ArchCoal

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Coal-Mac, Inc.
TDS Reduction from Valley Fills

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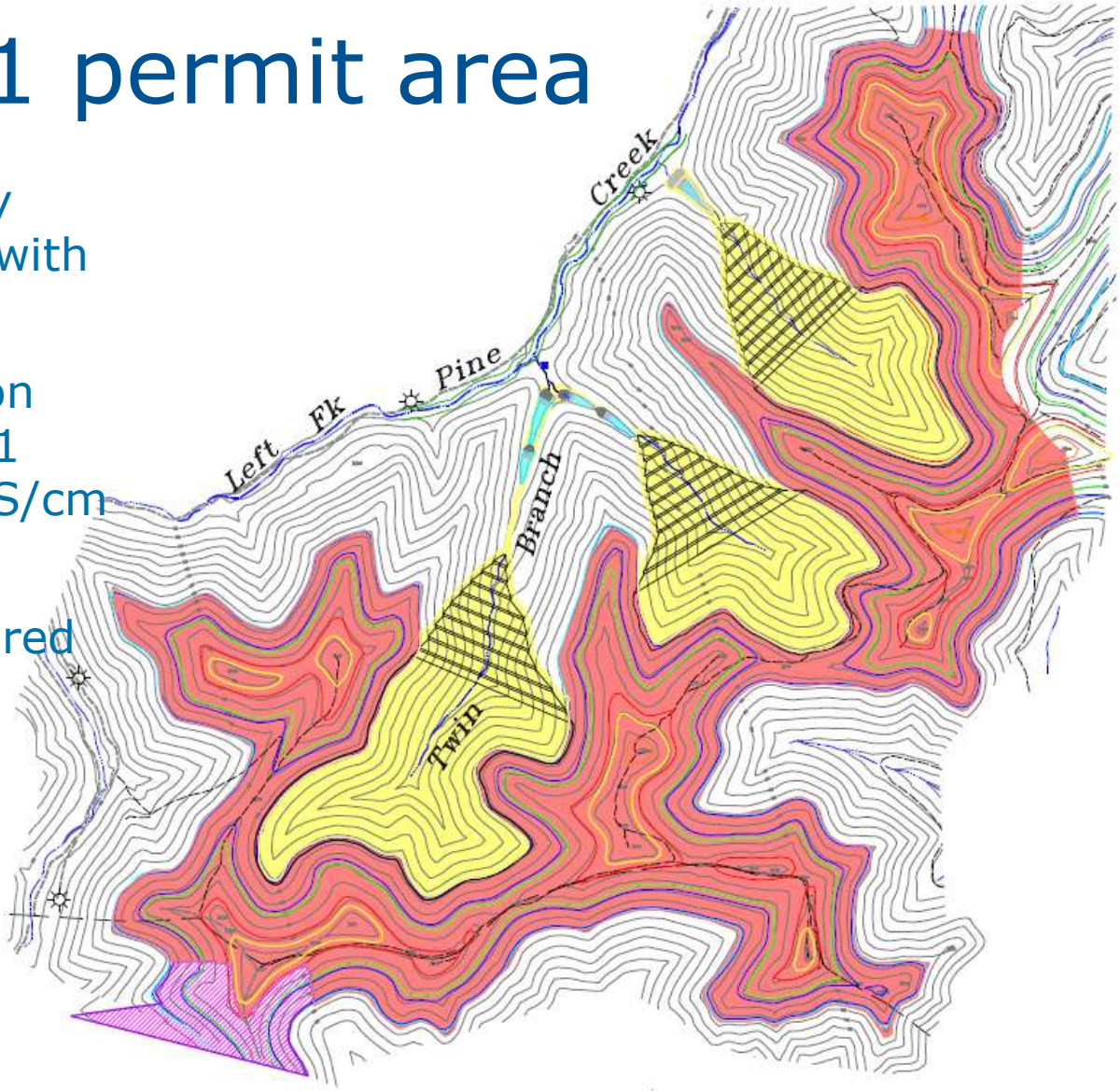
Coal Mac, Inc.

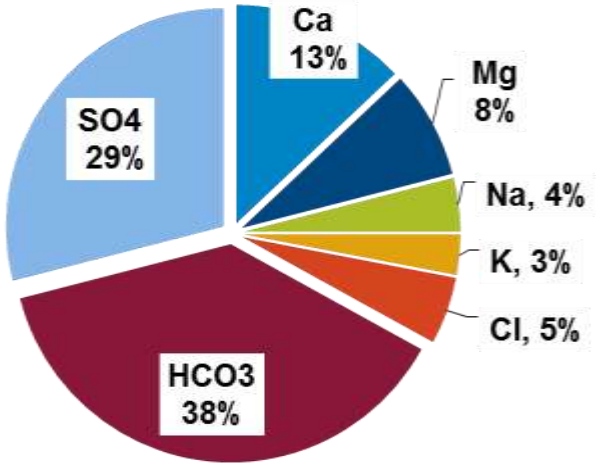
- Subsidiary of Arch Coal, Inc.
- Employees - 306
- Annual sales - 3 MM tons
- Excavator/Loader mine

Pine Creek 1 permit area

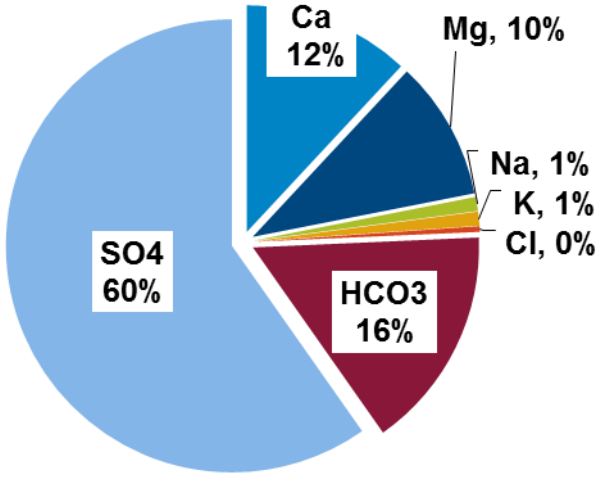
- Valley fill 1 approved by USCOE, in conjunction with USEPA
- Future fills contingent on Conductivity below Fill 1 remaining below 500 µS/cm during construction
- Stream Mitigation required



Identify Source of TDS increase



Pond et al. 2008
Un-mined Sites (7)
Mean SC: 62 µS/cm
Mean ion sum - 56 mg/L



Pond et al. 2008
Mined Sites (13)
Mean SC: 1023 µS/cm
Mean ion sum - 1165 mg/L

Sulfates contribute the greatest increase to TDS – from 16 mg/l to 700 mg/l

Bicarbonates are next – from 21 mg/l to 186 mg/l

Design and Construction techniques to reduce sulfates

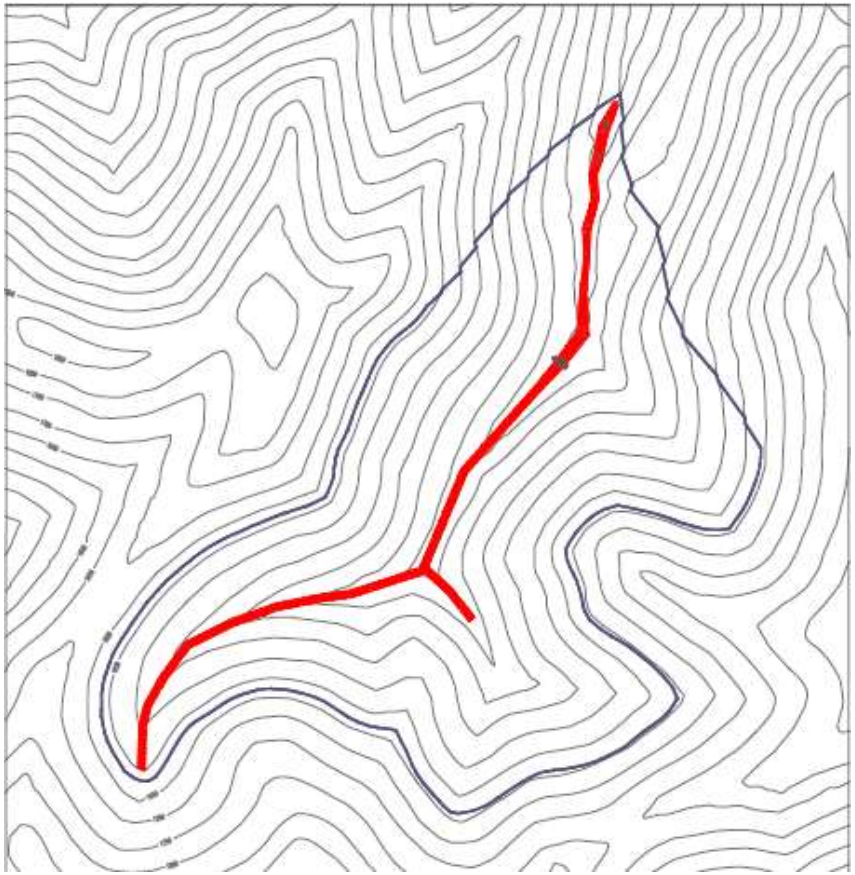
- **Construct underdrain of durable, low-sulfur material to reduce sulfate reaction**

Material Type	*Sulfur content*
Sandstone	*100 – 500 ppm*
Shale	*300 – 10,700 ppm*
Fireclay	*400 – 60,600 ppm*
Coal	*6,000 – 60,400 ppm*

- **Internal and surface drainage to prevent infiltration**
- **Limited initial brushing (5th bench level)**

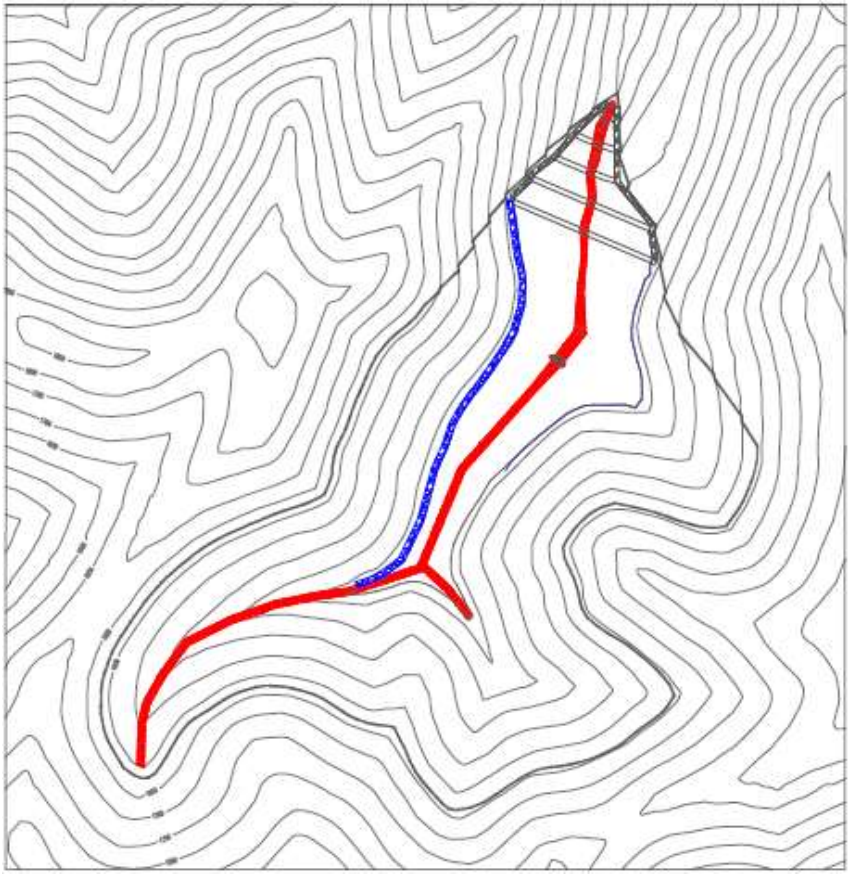
Check dams and wrapped underdrain

- *Nine (9) check dams*
- *Wrap 4,200’ of underdrain with filter fabric*



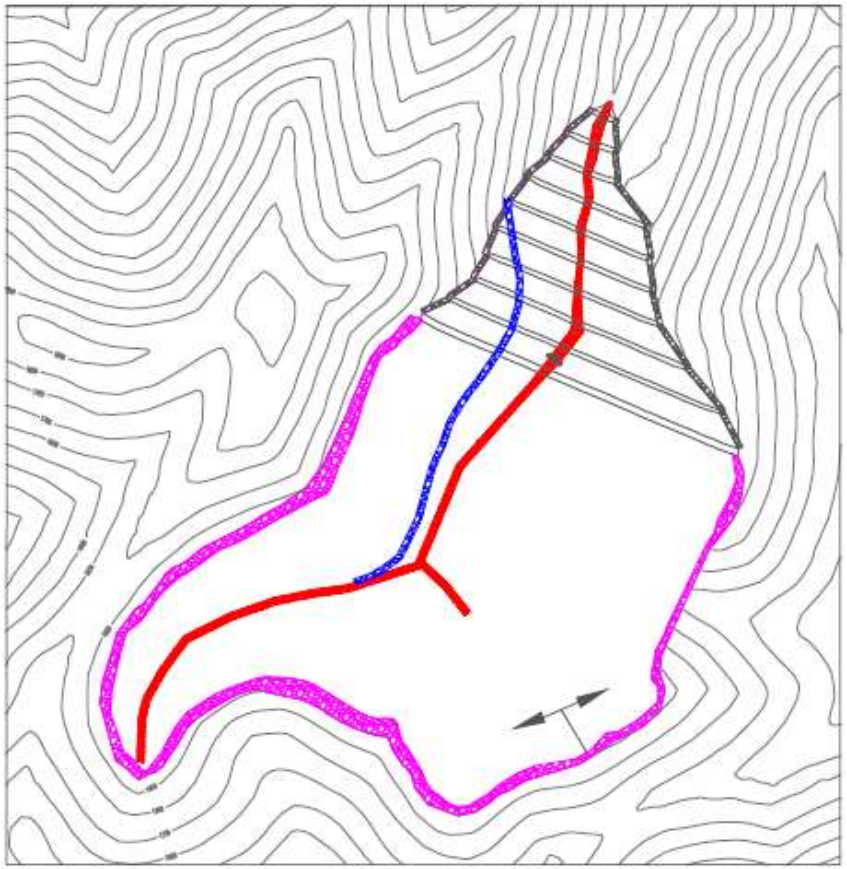
Fifth Bench Level Elev. - 1375’

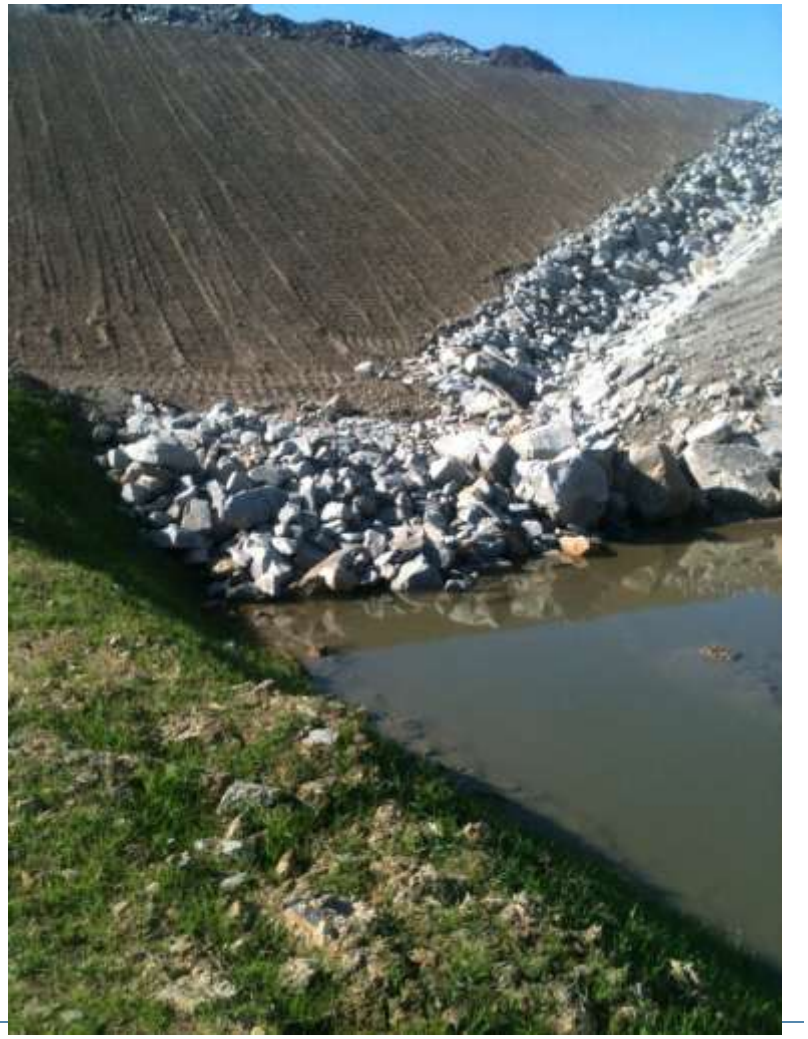
- *Compact and slope 5% to west side*
- *1,900’ underdrain daylights on 5th bench*



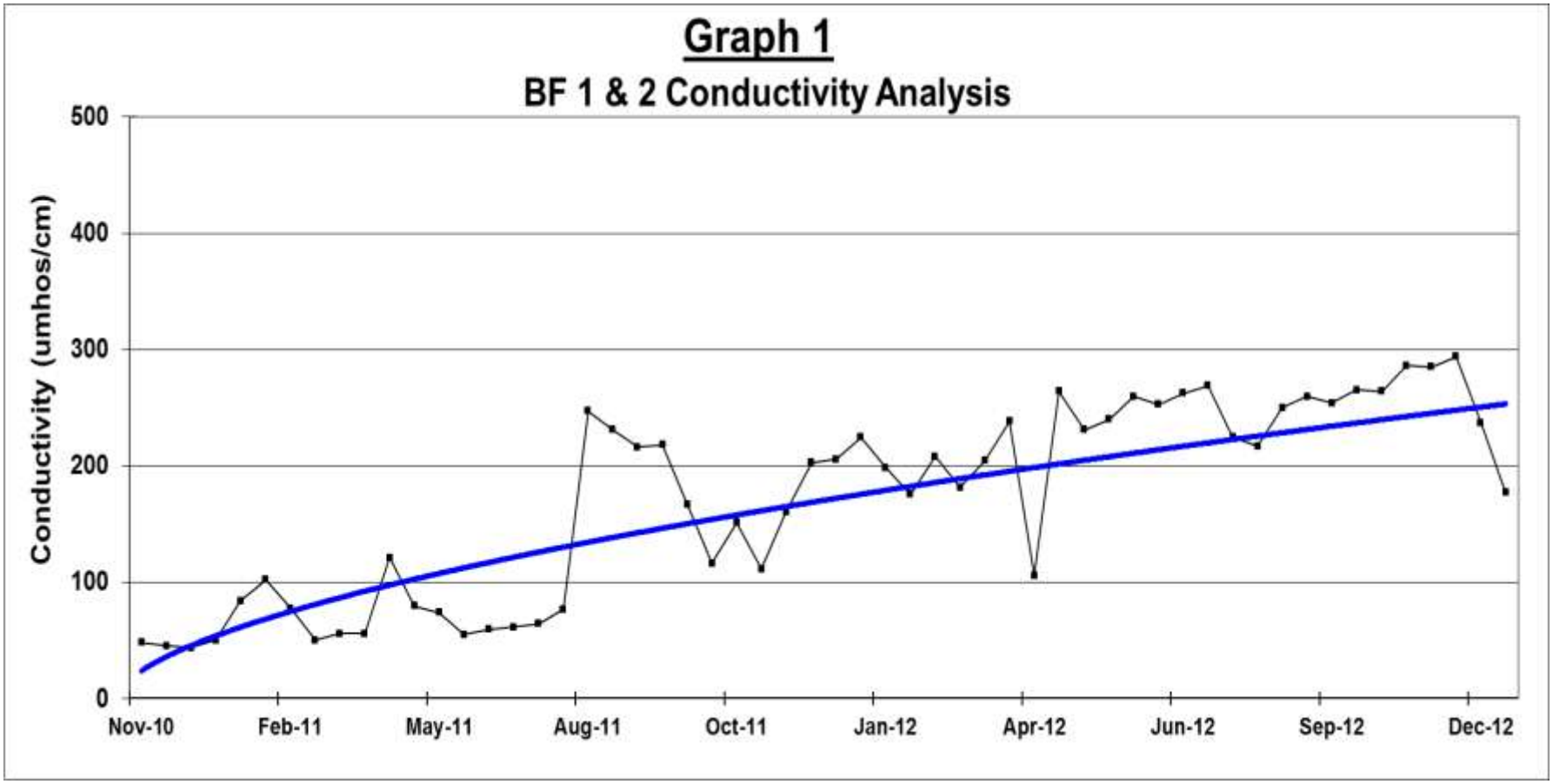
Coalburg level - 1595’

6,500’ pavement underdrain daylights into sediment ditch

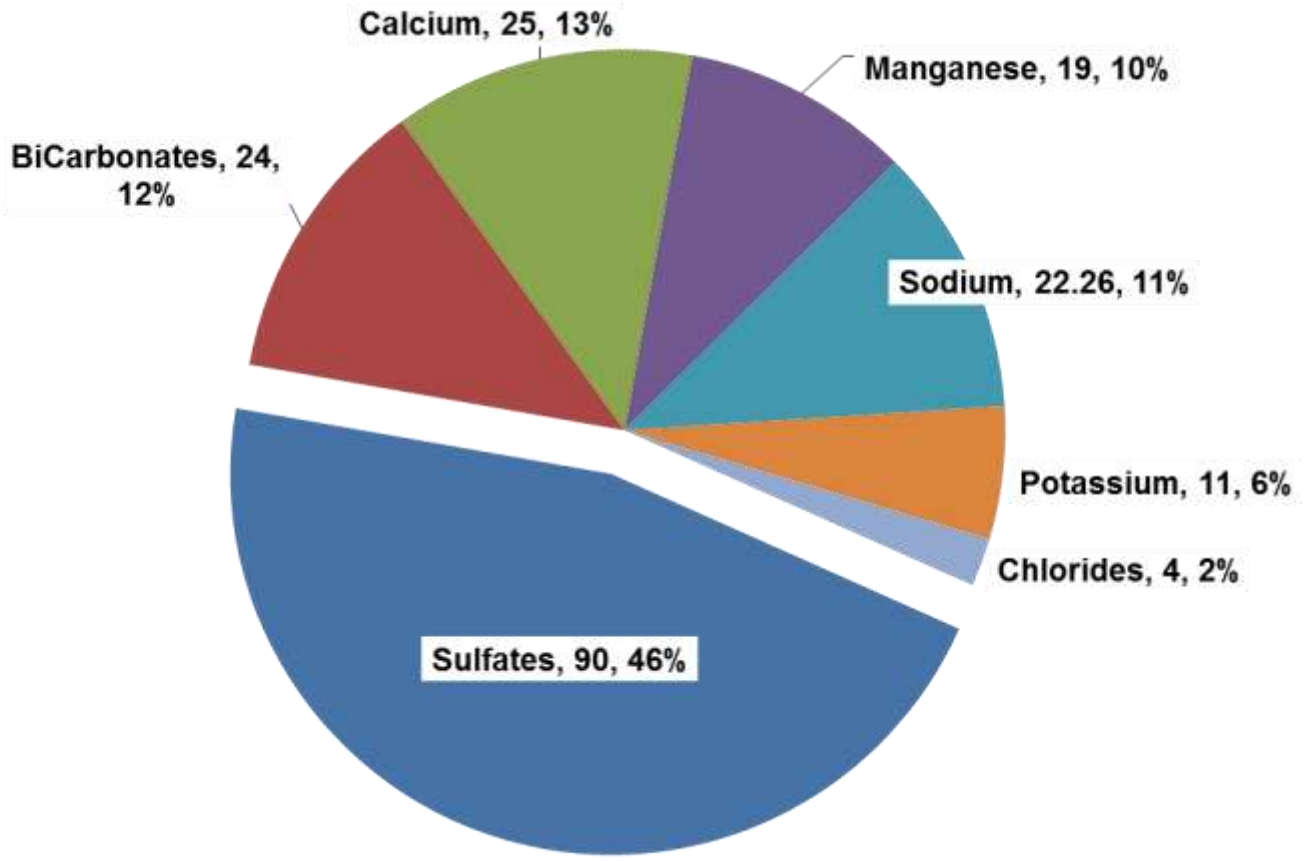




Valley Fill #1 and Backfill Configuration

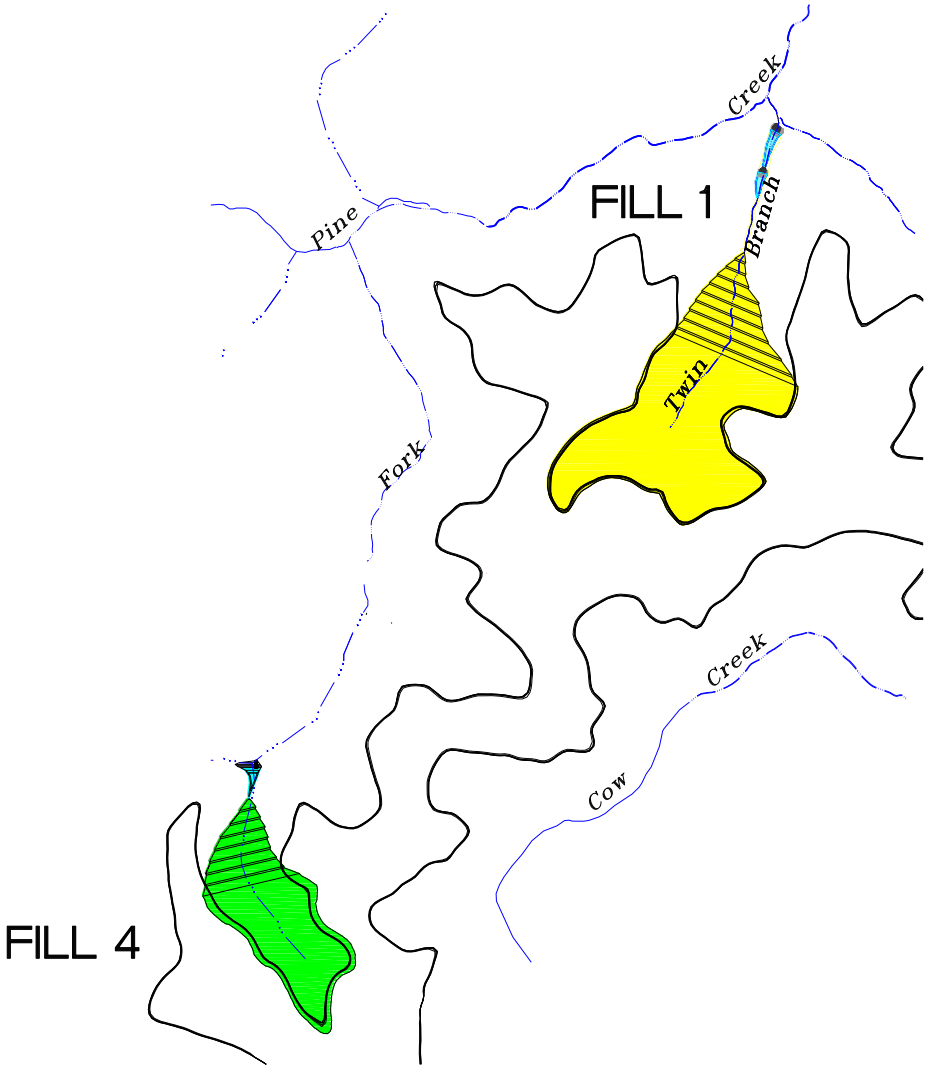

Graph 1
BF 1 & 2 Conductivity Analysis
Conductivity (umhos/cm)
500
400
300
200
100
0
Nov-10
Feb-11
May-11
Aug-11
Oct-11
Jan-12
Apr-12
Jun-12
Sep-12
Dec-12

Dissolved Solids Composition at Sample Site BF1&2 Concentration – 195 mg/l

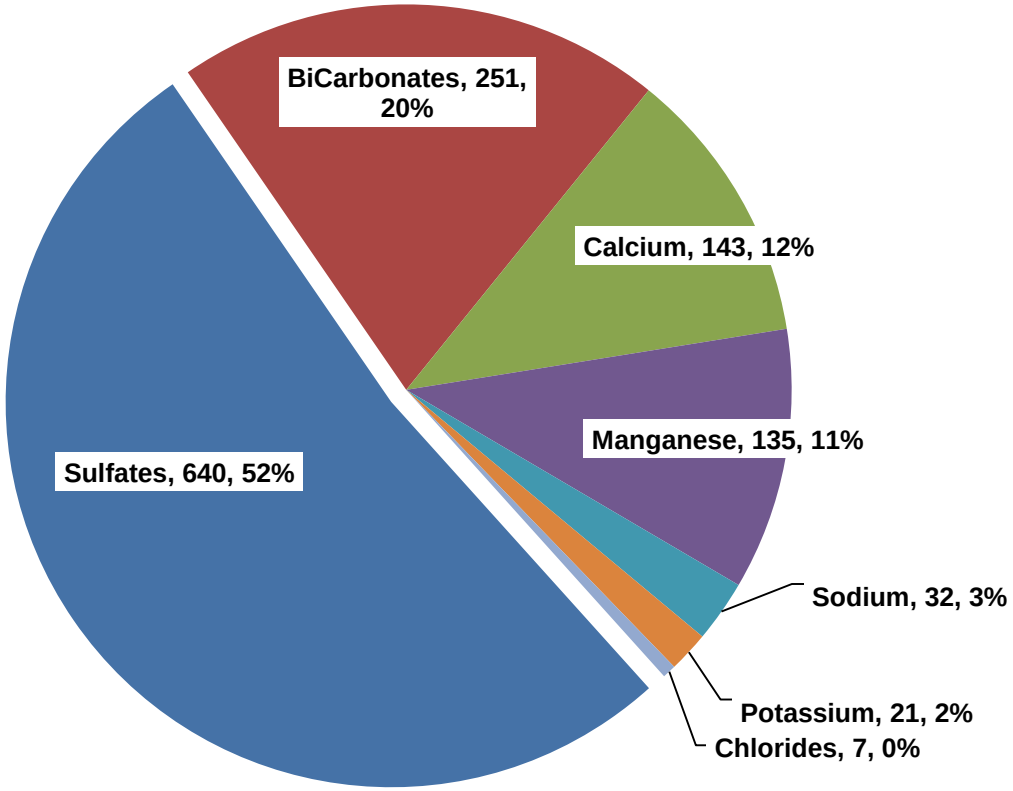


How do results compare to fills without special BMPs?

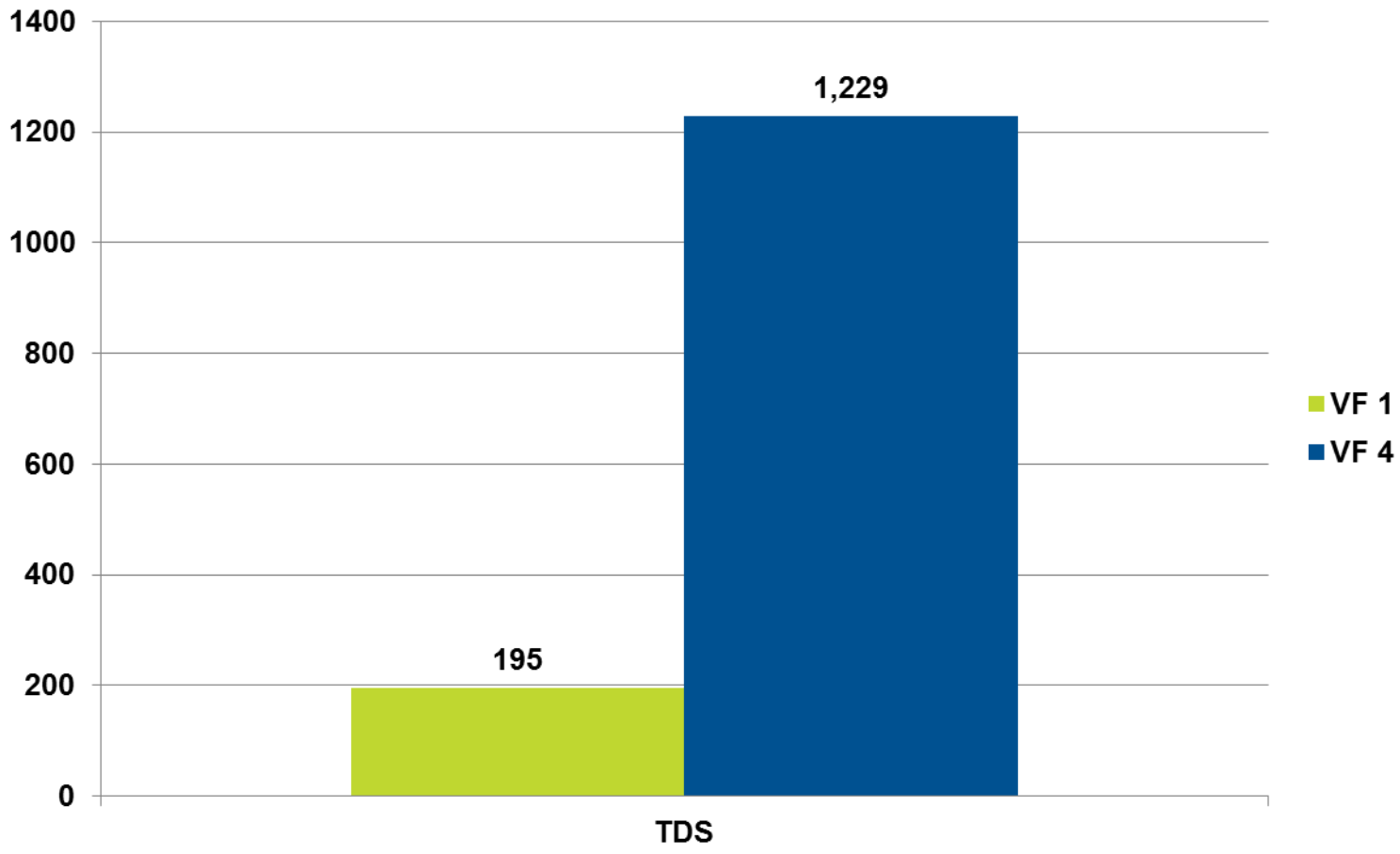
- Nearby Valley Fill 4
  - Approx. 9 MM cu yds



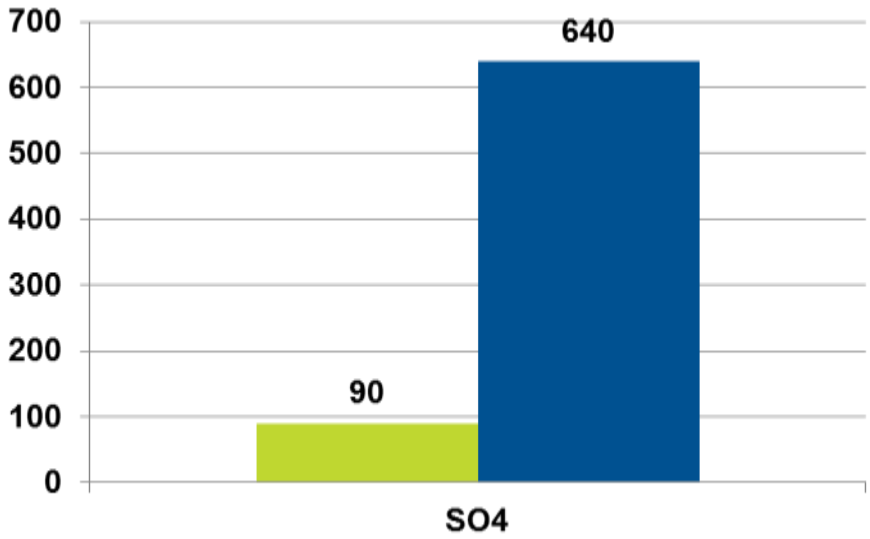
Dissolved Solids Composition below VF 4 Concentration – 1,229 mg/l

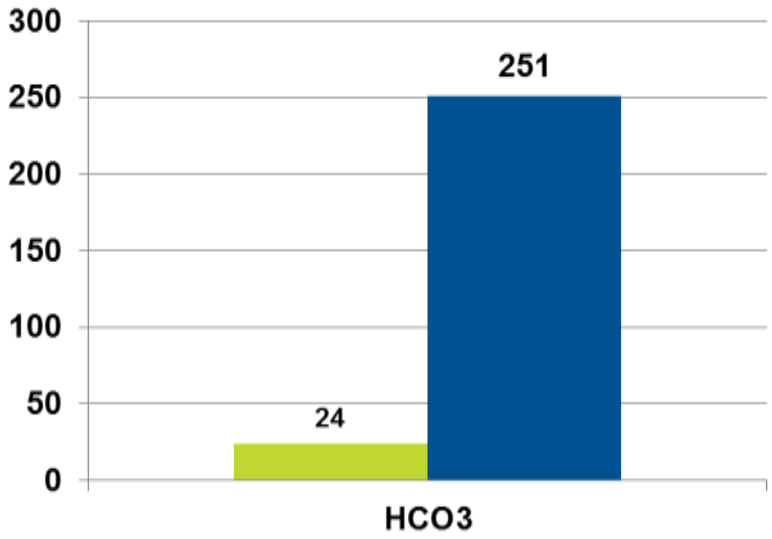


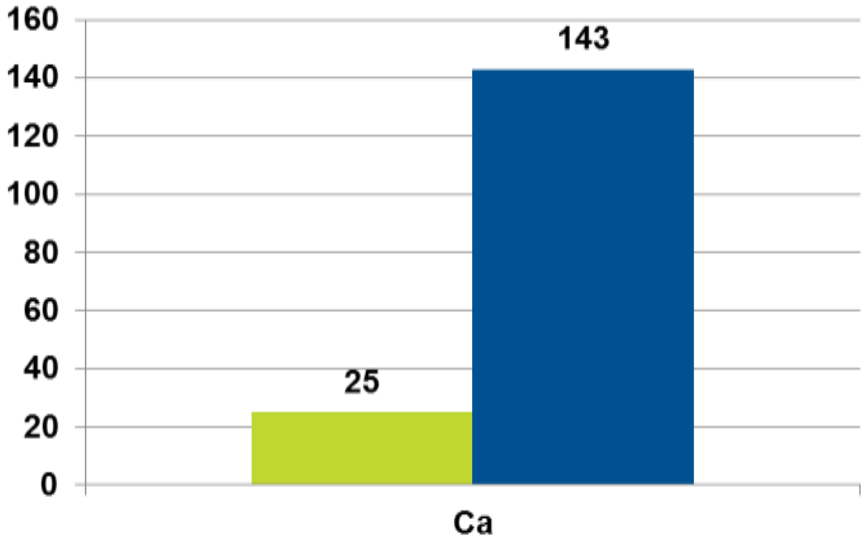
TDS Comparison

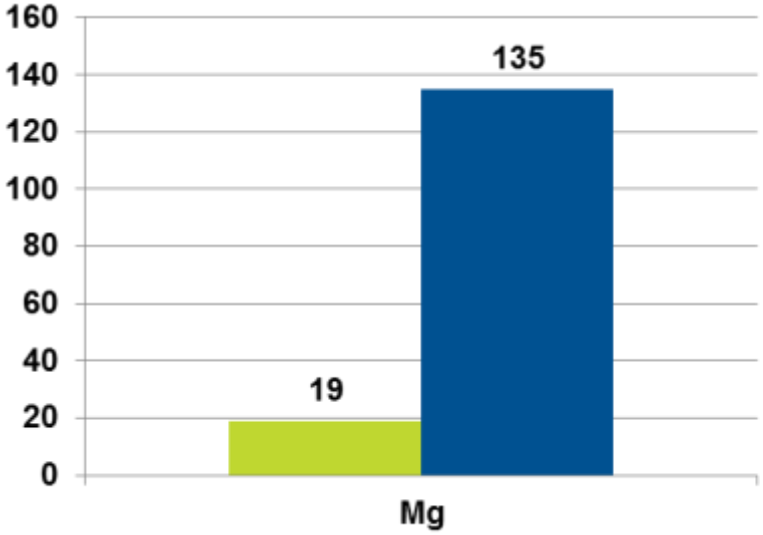


TDS Constituent Comparison - VF1 vs. VF4





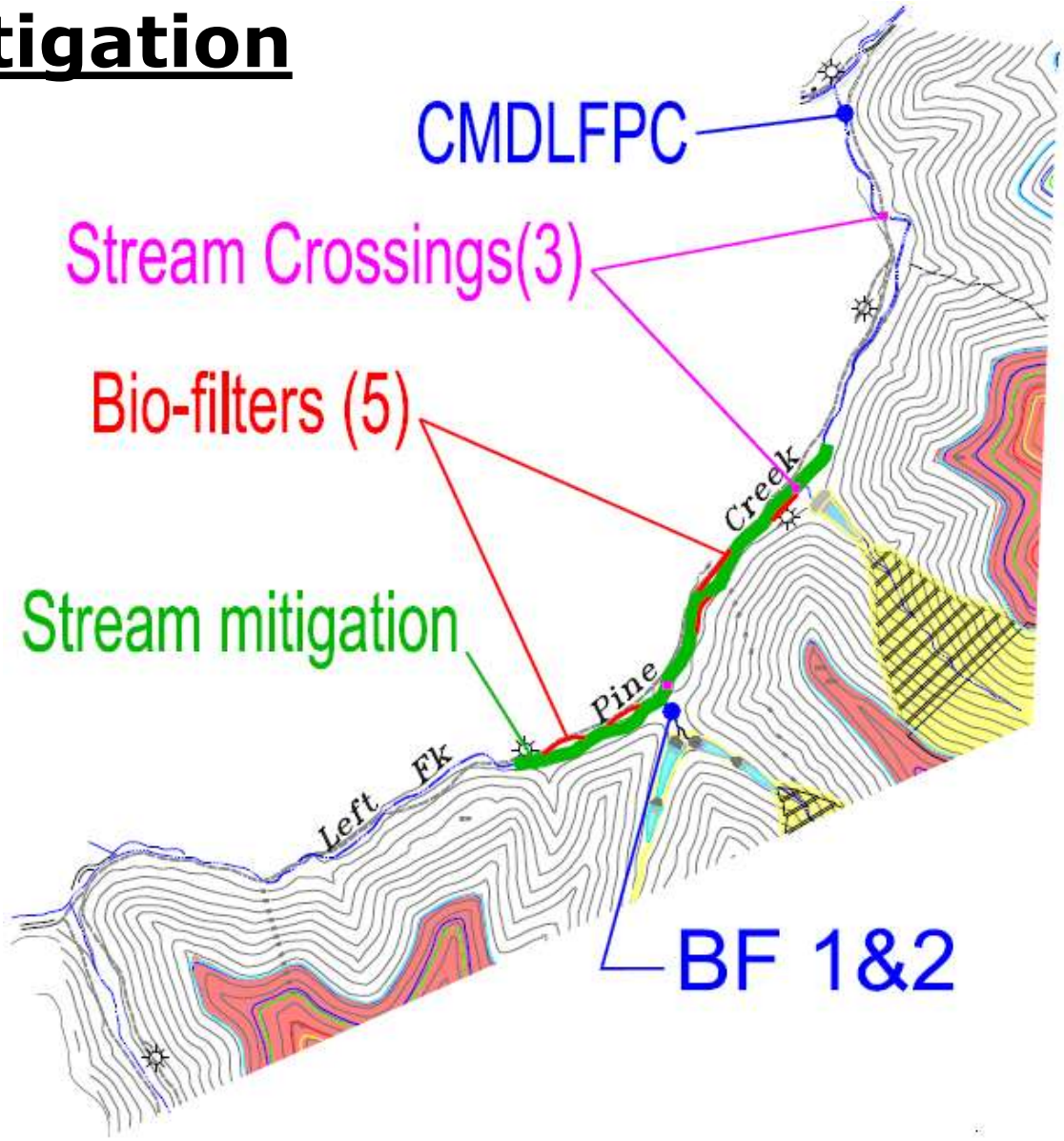




VF 1 VF 4

Compensatory Mitigation

- **Stream Restoration – 3,800’**
- **Construct three (3) stream crossings**
- **Install five (5) sand bio-filters**



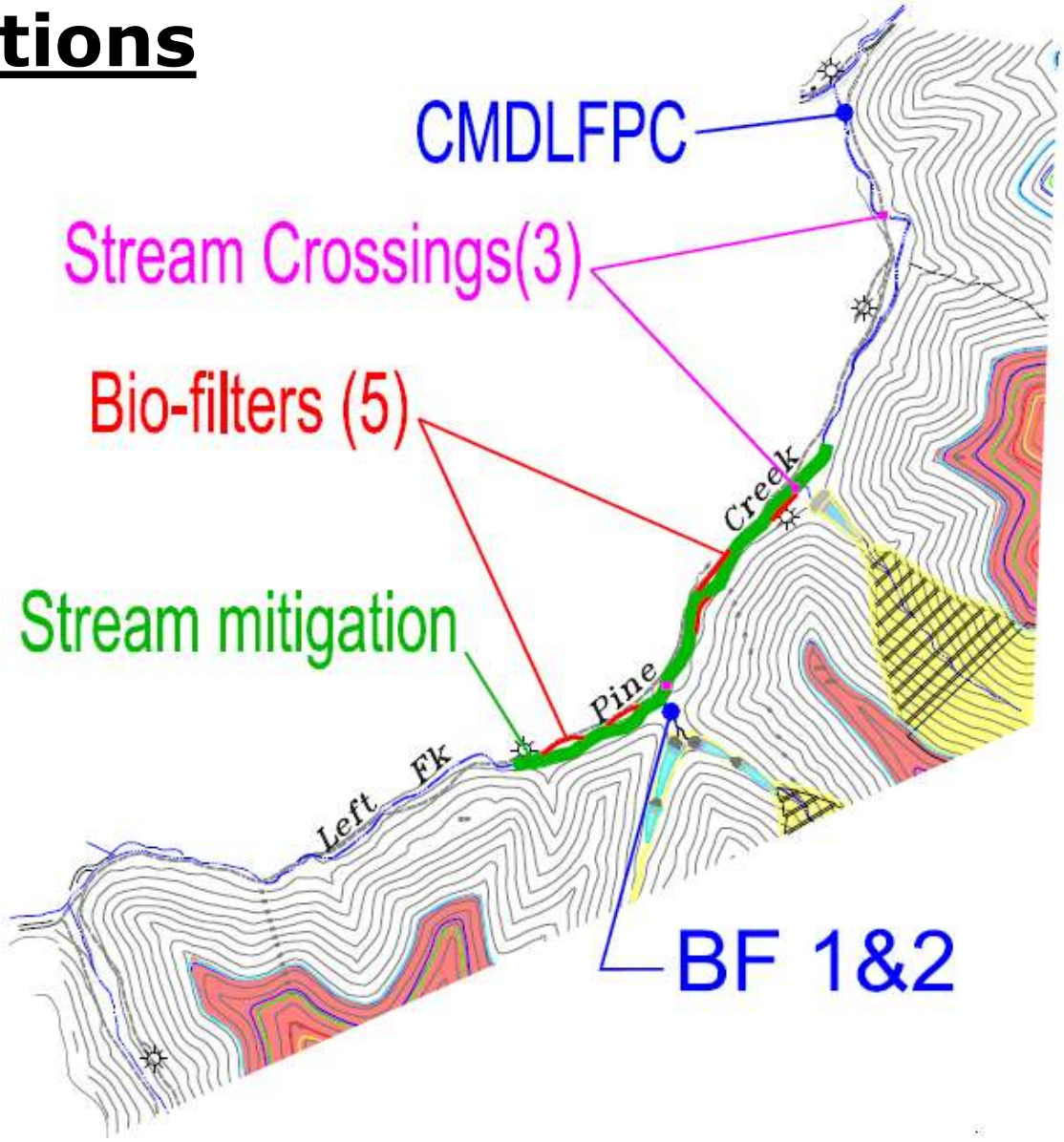
Existing Gas well access road through stream

Road construction and stream crossing

Mitigated Stream – Left Fork of Pine Creek

Benthic Locations

- **CMDLFPC – mouth of Left Fork**
- **BF 1&2 – directly below Valley Fill 1 pond.**



Benthic Monitoring Sites

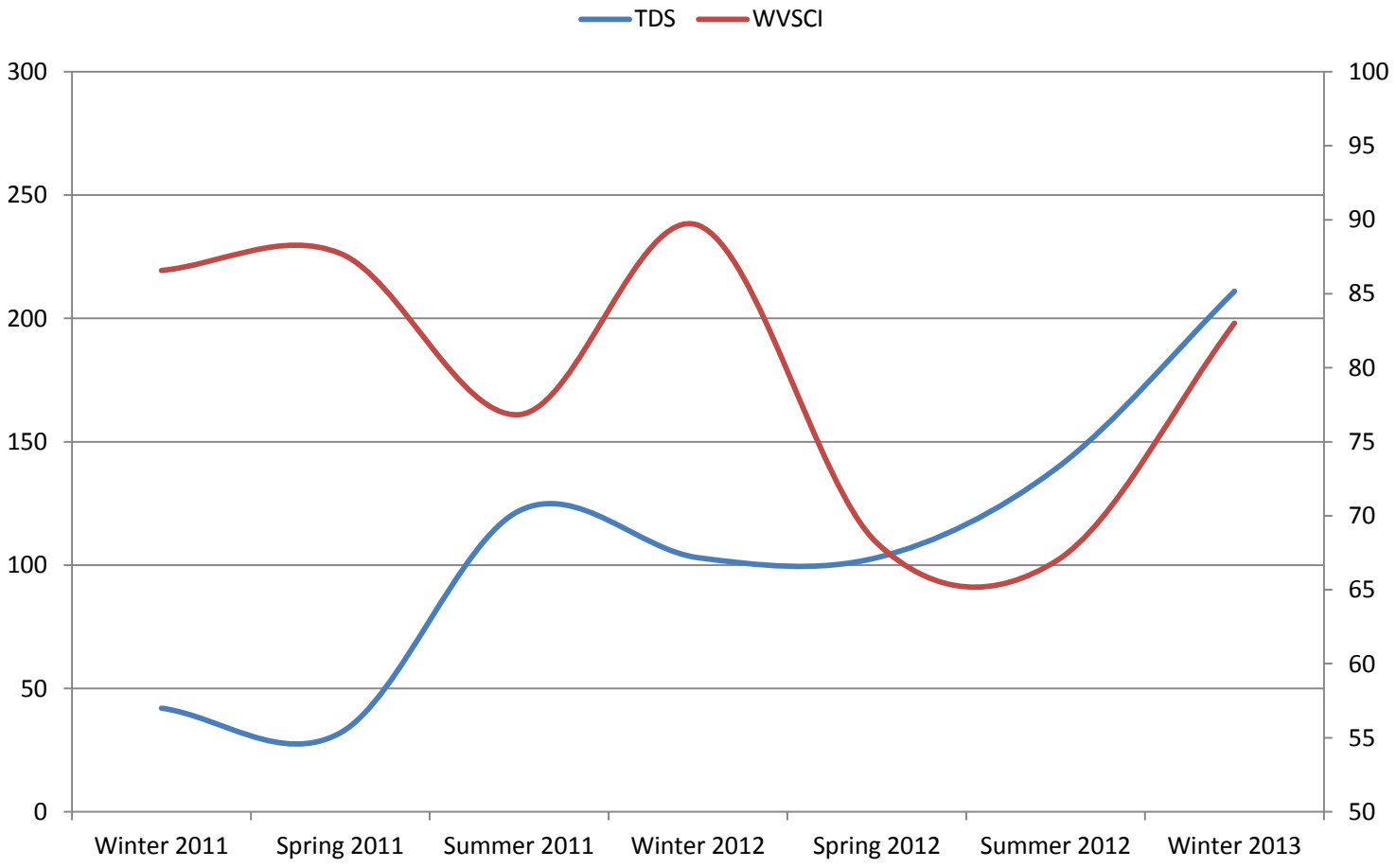
Site BF 1&2

TDS range	32 mg/l – 211 mg/l
WVSCI range	66.92 – 89.639.63

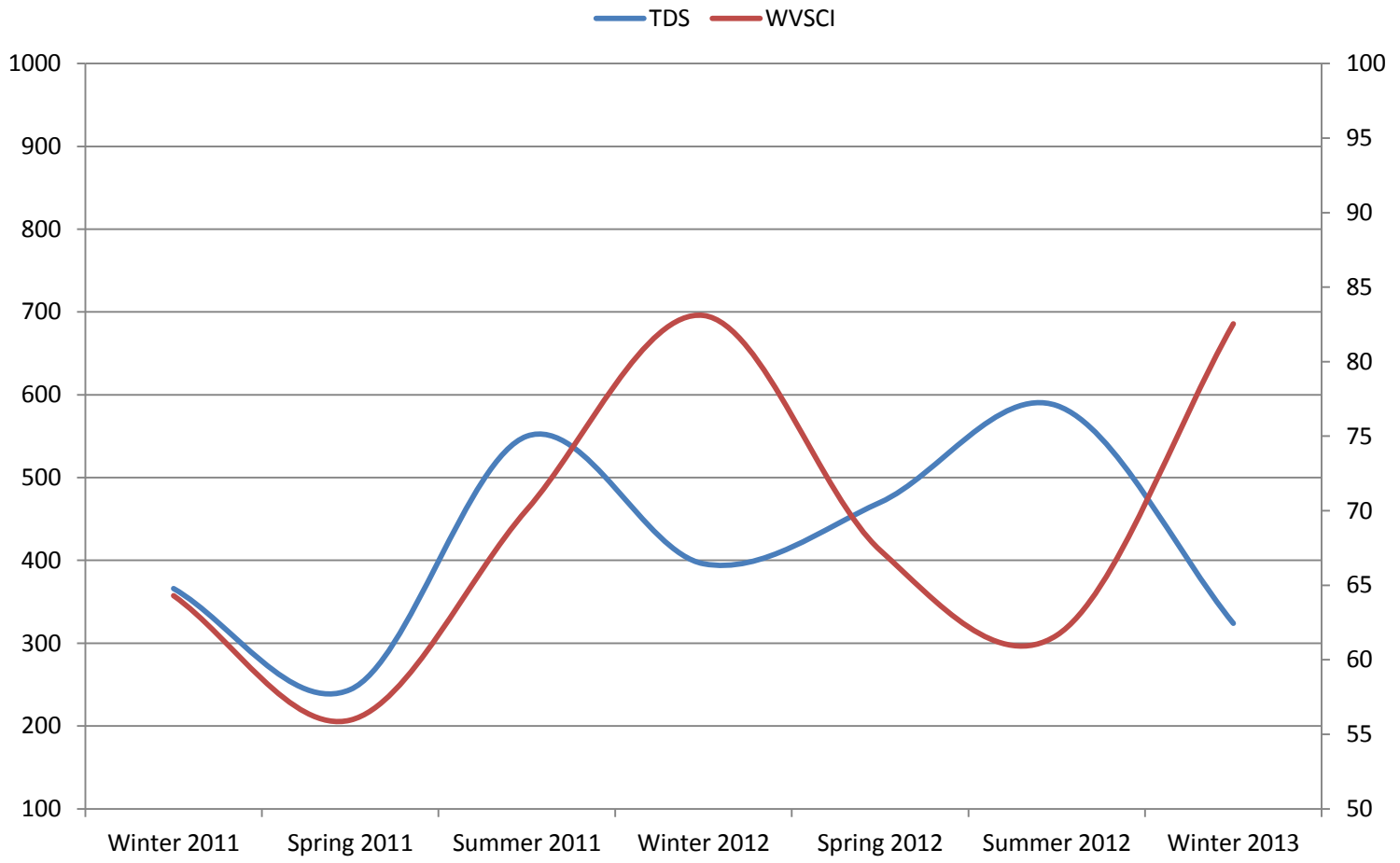
Site CMDLFPC

TDS range	244 mg/l – 587 mg/l
WVSCI range	55.95 – 83.10

Site BF 1&2
Graph of TDS vs. WVSCI



Site WVDLFPC
Graph of TDS vs. WVSCI



Summary

- Conductivity has remained below required levels during construction of Fill 1 for past two (2) years.
- Based on this success, US COE, in co-operation with US EPA, has authorized construction of second valley fill.
- The work performed in this watershed has not resulted in a change in the WVSCI. No real correlation between Conductivity and WVSCI can be determined.