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Water-quality monitoring of Canyon Lake, 2017-2018

Progress report: July 9, 2019 West Dakota Water Development District meeting

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Overview

- Review objectives and approach
- Summary of results
- What did we learn?
- Future plans

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Purpose of project:

- Evaluate water quality
  - Does it meet current standards?
  - How does the quality change from upstream to downstream?
  - Limited bacteria data was available prior to 2017
- Assist with water management
  - Dredging (was initially planned for 2017, has not yet started)
  - Waterfowl population on lake

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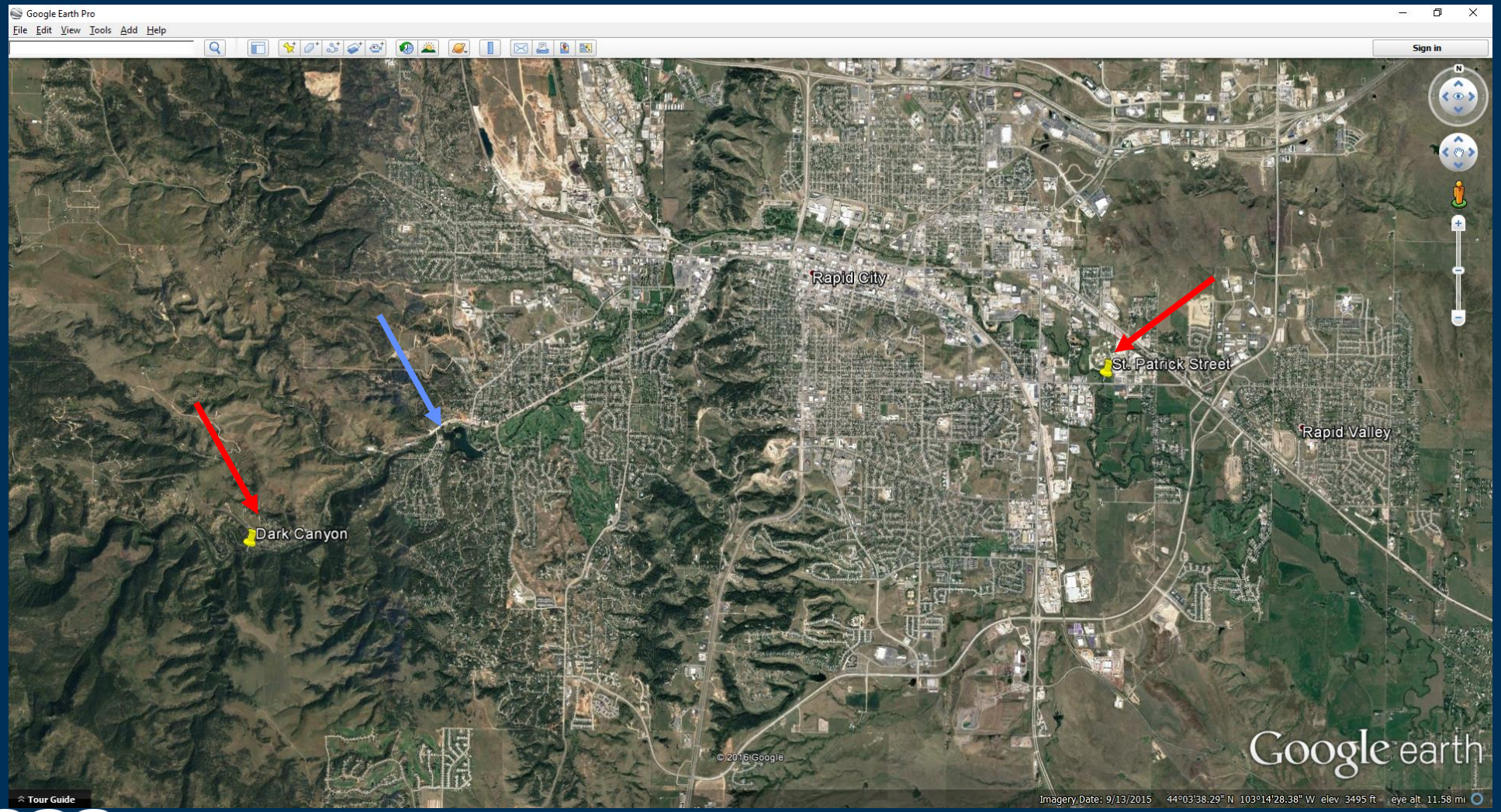
Public benefits and questions to be answered

- Do waterfowl significantly affect downstream water quality?
- Did the dredging have temporary or long term benefits to water clarity?
- Does Canyon Lake support beneficial use criteria for immersion recreation?

Current DENR Water Quality Monitoring (WQM) sites



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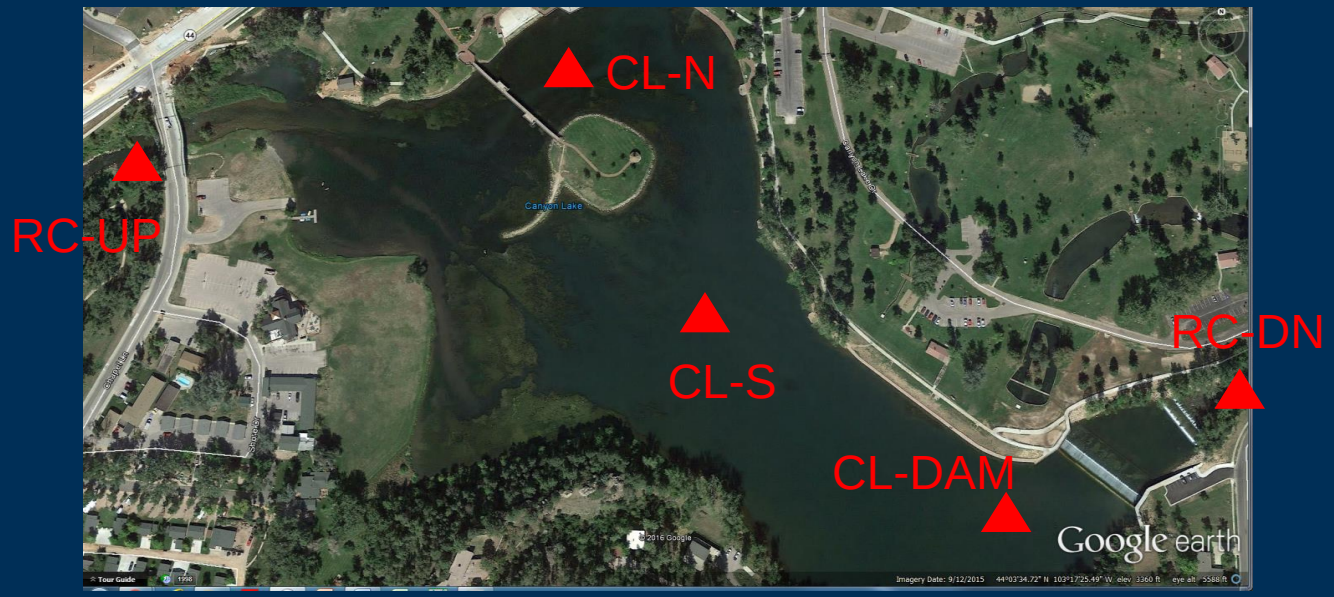
Approach

- 14 sampling visits during 2017-19
- Water-quality parameters:
- 5 sampling locations
  - Above, within, below Canyon Lake



Constituent	Laboratory
E. coli	Midcontinent
Total suspended solids	Midcontinent
Ammonia	NWQL
Ammonia + organic nitrogen	NWQL
Nitrite	NWQL
Nitrite + nitrate	NWQL
Ortho-phosphorus	NWQL
Total phosphorus	NWQL
Total organic carbon	NWQL
Chlorophyll a and pheophytin a	NWQL
Water temperature	field
pH	field
Specific conductance	field
Dissolved oxygen	field
Secchi disk	field
Turbidity	field

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Relevant standards – beneficial uses

- **Domestic water supplies**

Parameter	Criteria	Unit of Measure	Special Conditions
Total dissolved solids	≤ 1,000	mg/L	30-day average
	≤ 1,750	mg/L	daily maximum
Nitrates as N	≤ 10	mg/L	daily maximum
pH	≥ 6.5 - ≤ 9.0	units	
Total Coliform	≤ 5,000	/100 mL	geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period and may not exceed this value in more than 20 percent of the samples examined in the same 30-day period
	≤ 20,000	/100 mL	in any one sample
Barium	≤ 1.0	mg/L	daily maximum
Chloride	≤ 250	mg/L	30-day average
	≤ 438	mg/L	daily maximum
Fluoride	≤ 4.0	mg/L	daily maximum
Sulfate	≤ 500	mg/L	30-day average
	≤ 875	mg/L	daily maximum
Total Petroleum Hydrocarbons	≤ 1.0	mg/L	daily maximum

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Relevant standards – beneficial uses

- **Coldwater permanent fish propagation**

Equation 1: For Waters where salmonid fish are present

$(0.275/(1+10^{7.204-pH})) + (39.0/(1+10^{pH-7.204}))$

~3.8 mg/L

Equation 2: For Waters where salmonid fish are not present.

$(0.411/(1+10^{7.204-pH})) + (58.4/(1+10^{pH-7.204}))$

Equation 3: For waters where early life stages are present

$(((0.0577/(1+10^{7.688-pH})) + (2.487/(1+10^{pHh-7.688}))) * MIN(2.85, 1.45 * 10^{0.028 * (25-T)})$

Equation 4: For waters where early life stages are absent.

$(((0.0577/(1 + 10^{7.688-pH})) + (2.487/(1 + 10^{pH-7.688}))) * 1.45 * 10^{0.028 * (25-MAX(T,7))})$

T = *the water temperature of the sample in degrees Centigrade*
pH - *the pH of the water quality sample in standard units*
MIN = *use either 2.85 or the value of* $1.45^{0.028 * (25-T)}$, *whichever is the smaller value*
MAX = *use either the water temperature (T) for the sample or 7, whichever is the greater value*

Parameter	Criteria	Unit of Measure	Special Conditions
Total ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A	mg/L	30-day average
	Equal to or less than the result from Equation 1 in Appendix A	mg/l	daily maximum
Chlorides	≤ 100	mg/L	30-day average
	≤ 175	mg/L	daily maximum
Dissolved oxygen as measured anywhere in the water column of a non-stratified water body, or in the epilimnion and metalimnion of a stratified water body	≥ 6.0	mg/L	daily minimum
	≥ 7.0	mg/L	in spawning areas during the spawning season
Undisassociated hydrogen sulfide	≤ 0.002	mg/L	daily maximum
pH	≥ 6.5 - ≤ 9.0	units	see § 74:51:01:07
Total Suspended Solids	≤ 30	mg/L	30-day average
	≤ 53	mg/L	daily maximum
Temperature	≤ 65	°F	see § 74:51:01:31

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Relevant standards – beneficial uses

- **Immersion recreation**

Parameter	Criteria	Unit of Measure	Special Conditions
Dissolved oxygen as measured anywhere in the water column of a non-stratified water body, or in the epilimnion and metalimnion of a stratified water body	≥ 5.0	mg/L	daily minimum
Escherichia coli	≤ 126	/100 mL	geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period
	≤ 235		in any one sample

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Results, 2017-2018

- **Average concentrations:**

NWIS link to data

	Water temperature, °C	Specific conductance, uS/cm	Dissolved oxygen, mg/L	pH	Turbidity, NTU	Total suspended solids, mg/L	E. coli, mpn/100 mL
RC-UP	10.5	319	10.1	8.1	0.8	8	41
CL-N	10.9	320	10.7	8.1	0.5	10	29
CL-S	11.4	324	9.8	8.1	0.4	6	27
CL-DAM	11.5	324	10.1	8.2	0.4	7	24
RC-DN	12.2	326	10.3	8.3	0.4	7	16

	Total phosphorus (unfiltered), mg/L as P	Ammonia + organic nitrogen (unfiltered), mg/L as N	Ammonia, mg/L as N	Nitrite, mg/L as N	Ortho-phosphorus, mg/L as P	Nitrate + nitrite, mg/L as n	Organic carbon, mg/L	pheo-a, ug/L	chl-a, ug/L
RC-UP	<0.02	0.12	0.015	0.0013	0.005	0.11	1.6	--	--
CL-N	0.03	0.54	0.021	0.0020	0.004	0.08	4.2	2.3	9.9
CL-S	<0.02	0.16	0.018	0.0013	0.003	0.08	1.8	1.5	2.0
CL-DAM	<0.02	0.14	0.016	0.0013	0.004	0.07	1.9	1.4	0.9
RC-DN	<0.02	0.15	0.020	0.0029	0.003	0.07	1.8	--	--

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Results, cont

- Decreasing trend in E. coli bacteria and total suspended solids from upstream to downstream
- Very low bacteria levels outside of the summer months

	Water temperature, °C	Specific conductance, uS/cm	Dissolved oxygen, mg/L	pH	Turbidity, NTU	Total suspended solids, mg/L	E. coli, mpn/100 mL
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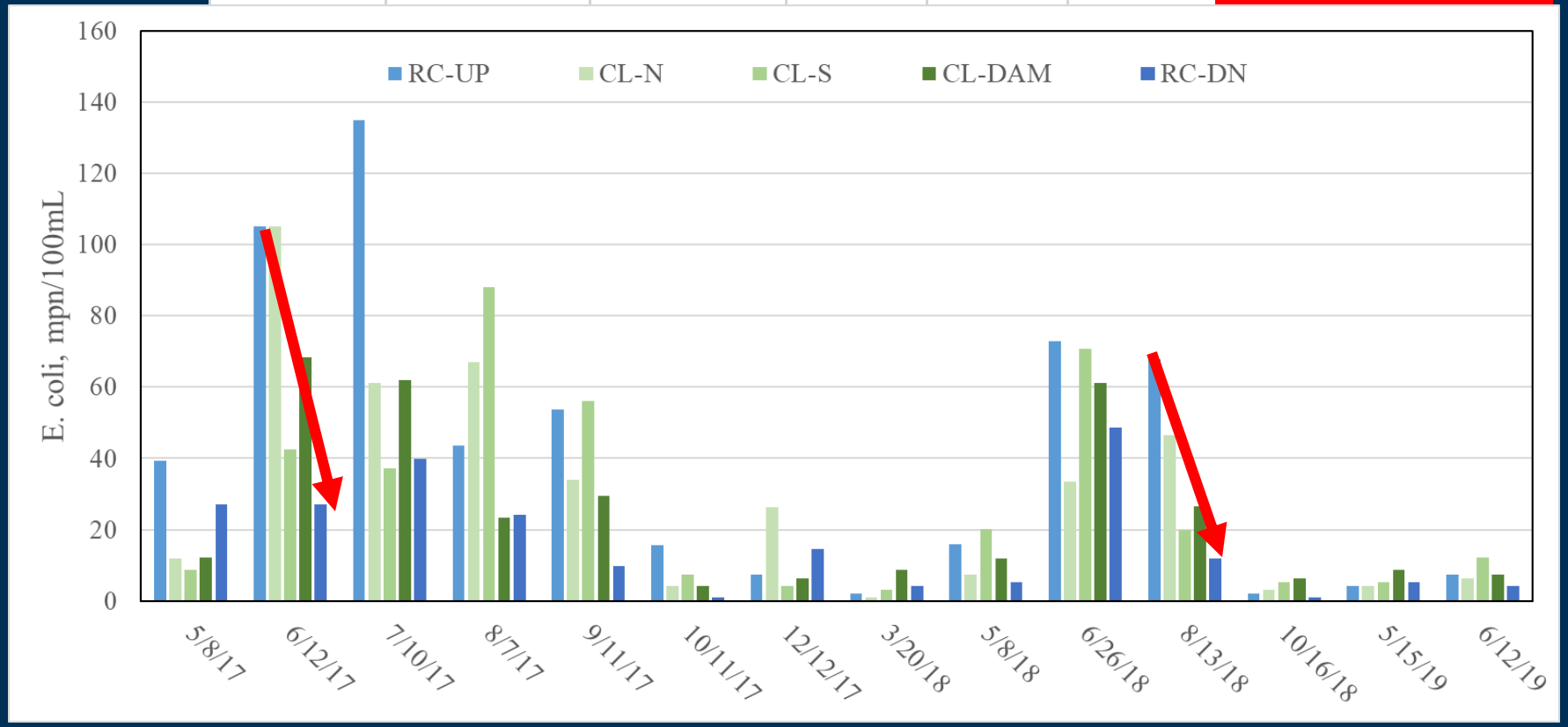

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Results, cont.

- North side of lake has highest nitrogen, carbon, chlorophyll
- All nutrient concentrations are low (below relevant standards or beneficial use criteria)

	Total phosphorus (unfiltered), mg/L as P	Ammonia + organic nitrogen (unfiltered), mg/L as N	Ammonia, mg/L as N	Nitrite, mg/L as N	Ortho-phosphorus, mg/L as P	Nitrate + nitrite, mg/L as n	Organic carbon, mg/L	pheo-a, ug/L	chl-a, ug/L
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CL-S	<0.02	0.16	0.018	0.0013	0.003	0.08	1.8	1.5	2.0
CL-DAM	<0.02	0.14	0.016	0.0013	0.004	0.07	1.9	1.4	0.9
RC-DN	<0.02	0.15	0.020	0.0029	0.003	0.07	1.8	--	--

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What we've learned so far:

- Bacteria concentrations decreasing, contrary to previous perceptions (waterfowl not likely degrading water quality).
  - E. coli concentrations well below the standard for immersion recreation of 235 mpn/100mL.
  - Seasonal trends are evident – greatest in the summer months.
- Nutrient concentrations are very low, good water clarity.
  - North side consistently higher than south side.
    Did not sample southwest corner (typically the area with the most issues with surface vegetation).
  - Dredging may temporarily affect nutrient and clarity levels.

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What we've learned so far:

- Good trout fishing (October 2018)

Future plan: continue monitoring during dredging
Funding request – 1 year extension

- Begin when dredging begins
  - FY 2020, October 1, 2019 – September 30, 2020
- 6 additional sampling visits
- $26k from West Dakota Water Development District
  - Matched with $13k from USGS coop funds

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