ANNUAL REPORT 2021

Conservation and Survey Division School of Natural Resources University of Nebraska-Lincoln





SURVEY DIVISION

School of Natural Resources

Conservation and Survey Division **Our Mission**

The Conservation and Survey Division (Nebraska Geological Survey), the natural resource survey component of the School of Natural Resources, is a unique, multi-disciplinary research, service and data-collection organization established by state statute in 1921.

The Division's mission is to investigate and record information about Nebraska's geologic history, its rock and mineral resources, the quantity and quality of its water resources, land cover and other aspects of its geography, as well as the nature, distribution and uses of its soils.

Cover photo: Smith Falls, Cherry County, is one of Nebraska's most scenic features. The falls are developed on the siltstones of the Rosebud Formation (Oligocene) and they began to form during the Late Pleistocene as the Niobrara River incised its valley. **Conservation and Survey Division**

Annual Report 2021

February 2022

R.M. Joeckel

Director, Conservation and Survey Division Senior Associate Director, School of Natural Resources

University of Nebraska-Lincoln

CSD 2021 Accomplishments at a Glance

Extension contacts by CSD personnel: 1,835

Number of organizations/programs/other entities served worldwide: 119

Requests for data and analysis served by CSD personnel: 5,779

Footage of test holes drilled and/or logged by CSD personnel: 5,400 ft

Automated groundwater-data entries overseen by CSD personnel: 122,304

Groundwater quality results processed by CSD personnel: 1,310

Teaching contribution of CSD personnel: CSD faculty taught 122 students in 10 different courses in 4 different programs at UNL, producing 364 student credit hours

Students advised by CSD personnel: 3 undergraduate students and 23 graduate students

Continuing education units for professionals (CEUs) generated by CSD personnel: 345 Total grant funding with which CSD personnel were associated: >\$3.86 million

Total scientific publications of all kinds authored or coauthored by CSD personnel: 46

- Peer-reviewed scientific journal articles: 26
- Book chapters: 1
- Survey reports, bulletins, and field guides: 5

Major field trips run or co-run by CSD personnel: 1 (Nebraska Geological Society)

Presentations by CSD personnel: 44

Media interviews by CSD personnel: 4

Total page views of CSD website: 103,438

Downloads of CSD publications from UNL Digital Commons: 800 CSD publications downloaded 13,033 times by users in 117 countries

Awards: UNL Soil Judging Team, Region 5 contest, coached by CSD's J.K. Turk: •3rd overall •2nd in group judging

•One 1st place individual

Publications Authored or Coauthored by CSD Personnel in 2021

- Ahamad, M., Burbach, M.E., and Tanin, F., 2021.
 Relationships among toilet sharing, water source locations, and handwashing places without observed soap: A cross-sectional study of the richest households in Bangladesh. *Environmental Health Insights* 15: 1-6
- Airori, A.J., Baker, T.J., and Turk, J.K., 2021. The Impact of sampling methodology on soil bulk density measurement by the clod method. *Communications in Soil Science* and Plant
- Burbach, M.E., Matkin, G.S., Joeckel, R.M., & Mott, B., 2021. Nebraska Water Leaders Academy – Final report. School of Natural Resources, University of Nebraska-Lincoln, Open-File Report 223. Crago, R., Szilagyi, J., Qualls R.J., 2021. Comment on "A review of the complementary principle of evaporation: from original linear relationship to generalized nonlinear functions" by S. Han and F. Tian, *Hydrology and Earth System Sciences* 25: 63-68, https://doi.org/10.5194/hess-25-63-2021.
- De Figueiredo Silva, F. Perrin, R.K., Fulginiti, L.E., and **Burbach, M.E**., 2021. Does stakeholder engagement improve groundwater management? *Water Economics and Policy* 7(2), 2150008.
- Delozier, J., and **Burbach, M.E.,** 2021. Boundary spanning: Its role in trust development between stakeholders in integrated water resource management. *Current Research in Environmental Sustainability* 3, 100027.
- Diffendal, R.F. Jr., Olafsen Lackey, S., Hallum,
 D.R., 2021. Geology and Hydrogeology of Northeastern Nebraska: Geology, Water Management and Geological Hazards,
 Nebraska Geological Society Field Trip 2021, Guidebook No. 38, University of Nebraska– Lincoln, Conservation and Survey Division, 32 pp.
- Eaton, W.M., Brasier, K.J., Burbach, M.E.,
 Whitmer, W., Engle, E.W., Burnham, M., ...
 Weigle, J., 2021. A conceptual framework for social, behavioral, and environmental change through stakeholder engagement in water

resource management. *Society & Natural Resources* 34: 1111-1132.

- Eger, G. Z. S., Silva Junior, G. C., Marques, E.
 A. G., Leão, B. R. C., da Rocha, D. G. T.
 B., Gilmore, T. E., et al. 2021. Recharge assessment in the context of expanding agricultural activity: Urucuia Aquifer System, western State of Bahia, Brazil. *Journal of South American Earth Sciences* 112, 103601 [https://doi.org/10.1016/j. jsames.2021.103601].
- Fyfe, E.R., de Leeuw J.R., Carvalho P.F., et al. (including Turk, J.K.), 2021. Many Classes
 1: Assessing the Generalizable Effect of Immediate Feedback Versus Delayed Feedback Across Many College Classes. Advances in Methods and Practices in Psychological Science [doi:10.1177/25152459211027575].
- **Gilmore, T.E.,** Cherry, M., Gastmans, D., Humphrey, E., & Solomon, D. K., 2021. The ³H/³He Groundwater age-dating method and applications. *Derbyana* 42. [https://revistaig. emnuvens.com.br/derbyana/article/view/740].
- Haigh, T., Hayes, M., Smyth, J., Prokopy, L., Francis, C., and Burbach, M., 2021.
 Ranchers' use of drought contingency plans in protective action decision making. *Rangeland Ecology & Management* 74: 50-62.
- Hallum, D., 2020. Hydrogeologic Framework and Water Balance Investigation of Land Near the Gothenburg Canal System. Lincoln, NE, University of Nebraska-Lincoln, Conservation and Survey Division, Open File Report 208, 42 pp.
- Humphrey, E.C., Solomon, D.K., Genereux,
 D.P., Gilmore, T.E., Mittelstet, A.R., Zlotnik,
 V.A., Zeyrek, C., Jensen, C.R., MacNamara,
 M.R., 2021. Spatial variability and estimation of groundwater flux from local discharge measurements. *Geological Society of America Abstracts with Programs*. 53 (6) [doi: 10.1130/abs/2021AM-366988].
- Joeckel, R. M., Suarez, C. A., Ludvigson, G. A., Suarez, M. B., Lee, J., Kirkland, J. I., 2021. First in-situ terrestrial record of Early

Cretaceous "Weissert Event" calibrated with U-Pb cryptotephra ages from paleosols; Yellow Cat Member of Cedar Mountain Formation, Utah. International Sedimentary Geoscience Congress (ISGC) Abstract Book. SEPM (Society for Sedimentary Geology) Miscellaneous Publication 21: 357. (SEPM).

Kambhu A., Li, Y, Gilmore, T.E., Comfort, S., 2021. Modeling the release and spreading of permanganate from aerated oxidant candles in a laboratory flow tank. *Journal of Hazardous Materials* [https://doi. org/10.1016/j.jhazmat.2020.123719].

Korus, J. T., Joeckel, R. M., Abraham, J. D., Hoyer, A.-S., Jorgenson, F., 2021.
Reconstruction of pre-Illinoian ice margins and glaciotectonic structures from airborne electromagnetic (AEM) surveys at the western limit of Laurentide glaciation, Midcontinent U.S.A. *Quaternary Science Advances* 4, 15 pp. [https://doi.org/10.1016/j. qsa.2021.100026].

Korus, J.T., Joeckel, R.M., and Tucker, S., 2021. Exhumed Cenozoic river channels on the High Plains USA revealed by high-resolution photogrammetry and LiDAR. *Geological Society of America Abstracts with Programs* 53 (3) [doi: 10.1130/ abs/2021NC-362674].

Kuntz, T. Sibray, S., Reedy, J., Yill, J., and Hallum, D., 2021. Mapping the Base of the High Plains Aquifer using Borehole Geophysical Logs and Airborne Electromagnetic Surveys in Western Nebraska. University of Nebraska-Lincoln, Conservation and Survey Division, Open File Report 210, 21 pp.

Lee, J. D., Ludvigson, G. A., Suarez, M. N., McLean, N. M., Joeckel, R. M., Maxson, J. M., Hunt-Foster, R. (2021). Volcanogenic zircons from mudrocks and chronostratigraphic refinement of the Cretaceous Cedar Mountain Formation, Utah. *Geological Society of America Abstracts with Programs* 53 (3): 1 pp. [https://gsa. confex.com/gsa/2021NC/webprogram/ Paper362848.html].

Ludvigson, G. A., Moller, A., McLean, N. M., Lee, J. D., Joeckel, R. M., Suarez, M. B., Maxson, J., 2021. Cryptotephras in siliciclastic mudstone paleosols and the geochronologic calibration of Cretaceous (Aptian-Albian) C-isotope stratigraphy. Geological Society of America Abstracts with Programs 53 (6): 1 pp. [https:// gsa.confex.com/gsa/2021AM/webprogram/ Paper367824].

Ma, N., **Szilagyi, J**., Zhang, Y., 2021. Calibration-free complementary relationship estimates terrestrial evapotranspiration globally. *Water Resources Research* 57 (9) [doi: 10.1029/2021WR029691].

Martens, K., & Burbach, M., 2021. Rancher preferences for conservation program in Nebraska's grasslands. USDA NIFA SARE Project Reports [https://www.sare.org/ grants/about-project-reports/].

Martens, K., & **Burbach**, M., 2021. Ranchers' preferences for payment for ecosystem services programs. School of Natural Resources, University of Nebraska-Lincoln, Open-File Report 222.

- Moller, A., Lee, J.D., Suarez, MB., Joeckel, R.M., McLean, N.M., Gulbranson, E., Rasbury, E. T., Maxson, J., Hunt-Foster, R., 2021.
 Improving the age constraints on Cretaceous carbon isotope excursions: A combined U-Pb dating approach using paleosol cryptotephras and pedogenic carbonates *Geological Society* of America Abstracts with Programs 53 (3): 1 pp. [https://gsa.confex.com/gsa/2021AM/ webprogram/Paper367530.html].
- Nagy, E.D., **Szilagyi, J.**, Torma, P., 2021. Assessment of dimension-reduction and grouping methods for catchment response time estimation in Hungary, *Journal of Hydrology: Regional Studies* 38,100971.

Owen, R.K., Anderson, A., Bhandari, A., Clark, K., Davis, M., Dere, A., Jelinski, N., Moorberg, C., Osterloh, K., Presley, D., **Turk**, J., and Young, R., 2021. Evaluating student attitudes and learning at remote collegiate soil judging events. *Natural Sciences Education* 50: e20065 [https://doi.org/10.1002/ nse2.20065].

Pétré, M.-A., Genereux, D. P., Koropeckyj-Cox, L., Knappe, D.R.U., Duboscq, S., Gilmore, T. E., and Hopkins, Z.R., 2021. Per- and Polyfluoroalkyl Substance (PFAS) Transport from Groundwater to Streams near a PFAS Manufacturing Facility in North Carolina, USA. *Environmental Science & Technology* 55(9): 5848–5856.

- Rabenhorst, M.C., Drohan, P.J., Galbraith,
 J.M., Moorberg, C., Spokas, L., Stolt, M.
 H., Thompson, J. A., **Turk, J.**, Vasilas, B
 L., & Vaughan, K.L., 2021. Manganesecoated IRIS to document reducing soil
 conditions. *Soil Science Society of America Journal* 85 (6): 2201-2209 [https://doi.
 org/10.1002/saj2.20301].
- Richards, G., Gilmore, T.E., Mittelstet, A.R., Messer, T L., & Snow, D.D. (2021). Baseflow nitrate dynamics within nested watersheds of an agricultural stream in Nebraska, USA. *Agriculture, Ecosystems & Environment* 308, 107223. [https://doi.org/10.1016/j. agee.2020.107223].
- Robertson, C., Ludvigson, G.A., Joeckel, R.M., Mohammadi, S., and Kirkland, J. I., 2021.
 Differentiating early from later diagenesis in a Cretaceous sandstone and petroleum reservoir of the Cedar Mountain Formation in Utah. *Rocky Mountain Geology* 56(1): 19-36 [https:// geobookstore.uwyo.edu/rmg].
- Russell, M. V., Mittelstet, A.R., Messer, T. L., Korus, J.T., Joeckel, R.M., 2021. Evolution of three streambanks before and after stabilization and record flooding. *Ecological Engineering*, 170 (106357): 8 pp. [https:// www.journals.elsevier.com/ecologicalengineering].
- Russell, M., Mittelstet, A., Joeckel, R. M., Korus, J., Castro Bolinaga, C. (2021). Impact of bank stabilization structures on upstream and downstream bank mobilization at Cedar River, Nebraska. *Transactions of the ASABE* 64(5): 1555-1567. [https://elibrary.asabe.org/abstract. asp?aid=52756].
- Santarosa, L. V., Gastmans, D., Gilmore, T. E., Boll, J., Betancur, S. B., & Gonçalves, V.
 F. M., 2021. Baseflow and water resilience variability in two water management units in southeastern Brazil. *International Journal of River Basin Management* 0(ja): 1–37. https:// doi.org/10.1080/15715124.2021.2002346.
- Scharenberg, M., Bacon, D., Blankenau, D.,
 Duguid, A., Hawkins, J., Heinrichs, M.,
 Hollenbach, J., Holubnyak, Y., Joeckel, R.
 M., Keister, L., Koperna, G., Lee, S.-Y.,

McDonald, S., Meuleman, E., Middleton, R., Riestenberg, D. E., Smith, V., Swanson, J., Walker, J. 2021. Development of an Integrated Carbon Capture, Utilization, and Storage Hub in the United States. pp. 8. Abu Dhabi: SSRN Electronic Journal. https://papers.ssrn.com/ sol3/papers.cfm?abstract_id=3820814 Status: Published

- Shrestha, N., Mittelstet, A.R., Gilmore, T.E., Zlotnik, V., & Neale, C.M. 2021. Effects of drought on groundwater-fed lake areas in the Nebraska Sand Hills. *Journal of Hydrology: Regional Studies* 36, 100877. https://doi. org/10.1016/j.ejrh.2021.100877
- Shrestha, N., Mittelstet, A. R., Young, A. R., Gilmore, T. E., Gosselin, D. C., Qi, Y., & Zeyrek, C. 2021. Groundwater level assessment and prediction in the Nebraska Sand Hills using LIDAR-derived lake water level. *Journal of Hydrology 600*, 126582.
- Smith, K.H., Burbach, M.E., Hayes, M.J., Guinan, P.E., Tyre, A.J., Fuchs, B., and Haigh, T., 2021. Whose ground truth is it? Harvesting lessons from Missouri's 2018 bumper crop of drought observations. *Weather, Climate, and Society* 13: 227-244.
- Szilagyi, J., 2021. Corrigendum to "On the thermodynamic foundations of the complementary relationship of evaporation" *Journal of Hydrology* 595, 126031.
- Szilagyi, J., 2021. On the thermodynamic foundations of the complementary relationship of evaporation. *Journal of Hydrology* 593, 125916 [https://doi.org/10.1016/j. jhydrol.2020.125916].
- Szilagyi, J., Crago, R., Qualls, R. J., 2021. Reply to Comment by S. Han and F. Tian on "A calibration-free formulation of the complementary relationship of evaporation for continental-scale hydrology" by J. Szilagyi et al., Journal of Geophysical Research-Atmosphere, 10.1029/2021JD034685.
- Turk, J.K., and Young, RA., 2021. A novel approach for teaching soil texture estimation: replacing standard protocols with directed selfcalibration. *Journal of Geoscience Education* DOI: 10.1080/10899995.2021.1891402.
- Wells, M J., **Gilmore, T.E.**, Nelson, N., Mittelstet, A., and Böhlke, J.K, 2021. Determination of vadose zone and saturated zone nitrate lag

times using long-term groundwater monitoring data and statistical machine learning, *Hydrology and Earth System Science* 25: 811–829 [https://doi.org/10.5194/hess-25-811-2021].

Westrop, J.P., Snow, D.D., and Weber, K.A., 2021. Mobilization of naturally occurring uranium under intensely managed farmland, p. 215-233 in: Ray, C., Muddu, S., and Sharma, S. (eds), *Food, Energy, and Water Nexus. A Consideration for the 21st Century.* Springer Nature.

Wilkening, E., Heeren, M.D., Hallum, D., Schellpeper, J., and Martin, D.L., 2021. Impact of irrigation technologies on withdrawals and consumptive use of water. ASABE Annual International Meeting, Paper No. 2101114, 11 pp [DOI: https://doi.org/10.13031/ aim.2101114].

Young, A.R., Burbach, M.E., & Howard, L.M., Lackey, S.O., and Joeckel, R.M., 2021. Nebraska statewide groundwater-level monitoring report – 2020. School of Natural Resources, University of Nebraska-Lincoln, Water Survey Paper 88.

Video Tutorials by CSD Personnel in 2021

Cameron, K., 2021. "AEM Data on ENWRA Website." Eastern Nebraska Water Resources Assessment [https://www.enwra.org/ downloads.html].

- Cameron, K., 2021. "AEM Data in Google Earth Tutorial Part 1." Eastern Nebraska Water Resources Assessment [https://www.cloudhq. net//screencast/366d32440a04b6].
- Cameron, K., 2021. "AEM Data in Google Earth Tutorial Part 2." Eastern Nebraska Water Resources Assessment [https://www.cloudhq. net//screencast/7f5c4672dcb151].
- Cameron, K., 2021. "AEM Data in Google Earth Tutorial Part 3." Eastern Nebraska Water Resources Assessment [https://www.cloudhq. net//screencast/03d38c56d0edf3].
- Cameron, K., 2021. "AEM Data in Google Earth Tutorial Part 4." Eastern Nebraska Water Resources Assessment [https://www.cloudhq. net//screencast/305abe09f3535d].
- Cameron, K., 2021. "AEM Data in Google Earth Tutorial Part 5." Eastern Nebraska Water Resources Assessment [https://www.cloudhq. net//screencast/8f123c5c6ace9c].

Organizations for which CSD Personnel Fulfilled Requests for Information, Consultation or Services in 2021

Adaptive Resources, Inc. Advance Resources International Advantek Waste Management Services, LLC American Association of Petroleum Geologists Aqua Africa Audubon Society Bartlett and West Consulting Engineers *Basin Research* (journal) Battelle Memorial Institute Black Hills Energy Budapest University of Technology and Economics Bullock, Inc. Oil Exploration and Oil Well Services Butler County, Nebraska California Geological Survey Catena (journal) Cedar Knox Rural Water Project Central Platte NRD Chemical Geology (journal) China Science and Technology Network City of Gering, Nebraska City of New York, New York City of Norfolk, Nebraska City of Scottsbluff, Nebraska Darrah Oil Department of Earth and Atmospheric Sciences, UNL Dougherty Water for Food Global Institute Duck Creek Ranch *Earth Science Reviews* (journal) Eastern Nebraska Water Resources Assessment Elk Creek Resources Geoderma (journal) Haliburton Co. Hawke's Bay Regional Council (New Zealand) HDR Hydrological Processes (journal) Hydrology and Earth Systems Sciences (journal) Indian Health Service Institut National de la Recherche Agronomique (France) Iowa Geological Survey JEO Consulting Journal of Geosciences Education (journal) Journal of Hydrology (journal) Journal of Soil and Water Conservation (journal) Kansas Geological Survey Kappa Ethanol Commodities, LLC Korea Advanced Institute of Science and Technology Layne-Western Co. Leonard Rice Engineers, Inc. Lewis and Clark NRD Lower Elkhorn NRD Lower Loup NRD Lower Niobrara NRD Lower Platte North NRD Lower Republican NRD Middle Niobrara NRD Middle Republican NRD Minnesota Geological Survey National Ecological Observation Network National Groundwater Monitoring Network National Science Foundation Natural Resources Conservation Service Nature Communications (journal) Nebraska Department of Energy and Environment Nebraska Department of Health and Human Services Nebraska Department of Natural Resources Nebraska Envirothon Nebraska Farmer (magazine) Nebraska GeoCloud Nebraska Geological Society Nebraska Hop Growers Nebraska Legislature Nebraska Oil and Gas Conservation Commission Nebraska Water Leaders Academy

Nebraska Water Science Center Nebraska Water Well Standards and Contractors' Licensing Program North Carolina State University North Platte NRD North Platte NRD Occidental Petroleum Office of Senator Deb Fischer Papio-Missouri River NRD Pennsylvania State University Petrotek Corporation PGM Resources LLC Playa Lakes Joint Venture **Primary Resources** Quaternary International (journal) **Rock Barn Outfitters** Sandhills Interactive Natural Resources **Education Complex** Science of the Total Environment (journal) Settje Agriservices & Engineering Shell Oil Co. South Platte NRD State of California Subsurface Modeling LLC Texas A & M University Town of Hickman, Nebraska Town of Stuart, Nebraska Tri-Basin NRD Twin Platte NRD United States Fish and Wildlife Service United States Public Health Service United States Geological Survey University of California, Los Angeles University of Nebraska-Lincoln University of Texas at Austin University of Toronto Upper Niobrara-White NRD Upper Republican NRD USDA Foundational and Applied Science Program USDA North Central Region Water Network **USGS Fundamental Science Practices** Utah Core Research Center Utilities Services, Facilities Maintenance and Operations, UNL Village of North Bend, Nebraska Village of Dawson, Nebraska Water for Ag Multistate Research Project Water Resources Research (journal) Western Nebraska Community College

Selected Objectives for 2022

Gilmore, Waszgis, Szilagyi, Hanson, Korus, Turk, Burbach, Young, Steele, Hallum, Joeckel, Cameron, Lackey

- Assessment of critical minerals in Forest City Basin and environs
- Begin characterization of hydrogeologic framework of eastern Knox County and parts of Cuming and Burt counties
- Cenozoic fluvial systems of the Great Plains
- Complete NGWMN commitments and observation-well upgrades
- CSD test-hole database
- Demonstration of evapotranspiration estimation accuracy by complementary relationship method
- Develop cyberinfrastructure and interactive GIS
- Development and evaluation of Nebraska Water Leaders Academy
- Development of method for field estimation of SOC in Nebraska soils
- Development of online mapping interface for historic aerial photos
- Documentation of Cretaceous paleoclimates and global carbon-sysle changes
- Documenting historic changes in Nebraska soils in relation to land use
- Eastern Nebraska Regional Groundwater Recharge Mapping
- Eastern Nebraska Water Resources Assessment
- Ecohydrologic studies using ground-based camera networks and new cyberinfrastructure
- Geology and formation of Nebraska's Rainwater Basins
- Groundwater installations and outline tutorial sessions to Sandhills Interactive Natural Resources Educational Complex (SINREC) at Valentine
- Groundwater transit times, nitrate, and solute delivery to streams

- Human dimensions of natural-resources management
- Increase production of surficial geologic maps through U.S. Geological Survey

STATEMAP Cooperative Geologic

- Mapping Program
- Integration of airborne EM and groundwater model applications
- Investigation of possible localized land-surface subsidence
- Mapping and analsis of eolian erosional landforms on Great Plains,

including Nebraska

- Nebraska Core Preservation, Inventory and
- Database, Phase II: Dam and
- Infrastructure Study Core
- Nebraska Critical Minerals Database, Phase II: Elk Creek carbonatite sample and data preservation
- Nebraska Critical Minerals Strategic Plan
- Nebraska GeoCloud
- Nebraska Groundwater level monitoring program
- Nebraska Groundwater Quality Database Phase II enhancements and interface with new data acquisition
- Publication of open-access groundwater tracer textbook
- Revisions of regional Pennsylvanian stratigraphy
- Stream-groundwater relationships of the lower South Platte River
- Update CSD groundwater maps (elevation of water table and aquifer saturated thickness)
- Watershed science education through NebraskaWAVES program





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