Public Water Supply Options for Crystal Lake

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WSP Canada Inc.
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WSP Canada Inc.

- One of the worlds largest professional consulting firms
  - Started in Canada in 1959
  - >50,000 employees across 40 countries
  - 8000 employees in Canada representing every province and territory
  - Experts in all areas of engineering

Charles Goss, Ph.D., CIT
Water Treatment Specialist

- **Education**
  - B.Sc. – Chemistry
  - M.Sc. – Civil Engineering
  - Ph.D. – Civil Engineering
- **Professional Designation**
  - Professional Chemist in Training – Association of the Chemical Profession of Alberta
- **Experience**
  - 2-years consultant with WSP Canada Inc.
  - 6-years private consultant

Crystal Lake Public Water Supply

- Drinking water sourced from 2 groundwater wells
- Simple water treatment system
  - Chlorine disinfection
- Raw water generally acceptable
  - Elevated iron (<0.5 to 2.0 mg/L)
    - Aesthetic Objective – 0.3 mg/L
  - Elevated arsenic (5-16 µg/L)
    - Maximum Allowable Concentration 10 µg/L
      - Recent update to the regulation
      - Previous limit was 20 µg/L
  - Elevated ammonia
    - Ranges between 0.75 - 1.0 mg/L
    - Impacts disinfection process

Arsenic exceeded the MAC which is a health concern
- RM of Keys retained WSP to address this issue

Arsenic Reduction in Crystal Lake Water Supply

- Field study was conducted in the summer of 2018
- Samples were collected from Wells 1 and 2 for water quality analysis and arsenic speciation testing
    - Total and dissolved metals
    - As (III) and As (V)

Arsenic Reduction in Crystal Lake Water Supply

Total Metals Results

Well #1
- Iron = 0.77 mg/L (exceeded AO)
- Arsenic = 0.055 µg/L (under MAC)
- All other parameters within acceptable limits

- Well #2
    - Iron = 0.72 mg/L (exceeded AO)
    - Arsenic = 16.8 µg/L (exceeded MAC)
    - All other parameters within acceptable limits

Arsenic Reduction in Crystal Lake Water Supply

Arsenic Speciation Testing

- Well #1
  - As(III) = 3.22 µg/L
  - As(V) = 1.27 µg/L
- Well #2
  - As(III) = 12.01µg/L
  - As(V) = 3.03 µg/L

Arsenic Reduction in Crystal Lake Water Supply

Treatment Design Considerations

- **Well #1**
  - Only iron needs to be reduced
    - Aesthetic Objective
- **Well #2**
  - Iron and arsenic need to be reduced
  - Arsenic is a health concern
  - As (III) needs to be oxidized to As (V) for adequate reduction

Arsenic Reduction in Crystal Lake Water Supply

Treatment System Design

- Treatment system was only designed to treat Well #2
  - Arsenic in Well #1 below limit
  - Iron is not regulated (not a health concern)

Arsenic Reduction in Crystal Lake Water Supply

Treatment System Design

- 3 treatment systems were evaluated for arsenic reduction in Well #2
  - Removal of arsenic below regulation of <10 µg/L
  - System operation and maintenance
  - Cost
  - Life expectancy

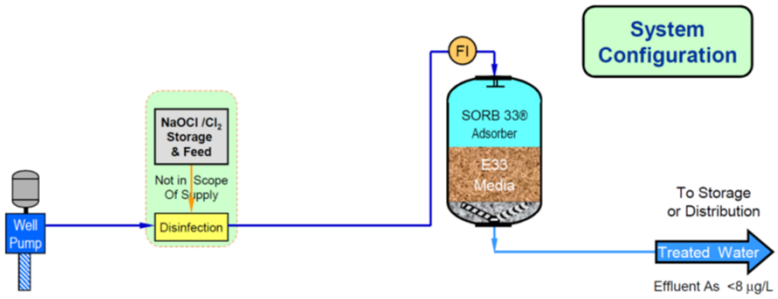
Arsenic Reduction in Crystal Lake Water Supply

Recommended Treatment System

DE NORA Water Technologies Inc.

SORB 33® Arsenic Removal System (ARS) ARS-24S

- Operator friendly
- Low backwash frequency (3-4 months)
- No sludge produced
- Training provided for operator
- Arsenic reduction guarantee
- Media expected to reduce iron as well



Arsenic Reduction in Crystal Lake Water Supply

Conclusion of Arsenic Reduction Project

- Suitable arsenic reduction system was designed that could meet provincial regulations
- System cost was approximately $30,000 for DE NORA system, upgrading some existing equipment and civil engineering works

Arsenic Reduction in Crystal Lake Water Supply

Conclusion of Arsenic Reduction Project

- Final report was provided to Saskatchewan Water Security Agency for review
  - Water Security Agency supported the design of the arsenic removal system
- WSP (2019) and KGS (2006) indicated the raw water source may not be properly classified as groundwater.
  - Water Security Agency red flag

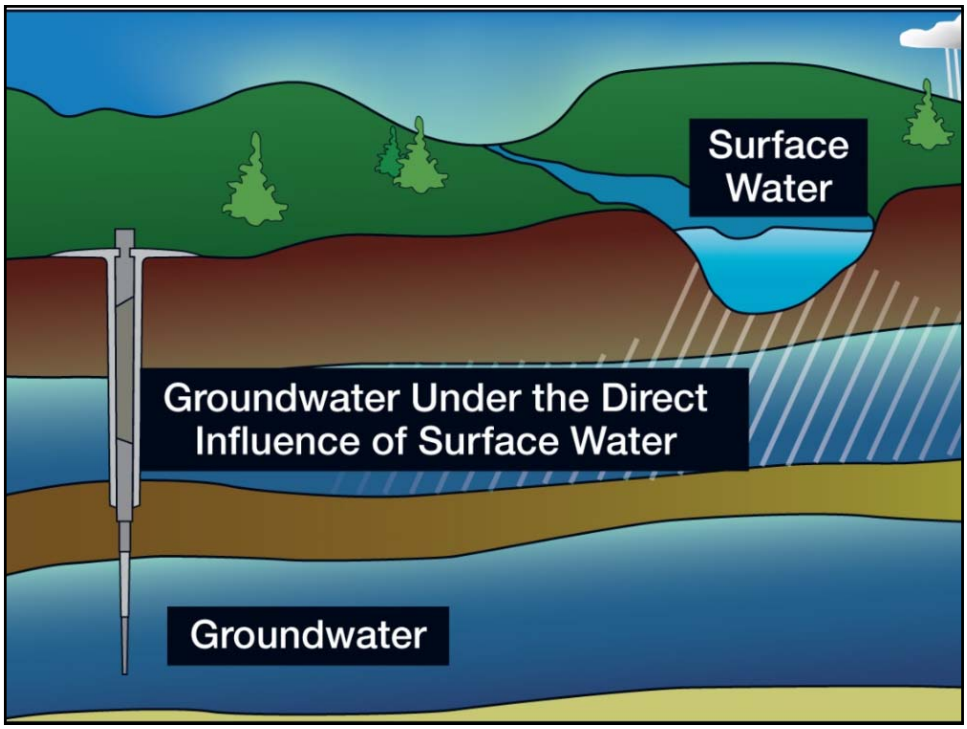
Classification of Raw Water Source

Three general classifications

1. Groundwater
   - True groundwater
   - Groundwater Under the Direct Influence (GUDI) of surface water
2. Surface water (Lakes or Rivers)
3. Seawater

- Groundwater, GUDI and surface water have different treatment and monitoring requirements

- Surface water and GUDI same treatment requirements



What does this mean?

Wells require classification to determine if they are GUDI or not

- Requires a hydrogeological study

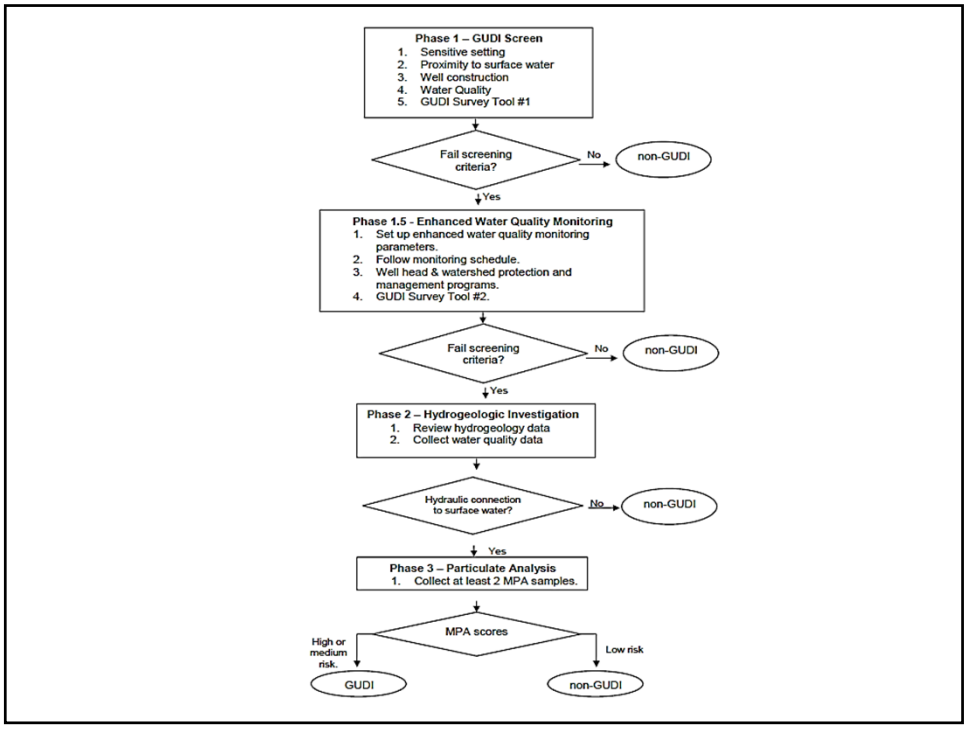
Hydrogeological Study

Saskatchewan GUDI Assessment Guidelines

Phase I
- Identify if source is obviously non-GUDI
- Review well construction details
- Prolonged monitoring and site visits

Phase II
- Office and field study to establish possible connections between ground and surface water

Phase III
- Sampling and laboratory analysis (seasonally)



Hydrogeological Study

Conducted in Spring 2019 by a Professional Hydrogeological Firm

Phase I Conclusions

- Automatic fail as wells were < 100 meters from the lake
- Classified as "*potentially GUDI positive*"
- Phase II was required

Hydrogeological Study

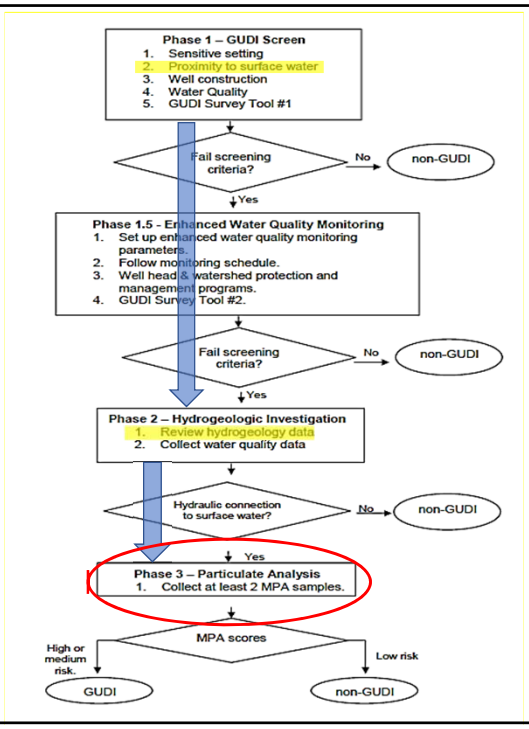
Phase II – Field study April 3rd, 2019

Summarized Results

- Based on elevations there was a net flow direction from the Lake to Well 1 and 2
- local groundwater flowed from east to south-west from Well 2 to the Lake to Well 1
- Natural groundwater flow through Crystal Lake provides evidence the developed aquifer is connected to the lake
- Failed Phase II – Phase III was required

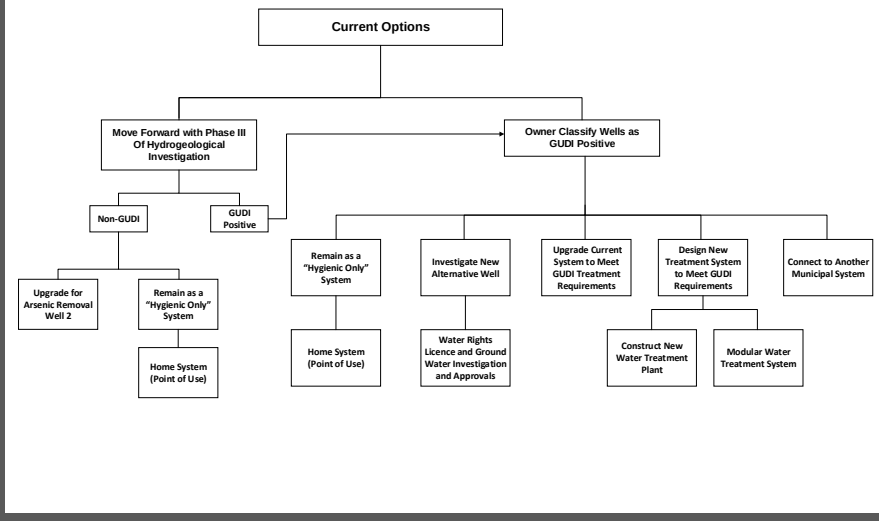
Hydrogeological Study

Phase III – Part of current discussion



Current Options

1. Proceed with Phase III of the hydrogeological study to determine if wells are GUDI or true groundwater
2. Owner classify the system as GUDI positive



Pros and Cons of Option 1 Hydrogeological Investigation

Pros

- Will have verification of the classification of wells
- Will provide confidence the initial arsenic reduction system is adequate to pass potable water quality guidelines (if classified as groundwater)

Cons

- Cost is approximately $20,000
- Takes 1-2 years based on monitoring and field work
- May be classified as GUDI and system will be required to meet surface water treatment objectives

Pros and Cons of Option 2 Owner Classify System as GUDI

Pros

- Won't spend money on hydrogeological investigation which could allow the money to be used for upgrading drinking water system

Cons

- Will need to upgrade system to meet potable water quality objectives and guidelines
  - Several options available with varying pros and cons

Health Concerns – Ground vs GUDI

Groundwater

- Metals
  - Arsenic
  - Lead
- Hardness (Aesthetic)
- Total Dissolved Solids (Aesthetic)
- Cyanide
- Sulphide
- Nitrate/Nitrite
- Ammonia
- Organic contaminants
- Viruses and Bacteria

Health Concerns – Ground vs GUDI

Surface and GUDI Water

- Microbiological and organic contaminants are greater concern
  - E. coli, fecal coliforms, protozoa, bacteria and viruses
- Greater impact from surrounding environment
  - Risk of contamination greater
    - Infiltration from farm land
    - Wastewater discharge or mismanagement
    - Industry
- Natural Organic Matter
  - Forms disinfection by-products

Surface and GUDI waters require more treatment!

Treatment – Ground vs GUDI

Groundwater

- Disinfect with a minimum 4-log removal for viruses
- Ensure treated water meets the current provincial legislation for water quality

Surface Water or GUDI

- Screening
- Coagulation
- Flocculation
- Filtration
- Taste and odour control
- Disinfection (multibarrier)
  - Minimum 4-log removal for viruses
  - Minimum 3-log removal for *Cryptosporidium*
  - Minimum 3-log removal for *Giardia*
- Turbidity requirements
- Treated water meets provincial water quality regulations

Monitoring – Ground vs GUDI

Groundwater

- Bacteria – 1 per week
- Chlorine residual – 1 per day
- Turbidity – 2 per day
- General Chemistry – 1 per 2-years
- Health and Toxicity – 1 per 2-years
- Disinfection By-products - NIL

Surface or GUDI

- Bacteria – 1 per week
- Chlorine residual – 1 per day
- Turbidity – 2 per day
- General Chemistry – Quarterly every 2-years
- Health and Toxicity – 1 per 2-years
- Disinfection By-products – Every 3 months

GUDI Treatment Options

Upgrade Current System

- Would require the addition of a filter that could meet turbidity requirements for multibarrier disinfection
- Would likely need to improve chemical disinfection to meet log-removal requirements
  - Increased storage time to increase chlorine contact time to meet minimum log-removal by chemical disinfection
- Systems would need to be designed for both wells
- Likely current buildings would not be sufficient to house the required equipment upgrades

GUDI Treatment Options

Design New Treatment System

Option 1 – New system in a new permanent structure

Option 2 – Modular all-season containerized water treatment system

GUDI Treatment Options

Advantages of Containerized System

- Lower capital costs
- Easy to expand for future needs
- System is modular – can be transported
- Designed for low waste production and easy operation
- Comes ready for use
- Comes with operator training

Containerized Treatment System

Year Round System

- Currently system is seasonal
  - Exposed distribution system
  - Water treatment buildings not suitable for winter

Year Round System

Winterizing Water Treatment System
Bury distribution system for all-season use

PROs

- Allows for comfortable all year use of property
- Increased property value
- Can be done in phased approach
- Can be executed with minimal surface disturbance

CONs

- Comes at a cost
- Can temporarily impact service during construction
- Likely will come with higher cost
  - Utility rate

Home Treatment Systems

Two types of systems

1. **Point-of-Entry (POE)**
2. **Point-of-Use (POU)**

Home Treatment Systems

1. Point-of-Entry (POE)
   - System will treat all water entering the home
   - Connects to main service line
   - Treats large volumes of water (1000 L/day)

Home Treatment Systems

2. Point-of-Use (POU)
   - Treats water for drinking or cooking only
   - Connects under a sink (bathroom/kitchen)
   - Treats smaller volumes of water (100 L/day)

Home Treatment Systems

Steps for Choosing a Home System (Sask H_2O)

Step 1 – Determine what system you want POE or POU

Will depend on personal preference

Home Treatment Systems

Step 2 – Identify Contaminants that you want to treat

Current water system
- **Arsenic (III)**
- **Iron**

Private Well Owners
- **Need to test water and determine what needs to be removed**
  - **Should discuss options with a water treatment professional**
  - **Should meet Sask Water Agency guidelines**

Home Treatment Systems

Step 3 – Determine a suitable system to treat water

DO YOUR HOMEWORK!

Ask a water professional for assistance

1. **What treatment options will address my water quality problems?**
2. **How does the system work?**
3. **What system is recommended and why?**
4. **Can system be expanded?**
5. **Advantages and disadvantages of a system?**
6. **Installation and maintenance costs?**

Home Treatment Systems

Pros

- You have a system to remove contaminants

Cons

- System is not monitored by operator
  - Monitoring is up to the owner
- Required to do maintenance yourself
- Not chlorinated (not multibarrier)
- Can be complicated
- Limited to the capacity of the system
- Can be costly for initial purchase and maintenance
- POU system limited to one tap

Connecting to Municipal System

Connect your service to a existing municipal system

Communities near with potable water utility

- Canora (27 km)
- Stenen (10 km)
- Preeceville (27 km)
- Sturgis (18 km)
- Norquay (28 km)

Connecting to Municipal System

Pros

- **No need to fund a new water treatment plant**
- **Existing plant likely meets regulations**
- **No maintenance or operator requirements**

Cons

- **Can be costly to engineer**
- **Will need to winterize distributions system**
- **Will come with utility rate costs**
- **No control of system**
- **Difficult to negotiate with RM and Landowners**
- **Subject to water by-laws**

Approximate System Costs

System costs will depend on what system is preferred

- Non-GUDI Arsenic Removal System - $30,000 (if system is true groundwater)
  - Requires hydrogeological study approximately $20,000
- GUDI Systems
  - Capital investment can range based on system $150,000 to $250,000
  - Additional cost for monitoring approximately $1000 per year
  - Operator wage $35,000 - $55,000 (dependant on system)
- Winterizing distribution system
  - $400,000 to $700,000
- Home System
  - POE - $5000 to $7500 per home
  - POU - $1000 per location in home