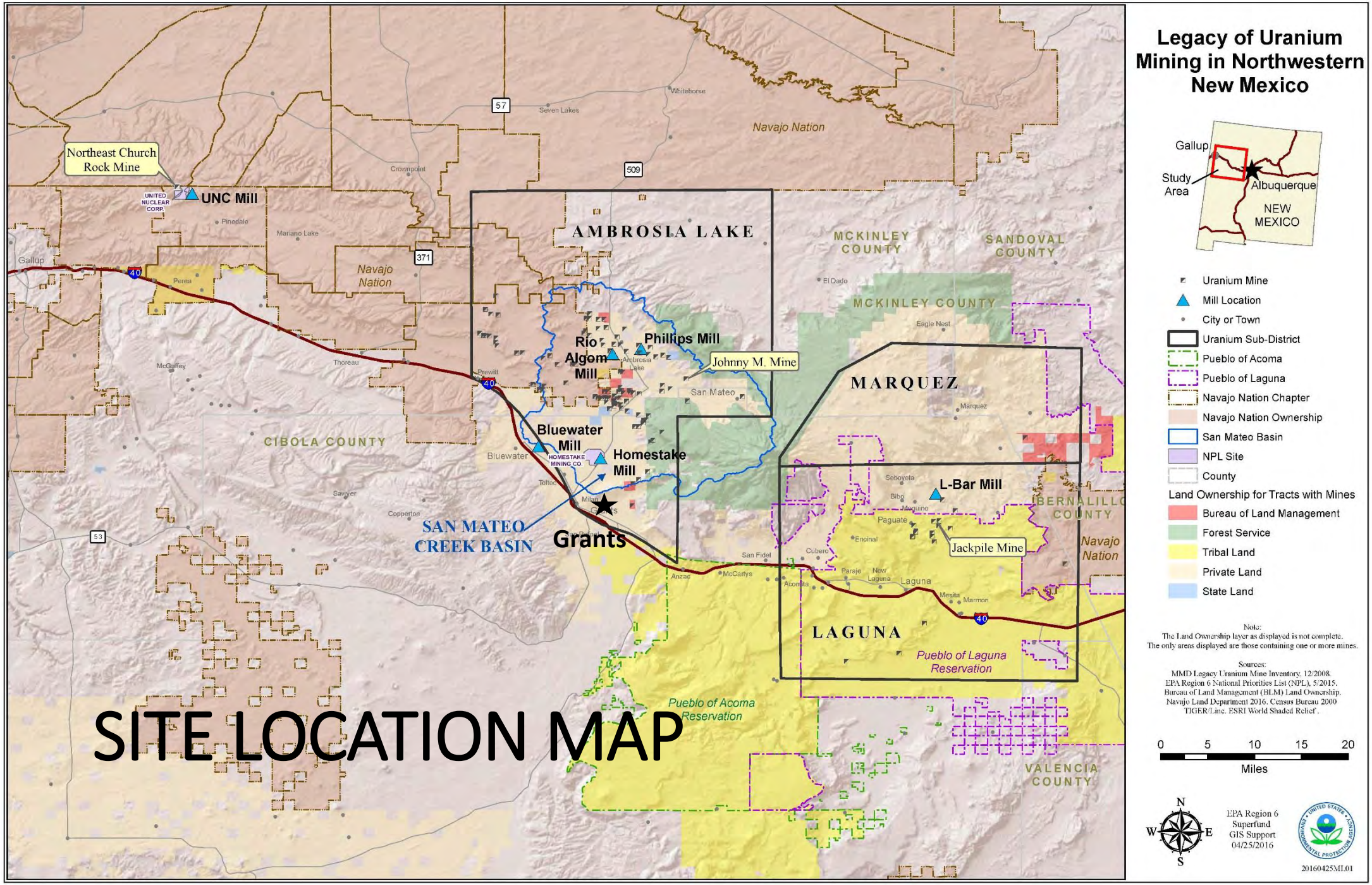
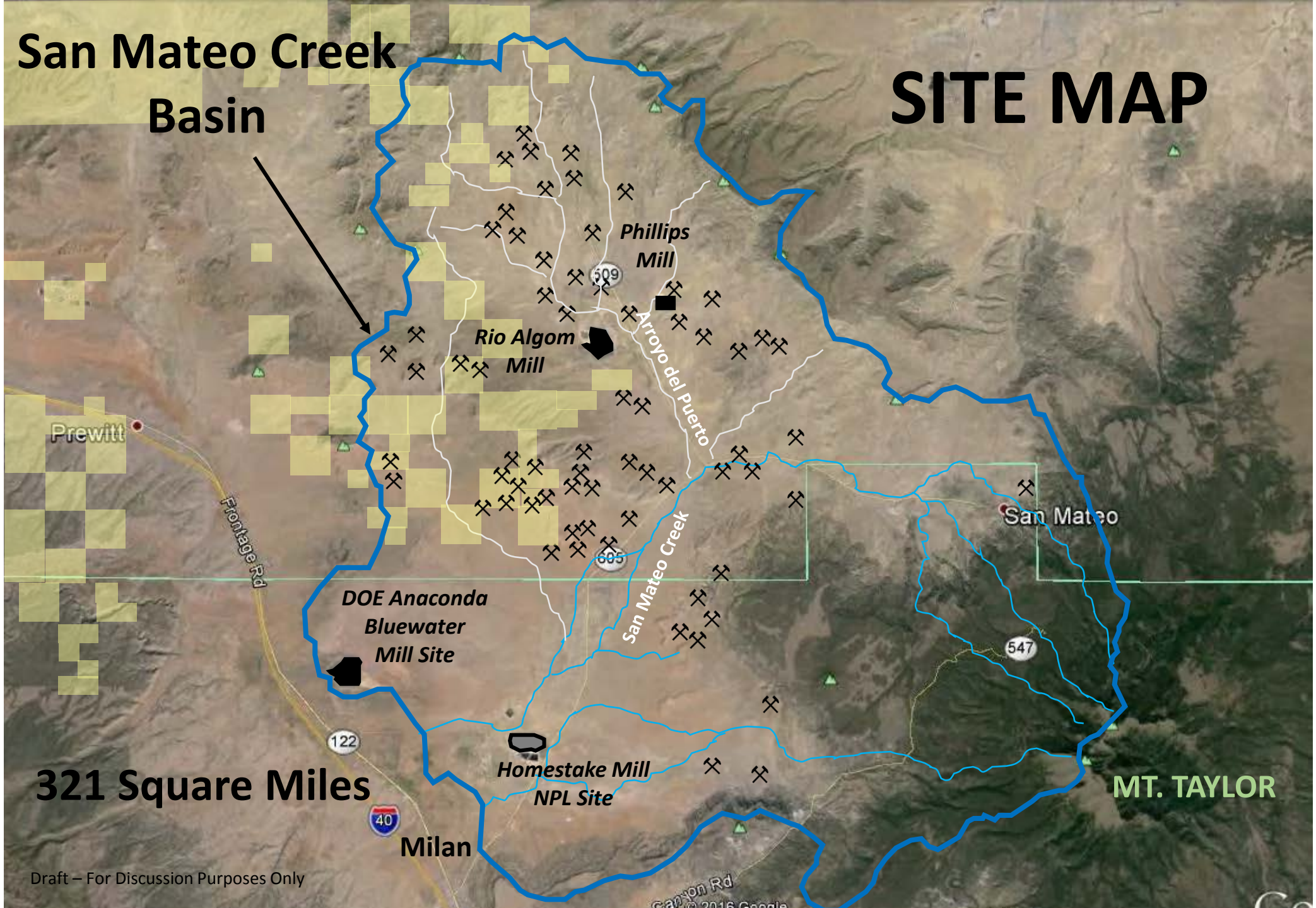
SAN MATEO CREEK BASIN GROUNDWATER INVESTIGATION

GMD PARTNERS MEETING
April 26, 2017

Mark Purcell
USEPA – Region 6

9881158


Legacy of Uranium Mining in Northwestern New Mexico
Gallup
Study Area
Albuquerque
NEW MEXICO
Uranium Mine
Mill Location
City or Town
Uranium Sub-District
Pueblo of Acoma
Pueblo of Laguna
Navajo Nation Chapter
Navajo Nation Ownership
San Mateo Basin
NPL Site
County
Land Ownership for Tracts with Mines
Bureau of Land Management
Forest Service
Tribal Land
Private Land
State Land
Note:
The Land Ownership layer as displayed is not complete.
The only areas displayed are those containing one or more mines.
Sources:
MMD Legacy Uranium Mine Inventory. 12/2008.
EPA Region 6 National Priorities List (NPL), 5/2015.
Bureau of Land Management (BLM) Land Ownership.
Navajo Land Department 2016. Census Bureau 2000
TIGER/Line. ESRI World Shaded Relief.
0 5 10 15 20
Miles
N
W
E
S
EPA Region 6
Superfund
GIS Support
04/25/2016
20160425MLO1
Northeast Church Rock Mine
UNITED NUCLEAR CORP.
UNC Mill
Navajo Nation
AMBROSIA LAKE
MCKINLEY COUNTY
SANDOVAL COUNTY
Rio Algom Mill
Phillips Mill
Johnny M. Mine
MARQUEZ
Bluewater Mill
HOMESTAKE MINING CO.
Homestake Mill
CIBOLA COUNTY
SAN MATEO CREEK BASIN
Grants
L-Bar Mill
Jackpile Mine
BERNALILLO COUNTY
LAGUNA
Pueblo of Laguna Reservation
Pueblo of Acoma Reservation
VALENCIA COUNTY
SITE LOCATION MAP



Draft – For Discussion Purposes Only

371
San Mateo Creek
Basin
Milan
53
Grants
Paguate
Encinal
Jackpile
Mine
Seama
40
Laguna
Rio San Jose Basin
© 2016 Google

MULTI-PHASED INVESTIGATION

Phase 1

Alluvial Aquifer
2012 – 2016

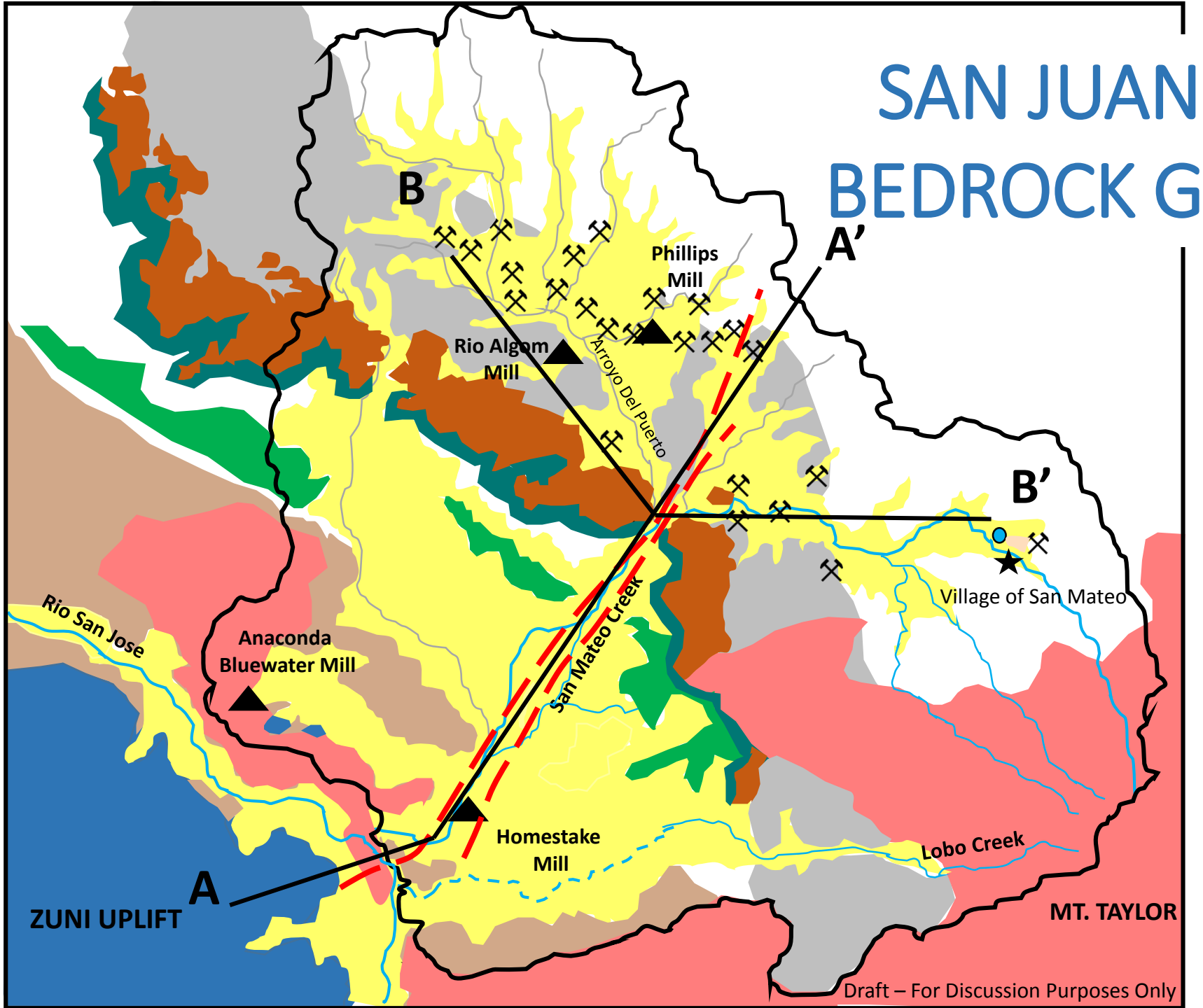
Phase 2

Bedrock & Alluvial Aquifers
2015 – 2017

Phase 3

Refine Conceptual Site Model
2018 ?

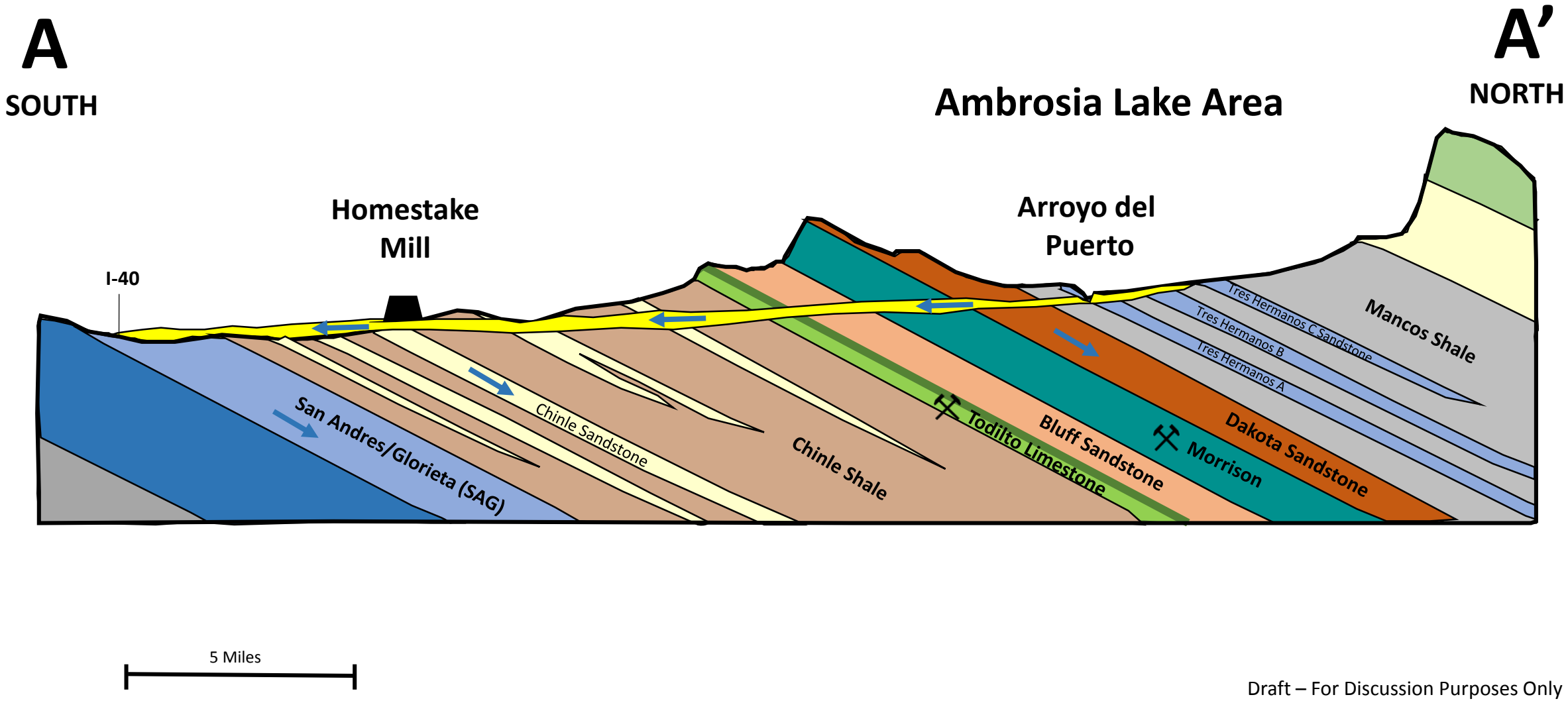
SAN JUAN BASIN BEDROCK GEOLOGY



- Alluvium
- Mancos Shale
- Dakota Sandstone
- Morrison Fm
- Todilto Limestone
- Chinle Shale and Sandstone
- San Andres/Glorietta Limestone
- Volcanic
- Former Uranium Mill
- Wet Mine
- San Mateo Fault

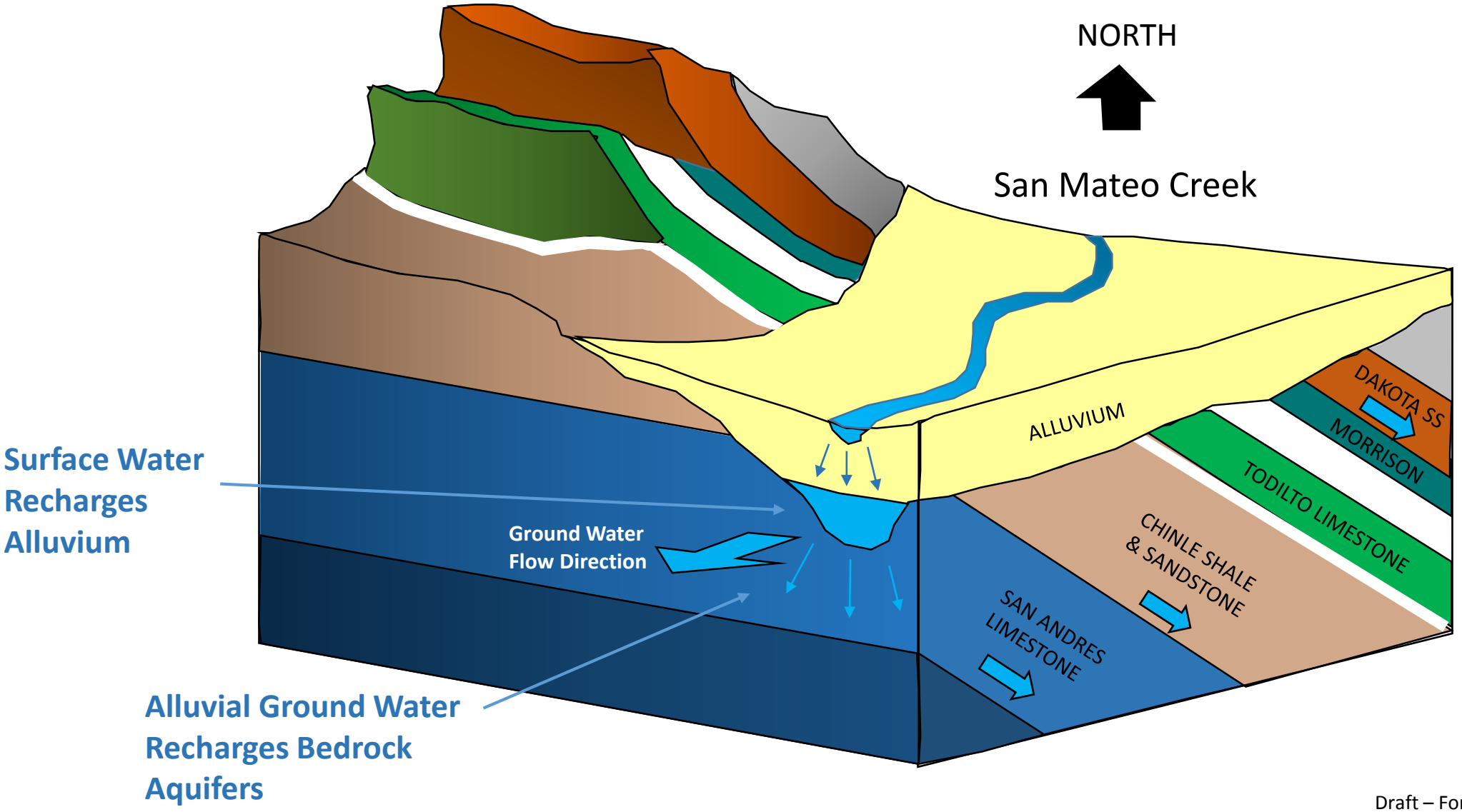
CONCEPTUAL SITE GROUND WATER MODEL

Generalized Cross Section Through San Mateo Creek Basin



Draft – For Discussion Purposes Only

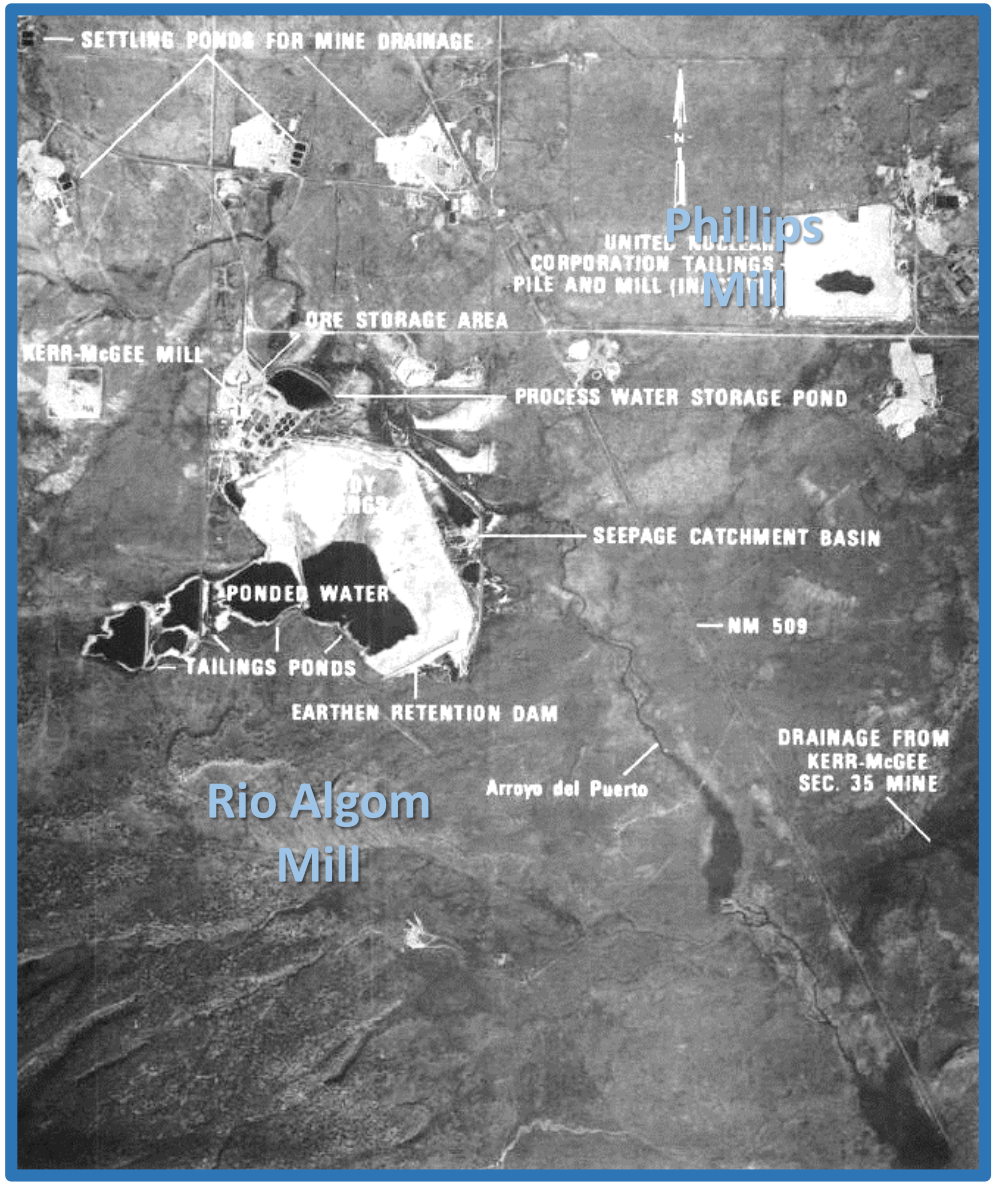
CONCEPTUAL SITE GROUND WATER MODEL



Draft – For Discussion Purposes Only

HISTORICAL STUDIES ON URANIUM MINING IMPACTS

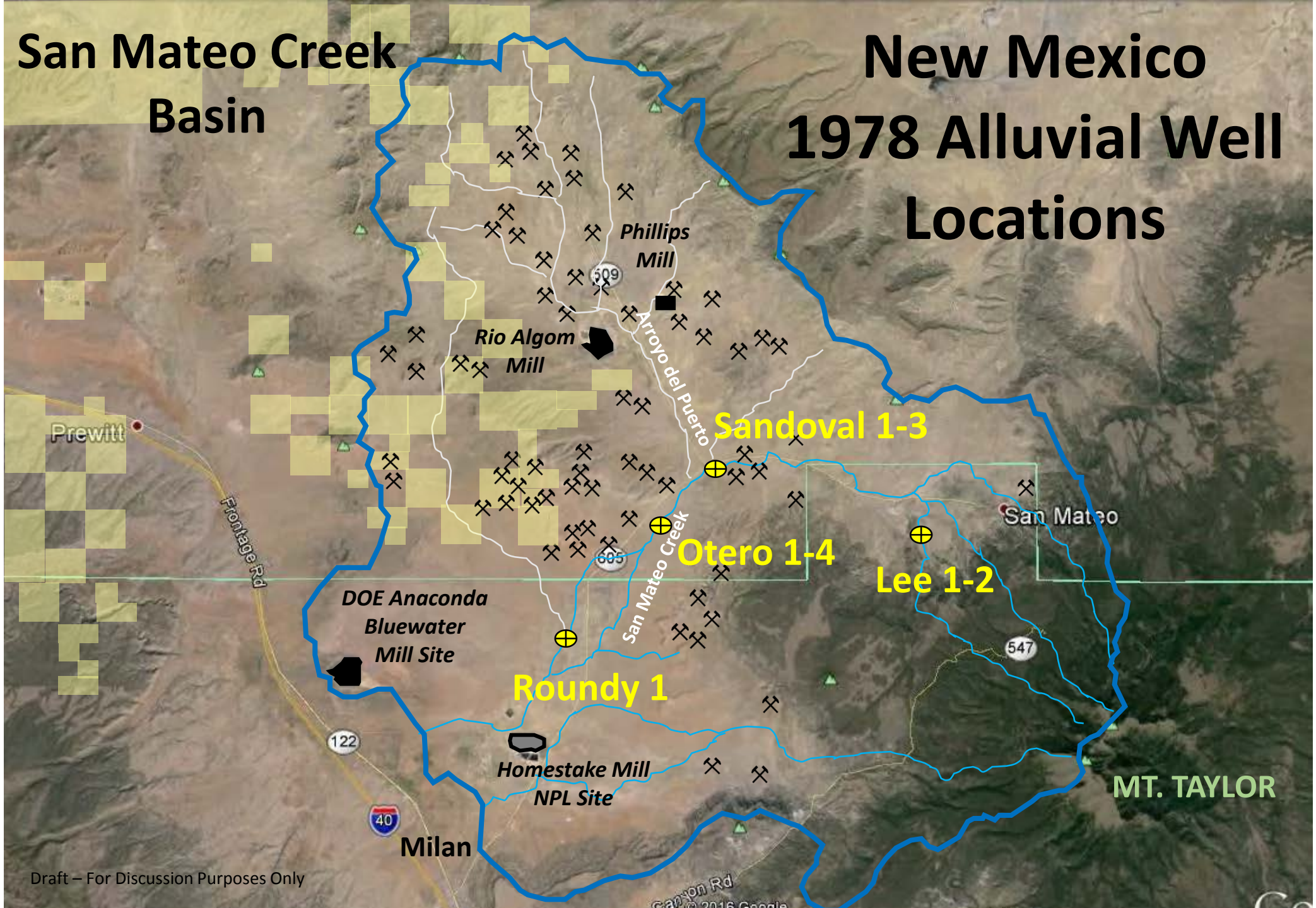
- 1975 EPA study
  - Ground water contamination discovered
  - Sources – mine water discharge and tailing seepage, ion exchange plants
  - Perennial flows created in creeks/arroyos
- 1981 and 1986 New Mexico studies
  - Alluvial ground water exceeds standards
  - Mine water discharge rapidly infiltrates and saturates alluvium



1975 – Ambrosia Lake Area

MINE WATER DISCHARGE

Artificially Created Perennial Flows Observed to Reached Homestake Impoundment (EPA 1980)



Draft – For Discussion Purposes Only

SUMMARY OF HISTORIC MINE WATER DISCHARGE QUALITY

Comparison to Alluvial Background Water Quality

Contaminant	1981 Mine Water Discharge Ambrosia Lake Area	1981 Mine Water Discharge San Mateo Area	1978-80 San Mateo Creek Upland Alluvial GW (Background)
Gross Alpha (pCi/L)	580	1,100	2.5 – 15.0
Uranium (mg/L)	2.4	0.080	0.005 – 0.010
Selenium (mg/L)	0.410	0.040	0.005 – 0.005
Molybdenum (mg/L)	0.79	0.32	0.005 – 0.010
Chloride (mg/L)	90	10	3 – 8
Sulfate (mg/L)	837	205	5-20
Total Dissolved Solid (mg/L)	1,690	520	125 – 300

New Mexico 1981 and 1986 Reports

PHASE 2 OBJECTIVE

- Assess Impact of Mine Discharge Water on Ground Water
  - Change in Saturation Levels Over Time
  - Change in Water Quality Over Time
  - Trace Movement and Mixing of Mine Discharge Water with Formation Water
  - Identify Isotopic Signatures

Mine Discharge Water *is from Morrison Fm (Ore Zone) and Overlying Dakota Sandstone Formation (Drained into Morrison Fm)*

Fingerprint of Mine Water

MAJOR COMPONENTS OF PHASE 2 STUDY

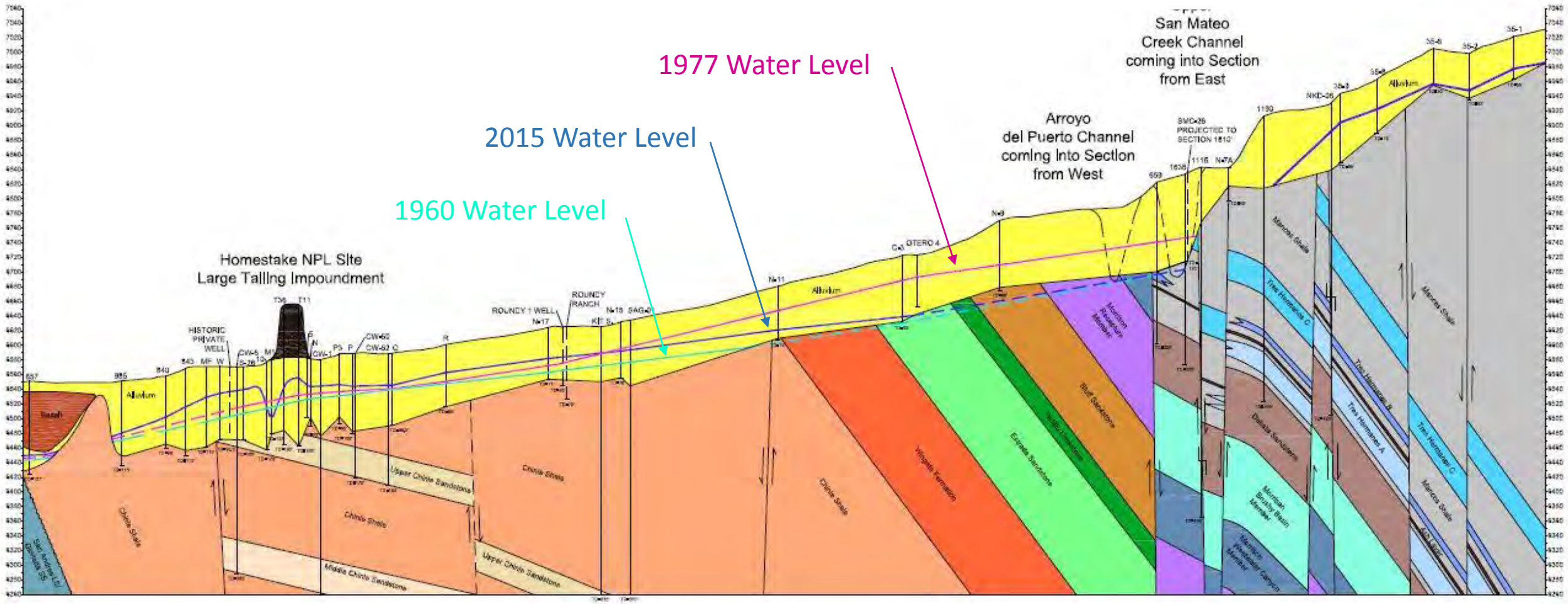
Hydrogeology

- Hydrogeological Cross Sections
- Structure Map – Base of Alluvium
- Ground Water Flow Maps
- Chemical Isoconcentration Contour Maps
- Saturation Thickness Maps

Geochemistry

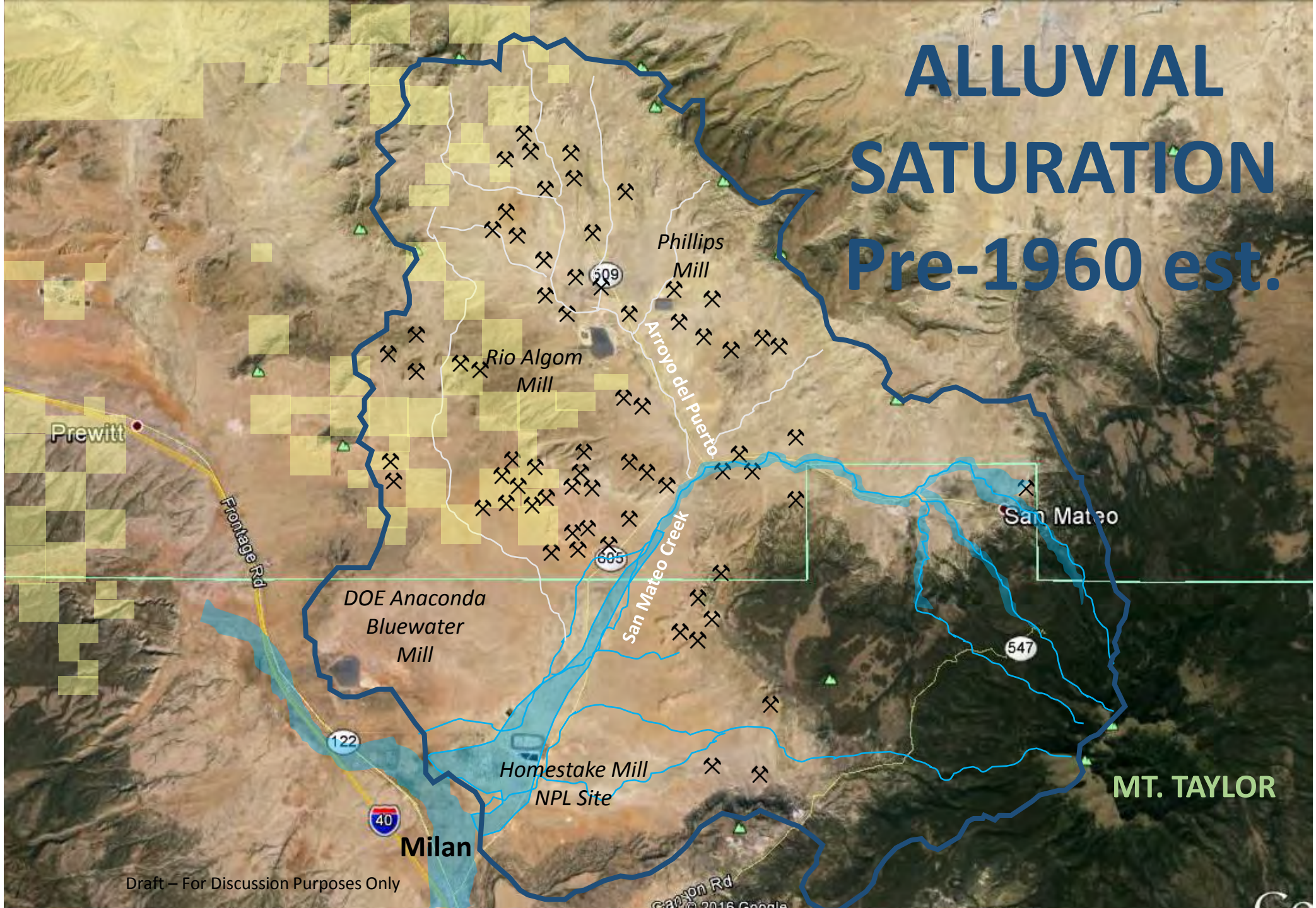
- Trace Metals,
- Major Ions,
- Stable Isotopes of Water,
- Sulfur Stable Isotopes
- Uranium Isotopes
- Uranium Activity Ratios

GEOLOGIC CROSS-SECTION D-D’

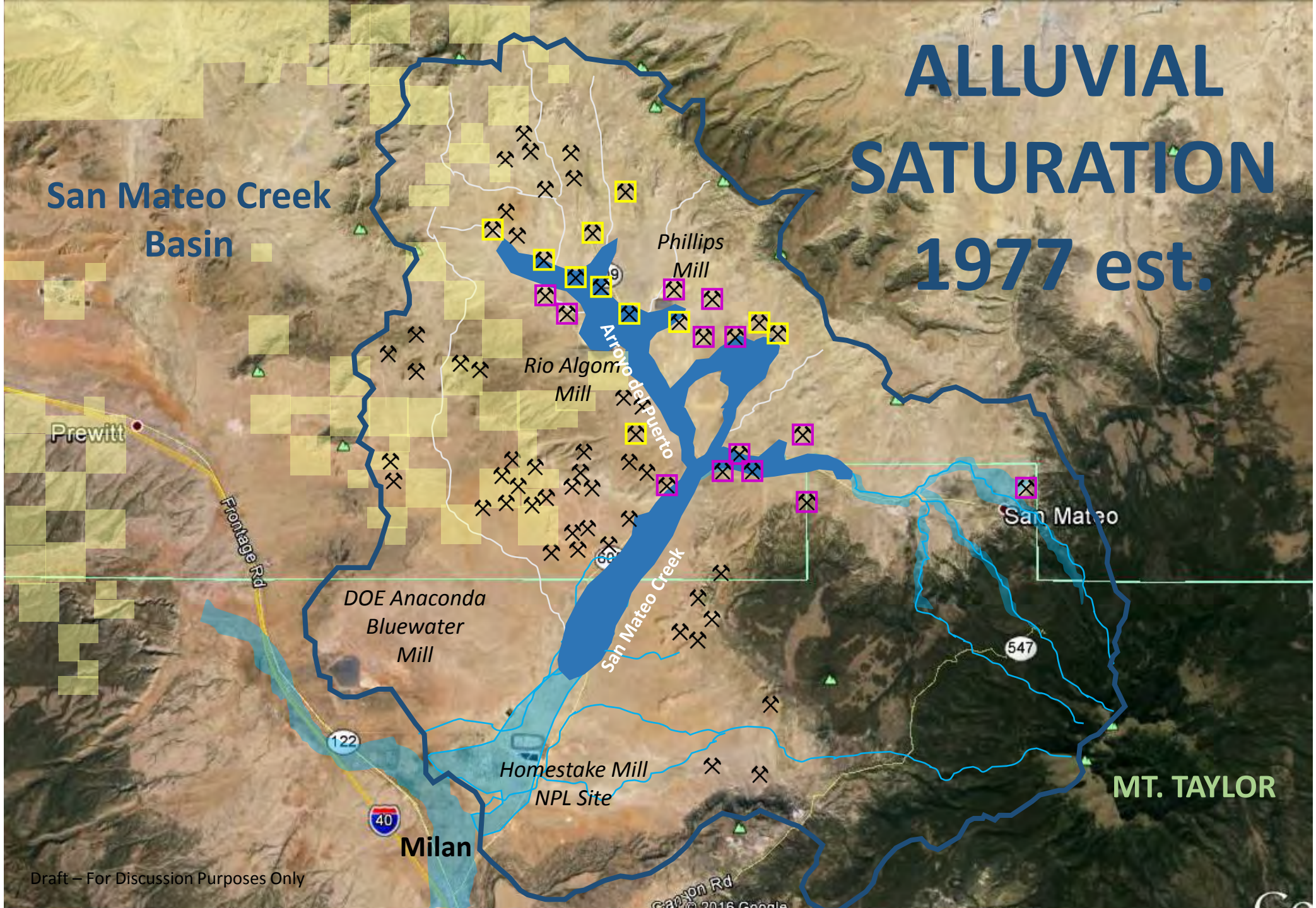


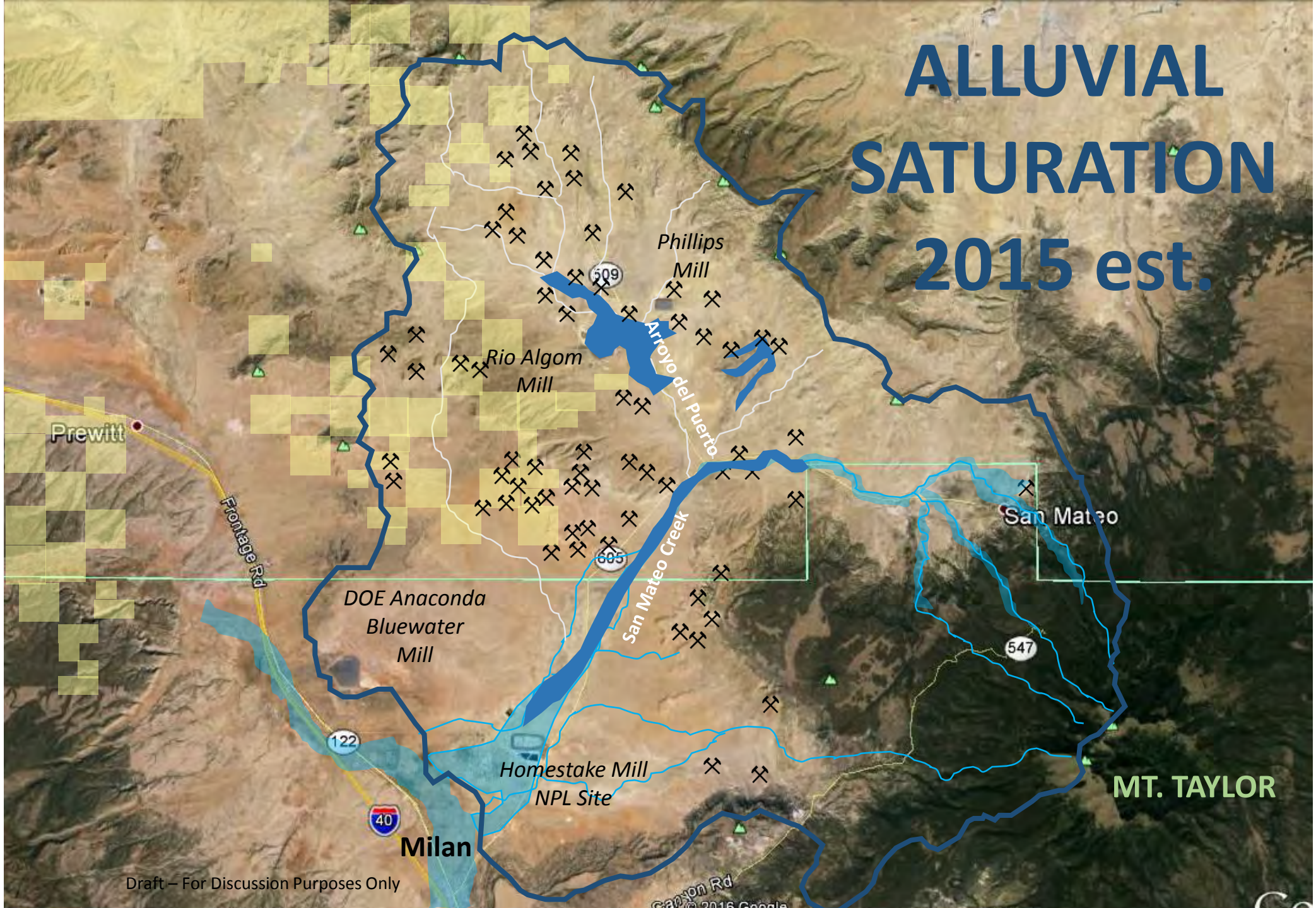
Vertical Exaggeration 50x

Draft – For Discussion Purposes Only

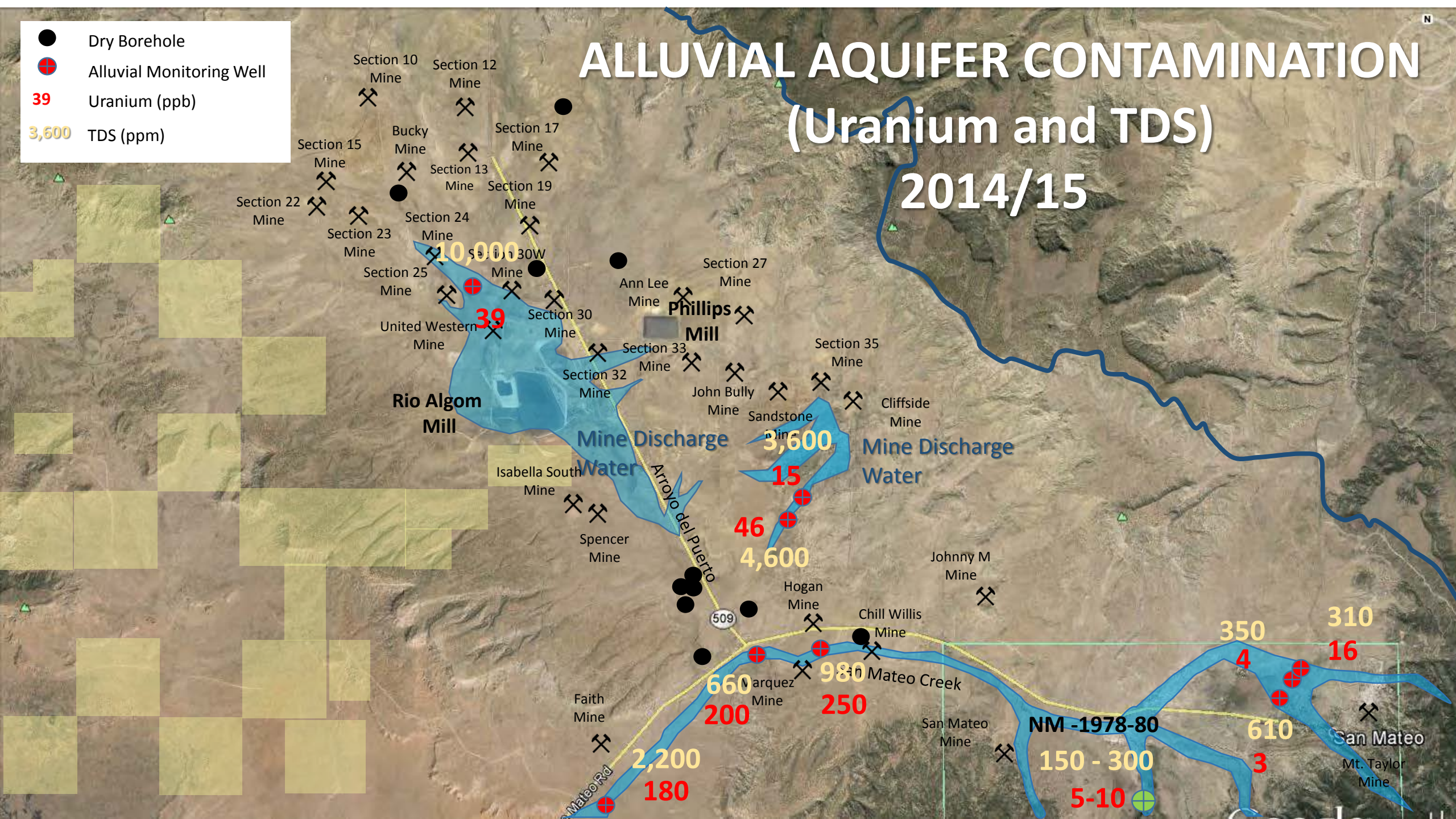


Draft – For Discussion Purposes Only

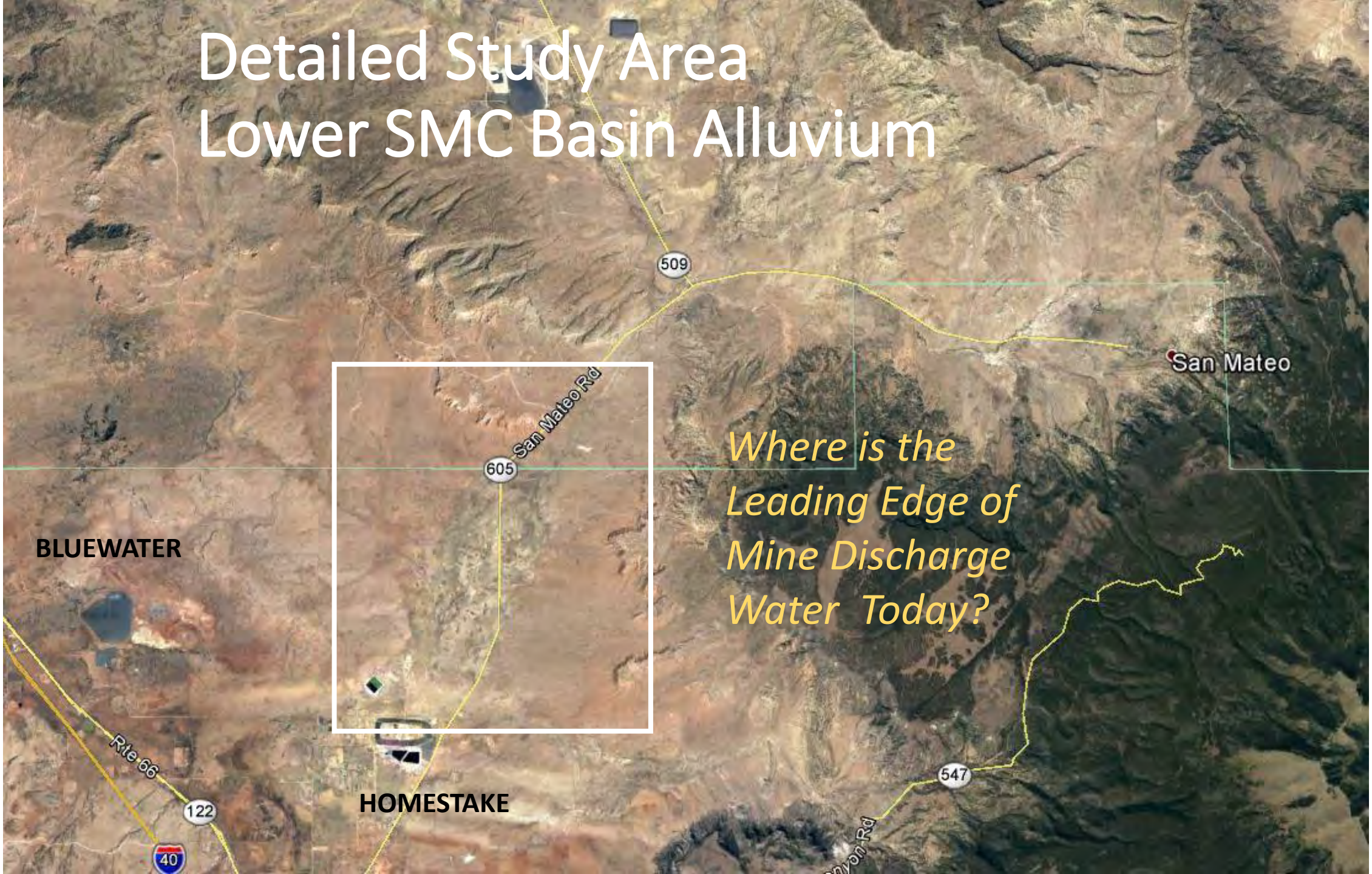

ALLUVIAL SATURATION 1977 est.
San Mateo Creek Basin
Phillips Mill
Rio Algom Mill
Arroyo del Puerto
San Mateo Creek
DOE Anaconda Bluewater Mill
Homestake Mill NPL Site
Prewitt
Frontage Rd
San Mateo
Milan
MT. TAYLOR
Navajo Land
Mine Discharge Water
Draft – For Discussion Purposes Only



Draft – For Discussion Purposes Only


ALLUVIAL AQUIFER CONTAMINATION
(Uranium and TDS)
2014/15
Dry Borehole
Alluvial Monitoring Well
39
Uranium (ppb)
3,600
TDS (ppm)
Section 10 Mine
Section 12 Mine
Section 17 Mine
Bucky Mine
Section 15 Mine
Section 13 Mine
Section 19 Mine
Section 22 Mine
Section 24 Mine
Section 23 Mine
Section 30W Mine
Section 25 Mine
Section 27 Mine
Ann Lee Mine
Phillips Mill
United Western Mine
Section 30 Mine
Section 33 Mine
Section 35 Mine
Section 32 Mine
John Bully Mine
Sandstone Mine
Cliffside Mine
Rio Algom Mill
Mine Discharge Water
Mine Discharge Water
Isabella South Mine
Arroyo del Puerto
Spencer Mine
Johnny M Mine
Hogan Mine
Chill Willis Mine
Marquez Mine
San Mateo Creek
Faith Mine
San Mateo Mine
NM -1978-80
San Mateo
Mt. Taylor Mine
San Mateo Rd
509
10,000
39
3,600
15
46
4,600
660
200
980
250
2,200
180
350
4
310
16
610
3
150 - 300
5-10

Detailed Study Area
Lower SMC Basin Alluvium

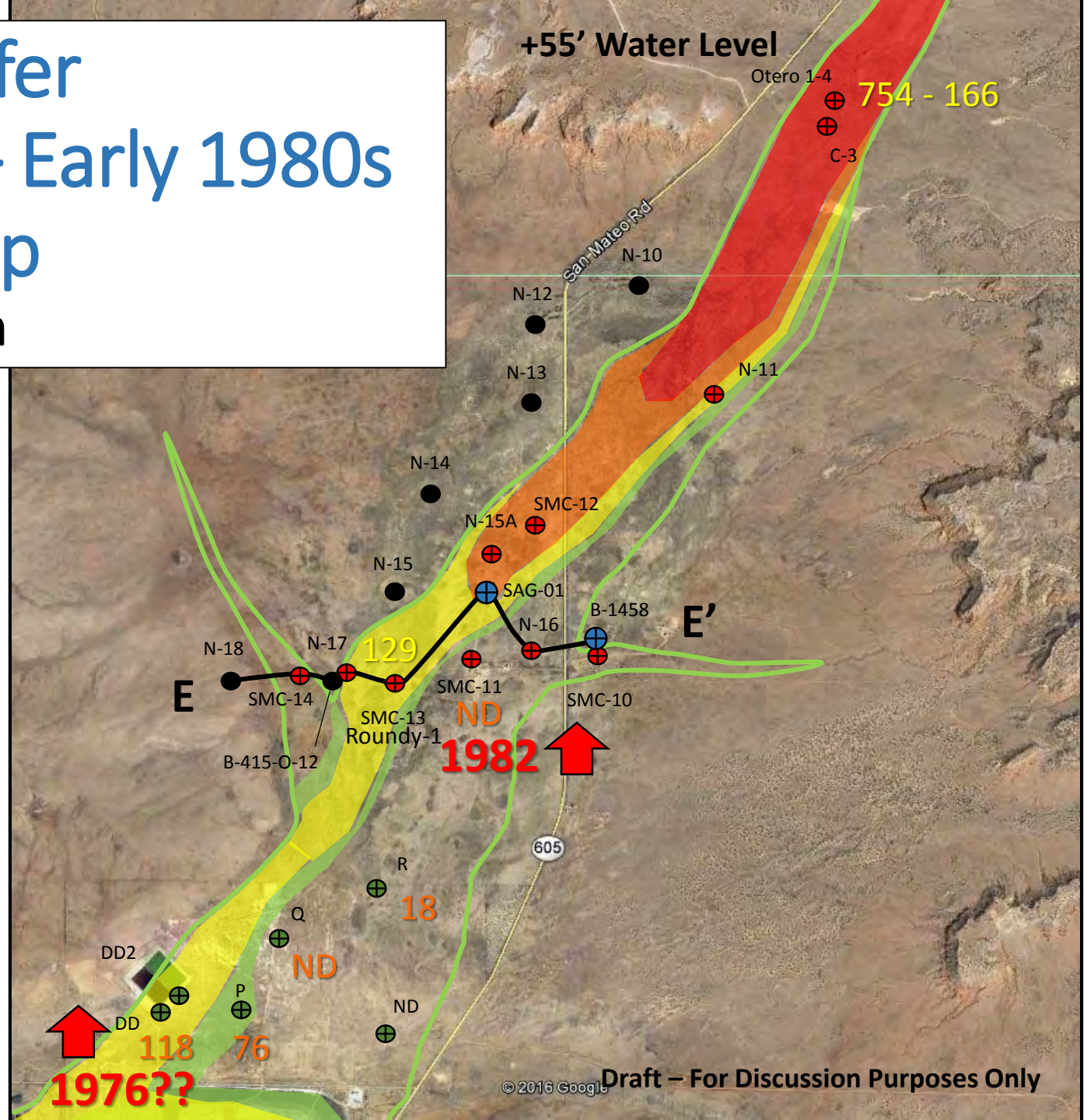


Where is the Leading Edge of Mine Discharge Water Today?

Alluvial Aquifer Late 1970s – Early 1980s Uranium Map

Central SMC Basin

- Dry Borehole
- Phase 1 or 2 Well
- Homestake Well
- 50 – 99 µg/L
- 100 – 299 µg/L
- 300 – 499 µg/L
- >500 µg/L
- Estimated Alluvial Aquifer Boundary

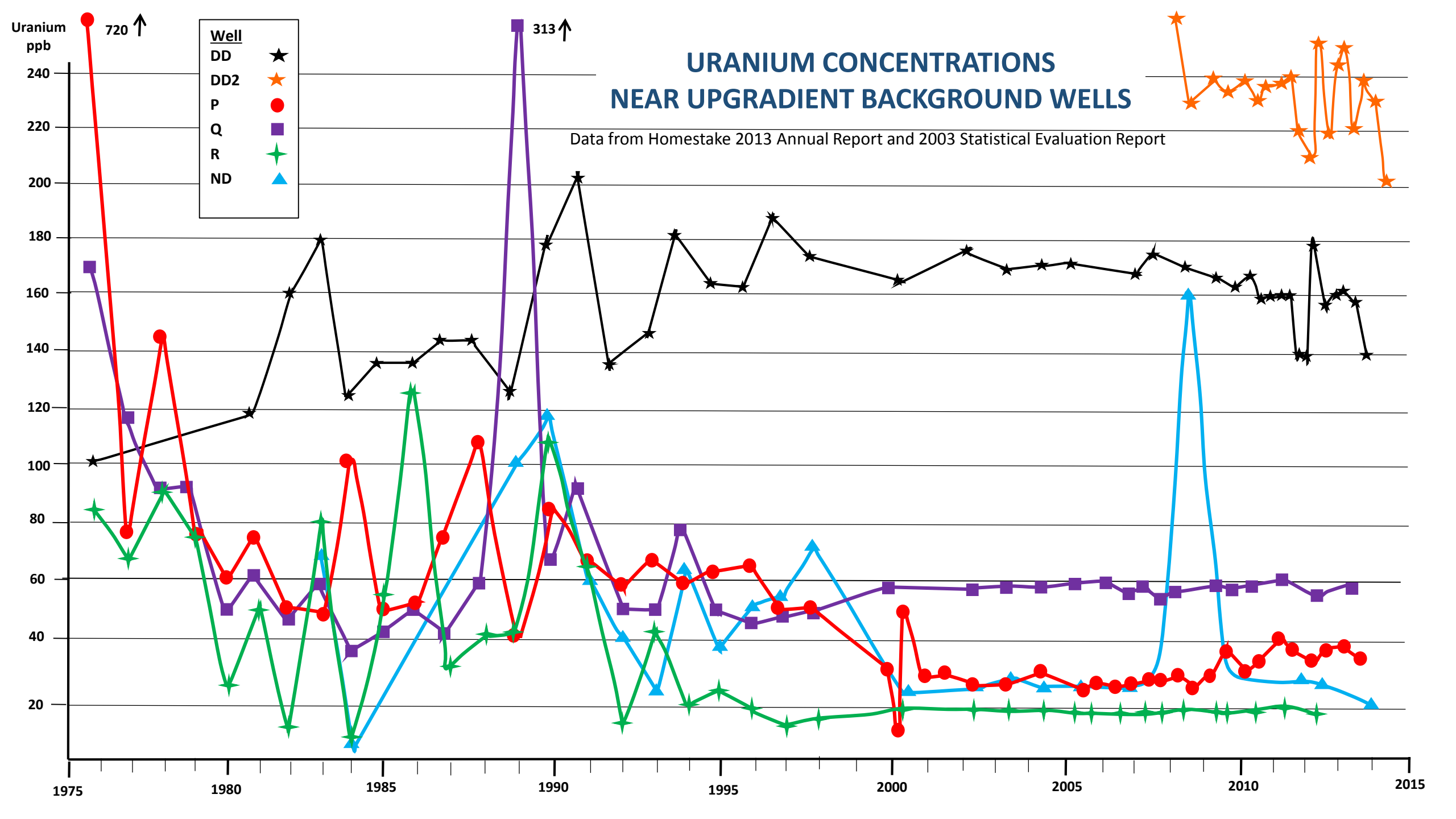


Start of Increasing Uranium Trend – Well SMC-11 and DD

190 Uranium Concentration (Homestake Monitorng Data - 1981)

210 Uranium Concentration (New Mexico EID Monitoring Data – 1978-1982 Mean)

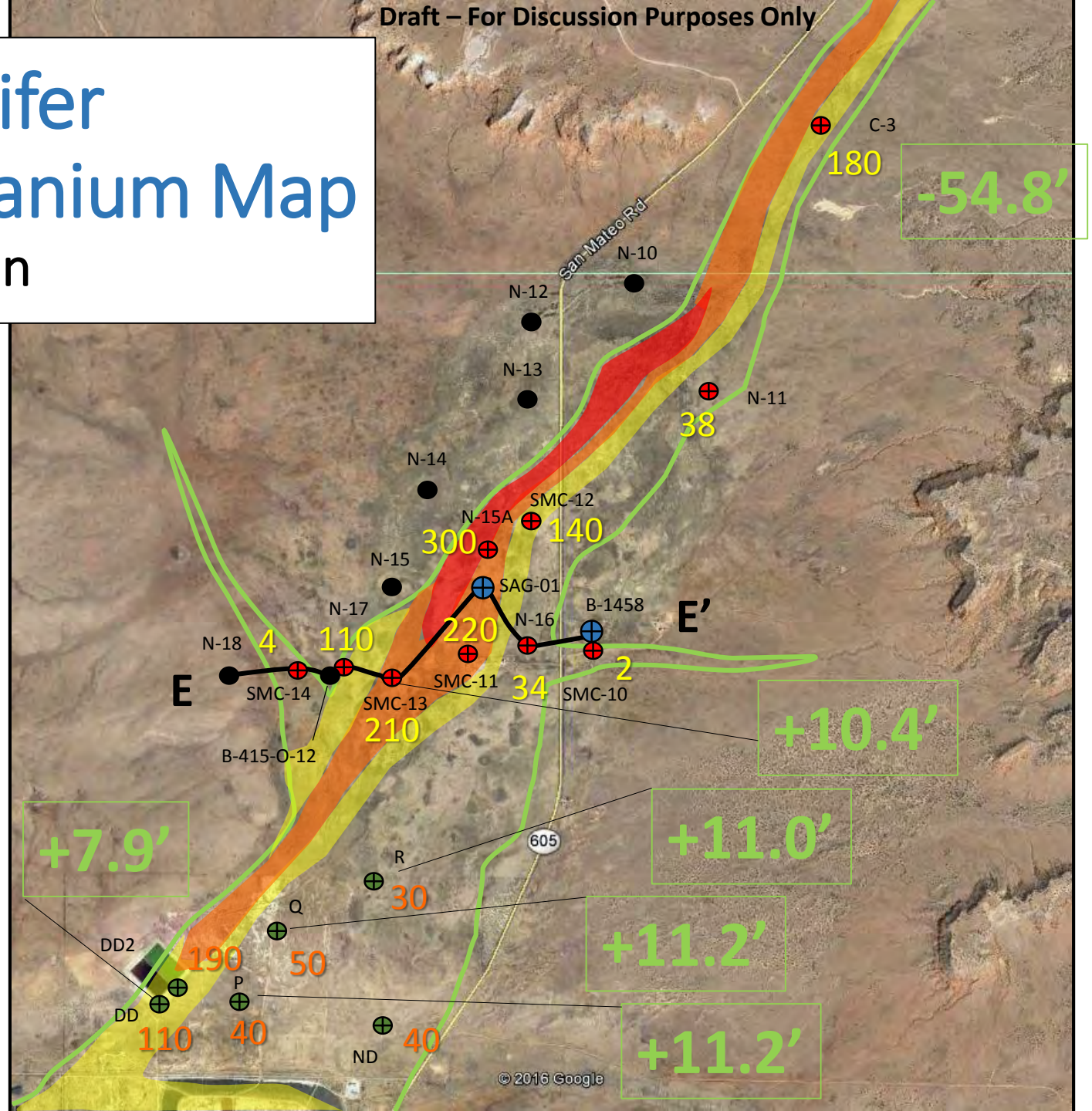
Homestake Well 920 (SMC-11)
Uranium-Time Trend Plot
1981 - 2015


URANIUM CONCENTRATIONS
NEAR UPGRADIENT BACKGROUND WELLS
Data from Homestake 2013 Annual Report and 2003 Statistical Evaluation Report
Uranium ppb
720
313
Well
DD
DD2
P
Q
R
ND
240
220
200
180
160
140
120
100
80
60
40
20
1975
1980
1985
1990
1995
2000
2005
2010
2015

Alluvial Aquifer 2014/15 Uranium Map

Central SMC Basin

Draft – For Discussion Purposes Only



- Dry Borehole
- Phase 1 or 2 Well
- Homestake Well
- 100 – 199 µg/L
- 200 – 299 µg/L
- >300 µg/L
- Estimated Alluvial Aquifer Boundary

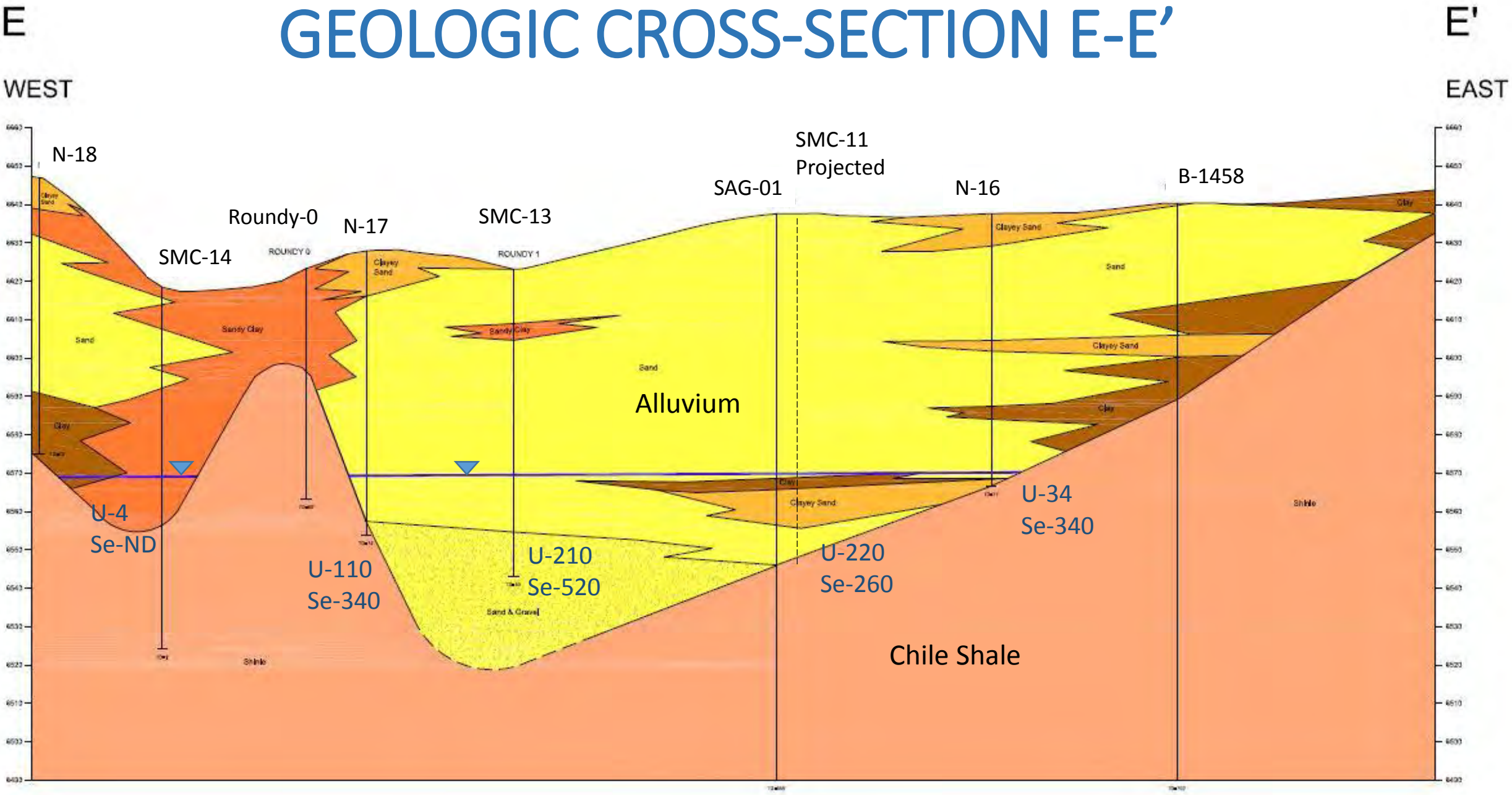
190 Uranium Concentration (from Homestake)

210 Uranium Concentration (Phase 2)

+11.0' Change in Water Level 1977 to Present

Draft – For Discussion Purposes Only

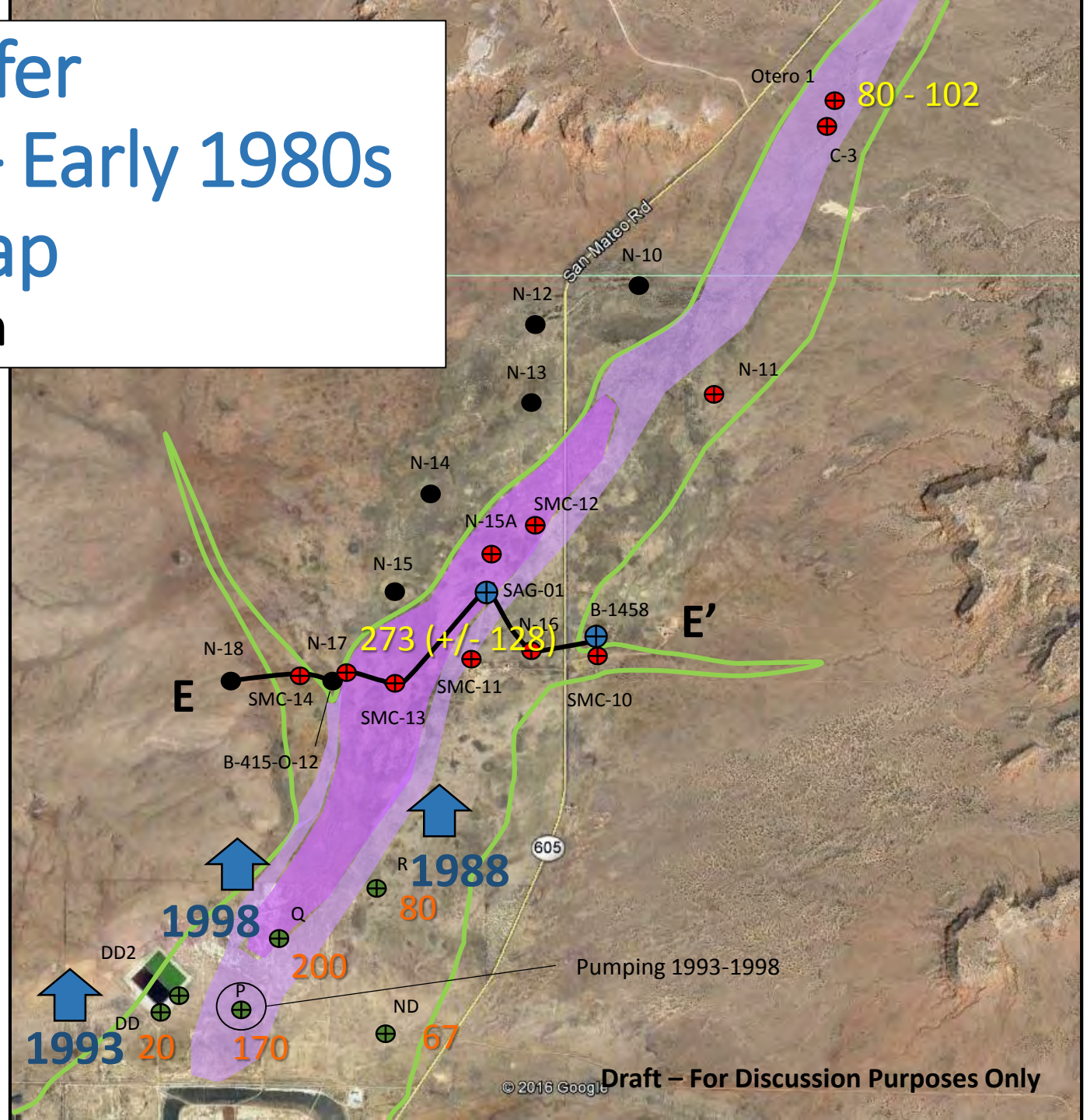
GEOLOGIC CROSS-SECTION E-E’



Draft – For Discussion Purposes Only

Alluvial Aquifer Late 1970s – Early 1980s Selenium Map

Central SMC Basin



Dry Borehole

Phase 1 or 2 Well

Homestake Well

100 – 199 µg/L

>200 µg/L

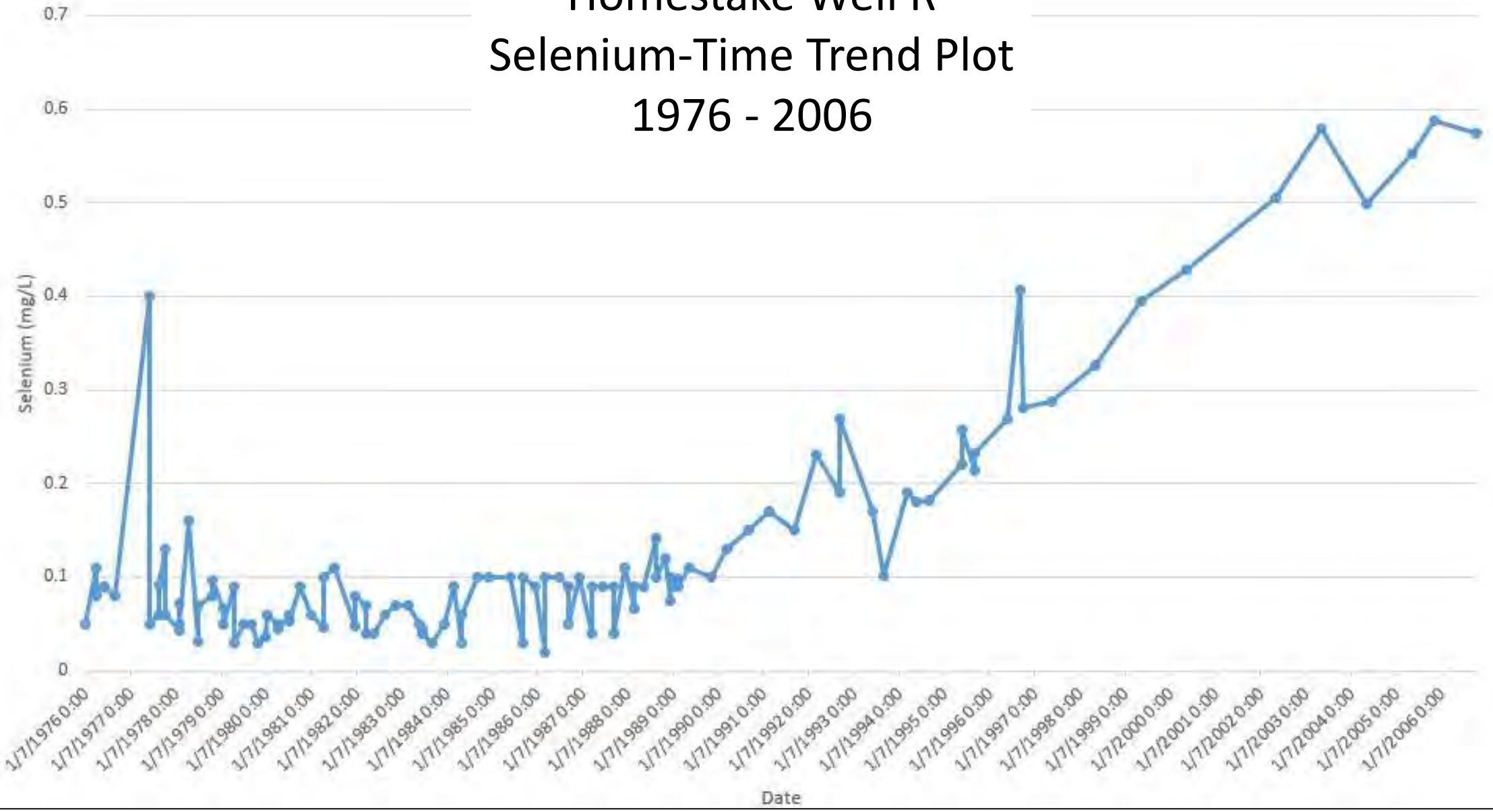
Estimated Alluvial Aquifer Boundary

Start of Increasing Selenium Trend

170 Selenium Concentration (Homestake Monitorng Data – 11/1981)

273 Selenium Concentration (New Mexico EID Monitoring Data – 1977-1982 - Mean)

Homestake Well R
Selenium-Time Trend Plot
1976 - 2006

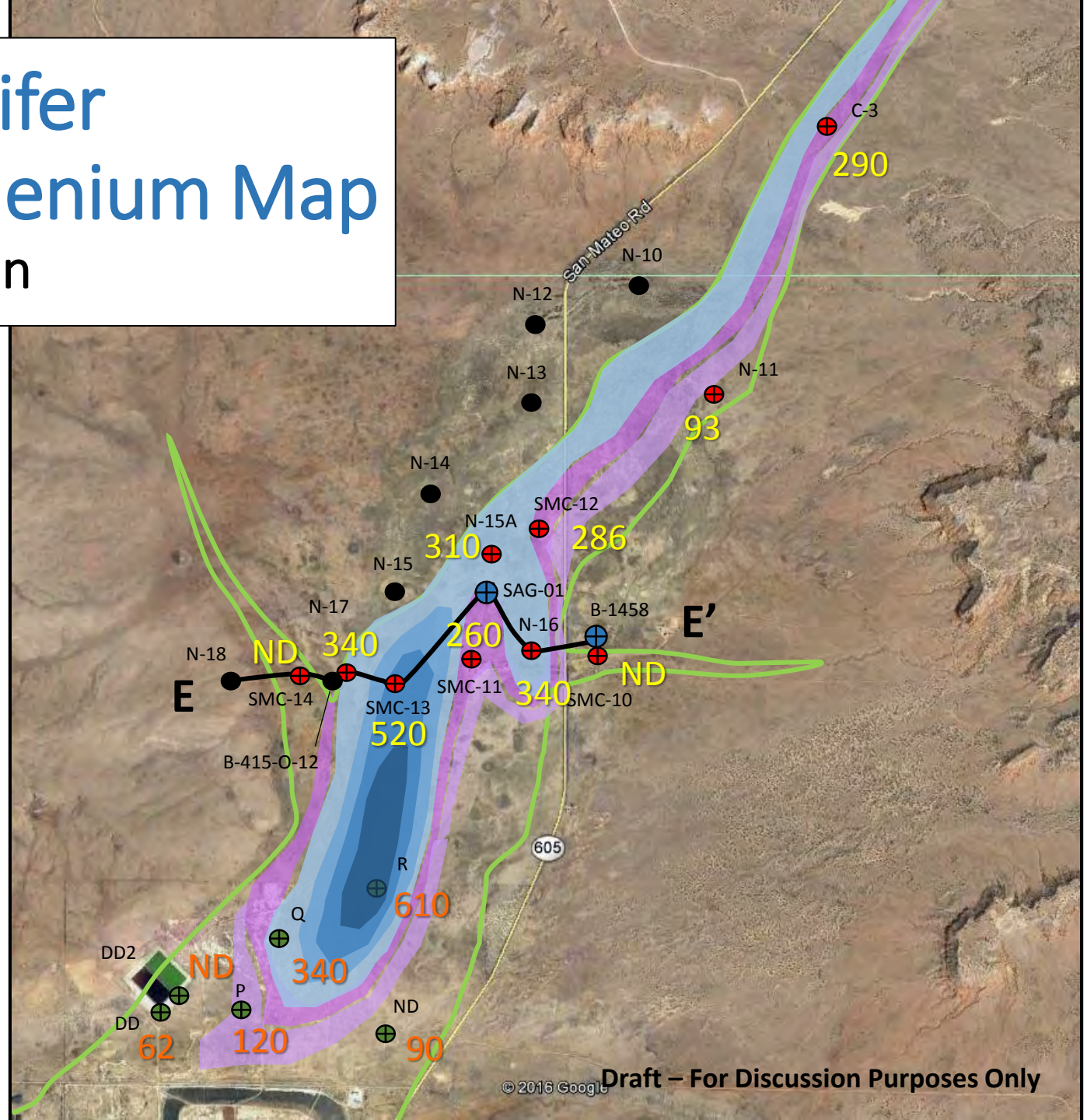


Alluvial Aquifer 2014/15 Selenium Map

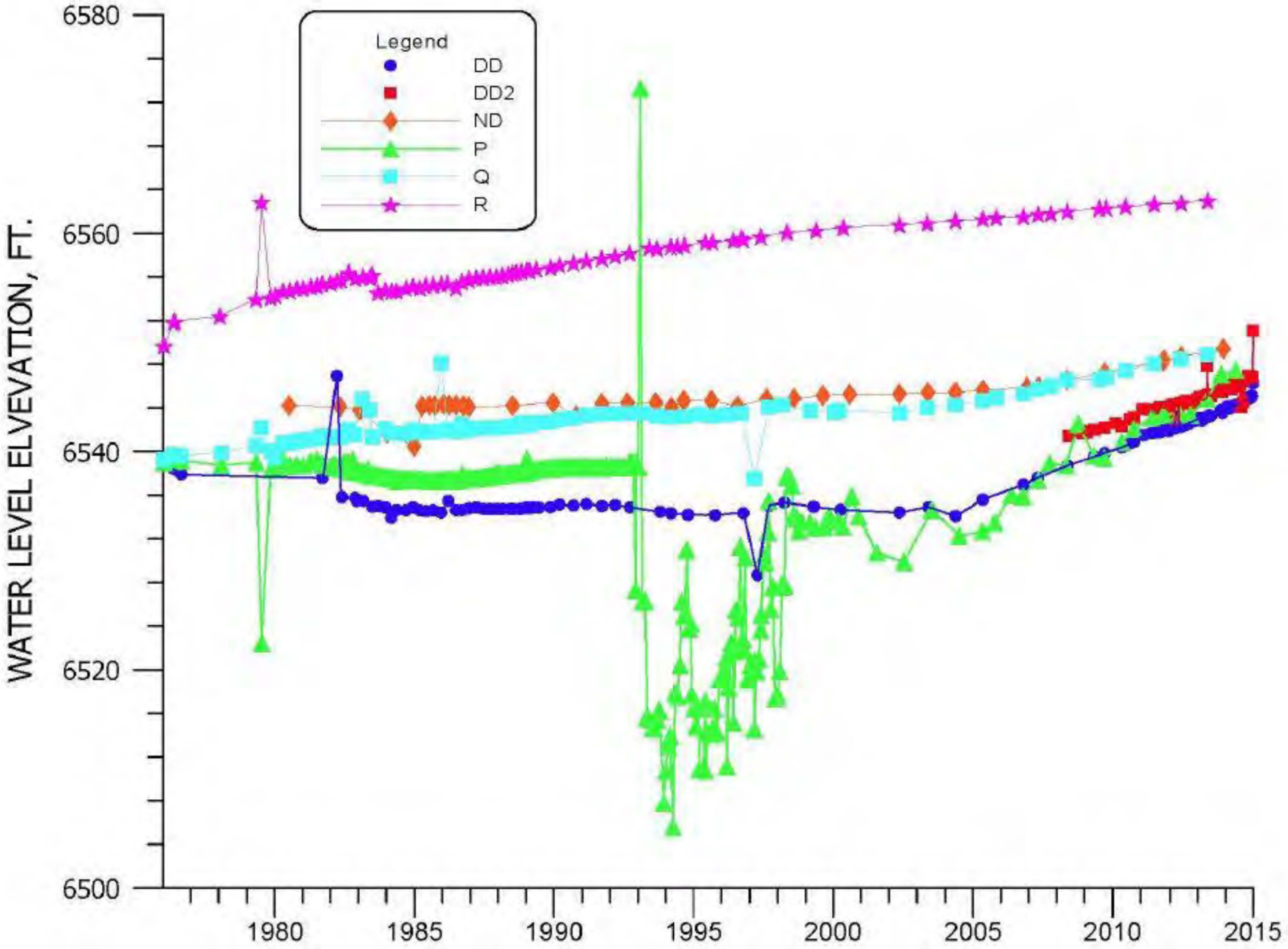
Central SMC Basin

- Dry Borehole
- Phase 1 or 2 Well
- Homestake Well

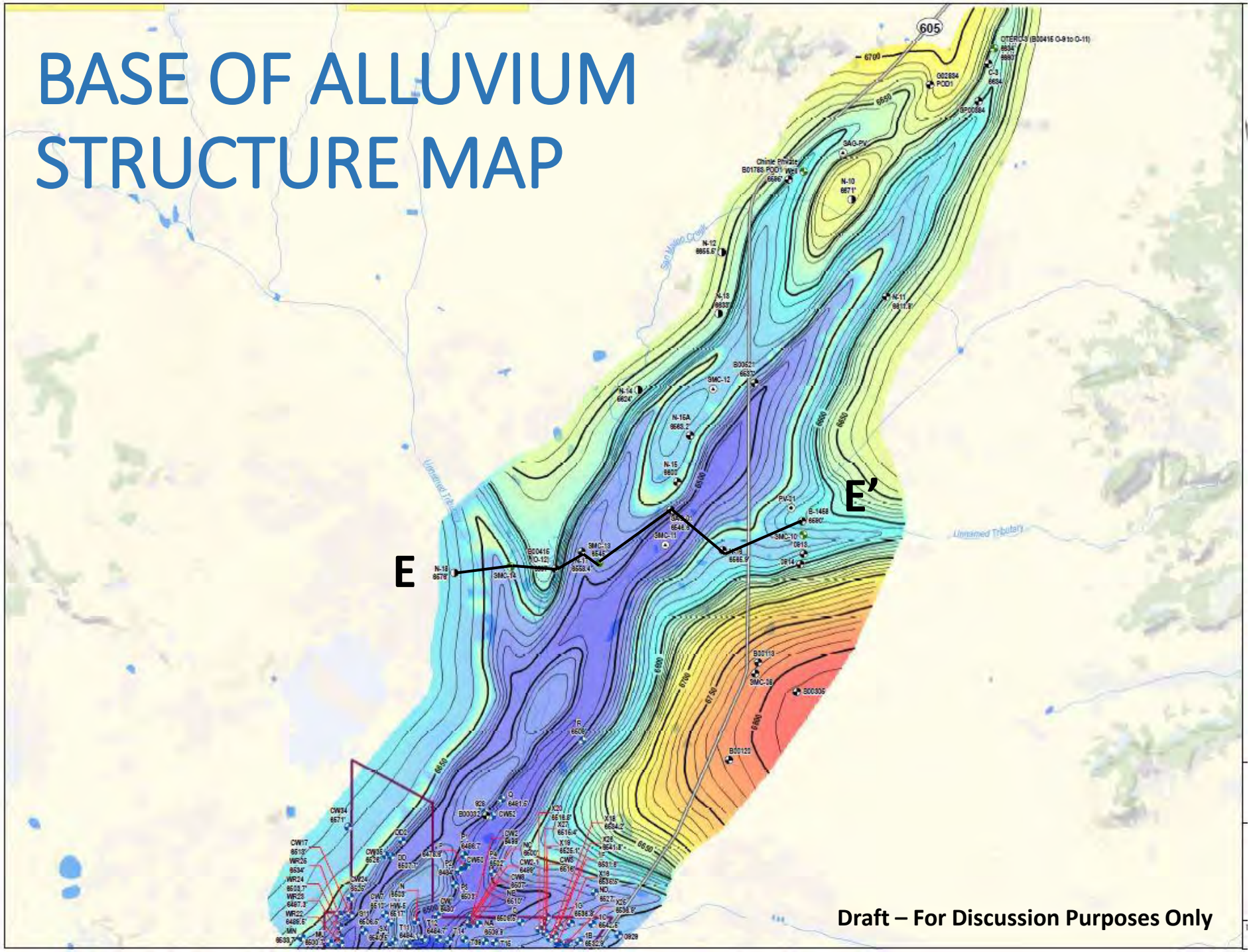
- 100 – 199 µg/L
- 200 – 299 µg/L
- 300 - 399 µg/L
- 400 - 499 µg/L
- 500 - 599 µg/L
- >600 µg/L



Estimated Alluvial Aquifer Boundary


Legend
DD
DD2
ND
P
Q
R
WATER LEVEL ELVEVATION, FT.
6580
6560
6540
6520
6500
1980
1985
1990
1995
2000
2005
2010
2015

BASE OF ALLUVIUM STRUCTURE MAP



Draft – For Discussion Purposes Only

DAKOTA URANIUM MAP

Cross-Roads Area

11 Kd – U Conc

23 Jmw – U Conc

Kd Dry Hole

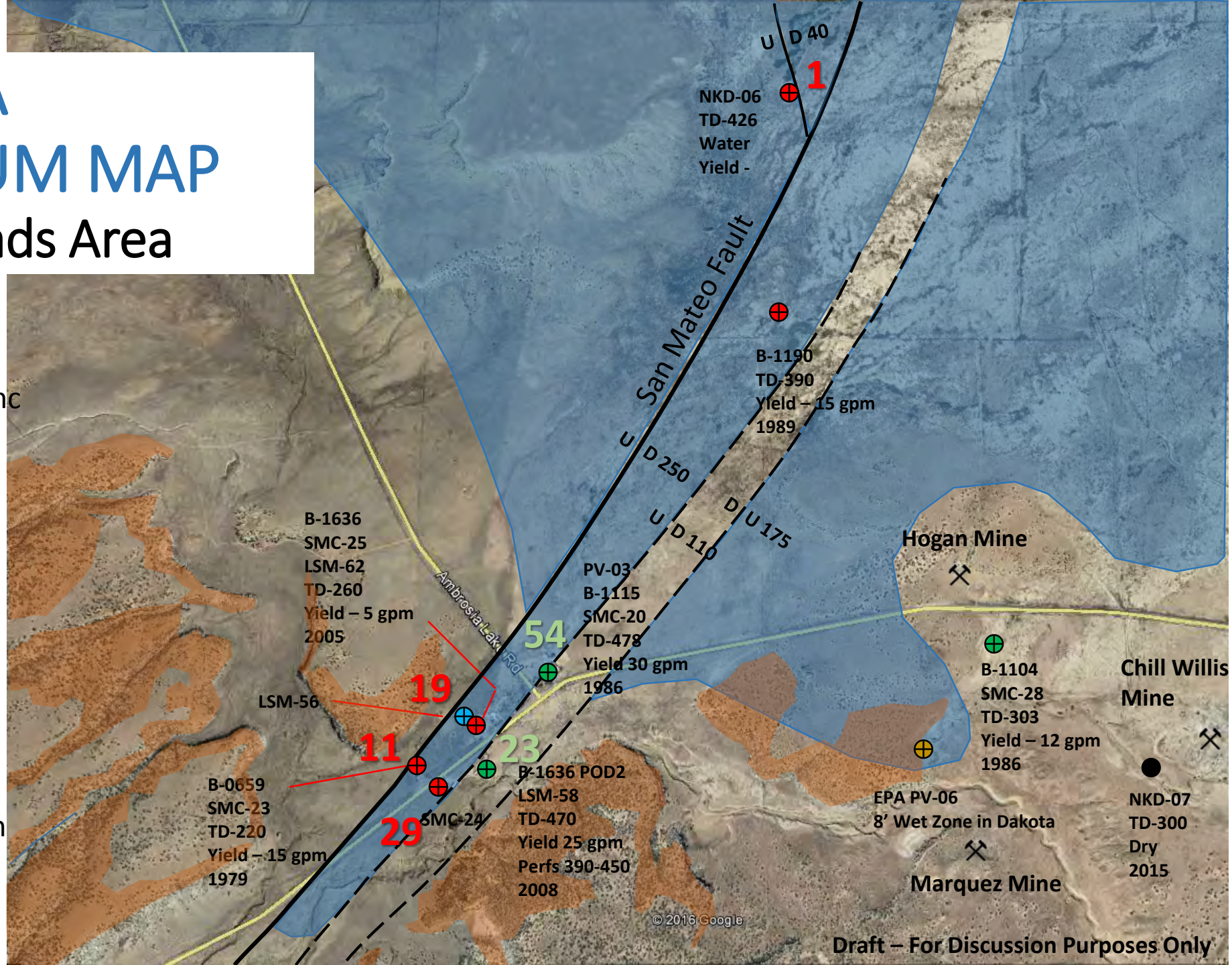
Kd

Jmw

Jmb

Dakota Saturation

Dakota Outcrop



Monitoring Well

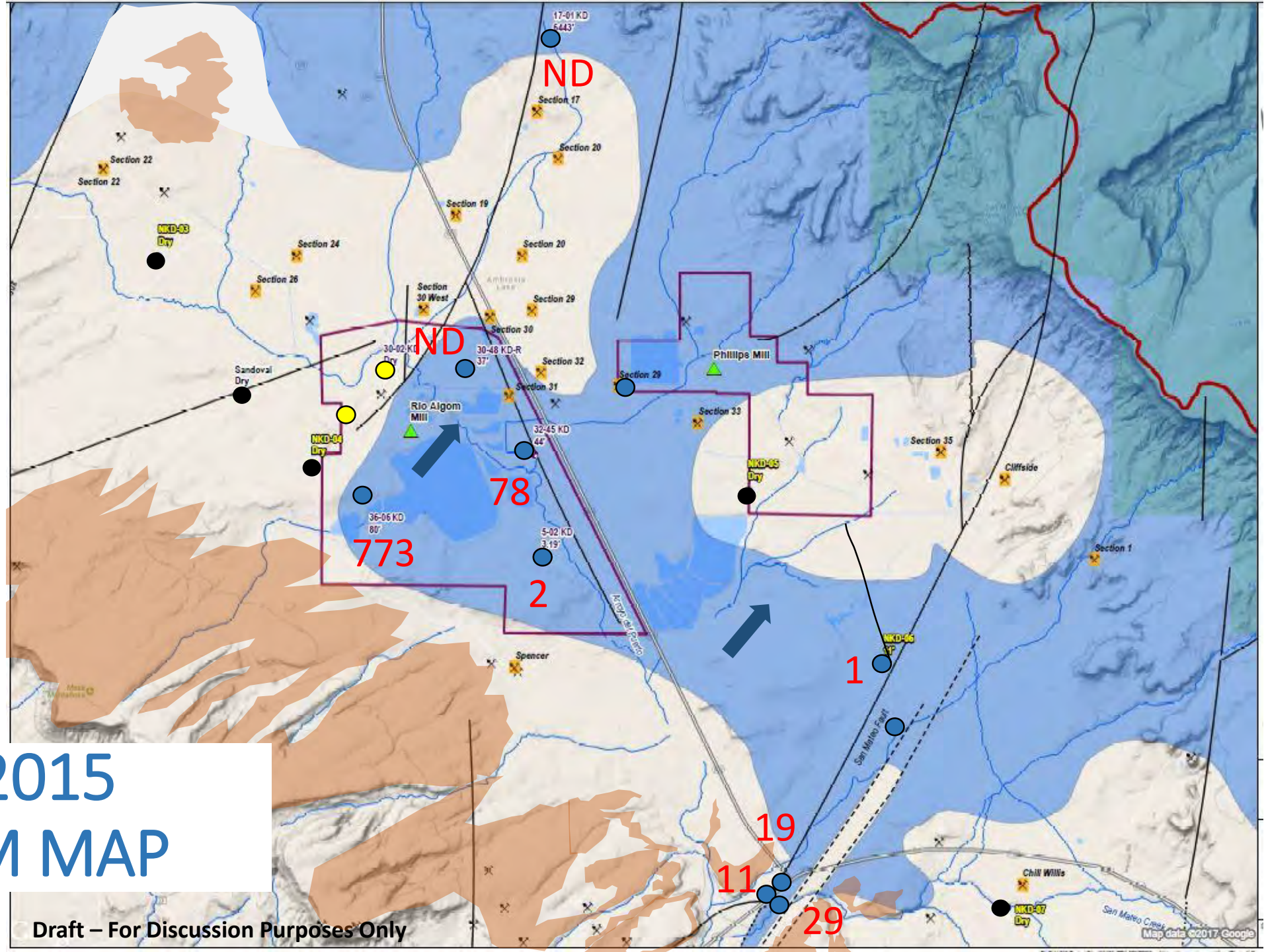
Abandoned or Dry Monitoring Well

Dry Hole

Dakota Saturation

Dakota Outcrop

Ground Water Flow Direction



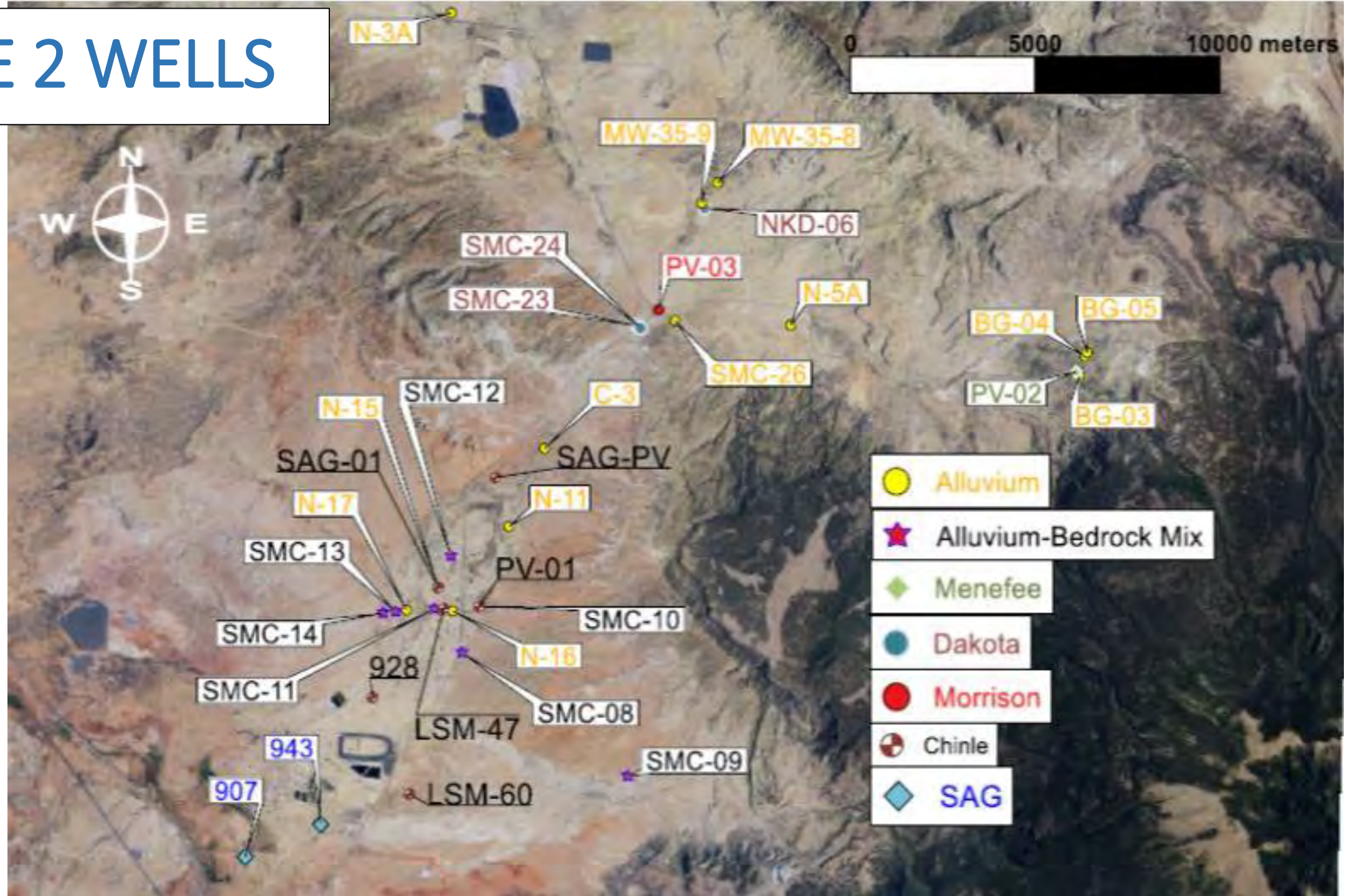
DAKOTA 2015 URANIUM MAP

Draft – For Discussion Purposes Only

GEOCHEMISTRY

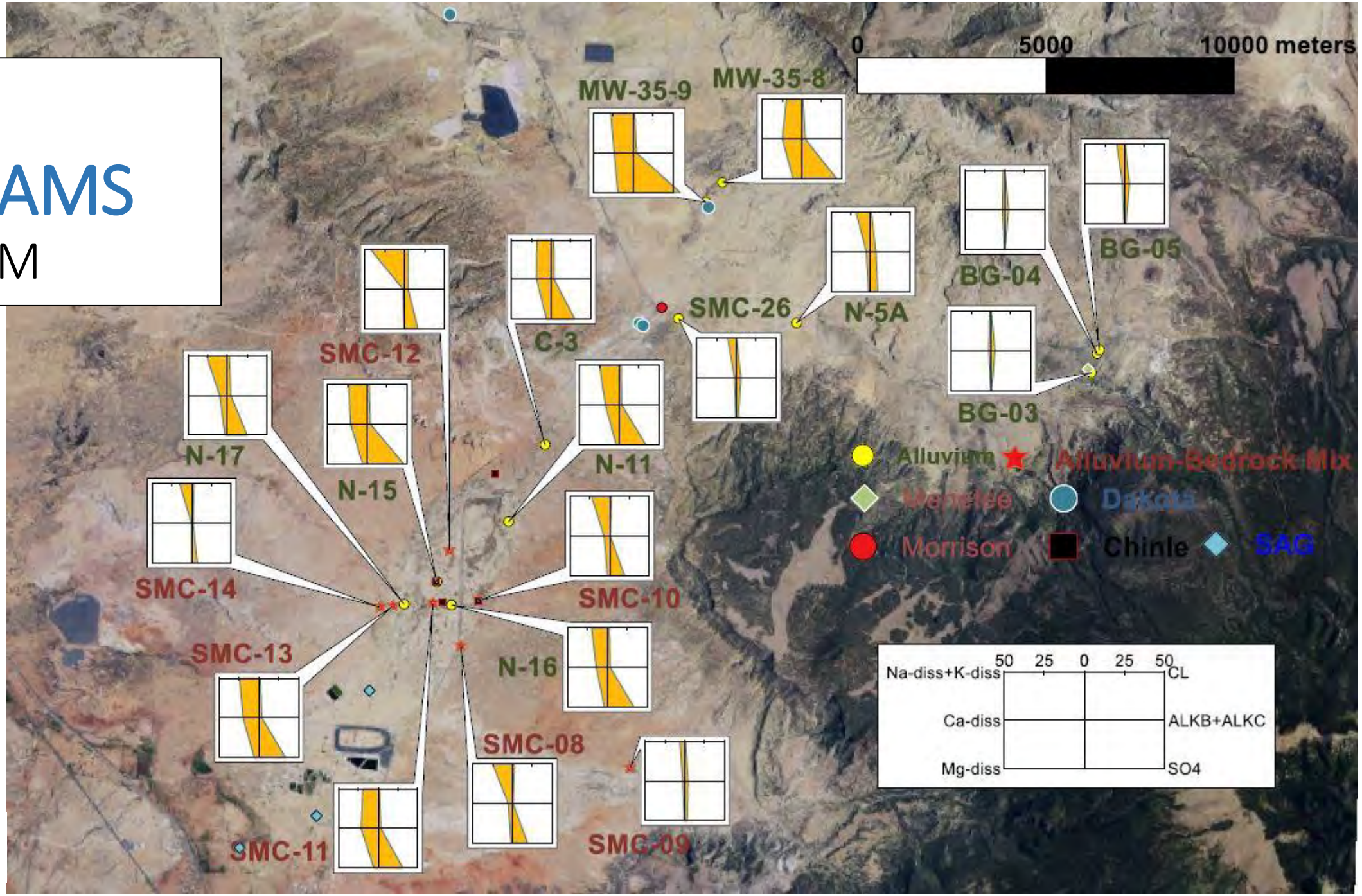
- Stiff Diagrams
- Tri-Linear Diagrams
- Delta 18O and 2H Isotope Plot
- Uranium Mass vs Uranium Activity Ratio (UAR) Plot
- Chart of Geography Area vs UAR
- Sulfur Isotope Plot

PHASE 2 WELLS



STIFF DIAGRAMS

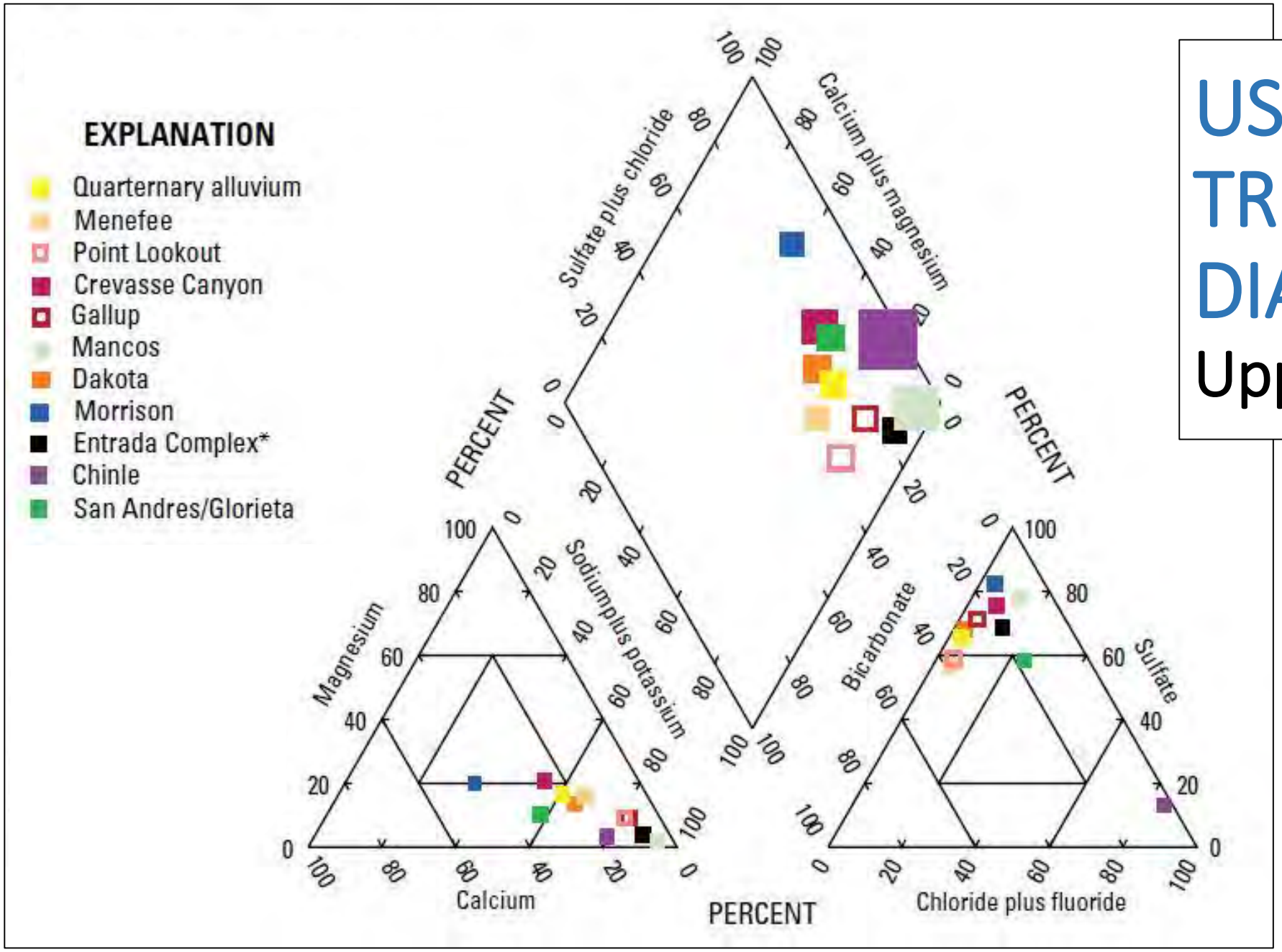
ALLUVIUM

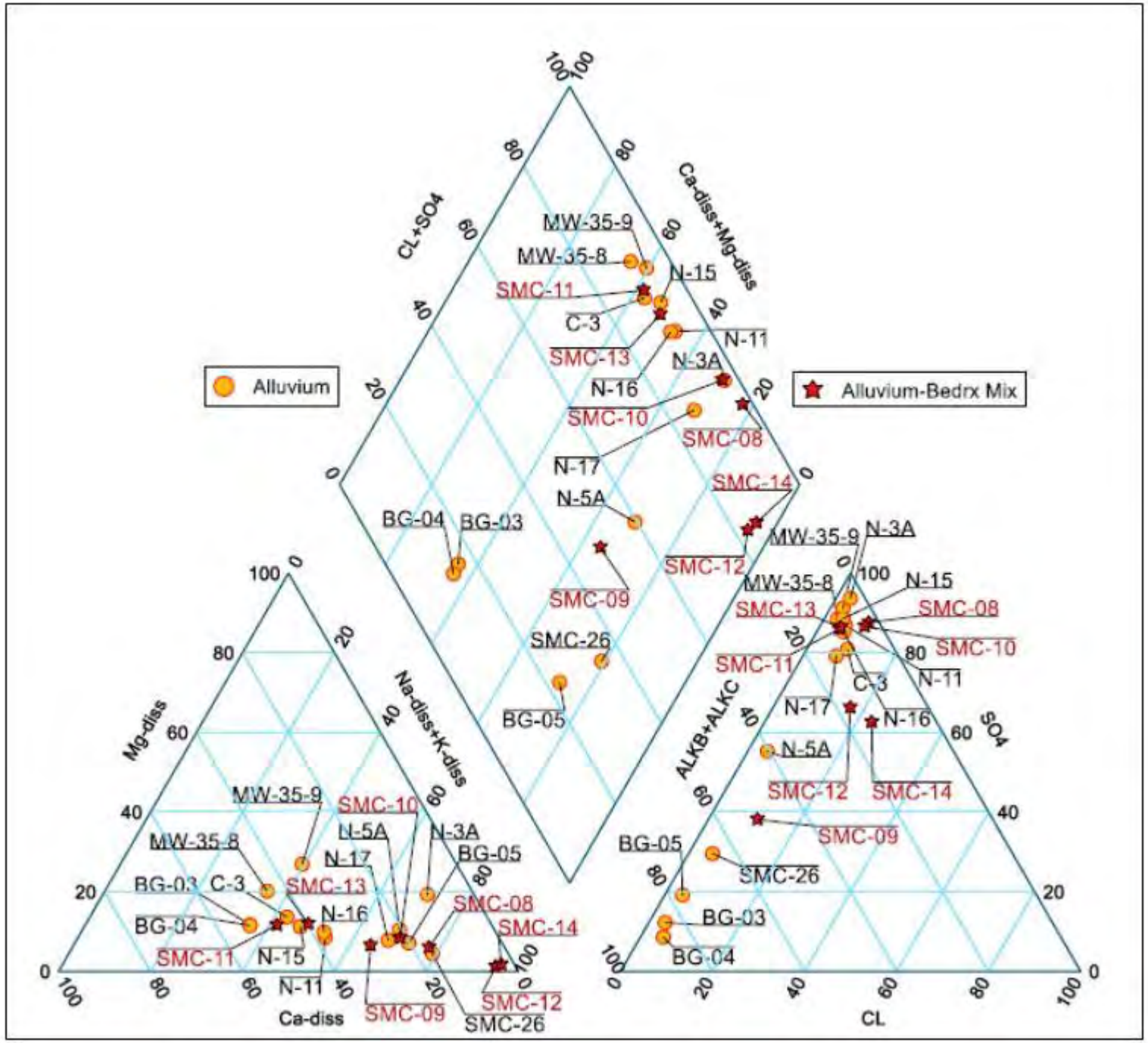


Draft – For Discussion Purposes Only

USGS TRILINEAR DIAGRAM

Upper SMC Basin

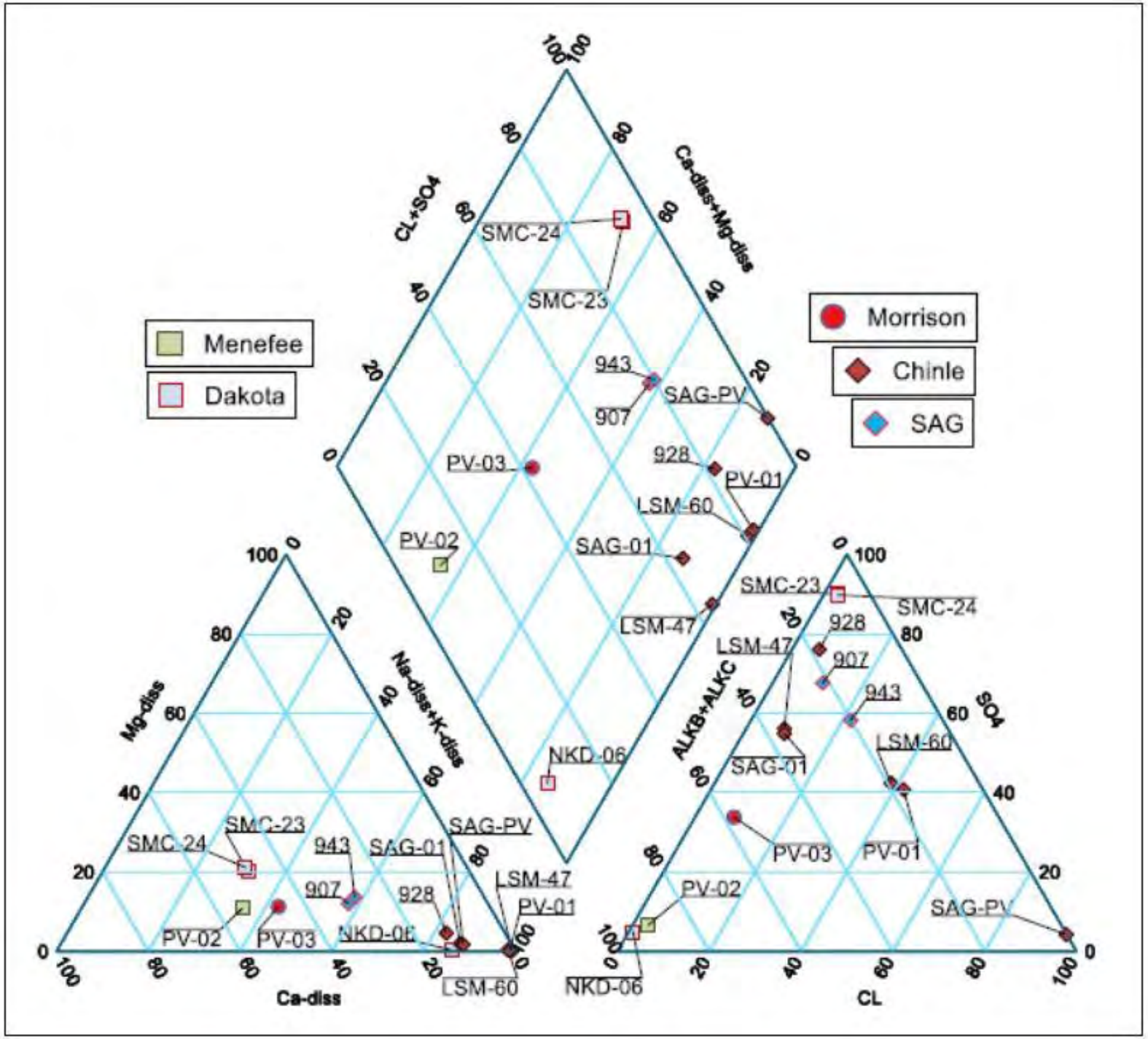




EPA TRILINEAR DIAGRAM

All Wells

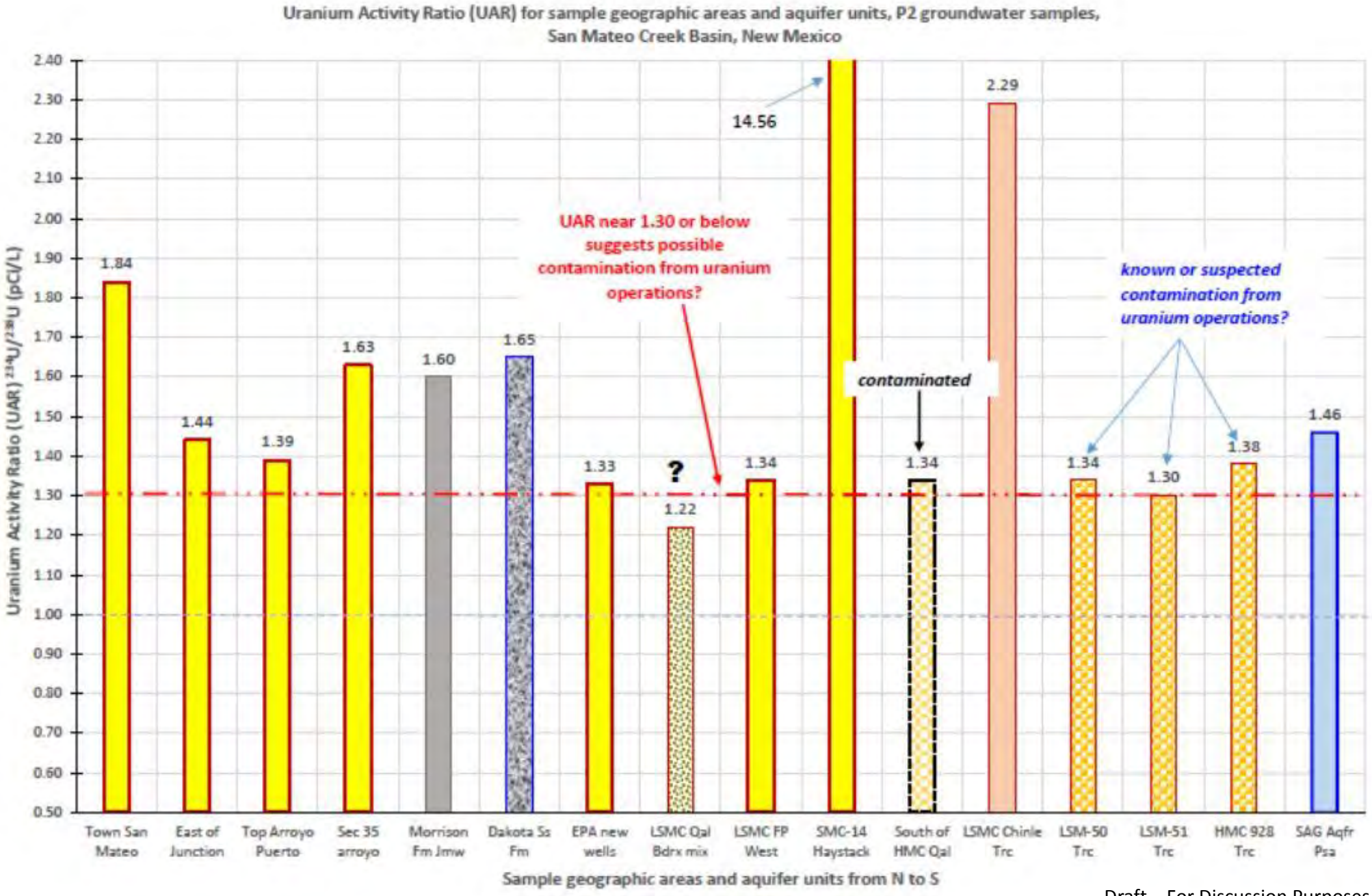
Draft – For Discussion Purposes Only



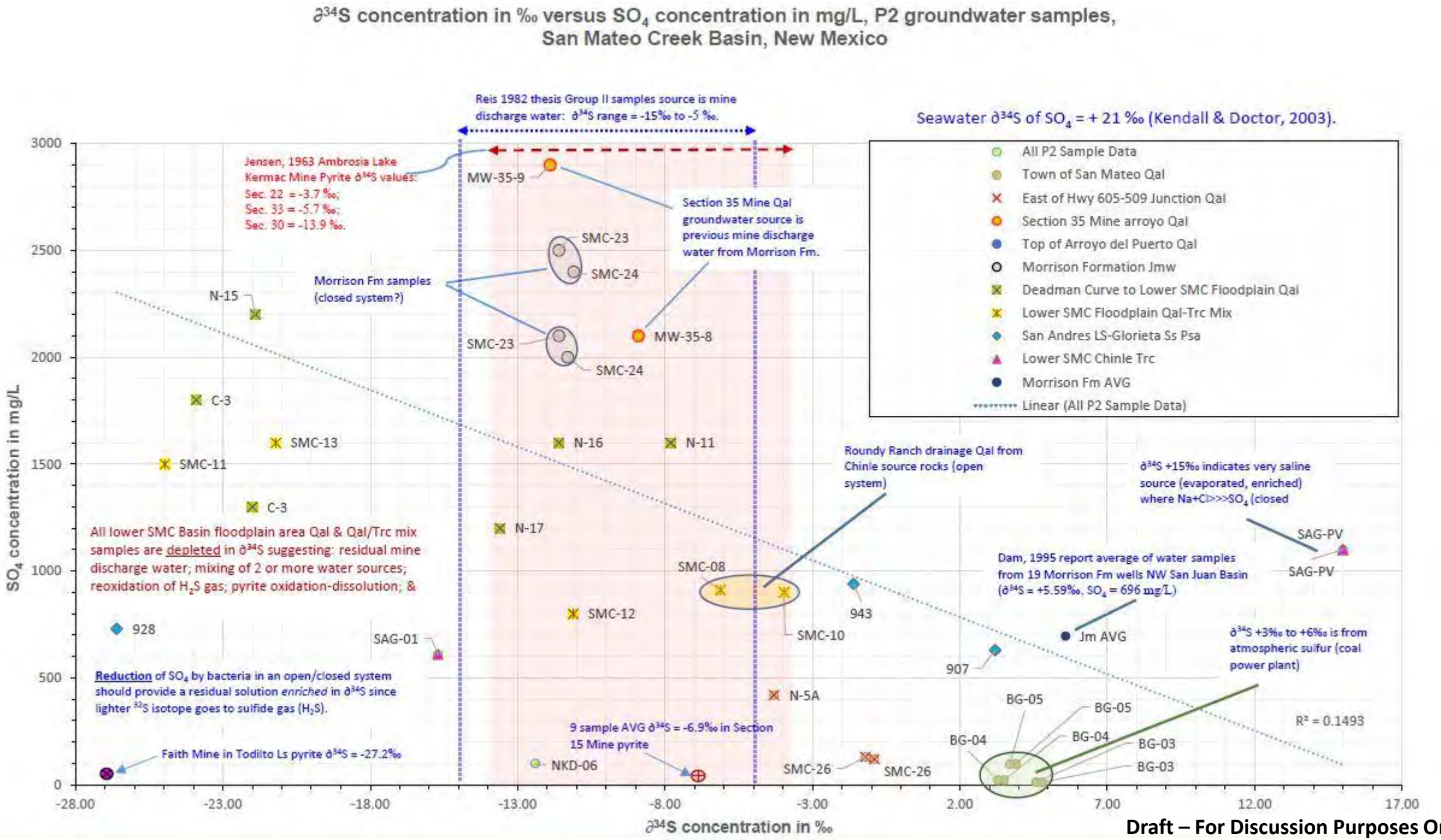
EPA TRILINEAR DIAGRAM

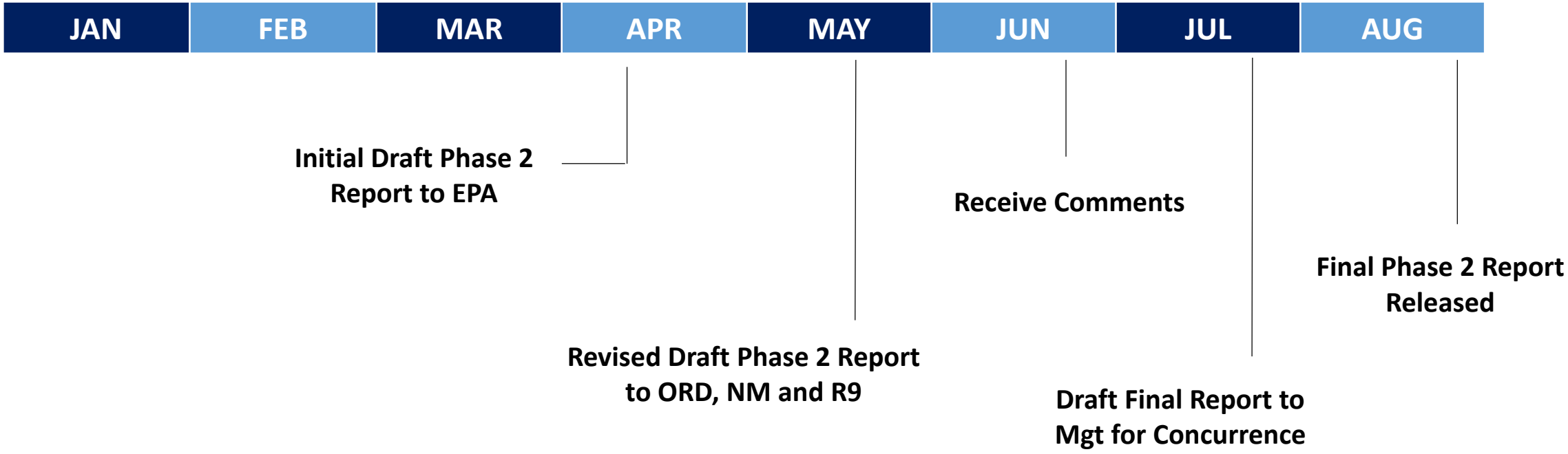
Bedrock Wells

Draft – For Discussion Purposes Only



Draft – For Discussion Purposes Only



Draft – For Discussion Purposes Only

PHASE 2 COMPLETION SCHEDULE - 2017