Heber Valley Aquifer Alliance

PROTECTING HEBER VALLEY'S WATER FUTURE AND THE LDS TEMPLE PROJECT

The Case for a USGS & UGS Environmental Impact Study

Fall 2025

Heber Valley Aquifer Alliance - Mission

Heber Valley Aquifer Alliance (HVAA) works to protect, preserve, and sustain the Heber Valley aquifer through science-based advocacy, public education and policy engagement. We partner with hydrologists, state scientists, water experts and community leaders to ensure decisions about development and groundwater use are responsible, transparent and grounded in sound science.

Heber Valley Aquifer Alliance – What We Do

Educate the Community - We simplify complex hydrology issues and make water data accessible through reports, visuals, events, and public briefings.

Advocate for Responsible Water Policy - We push for stronger oversight, groundwater protection standards, and cumulative impact studies before high-volume pumping occurs.

Promote Better Development Practices - Smart growth can coexist with water security — but only with transparent planning and science-based limits.

Collaborate with Experts - We work with USGS, UGS, engineers, hydrologists, and researchers to ensure assessments are accurate and independent.

Scientific Review

The topics and analyses presented in this report have been discussed with experts from the **Utah Geological Survey (UGS)** and the **U.S. Geological Survey (USGS)**. This document has also been **reviewed by hydrologists** with advanced degrees (Master's and Ph.D.) in **Civil Engineering, Limnology** and **Environmental Engineering** from **Brigham Young University** and **Cornell University**. This is a science-based assessment and should not be dismissed. The findings are grounded in decades of scientific research and should be regarded as a serious, evidence-based evaluation. The issues outlined in this document highlight **significant risks to Heber Valley's aquifer, municipal wells, ecosystems and long-term community water security** due to the LDS Temple's current dewatering plans.

Disclaimer

This paper represents the opinions and interpretations of its authors, who have undertaken their best effort to analyze publicly available data concerning the dewatering plans associated with the Heber Valley LDS Temple project. The findings, conclusions and recommendations expressed herein are based solely on information available in the public domain at the time of writing. The analyses contained in this document are intended for informational and educational purposes only and should not be construed as definitive scientific conclusions. The authors make no warranties, express or implied, regarding the accuracy, completeness or fitness of this material for any particular purpose, and expressly disclaim any liability for damages or losses arising from the use, reliance upon or interpretation of the information presented herein. It is not the authors intent to impugn the integrity of the LDS Church, its consultants or any public officials involved. This document is presented as an independent technical assessment prepared in good faith to encourage transparency, scientific review and responsible stewardship. A comprehensive, federally supported Environmental Impact Study conducted by the U.S. Geological Survey (USGS), in coordination with the Utah Geological Survey (UGS), would provide a more complete, peer-reviewed and authoritative evaluation of hydrologic conditions and potential environmental impacts.

Executive Summary

"We never know the worth of water till the well is dry."
— Thomas Fuller

When the Bowen Collins dewatering study for the LDS Temple project was released in March 2023, the scale of continuous pumping required at the temple site drew immediate concern from local residents. The realization that large volumes of water would be removed in perpetuity raised legitimate questions within the community, reflected both in public forums and ongoing discussion across local media and social platforms. These concerns are well-founded: **Heber Valley is a desert basin with an aquifer system that is dynamic, sensitive and deeply interconnected with wells, springs, wetlands, rivers and vegetation.** Continual pumping of this magnitude will not remain localized; groundwater that currently feeds the Middle Provo River would instead be diverted toward Deer Creek Reservoir, reducing river baseflows and degrading one of the valley's most important ecological and recreational assets.

The Bowen Collins report, however, was narrowly focused on the construction site and did not evaluate environmental consequences beyond the temple site. Local water managers and government officials, for their part, have tended to focus only on their specific jurisdictions. While many privately acknowledge that large-scale pumping could pose problems, the HVAA is not aware of anyone having taken a valley-wide view of how these impacts will cascade across municipal wells, private property, river systems and valley-wide ecosystems.

Therefore, this white paper has a single purpose: **to raise awareness of the urgent need for the United States Geological Survey (USGS) to conduct a comprehensive environmental study on groundwater impacts in Heber Valley arising from the large-scale dewatering required for the LDS Temple project.** Only an independent, science-based assessment can provide the valley-wide perspective that has been missing from local decision-making.

This **peer reviewed white paper** supports three key findings:

1. **The Bowen Collins de-watering study commissioned by the LDS Temple project was narrow, site-specific and incomplete.**
   The Bowen Collins report relied on **three 24-hour pump tests** at the temple site, providing a narrow snapshot of short-term well behavior. It did not evaluate valley-wide hydrology, potential impacts to municipal wells, surrounding trees and vegetation or long-term aquifer dynamics. Its site-specific conclusions stand in stark contrast to the **USGS data which has monitored ~57 wells over +50 years.**

2. **The Bowen Collins study underestimates dewatering projections by 2-3X.**
   The Bowen Collins tests were conducted in January—when aquifer recharge is at its lowest—ignoring seasonal variability and **underestimating the true volume of water that will need to be pumped**. Even more concerning, ***Bowen Collins appears to have overlooked their own field data when it contradicted their derived assumptions, further undermining the credibility of their estimates.***

Independent analysis shows that the **first year of temple dewatering alone will equal roughly 40% of Heber City's entire annual water use (~400M gallons)**—and the actual volumes could be substantially higher. This scale of extraction highlights just how dramatically the consultant's projections fall short of reality and underscores the urgent need for an independent, valley-wide hydrologic review.

3. **The Bowen Collins report ignored critical valley wide aquifer risks.**
   By focusing only on construction feasibility, the study omitted analysis of:

   - **Municipal wells** — including the Broadhead Well, Broadhead Spring and Hospital Well, which are all at measurable risk of long-term drawdown.

   - **Subsidence** — a known consequence of aquifer depressurization, with three distinct risk zones identified across central Heber City, threatening homes, utilities and critical infrastructure.

   - **Vegetation loss** — permanent lowering of groundwater will place up to **675 acres of surrounding land at risk**, including old-growth cottonwoods and willows along Mill Road and Center Street that are unlikely to survive more than 3 to 5 years.

Over the past two years, multiple efforts have been made to raise these concerns directly with Wasatch County and Heber City officials. Unfortunately, those efforts have been met with silence. Despite repeated written communications and follow-up requests, there has been no substantive response from elected officials or staff and all requests to raise this topic in a public forum have been ignored.

In parallel, multiple conversations with scientists at both the **United States Geological Survey (USGS) and the Utah Geological Survey (UGS)** have confirmed that a full valley-wide hydrologic study is both feasible and urgently needed. The USGS has expressed a willingness to conduct such a study and to meet with county and city officials to discuss how a project might be structured. However, without engagement or support from local government representatives, no progress was possible, and outreach went unanswered.

This lack of local interest in pursuing a scientifically rigorous and federally supported study is deeply concerning. A site specific, construction-focused engineering report cannot substitute for a **comprehensive, federally supported study**. Because of this inaction, the goal of this white paper is to provide a foundation of technical information and encourage open and transparent dialogue. We have the technology, the data and the expertise available today to conduct a thorough analysis. What is lacking is not the capability—it is the will. Hopefully this white paper helps bridge that gap, sparks a conversation grounded in science and responsibility and compels the necessary agencies to act. The risks to our shared water resources are too great to ignore, and waiting until after the Temple is constructed will leave us with little to no opportunity for remediation.

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Section 1: Scientific Basis and Sources of Analysis

The conclusions presented in this white paper are not speculative. They are grounded in more than seventy years of hydrologic research conducted by the U.S. Geological Survey (USGS), the Utah Geological Survey (UGS), the Utah Division of Water Rights and academic researchers. These studies consistently point to the same reality: **Heber Valley's groundwater system is complex, layered and partly confined—not a simple, shallow, unconfined water table.**

Early USGS Work (1949)

As early as 1949, the USGS documented the valley-fill aquifer system in Heber Valley and emphasized its strong connection to surface water sources such as the Provo River. These foundational studies highlighted the importance of groundwater management and recognized the risk of overdraft in a desert basin environment.

John Baker Study (1970)

John Baker conducted the first comprehensive hydrologic studies of the Heber and Kamas areas (which include Heber Valley), establishing key baseline data on groundwater conditions. His work focused on how groundwater in the valley interacts with surface water features such as the Provo River, irrigation canals and wetlands. His research highlighted that groundwater levels are not static—they rise and fall with snowmelt, irrigation recharge and seasonal use. Baker's work underscores the risks of oversimplifying the valley's aquifer system and the importance of understanding that pumping in one part of the valley can propagate wide-reaching effects on wells, springs and surface water features far beyond a local project footprint.

USGS / Utah DNR Technical Publication 101 (Roark, Holmes, Shlosar, 1991)

In 1991, the USGS and Utah DNR published a landmark study (*Technical Publication 101*) that remains the reference framework for all subsequent hydrologic modeling in the valley. Using field data and MODFLOW computer simulations, the study confirmed that Heber Valley is underlain by a **layered system of unconfined and confined aquifers**, with strong hydraulic coupling to the Provo River. It demonstrated that management actions in one part of the system can shift both groundwater levels and river flows valley wide.

Utah Geological Survey Reports

The Utah Geological Survey (UGS) has since confirmed and extended these findings:

- **Hydrogeology of Round Valley (RI-279):** Showed nearly identical aquifer behavior next door to Heber Valley, with no conflicting conceptual model.
- **Ground-Water Sensitivity and Vulnerability to Pesticides (MP-03-5):** Mapped areas of shallow, unconfined aquifer conditions, but stressed that these zones coexist with deeper confined layers.

Hydrochemical and Geophysical Studies (Midway Area)

Independent researchers (Carreón-Diazconti, Mayo, et al.) have provided hydro chemical and geophysical evidence of a mixed groundwater system near Midway. Their studies identified three components:

1. A shallow unconfined valley-fill system,
2. Deeper confined aquifers, and
3. Thermal upwelling that mixes before discharge into the Provo River.

These results support the idea of a multi-layered, dynamic aquifer system rather than a uniform shallow one.

Utah Division of Water Rights and Watershed Planning

The Utah Division of Water Rights maintains a transient model of the valley that explicitly traces back to the 1991 USGS conceptualization. At no point has the State adopted an "all-unconfined" model. Likewise, Provo River watershed planning documents treat the aquifer as tightly linked to surface flows, consistent with the layered, partly confined framework.

Why This Matters

By grounding this white paper across seven decades of publicly available studies—both federal and independent—it becomes clear that every credible hydrologic study has confirmed that Heber Valley's groundwater is not one simple, shallow pool of water. Therefore, the risks described below are not hypothetical. They are based on well-documented scientific principles and conditions in Heber Valley, repeatedly confirmed over time. What remains missing is not the science, but the political will to commission the next logical step: a comprehensive USGS-led environmental impact study that updates and applies this knowledge to the long-term dewatering of the LDS Temple site.

Section 2: Definitions and Terminology

INTRODUCTION TO KEY TERMS

Groundwater science often uses technical terms that can feel unfamiliar or abstract. Yet, understanding just a few of these concepts is essential for grasping the risks described in this white paper. Terms like "confined aquifer," "drawdown," or "transmissivity" are not academic jargon—they describe how water moves under our feet, how wells respond to pumping and how quickly changes in one place can affect water supplies somewhere else.

Because much of this discussion compares the **1991 USGS study** with the more recent **Bowen Colline / LDS Temple dewatering report**, it is important for community members, local officials and other non-technical readers to understand what these terms mean and why they matter. The USGS study identified a **layered system** of aquifers—some unconfined, some semi-confined and some confined—while the Bowen Collins report assumed the groundwater system was ***entirely unconfined***. That difference alone explains why the two studies reach such different conclusions about risk.

In the following section, each key term is explained in plain language, supported by everyday analogies, to help make the science more accessible. These definitions will also highlight how the scientific record supports the USGS framework and why relying on an oversimplified model risks **underestimating the long-term risks and impacts from the Bowen Collins Temple's de-watering plans**.

Key Terms Explained

Confined Aquifer: A confined aquifer is like a water-filled sponge sandwiched between two layers of plastic wrap. The water is under pressure because it is trapped between less-permeable layers of clay or rock. When tapped by a well, water may even rise above the aquifer level.

> ***Why it matters here:*** The USGS found that Heber Valley contains confined aquifers. The Bowen Collins report treated the whole system as unconfined, ignoring this layered, pressurized behavior.

Semi-Confined Aquifer: A semi-confined aquifer is like a sponge with one side wrapped in plastic wrap and the other side covered with a towel. Some water can leak through, but not as freely as in an unconfined aquifer.

> ***Why it matters here:*** Heber Valley's deeper aquifers behave this way. Pumping from one area can slowly transmit impacts valley-wide, even if it looks isolated at first.

Unconfined Aquifer: An unconfined aquifer is the simplest kind: a sponge sitting out in the open. Its water table rises and falls with rainfall, irrigation and snowmelt. It is directly connected to the surface.

> ***Why it matters here:*** The Bowen Collins report assumed the Temple site is sitting entirely on this type of aquifer, which would make pumping effects appear local. The USGS showed the valley is more complex, with confined and semi-confined layers below.

Drawdown: Drawdown means the drop in water level in a well or aquifer after pumping begins. Imagine sipping from a milkshake with a straw—the liquid level near the straw drops as you draw it out. The deeper and faster you pump, the larger the "cone of depression."

> ***Why it matters here:*** Drawdown at the Temple site could spread to city wells if confined or semi-confined layers are tapped, even if the wells are miles away. **Not a temporary phenomenon.**

Transmissivity: Transmissivity is a measure of how easily water can move through an aquifer. Think of it as the width of a pipe: a wide pipe (high transmissivity) lets water flow quickly, while a narrow pipe (low transmissivity) slows the flow.

Why it matters here: If Heber Valley aquifers have high transmissivity, then the cone of depression is broader, higher pumping rates are required to achieve and maintain the lower, local water table, and pumping impacts can travel farther and faster than the Bowen Collins report assumed.

Storativity: Storativity describes how much water an aquifer can store and release when the water level changes. It's like the size of a water tank: a large tank (high storativity) changes its level slowly, while a small tank (low storativity) drops quickly when you remove water.

Why it matters here: Confined aquifers usually have low storativity, which means even small amounts of pumping can create large drawdowns that propagate widely.

Why This Matters

These terms—confined, semi-confined, and unconfined aquifers, along with drawdown, transmissivity and storativity—may sound technical, but they describe very practical realities. They explain how far and how fast water moves underground, how wells react to pumping and how much stress an aquifer can handle before the effects spread across a community.

USGS 1991 Study: Recognized this complexity, showing that Heber Valley is a layered system where confined, semi-confined and unconfined aquifers play a major role in Heber Valley. ***This explains why pumping in one area can affect wells and ecosystems across the valley.***

Bowen Collins 2023 Study: By contrast the Bowen Collins Study treated the system as if it was an entirely unconfined aquifer, ignoring deeper pressure-driven dynamics. This oversimplification of the valley's hydrogeology ***significantly underestimates the risks and true impacts of long-term pumping***.

The takeaway is simple: water under Heber Valley does not behave like a single open pool. It is a layered, pressurized system where pumping in one place can cause impacts miles away. Understanding these terms helps explain why an independent, valley-wide study is necessary before major withdrawals of groundwater begin.

Section 3: Differences Between the USGS Study & Bowen Collins Study

A major concern in evaluating the Bowen Collins March 2023 dewatering plan is that its supporting hydrologic study takes a narrow and simplified view of the aquifer system. When compared to the authoritative 1991 U.S. Geological Survey (USGS) study, the differences are significant. The following table is a side-by-side analysis of the USGS 1991 Field Study and the LDS De-Watering study by Bowen Collins & Associates. The comparison makes it clear that the USGS report focused on sustainability and system complexity, while **the Bowen Collins Study appears to have simplified the hydrology to support construction feasibility, ignoring seasonal variability and ecological impacts.**

DETAILED COMPARISON TABLE

Category	USGS 1991 Hydrology Study	Bowen Collins 2023 Dewatering Study	Key Differences
Primary Objective	Regional hydrologic scientific study of Heber Valley's aquifer system; focused on long-term hydrology and groundwater flow, recharge/discharge sources and sustainability.	Narrow, site-specific engineering report to assess localized aquifer impacts from dewatering required for temple construction and foundation protection.	USGS focuses on valley wide water management, regional water balance & aquifer sustainability, whereas the Bowen Collins study was construction driven and focused on temporary and long-term pumping impacts ***only*** at the temple site.
Geographic Coverage *(Scale of Study)*	Valley-wide; covers entire Heber Valley and surrounding groundwater systems, including Provo River, wetlands and mountain recharge.	Extremely localized, a single 17-acre parcel (temple footprint, 3 test wells to ~50 ft). No deeper aquifer systems were investigated. The report explicitly states that no USGS monitoring wells existed at the site and relied only on their limited fieldwork.	USGS study provides regional context; whereas the Bowen Collins study lacked broader valley coverage and does no address broader hydrologic interconnections or cumulative downstream effects.
Depth to Groundwater	Historical water levels ranged from 5–30 ft below ground surface in shallow zones depending on location/season and showed strong seasonal variability.	Found consistent groundwater 10–16 ft below ground surface at temple site with no analysis for seasonal changes.	The Bowen Collins results are consistent locally, but the USGS found (and warns) of ***major significant inter-annual seasonal fluctuations that the Bowen Collins study did not address.*** Pumping estimates could be off by a factor of 2-3X.
Aquifer Type Assumptions	Identified layered systems with unconfined aquifers near the surface aquifers transitioning to semi-confined and confined aquifers at depth beneath Heber Valley with storativity values consistent with confined zones (storativity of 0.0001 to 0.005).	Treated aquifer as unconfined *only* for dewatering using a storativity value of 0.05.	USGS emphasized complex aquifer layering while the Bowen Collins study assumed a uniform unconfined system. This is a major difference. If the aquifer is actually semi-confined, the Bowen Collins study calculations ***severely underestimate drawdown*** impacts and potential spread of effects.
Hydraulic Conductivity	USGS identified shallow alluvial sand & gravel ≈ 10–50 ft/day; deeper confined layers slower (~1–10 ft/day).	Bowen Collins reports 6.6 ft/day average from pumping wells, but observation wells suggested 103.5 ft/day (likely influenced by snowmelt anomalies).	**Massive discrepancy**: Bowen Collins discounts their own 103.5 ft/day observation data, blaming snowmelt, but this introduces uncertainty in reliability.
Groundwater Flow Direction *(Gradient)*	Regional flow generally west to northwest, draining toward the Provo River.	Bowen Collins also measured a west-northwest flow at the site, consistent with USGS.	Consistent finding, but Bowen Collins doesn't evaluate regional impacts downstream where pumped water would be discharged.
Pumping Test Methodology	USGS used multi-well (24), long-duration pumping tests (often >72 hours) over a 2 year period and integrated data from decades of regional monitoring wells.	Bowen Collins conducted 24-hour pump tests in three shallow test wells and relied heavily on modeling software to extrapolate transmissivity and drawdown.	The Bowen Collins approach ***underestimates long-term dewatering impacts*** since it lacks extended duration and valley-wide correlation.

Predicted Dewatering Volumes	USGS does not simulate site-specific dewatering but highlights risk of localized drawdowns propagating several thousand feet in sandy zones.	Bowen Collins predicts 600–800 gpm initial pumping, declining to 200–300 gpm after 1 month, with long-term dewatering of 125–230 gpm required indefinitely.	Bowen Collins may underestimate cone of depression effects — pumping at these rates for months to years can impact aquifers far beyond the temple site, something the USGS warns about.
Environmental Risks (Recharge & Seasonal Variations)	Finds strong seasonal recharge from snowmelt, streams, and irrigation return flows; groundwater levels fluctuate significantly based on precipitation cycles. USGS warns that groundwater lowering could harm wetlands, springs, riparian zones and fish habitats (stream flows) linked to shallow groundwater.	The Bowen Collins Study reports minor differences between summer and winter groundwater levels (~1–2 ft change) and assumes stable levels in the future. Bowen Collins focuses only on construction feasibility and does not address ecological consequences of long-term drawdown.	The Bowen Collins conclusions contradict USGS evidence showing much ***larger seasonal variability*** in wet vs. dry years. USGS prioritized ecological sustainability; Bowen Collins did not address broader environmental impacts. If nearby wetlands, creeks or riparian vegetation depend on shallow groundwater, the Bowen Collins plan could *cause permanent damage.*
Data Robustness	Based on decades of USGS monitoring wells, water table maps, and valley-wide testing. Incorporated decades of regional monitoring, multiple aquifer tests, water table maps and seasonal datasets	Based on 3 test wells with each well tested for 24 hours; acknowledged lack of long-term data. Questionable assumptions were made where results conflicted.	USGS study based on monitoring 57 wells for +50 years across entire valley and regional datasets; Bowen Collins used short-term, site-specific tests.
Risk Analysis	USGS recommends conservative groundwater management, modeling worst-case drought scenarios and potential aquifer depletion.	Bowen Collins assumes stable conditions, does not test worst-case scenarios, and relies on a single year's groundwater levels.	The Bowen Colline report appears optimistic and lacks contingency modeling for dry years.
Public Disclosure & Oversight	USGS study is public, peer-reviewed, and broadly applicable for regulatory decisions.	Bowen Collins Study appears commissioned privately for construction purposes, with limited transparency beyond the client.	USGS data are more rigorous for environmental permitting; Bowen Collins results appear to be narrowly tailored to justify the temple build.
Conclusions	Valley aquifer is dynamic and exhibits seasonally and inter-annual variability, is multi-layered, and sensitive to pumping.	Aquifer treated as stable, unconfined with minor variability; long-term engineered dewatering deemed as manageable.	USGS emphasized complexity and environmental risks; Bowen Collins appears to have simplified aquifer to justify construction.

Section 4: Key Differences Explained

Scope of Analysis

USGS 1991 Study: Covered the *entire Heber Valley*, including interactions between the valley-fill aquifers, the Provo River and surface recharge. It was designed to provide a comprehensive conceptual and numerical model for long-term water management.

Bowen Collins 2023 Study: Focused narrowly on the *Temple construction site*. Its analysis was confined to three on-site wells and a short (24 hours per well) data record, with no attempt to evaluate valley-wide impacts or long-term aquifer dynamics.

Implication: The USGS study provides a valley-wide context; the Bowen Collins Study doesn't consider downstream or cumulative impacts.

Conceptual Model of the Aquifer

USGS 1991 Study: Identified layered aquifer behavior—an unconfined shallow system overlying deeper semi-confined and confined aquifers, all hydraulically connected to the Provo River.

Bowen Collins 2023 Study: Treated the system as uniformly unconfined, assuming water levels respond locally and ignoring confined aquifer dynamics.

Implication: By ignoring the confined system, the Bowen Collins study underestimates how far and how fast pumping effects can propagate across the valley impacting wells and water sources.

Data, Monitoring Period & Seasonal Variations

USGS 1991 Study: Built on **decades of data (57 wells over +50 years)**, including continuous monitoring records, aquifer tests and groundwater-surface water modeling (MODFLOW). Showed strong seasonal fluctuations in groundwater levels, sometimes exceeding 30 feet due to snowmelt and irrigation recharge.

Bowen Collins 2023 Study: Based on **24-hour pump tests on 3 site-specific wells** with limited replication, providing only a snapshot rather than a full understanding. Seasonal variations we not considered, basing conclusions on short-term tests that do not capture long-term dynamics. ***Most critically, Bowen Collins appears to have disregarded their own observed water-level readings because those results directly contradicted their derived assumptions on which their analysis depends.***

Implication: Seasonal variations, inter-annual variability and long-term trends documented by USGS are overlooked in the Bowen Collins dataset, which risks creating a misleading picture of groundwater dynamics and response to pumping.

Environmental Sensitivity & Risks

USGS 1991 Study: Explicitly modeled interactions between pumping, municipal wells, streamflow and recharge, highlighting tradeoffs and management risks. Emphasized how changes in groundwater levels could affect rivers, wetlands and vegetation, warning that ecosystems depend on stable aquifer conditions.

Bowen Collins 2023 Study: Focused only on construction dewatering feasibility. Did not analyze municipal well interference, aquifer depletion, subsidence, ecological impacts or flood risk. Focused almost exclusively on construction feasibility, neglecting ecological risks.

Implication: The Bowen Collins study is too narrow to assess potential off-site impacts and support decisions with valley-wide consequences.

Why This Matters

The Bowen Collins study's narrow scope, reliance on simplified assumptions **and apparent decision to ignore contradictory field data** give a false sense of security. By contrast, the USGS findings—and decades of supporting research—show that Heber Valley's groundwater system is complex, interconnected and highly sensitive to pumping. Ignoring this reality increases the risk of unintended, long-term impacts to city wells, ecosystems and community water security.

Section 5: "The Myth" that Groundwater is Separate from Surface Water

WHAT IS THE TRUTH?

The LDS Church retained engineering consultants—Bowen & Collins and Hansen, Allen & Luce—to prepare reports evaluating potential groundwater impacts of Temple construction. Their conclusions reflect a site-specific construction perspective, focusing on the shallow aquifer directly beneath the temple site.

Unfortunately, these reports also **reinforce a persistent "*myth*"** that has been repeated by city officials, county representatives, water engineers and members of the community: the claim that **groundwater and surface water are separate and unconnected.**

This myth is contradicted by decades of scientific evidence. For example, the **U.S. Geological Survey** has found that **"84% of groundwater in Heber Valley originates from surface-water sources."** In other words, the majority of the deeper groundwater is directly recharged from streams, rivers, canals and irrigation practices on the surface.

Similarly, the State of Utah has stated:

> *"Recent studies by the USGS have indicated a very strong inter-relationship between ground water and surface sources. This inter-relationship means that water use in the upper Provo River valleys has an effect upon water supplies."*

Springs exist precisely because of this relationship: pressure in confined or fractured systems pushes groundwater to the surface. River flows in the Provo Valley are sustained through late summer largely by groundwater discharge. To deny the connection between the surface and subsurface is to deny the very mechanism that sustains our rivers, wetlands and wells.

By perpetuating the myth of "no connection," decision-makers risk dismissing valley-wide impacts as though pumping were only a local issue. In reality, **removing water at one site lowers pressure and alters flows miles away.** The science is clear: groundwater and surface water in Heber Valley are part of the same hydrologic system. Ignoring this truth creates blind spots in planning and underestimates the risks to municipal wells, Broadhead Spring, vegetation and the Provo River itself.

The following table compares the LDS consultants' narrow findings with the broader body of evidence from the USGS and UGS, showing how oversimplifications can lead to misleading conclusions about Heber Valley's groundwater.

LDS CONSULTANT REPORTS VS. USGS/UGS FINDINGS

Topic	LDS Consultant Reports (Bowen & Collins; Hansen, Allen & Luce)	USGS / UGS Findings	Key Concern
Aquifer Type	Entirely unconfined alluvial aquifer beneath the Temple site; effects assumed local.	Heber Valley contains unconfined, semi-confined, and confined aquifers, hydraulically linked to each other and to the Provo River.	Consultants' assumption oversimplifies; confined aquifers allow pressure changes to travel valley-wide, not just locally.
Bedrock Barrier	Shallow ridge of Twin Creek Limestone/Nugget Sandstone acts as a "dam" between Temple site and Broadhead Spring, isolating the systems.	USGS conceptual model shows leakage between bedrock and valley-fill aquifers, with fractured systems feeding springs and streams. No impermeable barrier identified.	Bedrock may slow flow, but does not completely isolate systems; fractured rock acts as a **leaky dam**, not a wall.
Broadhead Spring	Discharges from a higher-elevation fractured bedrock aquifer, hydraulically independent of Temple parcel.	Hydrochemistry and geophysics near Midway show mixing of shallow unconfined, deeper confined, and bedrock waters before discharge.	Complete independence is unlikely; springs often depend on regional pressure conditions that can be altered by pumping.
Drawdown Effects	Predicted up to 1.4 ft at 2,000 ft from Temple site; impacts assumed to fade rapidly with distance.	USGS shows confined aquifers transmit pressure changes miles away; our screening analysis predicts measurable drawdown at city wells 0.6 mi down-gradient.	Consultants models ignore confined behavior; underestimate distance and magnitude of drawdown.
City Wells	Wells are much deeper and will not be affected; water removed during dewatering is returned downstream.	Confined aquifers have low storativity—pressure changes propagate even if water is returned downstream. USGS shows municipal well interference is possible.	Displacing water volume locally is not the same as restoring aquifer pressure; Consultant's logic appears to be flawed.

Why This Matters

The Bowen Collins consultant report offers a narrow, site-specific construction view of groundwater. Their assumptions—an entirely unconfined aquifer, a perfect bedrock barrier and isolated spring systems—minimize predicted impacts. In contrast, ***seven decades of USGS and UGS*** research have consistently shown that Heber Valley is a layered, hydraulically interconnected aquifer system. In such systems, pumping in one area can alter pressures, streamflow, and spring discharge across the valley.

The bottom line: Bowen Collins studies are incomplete. They describe what may be happening in the shallow alluvium at the Temple site, but they ignore the deeper, pressurized systems that the USGS has long documented. By doing so, they significantly underestimate risks to municipal wells, Broadhead Spring and valley-wide aquifer stability.

Section 6: Key Findings

This white paper contains a series of reports intended to highlight the potential environmental and hydrologic risks associated with continuous pumping at the proposed LDS Temple site in Heber Valley. These reports are organized into three categories:

A. **Hydrologic Risk of Large-Scale Dewatering on Heber City Water Wells**
   Aquifer Response and Pumping Impacts

B. **Subsidence Risk Analysis in Heber City**
   Land Stability at Risk from Aquifer Dewatering

C. **Environmental Impact to Surrounding Vegetation**
   Consequences to Streams, Trees and Land from Dewatering

As noted earlier in this report, these findings have been peer reviewed with experts in hydrology with advanced degrees (Master's and Ph.D.) in Civil Engineering, Limnology and Environmental Engineering from Brigham Young University and Cornell University. These findings are not intended to be definitive or final. They should be considered preliminary assessments that illustrate why the Bowen Collins consultant studies are insufficient and why **further investigation is necessary**.

Ultimately, these analyses demonstrate that ***an independent and comprehensive study by the United States Geological Survey (USGS) is required***. We need experts with the proper training, data and resources to conduct a thorough environmental impact study. The Key Findings in this white paper are not to present absolute conclusions, but rather to show enough evidence to warrant immediate professional evaluation before construction and large-scale dewatering commences.

HYDROLOGIC RISK OF LARGE-SCALE DEWATERING ON HEBER CITY WATER WELLS

Aquifer Response and Pumping Impacts

INTRODUCTION

This report presents a screening-level hydrologic risk analysis for continuous groundwater pumping at a parcel located on the eastern alluvial-fan apron of Heber Valley at the site of the LDS Temple (Lat., Long: 40.506799, -111.390683). The analysis evaluates potential drawdown impacts at three Heber City public water sources (PWS 1197).

Study Area and Wells Considered

The parcel lies on the eastern fan margin of Heber Valley. The valley-fill aquifer system has both shallow unconfined and deeper semi-confined/confined intervals. Regional groundwater flow generally trends west-northwest toward the Provo River. Three Heber City water sources were considered:

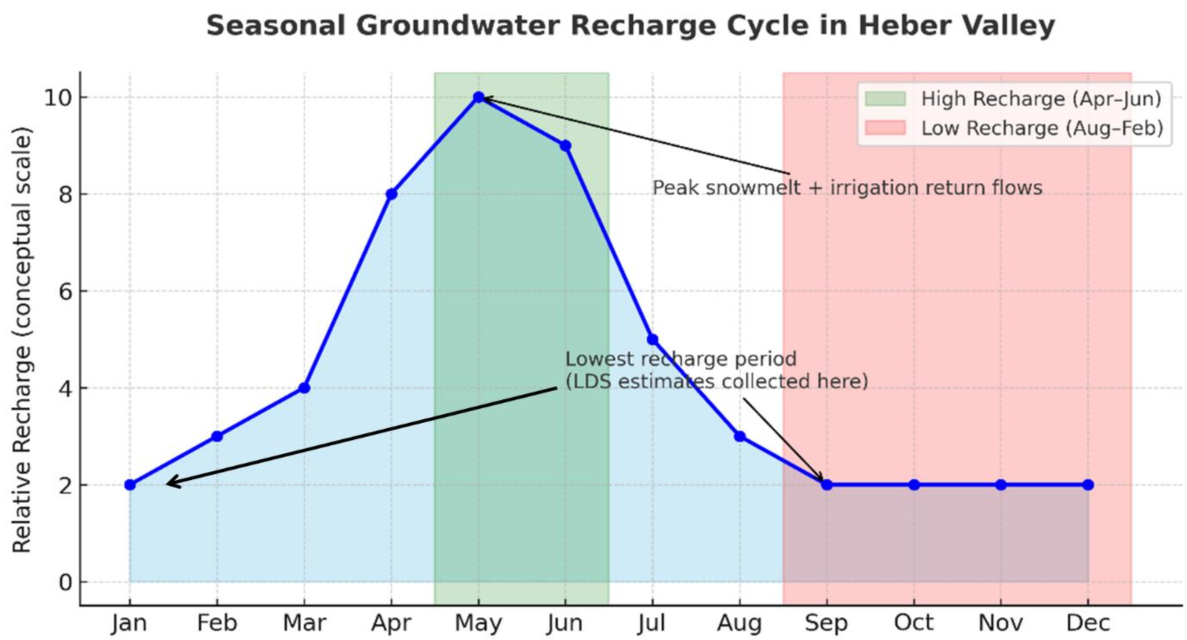
• Broadhead Well (0.17 mi east, up-/cross-gradient, finished 250 ft)
• Hospital Well (0.63 mi west, down-gradient, finished 371 ft)
• Broadhead Spring (0.49 mi east-southeast, spring source)

Of these three, the Hospital Well is the highest-risk receptor due to its distance and down-gradient position relative to the parcel.

LDS Dewatering Estimates May be Severely Understated

The LDS consultant studies modeled dewatering at the Temple site as if pumping rates and aquifer behavior were constant throughout the year. This assumption ignores one of the most critical realities of groundwater in Heber Valley: seasonal variability.

Seasonal Recharge and Decline: Groundwater levels in Heber Valley rise and fall dramatically over the course of the year. In spring and early summer, snowmelt and irrigation recharge the shallow aquifers, temporarily masking the effects of pumping. By late summer and fall, however, recharge slows, and aquifer levels naturally decline. At these times, even modest pumping can create much larger drawdowns in wells than models based on average conditions predict. The following graphic shows the typical seasonal recharge flows in Heber Valley. It should be noted that the Bowen Collins Dewatering study was conducted during the lowest seasonal recharge phase of the annual cycle (January).



How Seasonal Conditions Amplify Drawdown: Imagine a bathtub that is refilled continuously with a hose in the spring. As long as the hose is running, draining some water doesn't seem to change the water level much. But if the hose slows to a trickle in late summer, draining the same amount of water will lower the water level much faster. The same principle applies in confined and semi-confined aquifers—drawdown becomes more severe when recharge is low and higher pumping rates are required at other times of the year to achieve and maintain the local water level depression.

Why Bowen Collins Models Underestimate Risk

Constant Pumping Assumption: The Bowen Collins report assumes pumping effects are steady and predictable year-round, rather than fluctuating with recharge.

No Seasonal Scenarios Modeled: They did not test what happens during **low-flow periods**, when city wells rely most heavily on stored groundwater and when the aquifer is most vulnerable to pressure loss.

Risk to City Wells: As a result, the predicted 1–2 feet of drawdown in Bowen Collins models may, in practice, become **5–10 feet or more** during late summer and fall, when aquifer heads are already seasonally depressed.

Evidence from USGS Studies

The **1991 USGS study** documented seasonal water-level changes in Heber Valley of **up to 30 feet** in fan areas, driven by irrigation and snowmelt recharge cycles. This variability is a fundamental part of how the valley aquifer system functions. Any analysis that ignores it risks underestimating the cumulative effects of continuous pumping on municipal water supply.

Modeled Various Flow Rates

By assuming steady-state conditions and doing the pump test during the "low-flow" period, the test shows what degree of water table drawdown can be achieved locally with the tested pumping rates but understate the amount of pumping required to achieve and maintain the same local drawdown during times of higher recharge. Therefore, the Bowen Collins consultant reports present an overly optimistic picture of groundwater impacts. In reality, seasonal recharge cycles mean that pumping during low-flow periods ***will cause sharper drawdowns than predicted. This creates a much higher risk to municipal wells and water security than the Bowen Collins report estimates***. This seasonal variability is precisely why this analysis modeled multiple pumping scenarios ranging from 100 gpm to 500 gpm. By testing a range of pumping rates against both best-case and worst-case aquifer properties, it becomes clear that the Bowen Collins "steady state" conclusions do not reflect reality. Even modest rates of 100–200 gpm may cause significant drawdowns in late-season conditions, while higher rates push municipal wells into high-risk territory.

Methodology

A confined aquifer analytical solution (Cooper-Jacob/Theis approximation) was used to estimate drawdown at the city wells under continuous pumping. The equation applied was:

$$s = (2.3\ Q / (4\ \pi\ T)) * \log10((2.25\ T\ t) / (r^2\ S))$$

where:
s = drawdown (ft)
Q = pumping rate (ft^3/day)
T = transmissivity (ft^2/day)
S = storativity (dimensionless)
t = time (days)
r = distance to observation well (ft)

Pumping rates modeled: 100, 200, 250, 300, and 500 gpm
Durations: 1 year (365 days) and 5 years (1825 days)

Assumptions

- Aquifer type: confined/semi-confined (deep valley-fill interval)
- Aquifer parameters: Transmissivity (T) = 5,000 ft^2/day (mid-case), Storativity (S) = 5×10^{-4} (mid-case)
- Distances: WS003 = 0.17 mi (897 ft), WS005 = 0.63 mi (3326 ft), Spring = 0.49 mi (2587 ft)
- Flow direction: west-northwest; therefore, the Hospital Well is down-gradient, while the Broadhead and Broadhead Spring Wells are up-/cross-gradient
- Results are screening-level and do not replace site-specific calibration

Results Summary

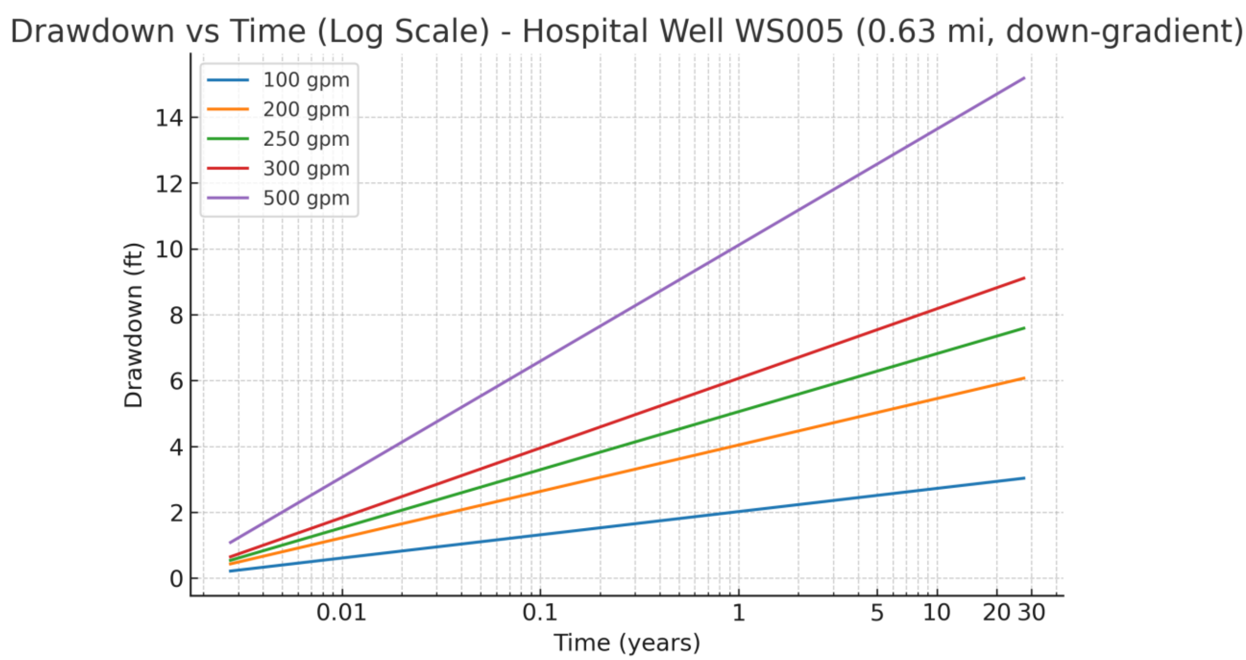
The analysis shows that continuous pumping, even at modest rates, produces measurable drawdown at Hospital Well over time. Broadhead Well and Broadhead Spring are less sensitive due to their up-/cross-gradient locations, but shallow unconfined pumping may still affect them locally. Key findings:

HOSPITAL WELL (0.63 MI, DOWN-GRADIENT)

Summary: High probability of measurable drawdown at ~100 gpm in perpetuity. Screening estimates show ~1–5 ft at 100 gpm and 6–24 ft at 500 gpm (5-yr horizon).

Details:

• 100 gpm in perpetuity: ~1–4 ft drawdown at the Hospital Well within 1–5 years (High risk)
• 200–300 gpm: ~2–14 ft drawdown at the Hospital Well within 1–5 years (High risk)
• 500 gpm: >20 ft drawdown at the Hospital Well within 5 years (High risk)
• The probability of measurable impact becomes material for any long-term pumping
• The risk escalates from moderate (≈100 gpm) to high (≥200 gpm) as rates rise.

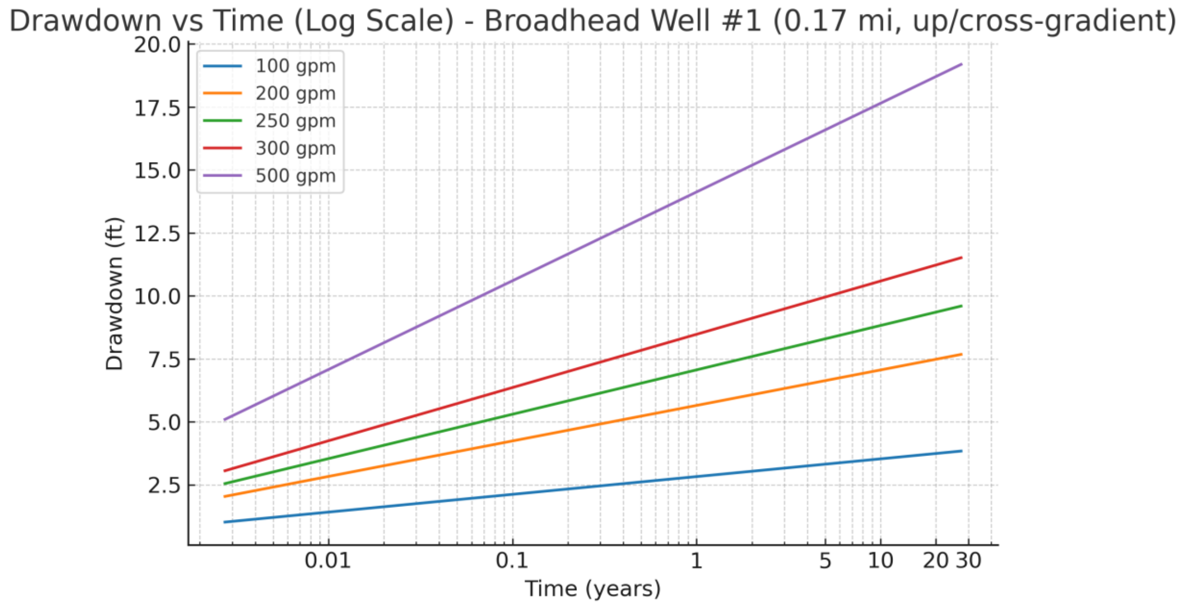


BROADHEAD WELL (0.17 mi, up/cross-gradient)

Summary: Significant probability of measurable drawdown although risk is reduced due to up-gradient position. Analysis estimates 2-6 ft drawdown at 100 gpm and 8-30 ft drawdown at 500 gpm.

Details:

- At 100 gpm, the analysis shows 1.4–5.3 ft drawdown after 1 year growing to 1.7–6.1 ft at 5 years
- At 250–500 gpm, the drawdown band reaches 3.5–26 ft over 1–5 years.

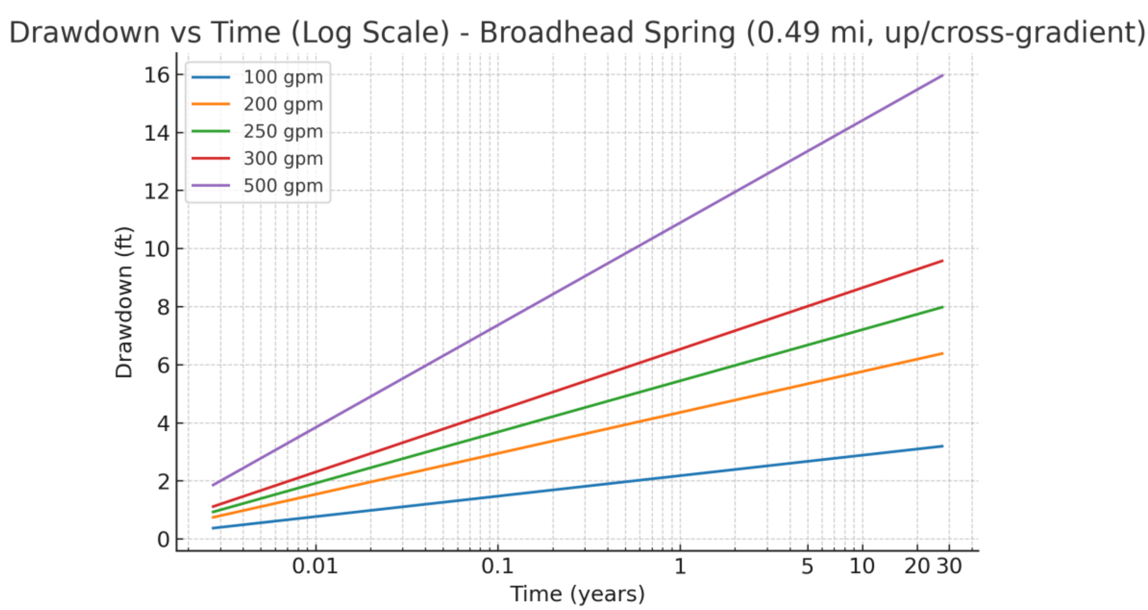


BROADHEAD SPRING (0.49 MI, UP/CROSS-GRADIENT)

Summary: Significant probability of measurable drawdown although risk is reduced due to up-gradient position. Analysis estimates 1-2 ft drawdown at 100 gpm and 4-12 ft drawdown at 500 gpm.

Details:

- At 100 gpm**,** predicted drawdown is ~0.6–2.0 ft after 1 year and up to ~0.8–2.4 ft after 5 years.
- At 250 gpm, the range is ~1.6–5.0 ft (1 yr) to ~2.0–6.0 ft after 5 years.
- At 500 gpm**,** the band grows to ~3.2–10 ft (1 yr) to ~4.0–12 ft (5 yrs).
- Distance and cross-gradient location make this less sensitive than the Hospital Well, but still in the "High" tier at continuous pumping rates ≥200 gpm.



Risk Matrix by Drawdown Level

The following Risk Matrix summarizes the calculated **groundwater drawdown**. It covers **Broadhead Spring** (spring-fed, very sensitive) and the **Broadhead & Hospital municipal wells** (deeper, semi-confined).

Risk Legend Low ▢ | Medium ▨ | High ▣ | **Critical ■**

"Drawdown" = how much lower groundwater levels fall compared to normal

Drawdown (ft)	Broadhead Spring *(Spring-fed)*	Broadhead & Hospital (Municipal Wells)	Likely Effects
0–5 ft	▢ Low	▢ Low	Minor level changes within seasonal range; negligible operational impact.
5–10 ft	▨ Medium	▢–▨ Low–Med	Spring flow reduction during dry spells; wells see slightly deeper pumping levels and small energy-cost increase.
10–20 ft	▣ High	▨–▣ Med–High	Spring flow may become intermittent or cease in late summer; wells see notable yield efficiency loss, possible air entrainment if pumps are set shallow.
20–30 ft	■ Critical	▣–■ High–Critical	High risk of spring flow loss; wells face sustained lower water levels, higher energy use, potential pump reset/deepening, possible turbidity/iron spikes.
>30 ft	■ Critical	■ Critical	Likely spring outage outside wet periods; wells may require immediate operational changes (rate reductions, rotation, pump adjustments) and contingency supply.

Summary of Hydrologic Risk Analysis

This analysis modeled continuous pumping at the proposed LDS Temple parcel (eastern alluvial-fan site) at rates ranging from **100 gpm to 500 gpm**, under the assumption of indefinite pumping. While simplified, the results **highlight important risks to Heber City's three primary municipal sources**:

1. **Hospital Well**
   - Located 0.63 miles down-gradient of the Temple parcel.
   - Highly vulnerable to interference because of its hydraulic position.
   - Even at **100 gpm** continuous pumping, measurable drawdown is likely within one year.
   - At **250–500 gpm**, long-term drawdowns of **10–20+ feet** are possible.
   - Risk Tier: **High**

2. **Broadhead Well**
   - Located 0.49 miles cross-gradient from the site.
   - Interference risk is lower than WS005 due to position relative to flow paths, but still present.
   - Conservative modeling predicts some drawdown at higher pumping rates (>250 gpm).
   - Risk Tier: **Moderate**

3. **Broadhead Spring**
   - Located 0.17 miles up-gradient from the Temple parcel.
   - Risk is lowest under simple assumptions of unconfined conditions, but USGS evidence of layered, partly confined systems means **hydraulic connections cannot be ruled out.**
   - Springs rely on regional pressure conditions in fractured bedrock; lowering pressure may reduce spring discharge over time.
   - Risk Tier: **Potentially High**

Key Observations

Confined and Semi-Confined Behavior Matters: The LDS consultant studies assumed an entirely unconfined system, leading to predictions of "minimal impact." In contrast, USGS studies demonstrate a layered system where confined units allow pressure changes to propagate valley wide. This is the most likely mechanism by which municipal wells could be impacted.

Seasonal Recharge Cycles Magnify Risk: The Bowen Collins models did not account for seasonal variation. USGS documented water-level fluctuations of up to 30 feet in fan areas, with peak recharge April–June and lowest recharge August–February. Pumping during late summer and fall, when aquifers are most stressed, will cause greater drawdowns than Bowen Collins estimates suggest. Notably, the Bowen Collins Study itself was conducted during this low-recharge window (Aug–Dec 2023), further skewing their conclusions.

Returning Pumped Water Downstream Does Not Restore Pressure: The Bowen Collins report argues that wells are too deep to be affected and that water pumped during construction is returned to the system. This overlooks a key principle: confined aquifers respond to ***pressure changes, not just volume***. Once pressure is lost, it propagates outward regardless of where water is later discharged.

Conclusion

The hydrologic risk analysis demonstrates that continuous pumping at the Temple parcel poses **serious risks to Heber City's municipal water supply.**

- **Hospital Well** is clearly at **high risk** of interference, even under conservative scenarios.
- **Broadhead Well** shows **moderate risk**, particularly under higher pumping rates.
- **Broadhead Spring** remains a **critical uncertainty**—but given the regional hydrogeology, its independence from valley-fill pumping cannot be assumed.

The LDS consultant studies severely understate these risks by assuming an oversimplified aquifer model, ignoring confined dynamics, neglecting seasonal variability and not adequately addressing the implications of returning water downstream.

Bottom line: This analysis reinforces the urgent need for an independent **USGS-led environmental impact study** before large-scale pumping begins. Without it, Heber City's water security may be compromised, and the risks could become irreversible once construction is underway.

SUBSIDENCE RISK ANALYSIS IN HEBER CITY

Land Stability at Risk from Aquifer Dewatering

INTRODUCTION

Heber Valley's aquifer is a layer cake of sands and gravels with thin clay/silt layers. Sands/gravels pass water easily; clays hold it like a sponge. When groundwater pressure is lowered and kept low, those clay layers can compress—slowly squeezing water out—so the ground above can settle. This risk analysis, provides a screening level, where that settling is most plausible if the dewatering of the LDS Temple site continues for many years.

What is Land Subsidence—and Why Can it Spread so Far?

Land subsidence means the ground surface slowly sinks. It usually happens when the soft layers below us—silts and clays—get squeezed and compact. One of the most common triggers is lowering groundwater levels by pumping.

A simple way to picture it:

- Imagine a thick, wet sponge under a board. If you press on the board (or squeeze water out of the sponge), the sponge gets thinner and the top surface drops. In the ground, fine-grained layers act like that sponge. When groundwater is pumped out and the water pressure drops, those layers slowly squeeze and the land settles.

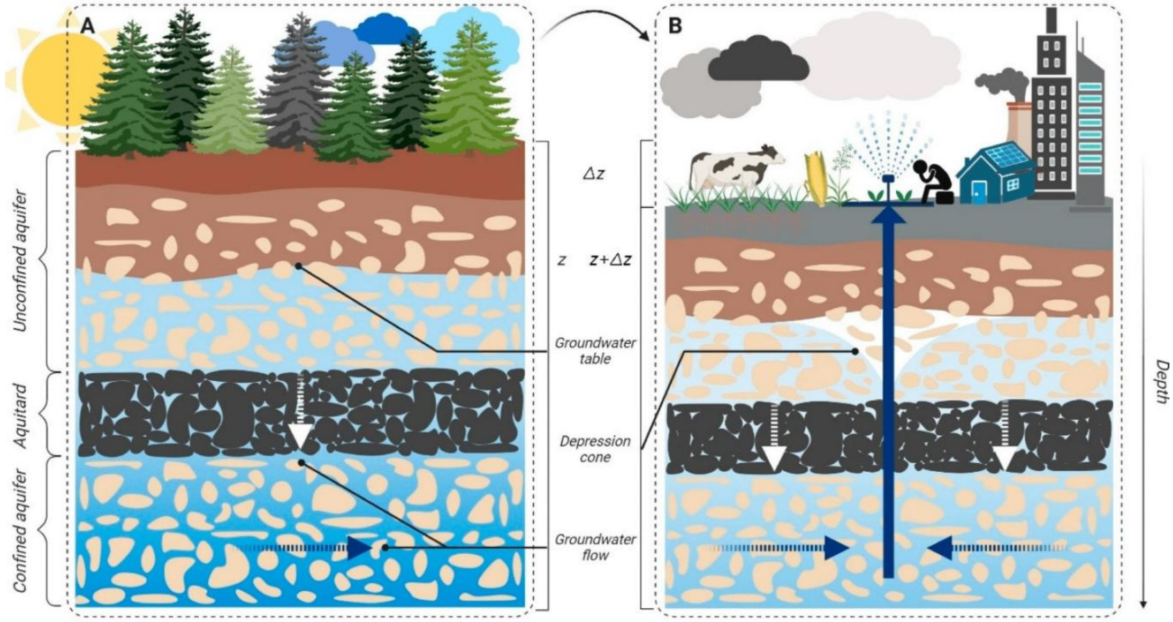
  -or-

- Imagine two people sitting on a big mattress, it doesn't sink only under them—nearby areas dip too because everything is connected. Aquifers (the water-bearing layers) work the same way: pump water in one spot and the pressure change spreads out, sometimes for many miles.

Why Does Pumping in One Place Affect Land Far Away?

Underground, sand and gravel layers can run for long distances—like a hidden network of connected pipes. When water is pumped from one well:

1. Pressure drops near the well, then…
2. That drop travels outward through the connected layers, and…
3. Fine-grained "spongey" layers along the way become compacted if the lower pressure persists.



So even if your neighborhood doesn't have a big well, it might still be influenced if it's connected to a part of the aquifer where water is being pumped steadily.

Not all Ground Behaves the Same

- Higher-risk ground: Flood-plain silts and clays—poorly drained, "sticky" soils—are most likely to compact when water levels stay low.
- Lower-risk ground: Coarse, gravelly areas drain well and don't compress much, so they're less prone to subsidence.
- Season matters: Natural recharge (from rivers, canals, snowmelt, irrigation) is higher in spring and summer and lower in winter. Long, dry periods with steady pumping increase risk.

What People Might Notice – the simple rule: Differential Settlement Drives Damage

If a whole house goes down evenly (uniform settlement), you may not notice much. But if one part drops more than another (differential settlement), walls crack, doors stick, pipes strain. Engineers describe this unevenness angular distortion:

$$\text{angular distortion} = \frac{\text{height difference}}{\text{distance}} = \frac{\Delta}{L}$$

Think of $\boldsymbol{L}$ as the span between two points (say, 20 ft across a room), and $\boldsymbol{\Delta}$ as how much one side has sunk relative to the other.

Most subsidence is slow and subtle. Large, sudden drops are rare in these settings; changes usually happen over months to years based on the amount of groundwater that is pumped. Below are widely used serviceability bands for typical low-rise buildings (wood frame or light masonry on shallow foundations). Values are approximate—stiffer, brittle buildings can be sensitive at lower numbers.

What you might see	Angular distortion	Example over 20 ft	What it means
Hairline/cosmetic cracks possible	**1/1000 – 1/750** *(0.10–0.13%)*	**0.24–0.32 in**	Watch, usually cosmetic only
Noticeable cracks, doors sticky	**≈ 1/500** *(0.20%)*	**0.48 in**	Start minor repairs & monitoring
Repair-level structural issues more likely	**≈ 1/300** *(0.33%)*	**0.80 in**	Expect crack repairs, check utilities
Significant damage risk	**≥ 1/150** *(0.67%)*	**1.6 in**	Engage a structural engineer promptly

Is it Permanent?

Typically yes. When clay layers compact, they tend not to "fluff back up" even if water levels later recover — just like a sponge that never quite returns to its original thickness.

Bottom-line

Pumping groundwater lowers water pressure in connected underground layers, and that pressure drop can spread for many miles, causing soft, clay-rich soils to slowly compact—which is why subsidence may appear far from the wells themselves.

STUDY AREA & DATA SOURCES

- Location: Eastern Heber Valley alluvial-fan margin. Groundwater gradient trends W→WNW toward the valley floor and Provo River system.
- Hydrogeologic framework: USGS Heber & Round Valleys model—layered valley-fill with discontinuous confining clays/tufa and strong surface-water interactions (rivers, canals, reservoir).
- Soils mapping (NRCS/SSURGO):
  - High susceptibility: Crooked Creek (very deep, poorly drained, smectitic clays) and Center Creek (somewhat poorly drained, fine-textured) on flood-plains/low terraces.
  - Lower susceptibility: Rasband (well-drained terrace loams) and Holmes (gravelly/loamy-skeletal fans/terraces).
- Project pumping scenarios: continuous 250 gpm and 500 gpm.

Soils Mapped At and Near The Site

Soil maps these types of soils: Rasband loam (RdA), Crooked Creek clay loam (CrA), Holmes gravelly loam (Hr), Center Creek loam (Ca).

NRCS Official Series Descriptions (OSDs / soilseries.sc.egov.usda.gov) characterize them as follows:

- Rasband – stream-terrace alluvium; well-drained, moderate permeability; common irrigated pasture use. (1–3% slopes at ~5,600 ft).
- Crooked Creek – very deep, poorly drained, fine, smectitic (shrink-swell) Cumulic Endoaquolls on flood-plains/terraces/valley floors and seepage zones (0–4% slopes).
- Holmes – very gravelly/cobbly loam to clay loam with 18–35% clay and 35–60% rock fragments; typically better drained/coarser.
- Center Creek – sandy loam to silty clay loam in the C horizon, with lime veins in places.

Mechanism of Subsidence to Watch For

Subsidence occurs when compressible fine-grained layers (silts/clays) compact as pore pressure is lowered by pumping; compaction is largely irreversible if water levels stay depressed. Utah has well-documented subsidence and earth fissures where long-term groundwater declines intersect thick fine-grained basin fill (e.g., Cedar Valley / Iron County; Milford area). Utah Geological Survey cicwcd.org USGS

Given the site's valley-fill with interbedded clays, and mapped Crooked Creek (poorly drained, smectitic) in the vicinity, localized compaction is plausible if sustained drawdown extends into these fine-grained units.

How Far Could a 250 gpm Drawdown Extend?

Using the pump-test-based T ≈ 250 ft^2/day and two storage cases:

- Case A (lower storage; layered/confined behavior): S = 0.002 (consistent with the USGS layered system and Theis fits in similar deposits).
- Case B (design value used in the LDS report): S = 0.05 (unconfined/looser assumption).

With the Cooper–Jacob approximation (screening only), the radius to ~1 ft of drawdown from continuous 250 gpm pumping is roughly:

- ~0.5 mi after 1 month (S = 0.002) vs ~0.11 mi (S = 0.05)
- ~1.3 mi after 6 months (S = 0.002) vs ~0.26 mi (S = 0.05)
- ~1.9 mi after 1 year (S = 0.002) vs ~0.37 mi (S = 0.05)
- ~3.2 mi after 3 years (S = 0.002) vs ~0.64 mi (S = 0.05)

These ranges widen if startup rates (500–700 gpm) persist, and they shrink where canal seepage and irrigation recharge are strong (peak May–July, weakest in winter). Treat these as first-order bounds, not a site-calibrated model.

METHODOLOGY

We estimate drawdown (drop in groundwater level) with distance and time from constant pumping using the Theis solution, in its late-time Cooper–Jacob form for a confined aquifer:

$$s(r,t) = \frac{Q}{4\pi T} \ln\left(\frac{2.25\,T\,t}{r^2\,S}\right) \quad \Rightarrow \quad r = \sqrt{\frac{2.25\,T\,t}{S} \exp\left(-\frac{4\pi T s}{Q}\right)}$$

Where:

- Q = pumping rate (ft^3/day)
- T = transmissivity (ft^2/day)
- S = storativity (dimensionless)
- t = time (days)
- s = drawdown (ft)
- r = radius (ft)

Parameterization (USGS-based):

- S (confined storage) = 1×10^{-4} (layer 2 typical)
- T (transmissivity) = 6,700–20,000 ft^2/day (calibrated model range consistent with published values)
- Scenarios: Q = 250 and 500 gpm; s = 1.0 ft and 0.5 ft contours; t = 1 year and 5 years

Mapping approach:

1. Compute drawdown envelopes (radii to the sft contours) and display them as circles centered on the site.
2. Focus on the down-gradient W→WNW "risk wedge" (bearings 255°–315°), where effects are most plausible.
3. Overlay SSURGO soils to highlight high-susceptibility pockets (Crooked/Center Creek) vs low-susceptibility terraces (Rasband/Holmes).

Note: *These envelopes assume an infinite, homogeneous confined layer. In the real valley, gaining surface waters (Provo River, canals, Deer Creek) will limit and reshape the cone of depression. The wedge maps are therefore screening guides pending a boundary-aware calibration.*

ASSUMPTIONS & LIMITATIONS

- Confined behavior in the pumped interval (consistent with USGS deeper layer).
- No explicit boundaries in the analytic drawdown (rivers/canals/reservoir are discussed qualitatively).
- Homogeneous layer at screening scale; real heterogeneity (lenses, facies shifts) not resolved.
- Continuous pumping (no seasonal throttling) to estimate upper bound winter conditions.

These choices tend to overpredict area vs a calibrated, boundary-aware model—useful for siting monitors and prioritizing outreach, not parcel-level predictions.

RESULTS

Drawdown footprints (radii to contour; miles) — USGS parameters

Confined S = 1×10^{-4}; T bracket = 6,700–20,000 ft^2/day

After 1 Year

Pump	1.0-ft Contour	0.5-ft Contour
250 gallons/minute	5.64 - 18.5 miles	20.8 - 28.7 miles
500 gallons/minute	20.8 - 28.7 miles	35.7 – 40.0 miles

After 5 Years

Pump	1.0-ft Contour	0.5-ft Contour
250 gallons/minute	12.6 - 41.4 miles	46.5 - 64.1 miles
500 gallons/minute	46.5 - 64.1 miles	79.8 – 89.4 miles

NOTES:

1. *The values in the table estimate the drop in groundwater (1.0 or 0.5 ft Contour) at a distance from the LDS Temple site. For example after 1 year with a pumping rate of 250 gallons/minute, the water table would drop 1 foot within 5.64 to 18.5 miles from the site.*
2. *Some ranges descend with higher T: at very high T, the exponential term in the equation can dominate for a given Q and s, shortening the radius unless Q is larger; doubling Q expands radii again.*
3. *Boundary reality. These distances overshoot the valley; gaining boundaries will truncate the cone—hence the wedge focus and the soil overlay to localize risk.*

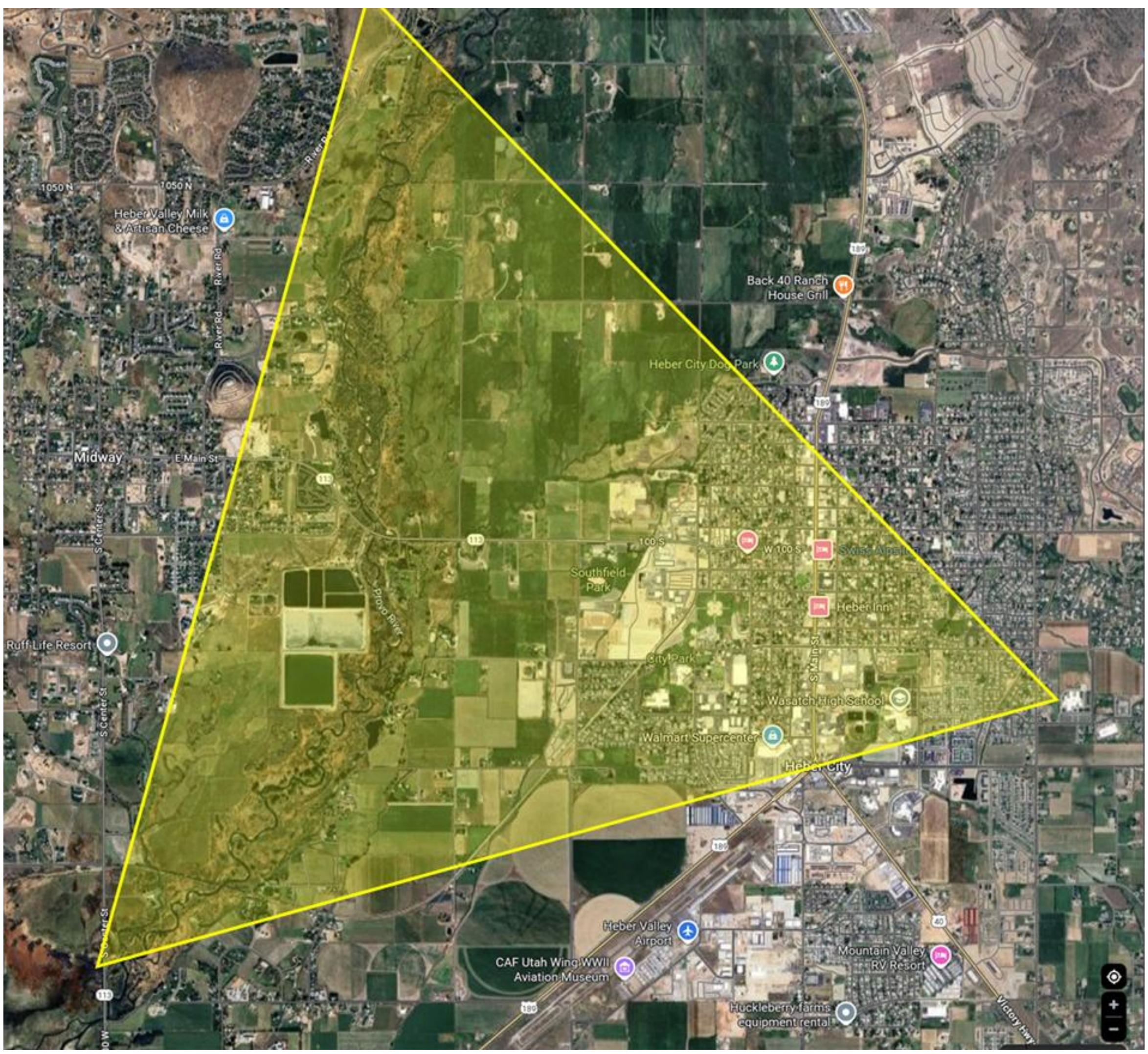
Downgradient Risk Wedge (W→WNW)

- **Focus sector**: bearings 255°–315° from the site.
- **Why here**: matches regional gradient toward the valley floor/Provo system; canal/irrigation corridors and flood-plains cluster here.
- **What to expect**: most offsite drawdown in winter; smaller/more asymmetric in spring–summer (irrigation return and stream recharge).

Subsidence Risk by Area (Priority Zones)

Based on (a) WNW groundwater gradient, (b) probable drawdown footprints above, (c) mapped soils, and (d) regional experience in Utah:

1. **<u>Immediately down-gradient W–WNW of the excavation (within ~0.1–0.6 mi)</u>**
   Highest potential for measurable settlement if Crooked Creek (poorly drained, smectitic) or other silty/clayey flood-plain materials are present at depth. Risk increases if the site operates at ~150–250 gpm for months.
2. **<u>Low-lying flood-plain/canal corridors to the W–WNW</u>**
   Clayey overbank/alluvial fines and historical seepage zones are most susceptible to consolidation if heads are depressed through winter. (USGS notes the fan-and-flood-plain areas also show largest seasonal water-level swings, which interact with pumping.)
3. **<u>Localized soft-clay lenses beneath/near the foundation</u>**
   Even if most flow is in sand/gravel (K≈4–10 ft/day), interbedded clays can compact if long-term heads are held down at the drain elevation (5696.5 ft amsl). This creates differential settlement risk at the structure unless fully isolated (membrane + structural reinforcement).
4. **<u>Lower risk zones</u>**
   Rasband stream-terrace areas and Holmes gravelly loams (better drained/coarser, high rock-fragment content) are less prone to compaction.



Soils & Hotspots Inside the Wedge

Highest susceptibility where fine-grained flood-plain soils occur:

- **Crooked Creek** (very deep, poorly drained, smectitic clay) — flood-plains/seeps.
- **Center Creek** (somewhat poorly drained, fine-textured) — low terraces/dry lake bottoms.

Lower susceptibility where coarse, well-drained deposits dominate:

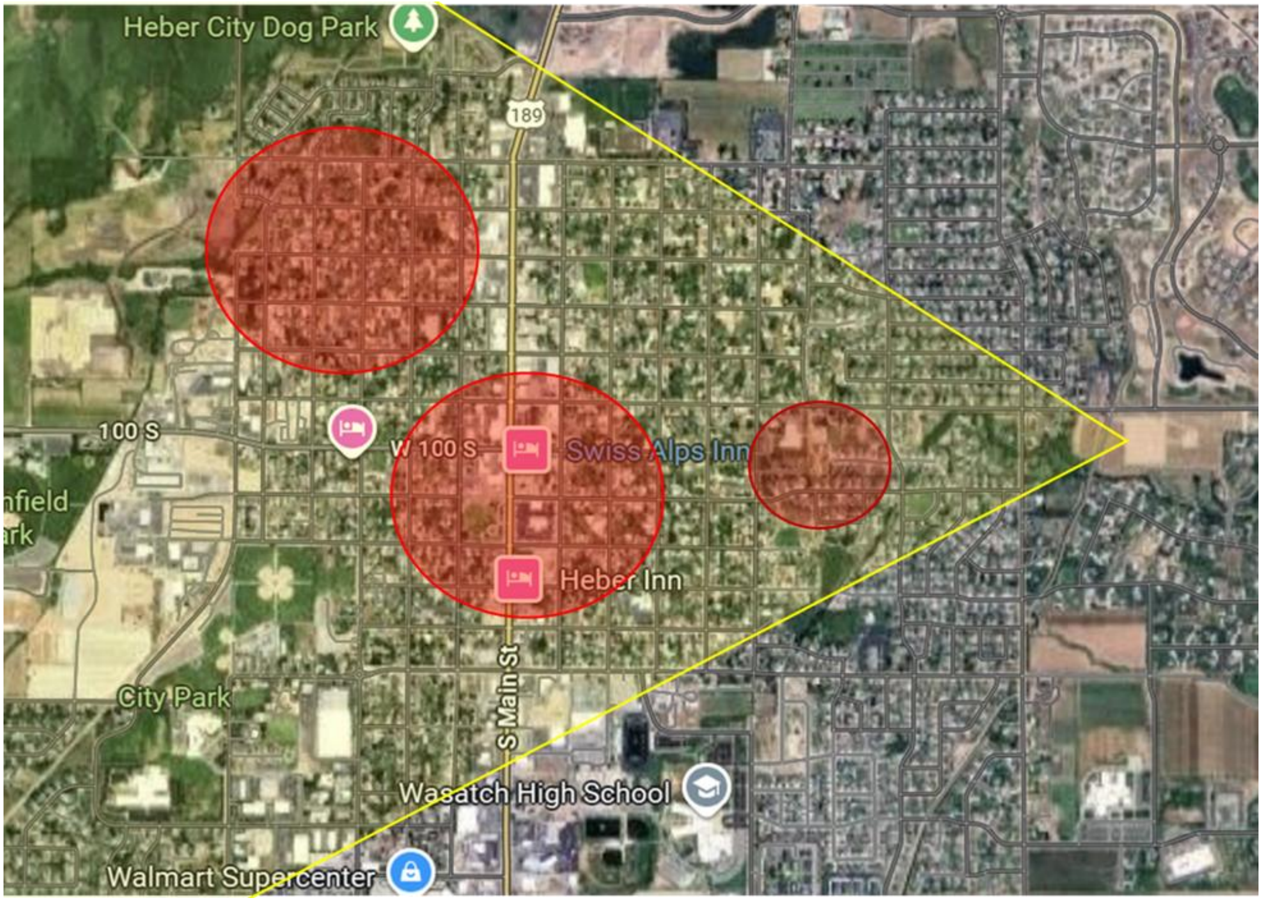
- **Rasband** stream-terrace loams; Holmes gravelly/loamy-skeletal fans/terraces.

Screening hotspots (centers & radii) included in soil_risk_hotspots.geojson/.csv:

- **Center Creek Flood-Plain (inner wedge):** ~1.65 mi at 285°; radius 0.8 mi — likely Crooked/Center Creek inclusions.
- **North Fields / Provo River laterals:** ~3.5 mi at 300°; radius 1.0 mi — valley-floor flood-plain & irrigation return.
- **Canal & seepage corridor (west):** ~1.4 mi at 270°; radius 0.6 mi — canal-adjacent hydric pockets.
- **Lower terrace below fan break (moderate):** ~2.0 mi at 255°; radius 0.7 mi.
- **Stream-terrace (Rasband) & gravelly fan (Holmes) (lower):** near 0.6–1.2 mi with smaller radii.

Severity & Likelihood

- **Within the wedge there are three (3) specific pockets near Crooked & Center Creek:** Expect utilities and multiple properties to need "repair-level" structural settlement. Typical examples are significant unequal movement of a building's foundation that compromises the structure's stability and requires professional and costly repairs, slab/driveway re-leveling, sewage backups and other lateral fixes.
    - **1–3 years:** 33-60% probability
    - **5 years:** 60–80% probability
- **Other Areas within the wedge:**
    - **Cosmetic cracking:** 60-80% probability
    - **Structural damage:** ≤30% probability
- **Valley-wide major damage:** Very unlikely



Key Uncertainties and Why They Matter

- **Aquifer type & storage:** The USGS model shows **layered behavior** with confined conditions in deeper layer(s). Using **S=0.05** (unconfined) underestimates drawdown reach if the pumped zone behaves **semi-confined** (e.g., **S ~ 0.002**). This directly controls the area potentially affected by subsidence.
- **Recharge timing:** Heber Valley heads rise **May–July** from canal and irrigation seepage and drop in winter; if pumping is continuous, **winter months** are the **critical window** for consolidation in clay units.
- **Clay thickness & compressibility:** The **discontinuous clay lenses** described by USGS are known to exist but aren't fully mapped at the site scale; subsidence magnitude depends on their **thickness and compressibility**.

SUMMARY

- The **direction and pattern** of potential effects are robust in the **W→WNW** direction toward flood-plain corridors.
- **Soil type controls susceptibility**: fine-grained flood-plain soils have the highest chance of settlement under multi-year drawdown; terraces/fans are low-susceptibility.
- The USGS parameter envelopes are **upper bounds**; a boundary-aware calibration with monitoring will yield smaller, asymmetrical footprints that officials can rely on for parcel-level decisions.

This analysis estimated drawdown from continuous pumping at 250–500 gpm using the Theis/Cooper–Jacob solution with USGS Heber Valley parameters (confined storage $S \approx 1\times10^{-4}$, transmissivity $T \approx 6{,}700$–$20{,}000\ ft^2/day$). Because surface-water features in Heber Valley strongly interact with the aquifer, the large "infinite aquifer" footprints were treated as upper bounds, then summarized in a down-gradient W→WNW wedge that reflects regional flow toward the valley floor/Provo system.

Subsidence potential is controlled by soil type and duration of lowered groundwater levels. Fine-grained flood-plain soils (e.g., Crooked Creek, Center Creek) can compact when heads stay low; coarser terraces/fans (e.g., Rasband, Holmes) are much less compressible. Winter typically has the lowest natural recharge, so multi-winter drawdown matters most.

Bottom-Line

Is subsidence possible? Yes—locally. The valley fill here contains interbedded clays, and at least one mapped soil series (Crooked Creek) is poorly drained, fine-grained, and smectitic, which is susceptible to consolidation if heads are held down for months. The simple drawdown bounds above show that continuous 250 gpm could depress heads hundreds to thousands of feet from the site, depending on actual storage conditions.

Where is risk highest…immediately W–WNW of the site. The main areas of concern are contained in a W→WNW "risk wedge" from the site and encompasses flood-plain and canal/irrigation corridors where fine-grained deposits occur. Within that wedge, several "hotspot" areas were identified in the Center Creek flood-plain, North Fields/Provo River laterals, a west-side canal corridor and directly beneath/around the excavation if long-term heads are kept near 5696.5 ft above sea level.

- Flood-plain pockets: 60-80% probability of significant utility & structural repair within 5 yrs
- Terraces/fans: ≤30% probability of structural damage; issues, will be mostly cosmetic.
- Valley-wide severe damage: Very unlikely (<10%)

The directional pattern (W→WNW wedge; flood-plain pockets) is robust, and the order of magnitude of distances is reasonable. Exact parcel-level outcomes depend on local clay thickness and compressibility and the actual seasonal drawdown as it occurs. River, canals and reservoir boundaries reduce and reshape the theoretical footprints, so the maps and numbers here should be read as screening-level guidance rather than precise parcel predictions.

ENVIRONMENTAL IMPACT TO SURROUNDING VEGETATION

Consequences to Streams, Trees and Land From Dewatering

INTRODUCTION

The proposed temple site in Heber City requires **permanent dewatering** to keep its below-grade areas dry. This will involve lowering the local groundwater table to a depth of **~34 feet below ground surface (bgs)**. Because the natural water table at the site typically ranges between **6–17 ft bgs**, this means the aquifer must be depressed by **~17 to 28 ft** beneath the building footprint on a continuous, long-term basis.

This analysis evaluates the **hydrologic and ecological risks** of that permanent drawdown. Specifically, it assesses:

1. How far outward the cone of depression extends,
2. The magnitude of groundwater declines in surrounding lands,
3. The likely consequences for **groundwater-dependent vegetation** (old-growth cottonwoods, willows, wetlands), and
4. The relative severity of impacts under **two drawdown scenarios**: 17 ft vs. 28 ft lowering.

EXPLANATION OF HYDROLOGIC DYNAMICS

Groundwater in Heber Valley is part of a **dynamic, interconnected system**. Snowmelt and irrigation recharge percolate into valley-fill sediments, sustaining a water table that naturally fluctuates by as much as **30 ft seasonally**. Much of this groundwater ultimately discharges into the **Middle Provo River**, springs, and wetlands, providing baseflow that supports ecosystems and recreation.

When groundwater is **artificially lowered at one location**, the effect is not confined to that site. Water naturally flows toward the pumping depression, creating a **cone of depression**. The depth of lowering is greatest at the pump (or drains) and gradually decreases with distance. However, as long as pumping continues, this cone can extend thousands of feet, capturing water that otherwise would have fed rivers, wetlands and vegetation.

In this case, the **temple site drains will maintain groundwater 17–28 ft lower than natural**. As that cone spreads outward, it will cause sustained groundwater declines of **3–5 ft or more** across a substantial area of surrounding land.

ASSUMPTIONS

- **Groundwater lowering required:** ~17 ft (best case) to ~28 ft (worst case) at the temple footprint.
- **Aquifer parameters:** Transmissivity ~3,000 ft^2/day (mid-range from USGS and pump test data); storativity values consistent with semi-confined behavior.

- **Boundary conditions:** Outer damping radius ~5,000 ft (~1 mile), representing aquifer connection to the Provo River and valley system.
- **Methodology:** Simplified Thiem-style steady analysis to estimate drawdown contours; results presented as approximate radii/areas of sustained lowering.
- **Vegetation thresholds:**
  - **≥3 ft lowering** = moderate stress (trees survive but are vulnerable to drought).
  - **≥5 ft lowering** = high risk (roots lose reliable groundwater access; mortality likely within a few years).

RESULTS

Scenario A — 17 ft maintained drawdown

- **≥5 ft zone:** extends ~1,290 ft (0.24 mi) from the temple; ~120 acres at **high risk**.
- **≥3 ft zone:** extends ~2,220 ft (0.42 mi) from the temple; ~356 acres at **moderate stress.**

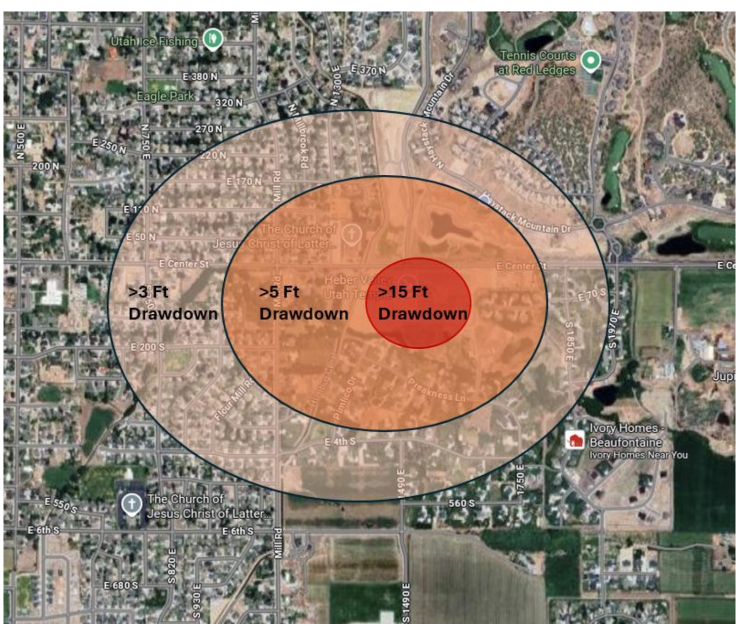
Scenario B — 28 ft maintained drawdown

- **≥5 ft zone:** extends ~2,200 ft (0.42 mi) from the temple; ~349 acres at **high risk.**
- **≥3 ft zone:** extends ~3,060 ft (0.58 mi) from the temple; ~675 acres at **moderate stress.**

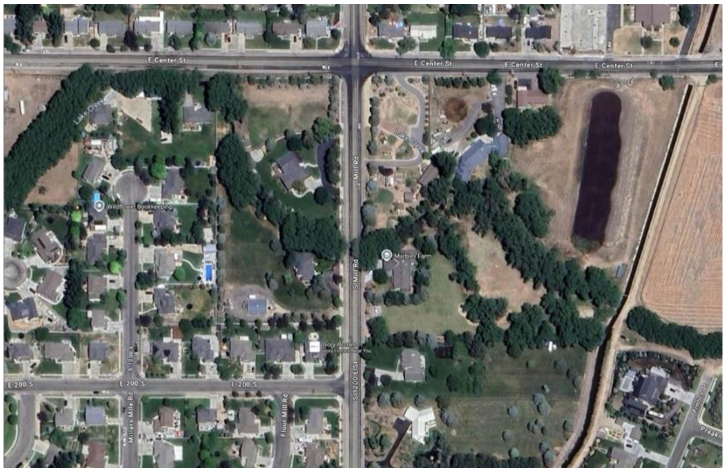
Vegetation response

- **3 ft zone (moderate risk):** Trees maintain marginal access to groundwater but suffer chronic stress. They become more vulnerable to drought, pests, and disease. Mortality accelerates in dry years.
- **5 ft zone (high risk):** Groundwater lowered beyond root reach. Old-growth cottonwoods and willows experience canopy dieback and mortality over 2–10 years. Wetlands shrink or disappear.

Visual footprint



Aerial overlays show that under the **28-ft drawdown scenario**, the **3-ft stress zone** would encompass **~675 acres**, extending more than half a mile from the site and potentially intercepting shallow aquifer corridors that normally discharge to the Middle Provo River. In addition, the **5-ft high-risk zone** would cover **~349 acres** closer to the temple, where groundwater-dependent vegetation is most vulnerable. Together, these impacts mean not only widespread **tree mortality** but also **reduced river baseflow, wetland loss, and ecological degradation** in one of the valley's most valued natural assets.



Vegetation Prior to Dewatering

(Intersection of Mill & Center Streets)

Illustration After Dewatering

(Intersection of Mill & Center Streets)

SUMMARY

Permanent dewatering at the temple site will **not remain localized**. To keep the foundation dry, groundwater must be lowered by **17–28 ft** directly beneath the site. That depression will propagate outward, creating sustained groundwater declines of **3–5 ft** across **hundreds of acres** of surrounding land.

- At **17 ft lowering**, ~120 acres face high risk of tree mortality, and ~356 acres face moderate stress.
- At **28 ft lowering**, those figures grow to ~349 acres and ~675 acres, respectively.

For Heber Valley, this means:

- **Loss of old-growth riparian trees** (cottonwoods, willows) within a half-mile of the site.
- **Wetland shrinkage** and reduced habitat diversity.
- **Reduced baseflow to the Middle Provo River**, harming recreation and ecosystems.
- **Irreversible landscape change**, as mature tree stands cannot be replaced within human timescales.

CONCLUSION

Even in the lower-impact scenario, the scale of groundwater decline represents a serious ecological risk. In the higher-impact case, both the **3-ft stress zone and 5-ft high-risk zone** expand dramatically, placing hundreds of acres of riparian land at risk of long-term degradation. These outcomes justify a **full USGS/UGS environmental impact study**, with calibrated modeling, vegetation monitoring and contingency planning, before dewatering proceeds.

Section 7: Conclusions and Call to Action

Heber Valley stands at a crossroads. The LDS Temple project, as currently designed, requires **continuous dewatering of 250–800 gallons per minute** — not just during construction, but **permanently**. This will lower the groundwater table beneath the site by **17–28 feet**, causing a lasting alteration to the aquifer that supports **our municipal wells, our trees, our wetlands and the Middle Provo River**. This is not a temporary construction measure — **it is a permanent alteration of our aquifer** with consequences extending far beyond a single building site.

Decades of research by the **U.S. Geological Survey (USGS)**, **Utah Geological Survey (UGS)**, and the **Utah Division of Water Rights** have documented that Heber Valley's groundwater system is **layered, interconnected and highly sensitive to pumping**. Groundwater here does not stay confined beneath a single parcel — it **moves**, it **feeds springs**, it **supplies our drinking water** and it anchors the valley's old-growth trees and riparian corridors. **It also feeds the Middle Provo River.** To disturb this system is to risk the very foundation of our community's water security.

By contrast, the Bowen Collins 2023 consultant report is **narrow in scope**, relying on a handful of short-term well test. It assumed the **aquifer was simple and unconfined (the exact opposite of USGS studies),** ignored decades of seasonal and regional data and **did not reconcile contradictory field measurements when they conflicted with their derived assumptions.** The result is an incomplete analysis that significantly **underestimates real pumping volumes and valley-wide impacts**.

Those impacts are serious and measurable:

- **Municipal Wells at Risk**: Hospital Well—less than a mile downgradient—is highly vulnerable. Even modest pumping rates could produce drawdowns of **5–20 feet**, undermining the reliability of one of Heber City's key water sources. The **Broadhead Wells and Broadhead Spring Well**, which provide critical supply to the municipal system, also fall within the projected influence of the temple's cone of depression. A sustained 3–5 ft drop in these wells would reduce production capacity, stress pumping infrastructure and compound seasonal late-summer shortages when the aquifer is already at its lowest.

- **Land subsidence in the heart of Heber City:** When aquifer pressures are permanently lowered, clay and silt layers can compact, leading to land subsidence. Historical cases in Utah and California show that **subsidence bowls can extend across hundreds of acres**, damaging roads, pipelines and private property. In Heber City, the predicted subsidence zone falls **directly in the heart of town**, placing homes, businesses, roads and utilities at risk. Once ground elevation is lost and the aquifer storage capacity is permanently reduced, it **cannot be reversed**,

- **Loss of Old-Growth Trees:** Within the **high-risk zone (~349 acres)**, old-growth cottonwoods and willows will not survive. The **stress zone (~675 acres)** will suffer chronic decline leading to canopy loss, reduced shade, higher stream temperatures and eventual ecosystem collapse. In practical terms, **the old-growth trees along and west of Mill Road and along Center Street will most likely die within five years**, forever altering the landscape and character of the community. These trees are centuries-old living landmarks of our valley — once lost, they cannot be replaced within our lifetimes.

- **Reduced Baseflow to the Middle Provo River**: Aerial overlays show that under the 28-ft drawdown scenario, the cone of depression extends **half a mile** from the site, intercepting shallow aquifer flow corridors that currently discharge directly to the river. Lower flows mean **warmer stream temperatures, degraded habitat and lost fisheries** — harm to a river that defines one of the valley's greatest natural assets and quality of life.

- **Irreversibility**: Aquifers are not like surface reservoirs; changes are not easily undone. When pressure is lost, **springs dry up, storage capacity collapses and trees that die back do not rebound simply by "adding water" later — even if pumping stops.** The damage is permanent.

This is not about opposing new development, the Temple or the LDS Church. It is about **stewardship** — about acting wisely and protecting the water, land and legacy of Heber Valley before irreversible harm occurs. For many in this community, faith plays a central role in daily life. **The LDS Church teaches the** values of **stewardship, caring for God's creations and loving one's neighbors**. To knowingly proceed with a **project that threatens water security, damages ecosystems and endangers community resources stands in direct contradiction to those values**. Protecting Heber Valley's aquifer is not just a scientific necessity—it is a moral responsibility consistent with the very tenets of faith that guide so many in this valley.

The USGS and UGS are both **willing and ready** to conduct a full, independent Environmental Impact Study, but they require the support of local government. To date, repeated requests for such action have gone unanswered. We now face a defining choice — **will we act to protect the lifeblood of Heber Valley — its water — or will we allow irreversible damage based on incomplete and inadequate studies?**

<u>To our local government officials</u> — your duty is to safeguard the public trust, especially our most precious resource, water.

<u>To the leaders of the LDS Church</u> — your legacy in this valley will be measured not only in the beauty of a temple but in the care shown for the land and people who surround it.

<u>To every resident of Heber Valley</u> — this is our shared future. The aquifer beneath us does not recognize property lines, city limits or religious denominations. It is one system and once it is harmed, all of us will feel the loss.

The responsible, science-based path forward is clear: **Commission and support a comprehensive, independent USGS-led Environmental Impact Study before construction continues.**

Future generations will judge this decision not by the size or location of a building but by whether government officials, LDS leaders and residents of Heber Valley can come together and have the courage to protect the lifeblood of this valley — its water. Let us not wait until wells fail, trees die and springs run dry to ask why a more comprehensive study wasn't conducted. Let us act now, together, so that when future generations look back, they will see a community that chose wisdom, collaboration and stewardship over haste.