LRES 575 · CAPSTONE PROSPECTUS · REVISION 5 · AUGUST 2026

Three pathways, one aquifer.

A comparative feasibility study of potable reuse strategies for Dodge City, Kansas — placing the land-application system, the planned managed aquifer recharge project, and direct potable reuse side by side within one geospatial and present-worth framework.

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01 — SETTING

A city on the Ogallala, weighing how to reuse its water.

Dodge City draws its municipal supply from the Ogallala aquifer. Declines across the High Plains have been pronounced: the Kansas Geological Survey reports parts of southwest Kansas retaining less than half of their original saturated thickness, and Groundwater Management District 3 — which includes Dodge City — has recorded roughly a 45% loss of saturated thickness since predevelopment. The city reported using about 95% of its available water capacity in 2025, and average-day demand is projected to rise substantially over the coming decades. How the city reuses its treated wastewater is a meaningful part of its long-term water picture.

One distinction shapes this study. The South wastewater treatment plant treats more than 2 billion gallons a year — but that is not one municipal stream. Three years of daily flow logs (2023–2025) place the composition at roughly 1.84 MGD municipal, 4.45 MGD industrial, or about 29% municipal by volume; the industrial flow comes from the National Beef packing plant and the Hilmar cheese plant, and runs high-strength and consistent year-round. Any look at reclaimed water as a drinking-water source has to separate the municipal fraction — the part most plausibly suited to potable reuse — from the larger industrial fraction, rather than treating the whole plant volume as available.

This study aims to place the pathways side by side, transparently, so the trade-offs can be examined.

02 — THE EXISTING SYSTEM

The effluent already has a job — and keeps it.

For more than four decades, the South plant has reused effluent through lagoon treatment and land application, currently supplying about 2,800 acres under 26 center pivots. The nutrient load has been sufficient that the operator has applied no commercial fertilizer for years, and the system is managed actively through twice-yearly soil monitoring, gypsum application for salinity, and crop rotation. This is a working reuse system, not a disposal method the city is abandoning. A second, smaller facility — the North reclamation plant — treats a municipal stream through a membrane bioreactor and ultraviolet disinfection for irrigation reuse.

The recharge project is additive rather than a replacement. The city intends to keep supplying the full irrigated acreage — it has signed a new agreement providing the farm operation more water — with recharge drawing on incremental supply. The question that remains is how incremental water is balanced across land application and recharge within a stream of roughly fixed volume.

Supply internalization C1

Land-applied effluent benefits private acreage; recharge near the municipal wellfield could return part of that water to city supply. The city's managed aquifer recharge concept estimates that about 90% of recharged water — roughly 3.7 of 4.1 MGD discharged — would be recoverable within the existing wellfield; that figure is described in project documents as a preliminary estimate, not a guaranteed recovery factor.

Water quality C2

A peer-reviewed study documented nitrate above the 10 mg/L drinking-water standard in groundwater beneath the irrigated fields (Sophocleous et al. 2010). The city also notes that recharge may build a hydraulic mound that helps hold back contaminants migrating down the Arkansas valley — a possible benefit this study weighs alongside the risks.

A step toward direct reuse C3

The city has described the recharge project as a step toward eventual direct potable reuse, a characterization confirmed in discussion with engineering staff. The recharge and direct-reuse pathways share much of the same advanced treatment.

Regulations still forming C4

Kansas has no managed-aquifer-recharge or direct-potable-reuse regulations in place. House Bill 2462, signed April 2026, requires the state to write them by mid-2028; comparable states took six to ten years. The project is advancing alongside the framework that will govern it.

03 — RESEARCH QUESTION

How do the three pathways actually compare?

Considering the municipal fraction of Dodge City's reclaimed wastewater alongside the city's long-term supply outlook, how do continued land application, managed aquifer recharge for indirect potable reuse, and direct potable reuse — potentially supported by co-located solar generation and storage — compare in geospatial feasibility, energy demand, human-health risk, and 25-year present-worth cost? The aim is a transparent side-by-side comparison.

Scenario	Pathway	Analytical role
A	Land application — lagoon treatment, irrigation of ~2,800 acres (current system)	Reference case; the established, working baseline
B	Managed aquifer recharge / IPR — advanced treatment, riverbed infiltration, and aquifer recharge (in development)	The pathway the city is pursuing; evaluated on its own terms
C	Direct potable reuse + grid — advanced treatment to direct municipal supply	Municipal fraction as direct supply; a comparison case
D	Direct potable reuse + co-located solar + storage	Explores whether on-site generation changes the picture

04 — METHODOLOGY

Four pillars, one present-worth framework.

1 · GIS & spatial analysis PRIOR WORK: SOLAR-SITING

Aquifer-depletion mapping, infrastructure overlay, wastewater-plant-to-wellfield proximity, and solar-irradiance suitability. Builds on the published Ford County solar-siting analysis.

2 · Human-health risk LRES 507 · FALL 2026

EPA four-step framework comparing exposure pathways across the scenarios — including the existing pathway from effluent-irrigated fields to municipal supply wells. This pillar is developed as the term project for LRES 507.

3 · Energy & solar/storage NREL PVWATTS

Reverse-osmosis energy intensity, photovoltaic sizing via NREL PVWatts, and storage scenarios — accounting for the plant's existing biogas-to-renewable-natural-gas operation and the city's note that on-site solar faces a real land-footprint constraint, rather than modeling solar in isolation.

4 · Present-worth cost-benefit HERMAN 2017

A four-scenario, 25-year present-worth comparison following Herman (2017), whose analysis of a comparable inland community found conveyance and pumping — not treatment — to be the dominant cost drivers.

05 — PRELIMINARY OBSERVATIONS

Supply wells near the irrigation area.

Infrastructure data assembled for this project identify several municipal raw-water supply wells (Well IDs 22–28; drilled 2004; depths 194–272 ft; yields 500–800 GPM) within and adjacent to the plant's effluent-irrigation area — the same area where prior study documented nitrate above the drinking-water standard (Sophocleous et al. 2010). City engineering staff report that raw-well nitrate near the plant generally runs in the 5–7 mg/L range, with one or two wells slightly above 10 mg/L, and that source water is blended before distribution to keep delivered water under the standard.

The proximity of supply wells to long-term effluent irrigation is an exposure pathway worth characterizing carefully. It underscores a theme of this study: each pathway carries its own risk profile, and the comparison is among real alternatives with real trade-offs, none risk-free. This is a starting point for analysis — the significance of these wells will be developed with care and, where possible, in consultation with those who manage the system.

06 — TIMELINE

Coursework → capstone, Fall 2028.

Fall 2026	LRES 507 Environmental Risk Assessment · LRES 534 Environmental Data Analysis
Spring 2027	LRES 544 Water Quality · MB 541 Microbial Genetics (MSSE)
Summer 2027	MB 540 Environmental Microbiology (MSSE)
Fall 2027	LRES 573 Remote Sensing · LRES 533 Wetland Ecology & Management
Spring 2028	LRES 530 Natural Resource Law
Fall 2028	LRES 575: integrated present-worth analysis, professional paper, and defense

07 — WORKING BIBLIOGRAPHY

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Under verification: EPA Potable Reuse Compendium · Kansas Geological Survey Technical Series 22 · EPA Disinfection Profiling & Benchmarking Manual (815-R-20-003).