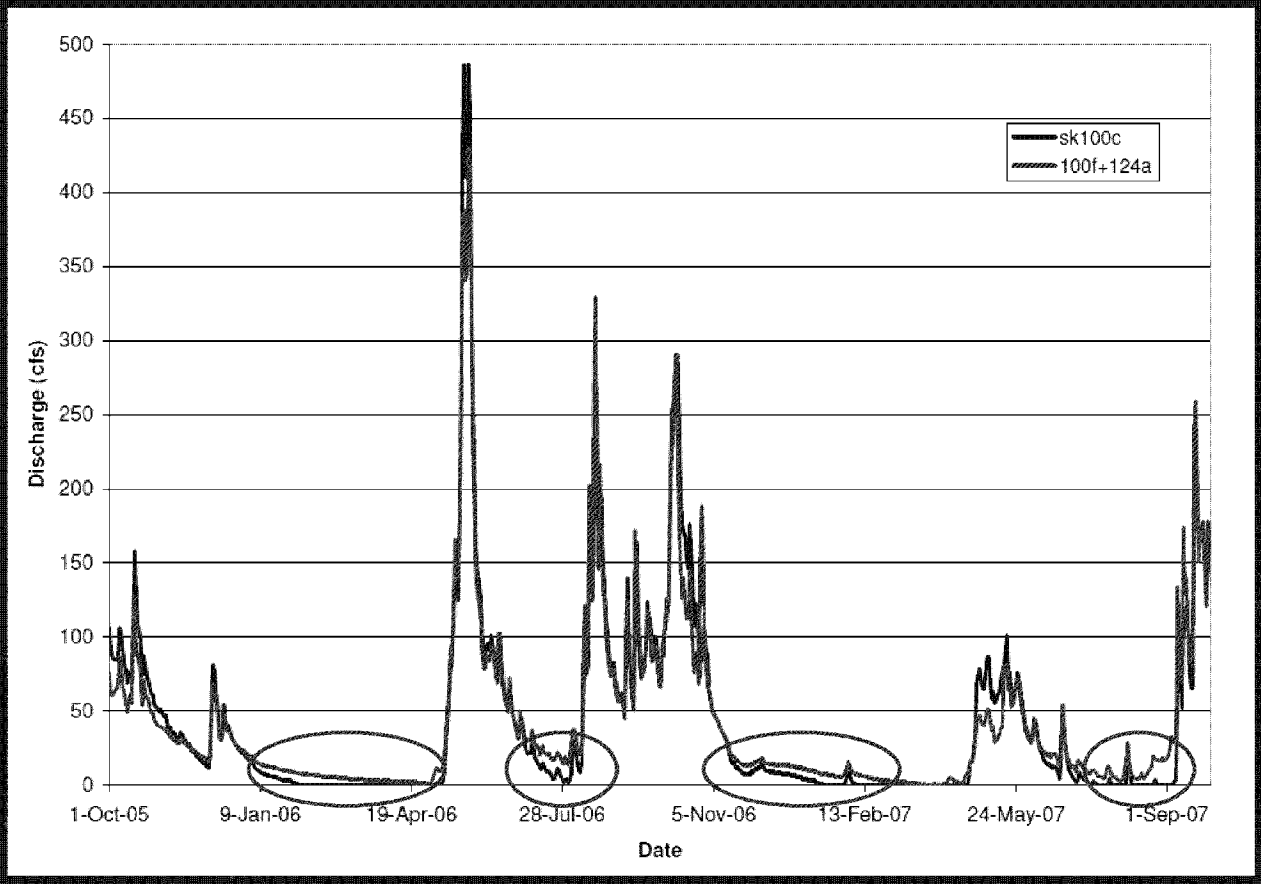


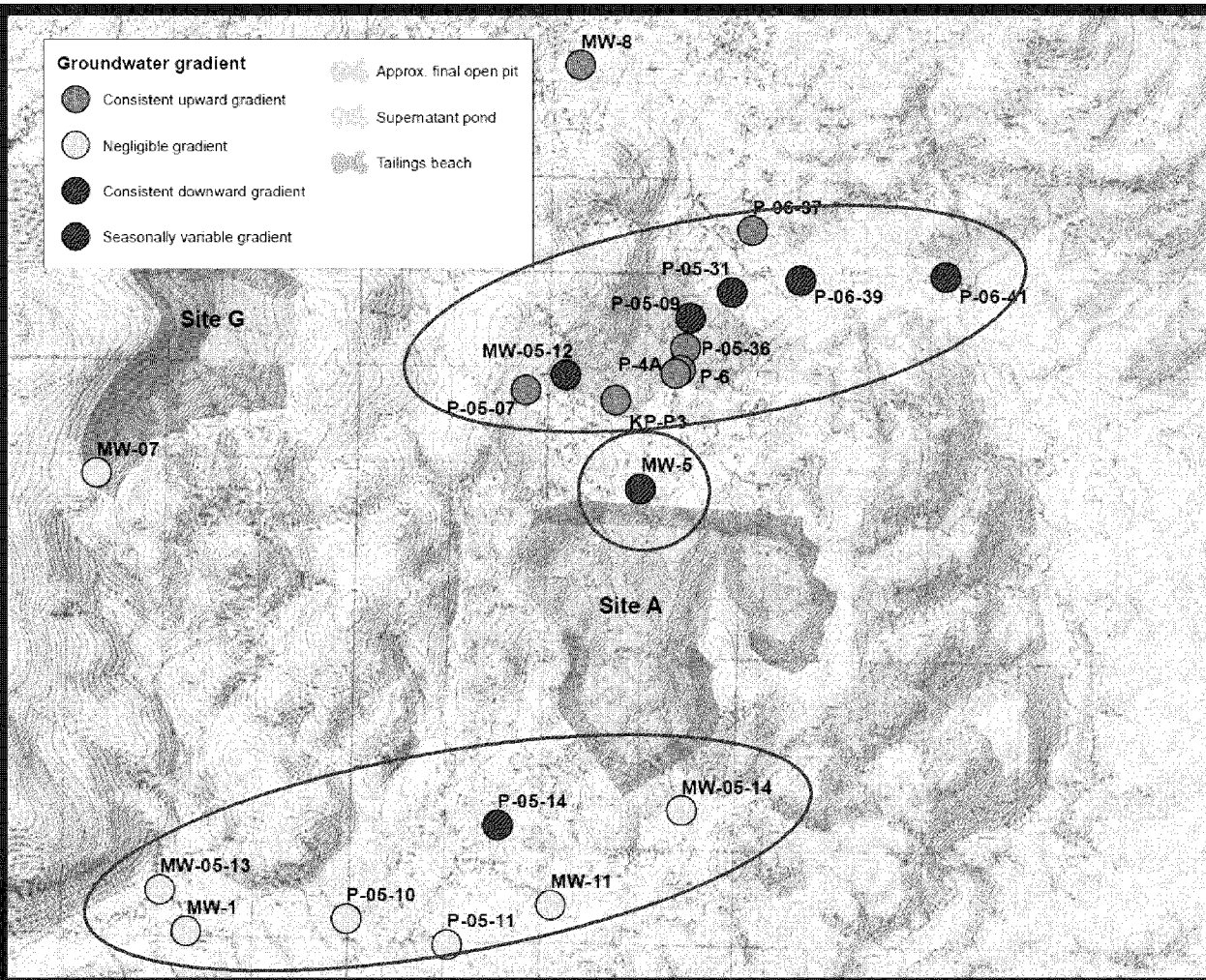

Groundwater from SF Koktuli feeds Upper Talarik springs (Interbasin Transfer)




Expectation: SK100C > (SK100F + SK124A)

# SFK Surface Flows are "Lost" between SK100F and SK100C




Groundwater gradient
Consistent upward gradient
Negligible gradient
Consistent downward gradient
Seasonally variable gradient
Approx. final open pit
Supernatant pond
Tailings beach
MW-8
P-06-37
P-05-31
P-06-39
P-06-41
P-05-09
P-05-36
MW-05-12
P-4A
P-6
P-05-07
KP-P3
MW-07
MW-5
Site G
Site A
P-05-14
MW-05-14
MW-05-13
MW-1
P-05-10
MW-11
P-05-11