Final Design Review

Floyd Hill Water Engineers

(F18-30)

April 16, 2019

COLORADOSCHOOLOFMINES

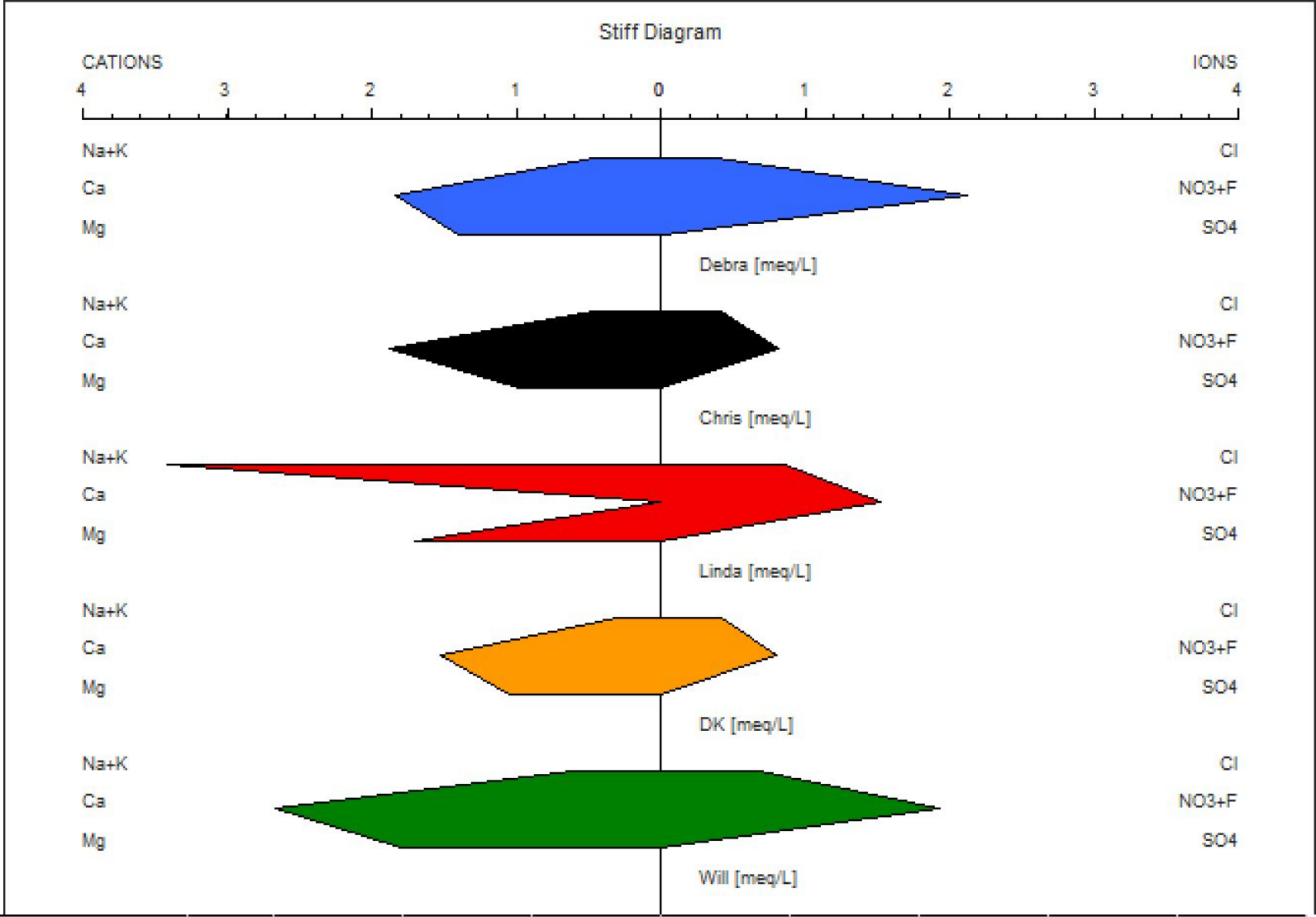
Introduction

Austin Toussaint

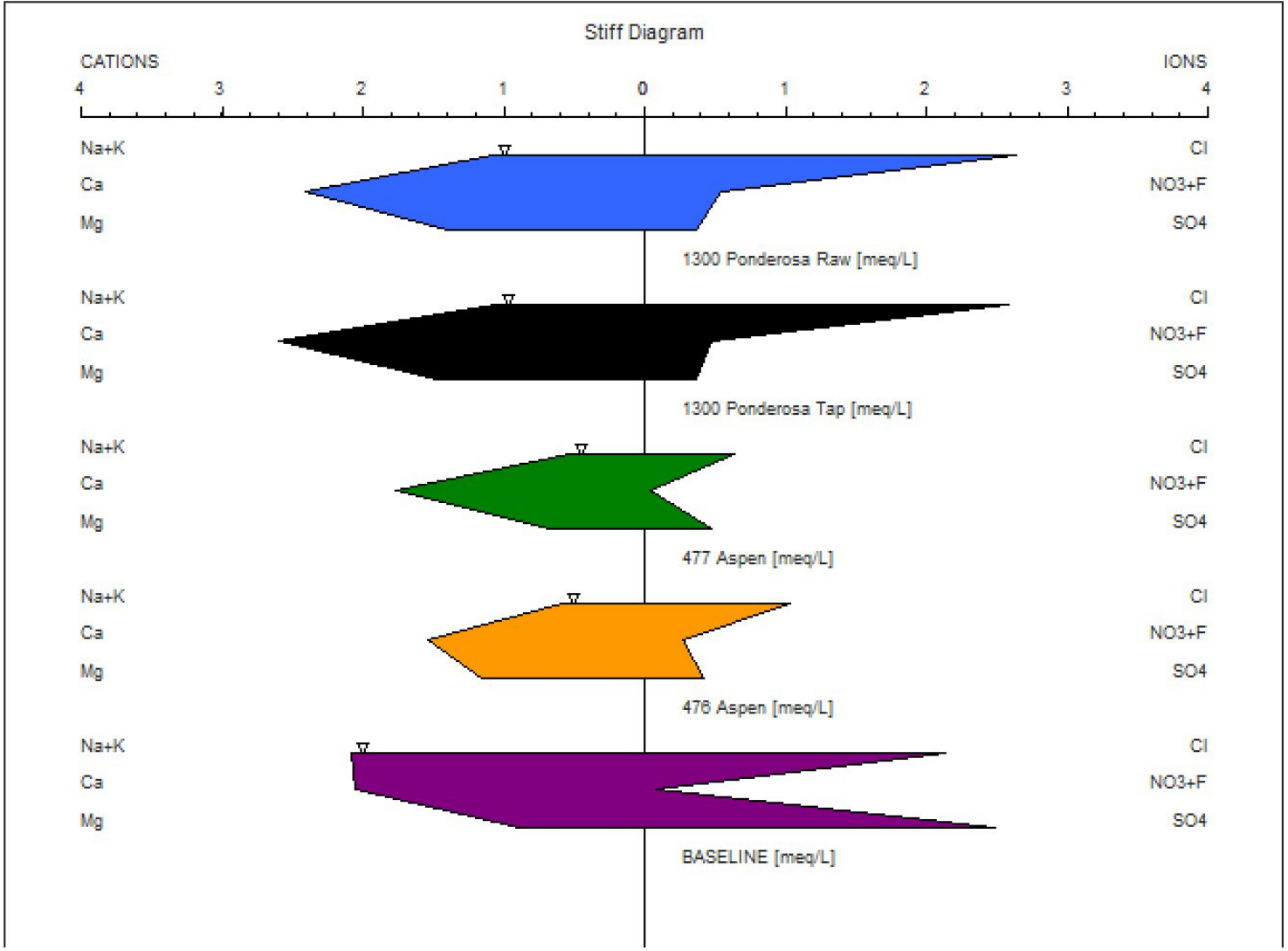
Key Deliverables

- 3D map of wells
  - Detailed model of all 500+ wells, as well as simplified model with the 5 tested wells
- Current water levels with water quality sampling
  - Can be seen in simplified 3D model. Water quality in stiff diagrams (Anna)
- Different sources
  - Groundwater, snow melt, rain (Katie)
- Aquifer details
  - No named aquifers, fractured bedrock with pockets of water with unknown size and volume
- Report in layman's terms
  - Final report will contain everything with a section dedicated to reporting findings in non technical terms
- Recharge and use rates
  - From stable isotope tests, recharge comes mainly from snow melt and other precipitation
  - Use determined from average usage of a household in the area with 3 occupants (Gabe)
- Age of water
  - We were not able to do this due to budget issues. This is the only deliverable that was not completed

Stiff Diagrams

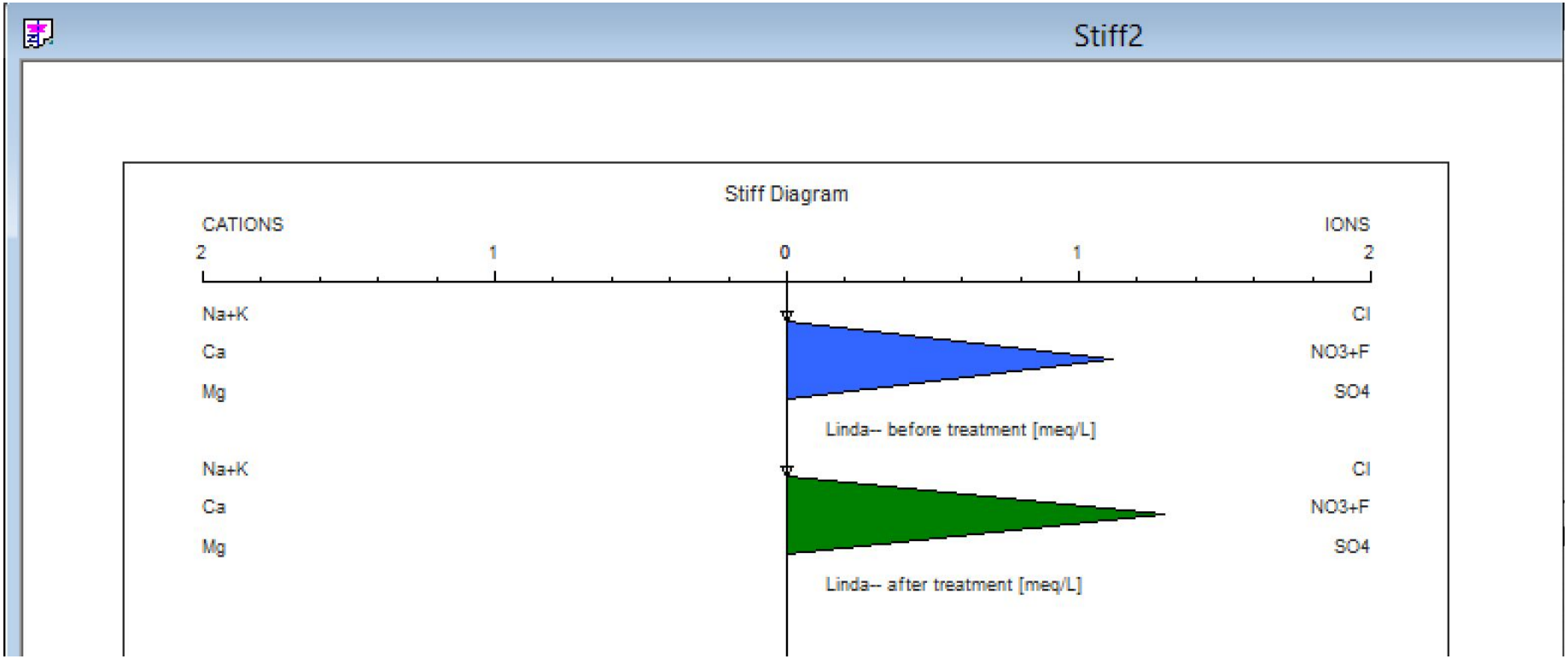


	Sample	Color	Na	K	Cl	Ca	NO3	F	Mg	SO4
1	Debra		8.8	3.1	13.4	36.7	3.2	19.7	17.1	1.5
2	Chris		8.0	4.5	15.1	37.7	4.0	7.2	11.9	0.2
3	Linda		2.1	130.2	30.3	0.1	94.1	0.0	20.6	0.1
4	DK		5.9	1.6	15.1	30.6	7.2	6.5	12.8	0.0
5	Will		12	3.1	24.3	53.4	17.7	15.7	21.9	0.0



	Sample	Color	Na	K	Cl	Ca	NO3	F	Mg	SO4
1	1300 Ponderosa Raw [meq/L]		22.9	3.2	93.5	48.4	33.4	0	17.1	17.9
2	1300 Ponderosa Tap [meq/L]		22.2	3.3	91.9	52.0	29.6	0	17.9	17.5
3	477 Aspen [meq/L]		10.2	3.5	22.5	35.5	0.17	0.35	8.3	22.6
4	476 Aspen [meq/L]		11.7	2.9	36.8	30.8	15.7	0.17	14.1	20.4
5	BASELINE [meq/L]		45.9	3.5	75.9	41.3	2.11	0.5	10.7	119.6

Linda’s nitrate levels before and after treatment



	Sample	Color	Na	K	Cl	Ca	NO3	F	Mg	SO4
1	Linda-- before treatment [meq/L]						69.3			
2	Linda-- after treatment [meq/L]						80.3			

Water Quality

Nicole Rooney

Contaminant	Recommended Level (mg/L)	Water Samples Exceeding Recommended Level (mg/L)
Fluoride*	4.0	None
Chloride**	250.0	None
Nitrite*	1.0	476 Aspen (**1.53**) Linda 2: tap (**2.56**)
Bromide***	Trace amounts-0.05	477 Aspen (**0.14**) 476 Aspen (**0.17**) Linda 2: tap (**0.06**)
Nitrate*	10.0	Will (**17.73**) Linda (**94.10**) Linda 2: tap (**80.29**) Linda 2: raw (**69.31**) 1300 Ponderosa: tap (**29.64)** 1300 Ponderosa: raw (**33.43**) 476 Aspen (**15.69**)
Phosphate***	0.005-0.05	None
Sulfate**	250.0	None

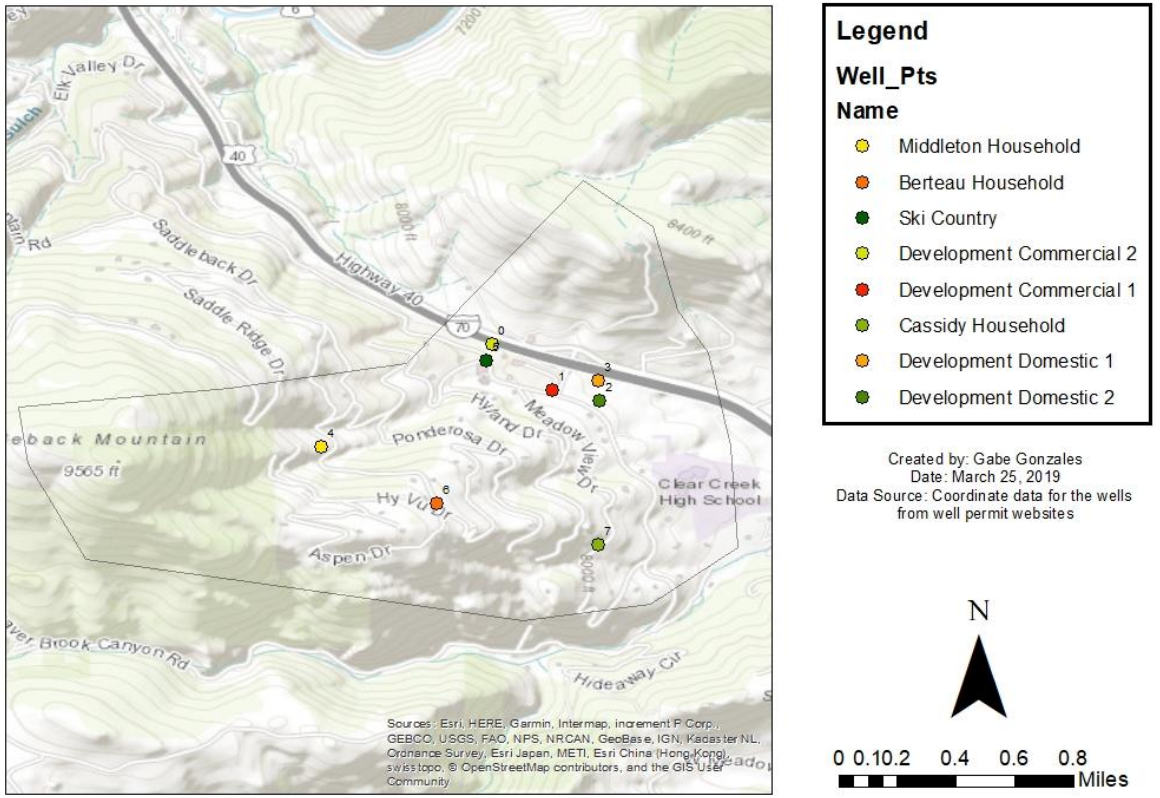
*=Enforceable
**=Not mandatory
***=Natural Levels

Hydro Model

Gabe Gonzales

- Difficulty with fractured rock aquifer systems
  - No software developed
- Assumptions for simplicity
  - Steady state, Changes in elevation
- Created using assumptions from hydro report and location of tested wells
- Assumed values based on research
  - Domestic usage rate, Geologic parameters
- Procedure in report

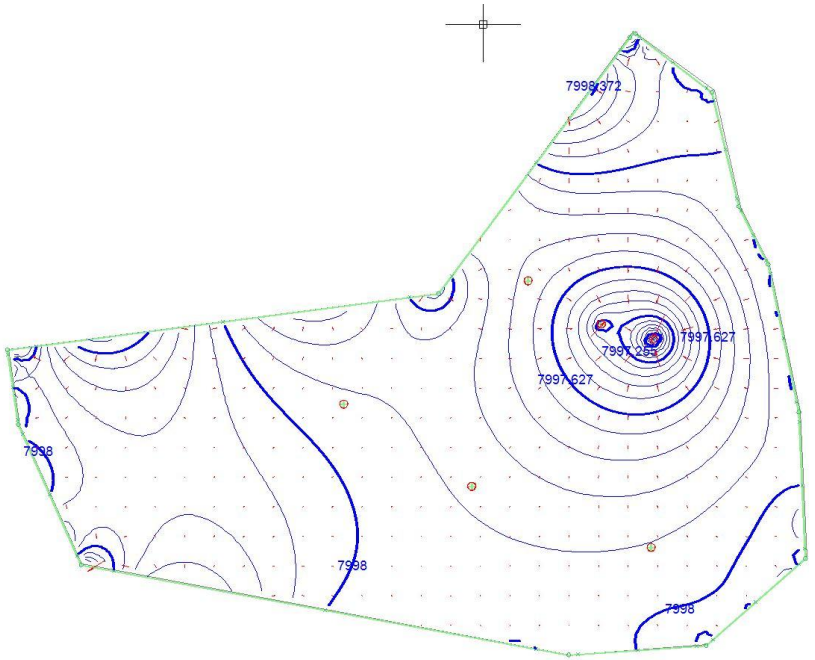
Model Boundary Used for AnAqSim

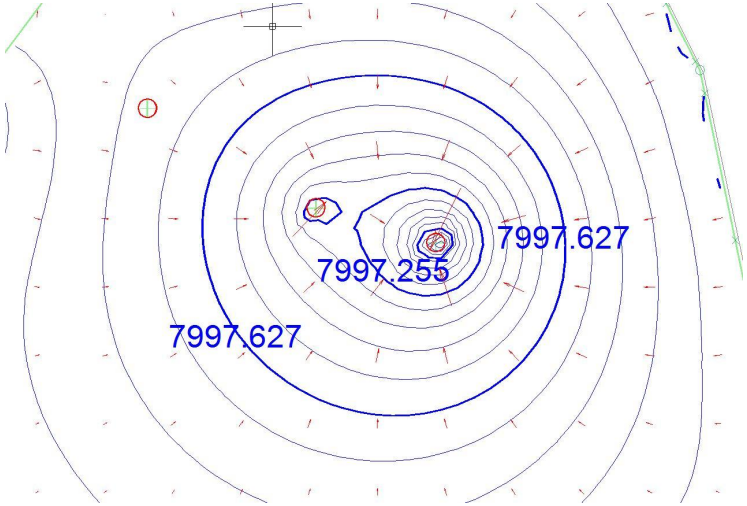


Hydro Model (cont.)

Gabe Gonzales

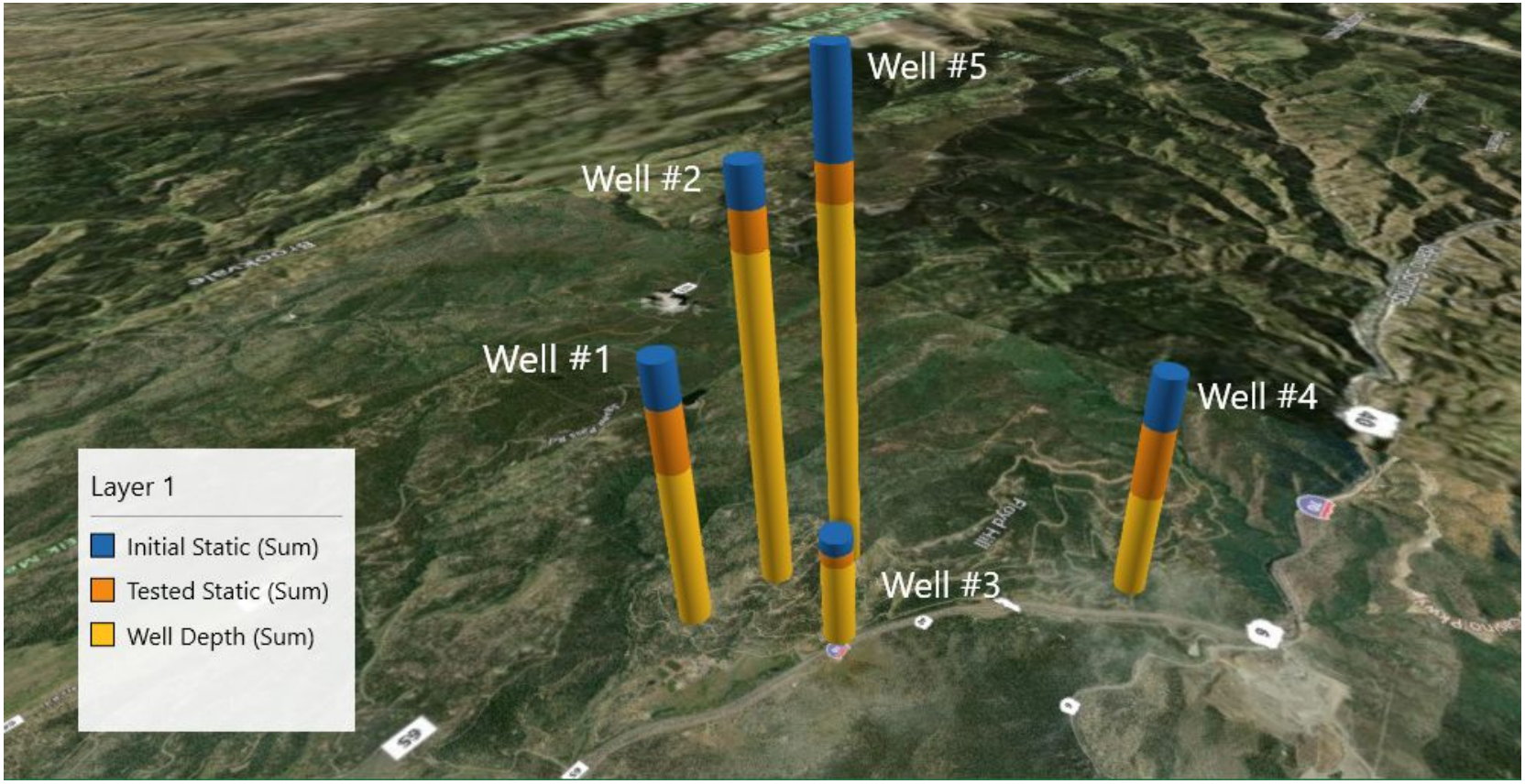
- Input parameters in AnAqSim
- Pumped the system
  - Wells that would be used for the development and known wells pumped
- Results
  - Wells for the development show larger drawdown due to larger pumping rates
  - Other wells show minimal impact
  - Shallow aquifer used will need to be refilled
    - Pumping tests similar result
    - Hydro report suggested using treated water as recharge for shallow aquifer
- General idea of what would occur to water based on development





3D Mapping

Austin Toussaint



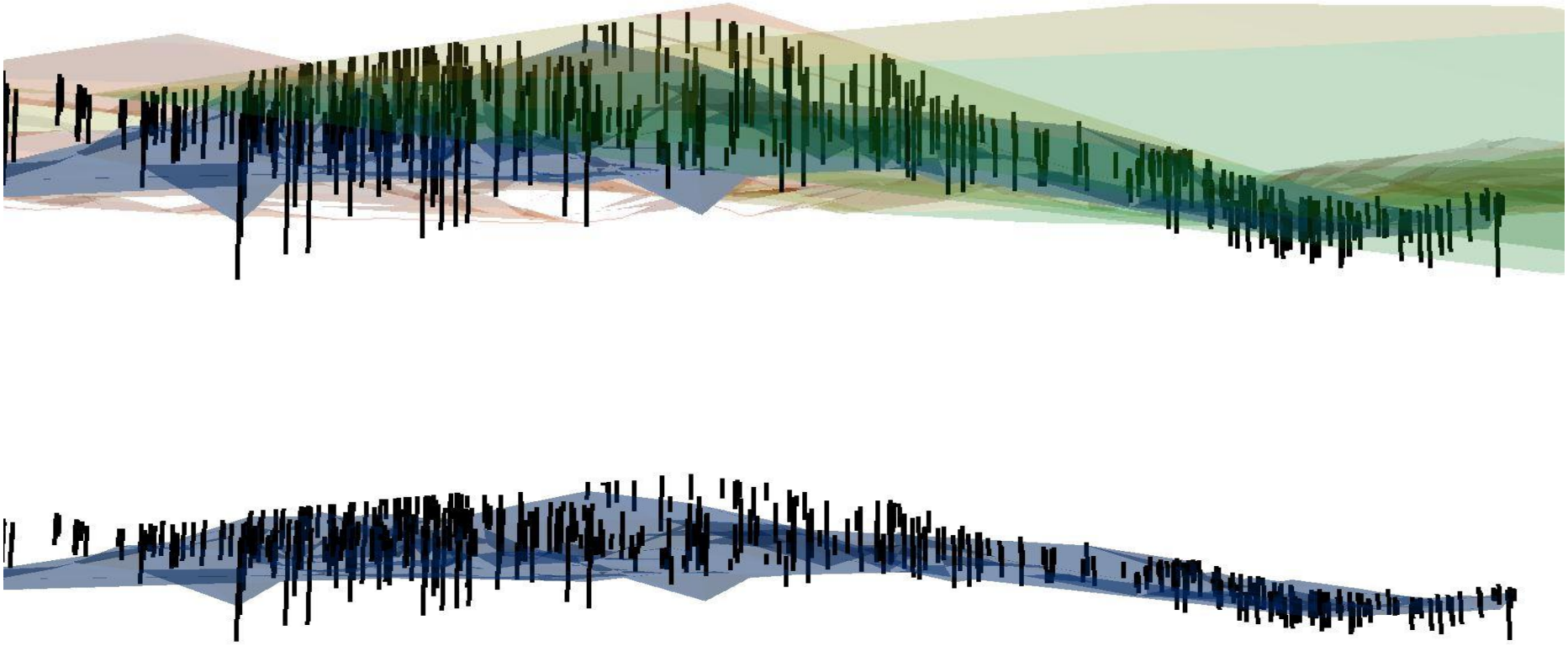
Depth testing

Katie Kerstiens

Well	Depth Measured (ft)	Depth on well permit (ft)	Difference (ft)
Will Cassidy (1)	110	75	-35
Linda Berteau (2)	61	61	0
Ski Country (3)	23	25	2
Debra Krems (4)	128	90	-38
477 Aspen (5)	56	150	56

3D Mapping (cont.)

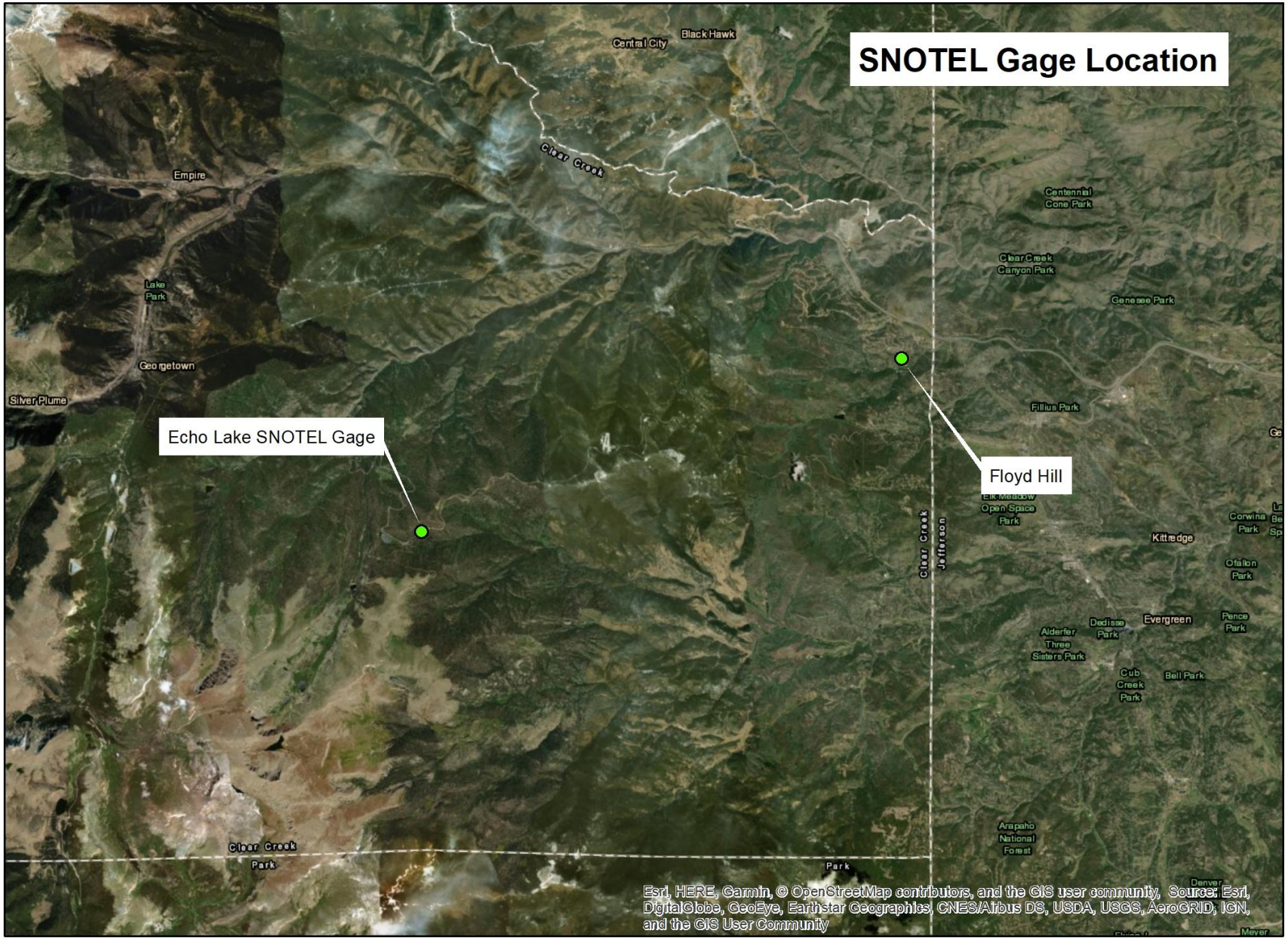
Katie Kerstiens



Weather/ Precipitation

Jonah Howe

- Precipitation data obtained through SNOTEL Gage Network
  - Specifically, the Echo Lake Gage, the closest one to the project site at 10 miles away and an altitude of 10,600’
- SNOTEL Stands for Snow Telemetry and is part of the Snow Survey and Water Supply Forecasting (SSWSF) Program for the National Water and Climate Center
  - The program consists of 800 Gages strewn throughout the Western U.S. in remote watersheds
- The data obtained includes precipitation and temperature
  - The difference in location and altitude between the two sites somewhat qualifies these results, however trends remain the same
  - Snowpack data was not included due to the lack of data specific to Floyd Hill



N

0 1.5 3 6 9 12 Miles

Drawn By: Jonah Howe
Data Produced: SNOTEL Gage Location Relative to Project Area
Sources: ESRI, SNOTEL

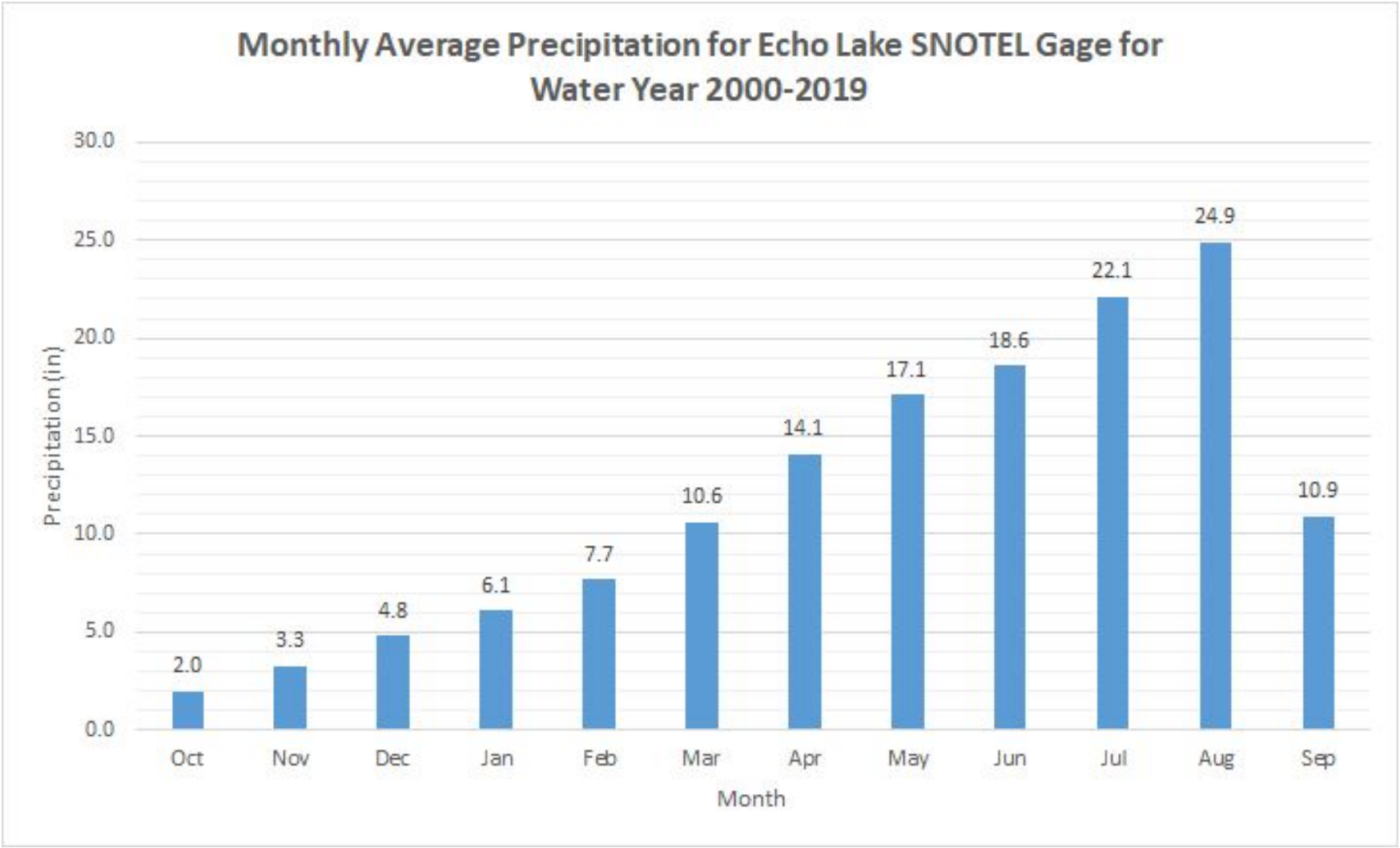
Weather/ Precipitation

Jonah Howe

	Monthly Average Precipitation Values											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	-	-	-	6.3	8.1	11.6	14.5	16	17.2	20.6	24.7	-
2001	0.4	1.6	2.7	3.3	4.6	8.5	12.2	16.1	17	21.5	24.3	6.3
2002	0.7	1.7	2.7	3.8	4.7	6.5	7.2	10.1	11.2	13.4	15.9	8.1
2003	2.5	3.8	4.2	5.2	7.2	16.6	19.2	20.4	22.1	24.2	27.5	11.6
2004	0.4	1.5	2.5	3.6	5.5	6.9	13.6	14.2	18.3	22.3	23.9	14.5
2005	3.8	6.4	7.2	9.7	10.2	12.4	17	18.3	20.2	21.7	25	16
2006	3.1	4.7	6	7	8.3	11.2	12.8	14.5	15	21.7	24.7	17.2
2007	4.7	6.2	10	11.8	13.3	16.3	21.7	25.2	26.6	29	32.4	20.6
2008	1.5	2.2	5.2	6.6	8.8	11.5	13.7	17.8	18.7	22	26.9	24.7
2009	2.4	3	4.8	5.8	6.3	7.9	13.9	17.4	19.7	22.5	23.2	-
2010	3.2	4.3	5.3	5.7	6.7	10	12.9	15.5	20	23.1	26.3	0.4
2011	1.9	3.1	3.9	5.2	7.5	9.3	12.4	16.8	18.7	22.9	25.3	1.6
2012	2.5	3.7	5.4	6.3	8.5	9.1	11.4	13.8	14.1	20.6	23.5	2.7
2013	0.8	1.1	2	2.6	4.3	7.2	11.2	14.7	14.9	19.1	25.2	3.3
2014	1.8	2.7	3.8	6	7.9	10.5	13.2	17.7	18.2	22	24.2	4.6
2015	1.4	3.4	5.7	7.3	10.3	12.1	17.4	23.5	25.5	30.3	32.3	8.5
2016	2.6	5.6	7.2	8.1	9.8	12.3	18	19.9	21.6	23.4	25.4	12.2
2017	0.7	1.5	3.9	6.7	7.6	11	14.4	19.2	19.8	24	26.5	16.1
2018	2.3	3.3	4.5	5.9	7	8.9	10.7	12.9	13.7	15.9	16.5	17
2019	1.8	3.1	3.6	6	7.3	11.2	-	-	-	-	-	-
Period Average	**2.0**	**3.3**	**4.8**	**6.1**	**7.7**	**10.6**	**14.1**	**17.1**	**18.6**	**22.1**	**24.9**	**10.9**

Weather/ Precipitation

Jonah Howe



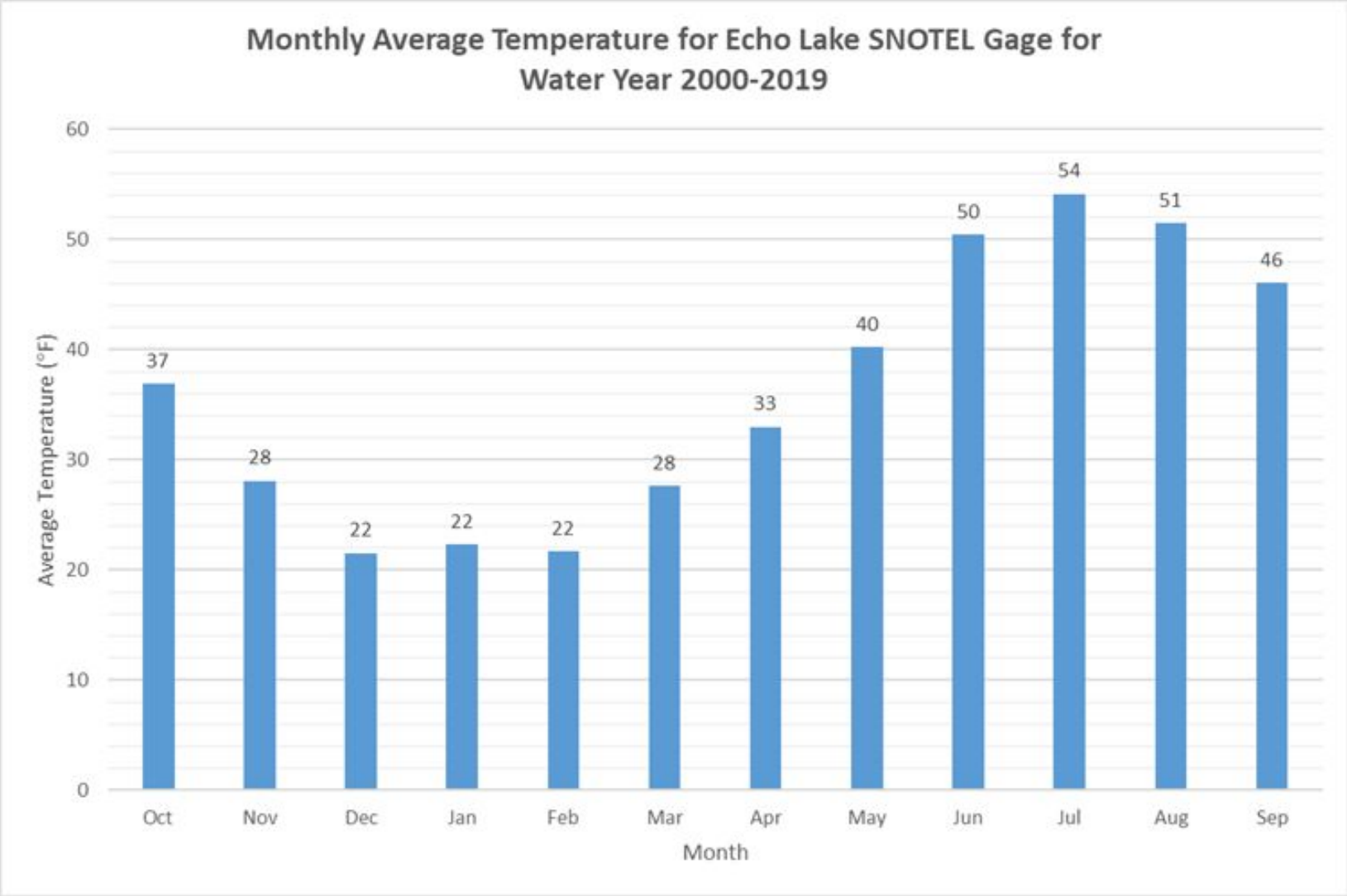
Weather/ Precipitation

Jonah Howe

	Monthly Average Temperature Values (°F)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000	-	-	-	22	26	26	35	44	49	54	52	46
2001	36	19	21	19	23	25	34	41	51	54	50	46
2002	38	27	21	19	20	23	37	40	53	56	52	45
2003	33	27	21	27	17	26	33	41	45	57	52	44
2004	41	26	24	21	18	32	32	43	46	51	48	44
2005	35	24	24	25	22	24	33	40	48	56	50	47
2006	37	29	21	23	21	25	35	42	52	54	51	41
2007	35	29	22	19	23	31	33	40	50	55	54	47
2008	38	32	18	18	21	24	31	38	49	55	51	44
2009	37	31	22	25	24	28	32	42	46	53	52	44
2010	32	31	15	22	18	26	32	38	51	54	52	49
2011	38	26	26	21	19	29	31	37	-	54	55	45
2012	37	28	20	25	19	33	37	42	55	54	53	46
2013	37	33	21	21	19	26	28	39	53	53	51	47
2014	34	29	20	22	22	28	32	39	50	53	49	47
2015	40	27	22	26	24	32	33	37	51	52	53	50
2016	40	26	20	22	27	27	32	39	53	56	50	47
2017	42	31	23	21	28	33	33	39	52	53	50	46
2018	37	35	27	27	23	28	34	44	54	55	53	50
2019	34	24	21	22	20	26	-	-	-	-	-	-
Period Average	**37**	**28**	**22**	**22**	**22**	**28**	**33**	**40**	**50**	**54**	**51**	**46**

Weather/ Precipitation

Jonah Howe



Design Critique

Nicole Rooney

REF/ID	PRE-MITIGATION				MITIGATIONS / WARNINGS / REMEDIES	POST-MITIGATION			
	RISK	RISK SEVERITY	RISK LIKELIHOOD	RISK LEVEL		RISK SEVERITY	RISK LIKELIHOOD	RISK LEVEL	ACCEPTABLE TO PROCEED?
Impacts of New Development									
Scenario 1 (+)	Impact on Current Community	ACCEPTABLE	POSSIBLE	LOW	None Needed	ACCEPTABLE	POSSIBLE	LOW	YES
Scenario 2 (-)	Impact on Current Community	UNDESIRABLE	PROBABLE	HIGH	Check well adjudication, water needed by development, current water levels (vague since there isn't a developer at this time)	TOLERABLE	POSSIBLE	MEDIUM	YES
Groundwater Supply Projection									
3	Well Depths	UNDESIRABLE	PROBABLE	HIGH	Difficulty getting residents to shut pumps off for desired amount of time to obtain static water level could result in inaccurate results. Insist that pumps need to be shut off before testing.	TOLERABLE	POSSIBLE	MEDIUM	YES
4	Recharge Rate	UNDESIRABLE	POSSIBLE	HIGH	Obtaining precipitation data and static water levels will majorly impact the recharge rates calculated (and the model). Careful analysis of conditions to help model predictions.	TOLERABLE	POSSIBLE	MEDIUM	YES
Health Implications									
5	Septic Seepage	INTOLERABLE	POSSIBLE	EXTREME	Test wells with outlying data again to confirm levels. Continue research on safe levels or indications of septc seepage	UNDESIRABLE	POSSIBLE	HIGH	YES
6	Water quality analysis	TOLERABLE	IMPROBABLE	MEDIUM	Continue to test an even spread of homes to understand flow of water and water quality in the area.	TOLERABLE	IMPROBABLE	MEDIUM	YES
Well Testing									
7	Damage to Well	UNDESIRABLE	IMPROBABLE	MEDIUM	Being careful when opening the well and dropping probe into the well. Careful consideration of wires or other important components of the well.	ACCEPTABLE	IMPROBABLE	LOW	YES

Conclusions

Austin Toussaint

- Wells with similar water chemistry could be drawing from the same aquifer, but cannot be certain due to the fractured bedrock
- Development would decrease the water level in the available aquifer for pumping and can be an issue if not enough water replaced to be self-sufficient
- We can’t say for sure how much the water level would decrease due to the unknown volume of the aquifer because of the fractured bedrock
- Further research and testing would need to be conducted to determine actual recharge rates

Questions?