

Nevada Water News

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Photo by DRI Science

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Pharmaceuticals, PFAS, Controlled Substances, and Other Contaminates in the Waters of the Las Vegas Wash and Their Impacts on the Wider Environment

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Nevada is a popular travel destination and one of the fastest-growing states in the nation. However, this increase in human activities also means increases in wastewater flow and fluctuations in the presence of emerging contaminants (ECs). For example, studies have found that EC levels increase during holiday seasons, weekends, and major social events such as music festivals (Bijlsma et al., 2009; Jiang et al., 2015; Kasprzyk-Hordern et al., 2009; Kim et al., 2017). Understanding these changing

EC levels and their effects on the wider environment is critical for improving water quality and wastewater management systems and ensuring environmental and human health.

Many ECs are mass-produced chemicals (such as pharmaceuticals, surfactants, plasticizers, PFAS compounds, and illicit drugs) that are used by humans daily. These chemicals eventually enter the environment and negatively affect waterways and aquatic

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If you have questions about submitting a NWRRRI proposal, email Suzanne Hudson (Suzanne.Hudson@dri.edu).

Visit the NWRRRI website (www.dri.edu/nwrrri) for current RFP information.



(Project Spotlight continued)

environments, as well as soil and sediments. “Humans depend on a large and complex food web for everything we eat, so understanding the extent of ECs in the environment helps us understand the potential risks of exposure,” says Dr. Douglas Sims, Dean of the School of Science, Engineering, and Mathematics at the College of Southern Nevada (CSN) who is the principal investigator (PI) of the project. “All agriculture uses these waters to grow and raise our food, so any resource that consumes or uses waters from

rivers such as the Colorado will be a conduit for ECs to enter the human food web.”

The focus of this project was to evaluate the extent of ECs in the Las Vegas Wash, which is the primary drainage channel for the Las Vegas Valley into Lake Mead (LVWCC, 2000), by analyzing water samples for target ECs, pharmaceuticals, PFAS, and illicit drugs. Flow from the Las Vegas Wash is comprised of reclaimed water (i.e., treated wastewater), urban runoff, shallow groundwater, and stormwater. The project team—which

includes Drs. Mark Garner, Amanda Hudson, and Desta Demissie and Mr. Josh Munk of CSN—selected the Las Vegas Wash as the study area because it contributes approximately two percent of the water to Lake Mead (SNWA, 2022). Areas with high populations have higher levels of these contaminants, which makes ECs even more of a concern for urbanized areas that are continuing to grow, such as Las Vegas.

The goal of the project was to understand the effects of ECs on the wash and the wider environment under stress from climate change and increasing populations. “The main concern about the ubiquitous presence of ECs is the long-term, sublethal effects of ECs on surface waters,” explains Sims. “Moreover, with climate change affecting the volume of water in the Colorado River, ECs present in tributaries such as the Las Vegas Wash will continue to increase over time. To address these concerns, we assessed the impacts to the wider environment by studying the effects ECs had on biota in the aquatic environment, such as on their reproduction, as well as how the effects on aquatic biota impacted the larger food web, such as bird populations.” The



Co-PI Josh Monk explaining the processes for sample collection to undergraduate CSN students involved in the project (photo courtesy of Douglas Sims).

(Project Spotlight continued)

team also assessed the occurrence and risks of EC biproducts in Las Vegas Wash surface waters, as well as the potential effects of the chronic daily intake and water quality and health risk indices for selected compounds.

To evaluate the spatial distribution of ECs in the wash system, the team collected samples from multiple locations along the Las Vegas Wash every 20 days from March 1 through June 6, 2022. The team chose this time frame because water would be available for sampling, flow conditions were less likely to drop in volume than in the summer, and the aquatic biota of interest would be sufficiently developed for collection and identification. Samples were also collected for the presence or absence of contaminants across 10 locations during the collection period. The team filtered the samples and analyzed the target compounds using a direct injection, high-performance



The LC-MS/MS at the CSN West Charleston Campus used to analyze the water samples for ECs (photo courtesy of Douglas Sims).

liquid chromatography–tandem mass spectrometry (LC-MS/MS) system located on the CSN West Charleston Campus.

In addition to common ECs, project personnel also analyzed samples for the presence of illicit drugs because they are understudied but their use for medical and recreational

purposes has increased. “With the increased use of recreational drugs, more research is needed to identify any long-term impacts from sublethal levels not only on waters, but also on the food web,” Sims explains. “Water agencies need to be prepared to mitigate these effects when it comes to drinking water across drought-impacted regions both

This project has also been featured in the following news stories:

- “Researchers find ‘forever chemicals’ in water across West, meth in snow near Las Vegas” by David Charns (8 News Now, KLAS, Las Vegas, posted June 27, 2023).
- “College of Southern Nevada part of global water study” by Les Krifaton (Fox5, KVVU-TV, Las Vegas, posted September 5, 2022).
- “I-Team: Drugs in Las Vegas wastewater explode during EDC; NFL Draft brings uptick in medication, researchers find” by David Charns (8 News Now, KLAS, Las Vegas, posted August 4, 2022).
- “I-Team: Las Vegas researchers find illicit drugs, medication, caffeine in Lake Mead” by David Charns (8 News Now, KLAS, Las Vegas, posted May 5, 2022).

(Project Spotlight continued)

locally and globally. In addition, the food web is interconnected with everything we do as humans, so knowing the long-term impacts of these substances is very important.”

The importance of including illicit drugs in EC analysis is reflected by the data the researchers collected during the project. “During the NFL draft and Electric Daisy Carnival music events of 2022, seven ECs were detected in the Las Vegas Wash that included prescription and over-the-counter compounds ranging from 25 to 114 ng L⁻¹ of atenolol, 0 to 9.2 ng L⁻¹ of bezafibrate, 95 to 216 ng L⁻¹ of carbamazepine, 0 to 4 ng L⁻¹ of diazepam, 330 to 884 ng L⁻¹ of metoprolol tartrate, 46 to

121 ng L⁻¹ of naproxen, and 59 to 192 ng L⁻¹ of diclofenac acid that varied by event, day, and demographics,” Sims says. “This study also found four illicit drugs ranging from 8 to 41 ng L⁻¹ of benzoylecgonine [cocaine], 14 to 192 ng L⁻¹ of ketamine, 3.5 to 2,118 ng L⁻¹ of MDMA, and 13.7 to 194 ng L⁻¹ of methamphetamine that also varied by event, day, and demographics. Some prescription and illicit drugs were not detected in the wash, such as THC, which was likely due to a robust treatment process removing such compounds.”

This project also included a teaching component to promote the entry of new student researchers in the water

resources research field.

“Students from both CSN and the University of Nevada, Las Vegas [UNLV] who worked with our team learned how to deploy a project, which included field planning and sampling, sample logging, sample preparation, analysis techniques, data review and interpretation, building a poster, and writing a manuscript,” Sims says. “But most importantly, they learned teamwork and comradery—and that it is cool to be a scientist!”

The teaching component also gave faculty the opportunity to train students in scientific research methodologies in the field and laboratory instead of just the classroom, encouraging them to conduct research that

ECs and illicit drugs detected in the Las Vegas Wash during the study:

Atenolol: Used for high blood pressure.

Bezafibrate: A lipid-lowering agent to treat hyperlipidaemia.

Carbamazepine: Used to treat certain types of seizures and bipolar disorder, and relieve pain caused by trigeminal neuralgia.

Diazepam: Used to treat anxiety disorders and alcohol detoxification, acute recurrent seizures, severe muscle spasms, and spasticity associated with neurologic disorders.

Metoprolol tartrate: Used to treat high blood pressure.

Naproxen: A nonsteroidal anti-inflammatory drug (NSAID) used for pain relief.

Diclofenac acid: An NSAID used for swelling and pain.

Benzoylecgonine: The main metabolite of cocaine excreted in the urine of cocaine users after the drug is processed in the liver.

Ketamine: A dissociative anesthetic used medically during anesthesia that is also used as a treatment for depression, a pain management tool, and as a recreational drug.

MDMA (3,4-Methylenedioxymethamphetamine): Used for recreational purposes for its short-term psychoactive effects.

Methamphetamine: A central nervous system stimulant mainly used as a recreational drug that is also less commonly used to treat attention deficit hyperactivity disorder and obesity when initial treatments either don't work or stop working.

(Project Spotlight continued)



The team collecting water samples at Lake Mead and the Colorado River (left: PI Douglas Sims; right: co-PI Josh Monk working with co-PI Desta Demissie, a Fulbright Visiting Scholar from Ethiopia; photos courtesy of Douglas Sims).

engages two-year college students and motivates nontraditional, underrepresented students to pursue STEM careers. “With all of our projects, we always build in peer-led learning to inspire and excite all students about a career in STEM,” Sims adds. “Our large network with DRI, UNLV, and other institutes helps guide students in any

direction they choose with our overall team of scientist through direct learning.”

The team presented two project posters during the Nevada Water Resources Annual Meeting and the Desert Symposium in California. They also have a manuscript currently in review titled “Spatial-temporal distribution of pharmaceuticals

and illicit drugs in the surface waters of the Las Vegas Wash (Las Vegas, Nevada, USA),” which is under review with a high-impact journal at this time. The work conducted for this project has also led to other projects. “Because of this project, we received a state grant (\$200,000) to engage students across Nevada and beyond to

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– Douglas Sims

(Project Spotlight continued)

look at ECs in rivers across the eleven western states, with data thus far showing similar trends of both prescription and illicit drugs,” Sims says. “For this larger project, we have completed the LC-MS/MS analysis and we’re putting together manuscripts based on the results. We are also working on a grant with Dr. Duane Moser (DRI) to expand the project across the rest of the United States that will build one of the most comprehensive datasets for ECs.”

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Events List

Please keep an eye on the event websites for changes in conference schedules.

2023 Sustainable Agronomy Conference
July 12, 19, 26, & August 2, 2023
Online
www.agronomy.org/meetings/sustainable-agronomy

Marlette Lake Tour
September 12, 2023
Carson City, NV
www.nvwra.org/2023-marlette-lake-tour

2023 NWRA Fall Symposium
September 13 & 14, 2023
Reno, NV
www.nvwra.org/2023-fall-symposium

2023 NWRA Walker River Tour
September 15, 2023
Sparks, NV
www.nvwra.org/2023-walker-river-tour

2023 Tahoe Science Conference
October 11-13, 2023
South Lake Tahoe, CA
www.nvwra.org/2023-tahoe-science-conference

GSA Connects 2023
October 15-18, 2023
Pittsburgh, PA
community.geosociety.org/gsa2023/home

2023 ASA, CSSA, SSSA International Annual Meeting
October 29-November 1, 2023
St. Louis, MO (limited virtual)
www.acsmeetings.org/

2023 UNLV/NWRA Dinner Forum
November 1, 2023
Las Vegas, NV
www.nvwra.org/unlvnwra-dinner-forum

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Student Interview: Tejinder Singh

We asked Tejinder Singh, who is a second-year graduate student in the School of Life Sciences at UNLV and worked on the NWRRI COVID-19 wastewater monitoring project, about his current studies and plans for the future. Here's what he had to say:

1) What field are you currently studying and what sparked your interest in that field?

I am currently pursuing an MS in microbiology from UNLV. Honestly, I never thought of pursuing microbiology back when I was an undergrad. It was my exposure to astrobiology that made me interested in microbiology. When we think about astrobiology (i.e., life in outer space), we don't anticipate finding large animals or plants elsewhere (of course it would be awesome if we did!), but we do look for small organisms that are otherwise invisible to the naked eye.

2) You worked on the NWRRI project "Strain-specific Monitoring of SARS-CoV-2 in Rural Wastewater Systems." What did you learn from your experience on that project?

Because I'm in the lab most of the time, it was good for me to get fieldwork experience and this project allowed me the opportunity to do some fieldwork.

3) Was there anything that you learned while working on this project that

you found particularly interesting or surprising?

While collecting wastewater samples, I got to learn a lot about different bird species, both native and migratory, from Dr. Moser (who is an ardent birdwatcher) because they frequently visit the wastewater systems for their water needs.

4) What are you currently studying/researching and what do you hope to learn more about?

Currently, I am involved in a project funded by the NASA Habitable Worlds program. The objective of this project is to explore the possibility of surface life on Mars by studying lichens and cyanobacteria found in the Mojave Desert. Specifically, I am investigating how these organisms can resist high levels of ultraviolet C (UV-C) and gamma radiation. Although the project's primary focus is to answer whether life could survive on Mars, it has the added benefit of deepening our understanding of these often-overlooked organisms. Moreover, the resistance mechanisms we uncover could have practical applications in the field of medicine, such as developing effective UV-blocking sunscreens and



Photo courtesy of Tejinder Singh

powerful antioxidants to combat diseases such as cancer.

5) What are your goals for the next steps in your studies/career?

My goal is to continue working in a collaborative and interdisciplinary setting, similar to what I'm currently doing. This type of work is often found in organizations such as NASA, where scientists from different disciplines work together to tackle fundamental questions, such as "What is life and how do we look for it elsewhere?" As someone who hails from a small town in the Punjab state of India, where most people are not exposed to such opportunities, I also see myself engaging in science outreach.

(Continued on page 8)

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Tejinder Singh

(Student Interview continued)

6) What is one of your favorite movies or books and why?

One of my favorite books is *Sapiens* by Yuval Noah Harari. I read it back in 2017 and since then, I haven't found any book that has impacted my thinking the way this book did (partly because of my interest in evolution and history). Harari logically explains why only we, *Homo sapiens*, are flourishing today, whereas other human species such as *Homo neanderthalensis* are no longer in existence. He doesn't end there but it starts with that question and later talks about the whole of human history from before the hunter-gatherers to the

industrial era. What's different from history books is that he does not dictate history but tells all the "whys" and "hows."

7) If you had six months with no obligations or financial constraints, what would you do with the time?

If I had time with no obligations, I would go back to my hometown and spend time in my ancestral home working on my farm: growing my own veggies and managing farm animals, essentially becoming self-sufficient and not relying on food from grocery stores. Why? To take a break from

busy city life and processed foods! In my spare time, I would like to read all the unfinished books that have been hanging around me for ages now! ■

Events List Continued

Please keep an eye on the event websites for changes in conference schedules.

AWRA 2023 Annual Water Resources Conference
November 6-8, 2023
Raleigh, NC
www.awra.org/Members/Events_and_Education/Events/2023-Annual-Conference/2023_Annual_Conference.aspx

NGWA Groundwater Week 2023
December 5-7, 2023
Las Vegas, Nevada
groundwaterweek.com/

AGU23
December 11-15, 2023
San Francisco, CA
www.agu.org/Fall-Meeting/Pages/Attend

2024 NWRA Annual Conference Week
January 29-February 1, 2024
Las Vegas, NV
www.nwra.org/2024-annual-conference-week



Photo by Jackson Crews

Chapman Conference: Remote Sensing of the Water Cycle
February 13-16, 2024
Honolulu, HI
www.agu.org/Chapman-Remote-Sensing

NWRRRI - Nevada Water Resources Research Institute

Success and the dedication to quality research have established the Division of Hydrologic Sciences (DHS) as the Nevada Water Resources Research Institute (NWRRRI) under the Water Resources Research Act of 1984 (as amended). As the NWRRRI, the continuing goals of DHS are to develop the water sciences knowledge and expertise that support Nevada's water needs, encourage our nation to manage water more responsibly, and train students to become productive professionals. The work conducted through the NWRRRI program is supported by the U.S. Geological Survey under Grant/Cooperative Agreement No. G21AP10578. The Desert Research Institute (DRI) administratively houses and logistically supports the operations of the NWRRRI.

About DRI

The Desert Research Institute (DRI) is a recognized world leader in basic and applied environmental research. Committed to scientific excellence and integrity, DRI faculty, students who work alongside them, and staff have developed scientific knowledge and innovative technologies in research projects around the globe. Since 1959, DRI's research has advanced scientific knowledge on topics ranging from humans' impact on the environment to the environment's impact on humans. DRI's impactful science and inspiring solutions support Nevada's diverse economy, provide science-based educational opportunities, and inform policymakers, business leaders, and community members. With campuses in Las Vegas and Reno, DRI serves as the nonprofit research arm of the Nevada System of Higher Education. For more information, please visit www.dri.edu.

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Banner photo: A classic Nevada landscape showing the red rocks. Photo by DRI Science.

Pages 2-5: Project photos courtesy of Douglas Sims.

Page 7: Photo courtesy of Tejinder Singh.

Events list, page 8: A pinion pine undercut by a monsoonal flash flood in Lincoln County, Nevada. Photo by Jackson Crews.