



**GRAND VALLEY WATER
WORKFORCE NEEDS
ASSESSMENT**

A Project of the Ruth Powell Hutchins Water Center

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COLORADO MESA
UNIVERSITY

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Introduction

In a changing water landscape, Western Colorado communities are facing the need to find solutions to new challenges. This report seeks to illuminate the work of people involved in water management, the information and skills they need to succeed, and how students can access water-related professions.

A wide variety of professions across the Grand Valley and western Colorado require some degree of knowledge and skill related to water. These include personnel directly involved in the distribution of irrigation and drinking water, engineers who design water management infrastructure, consultants who develop environmental compliance plans, staff at government agencies with regulatory and stewardship responsibilities, and nonprofits involved in environmental policy, restoration and education.

For this project, Hutchins Water Center staff interviewed 30 people in a broad cross-section of these organizations in order to better understand their water-related workforce skill and knowledge needs. The purpose was to gain insights into how CMU could better prepare students to enter these professions, and how the Hutchins Water Center could better serve these agencies' continuing education needs. This document can also help students understand water career opportunities and pathways.

The following skills and knowledge areas were listed frequently as important across multiple water-related professions:

- Basic hydraulics
- Math, from basic to advanced calculus
- Strong writing and oral communication
- The ability to do fieldwork
- Project management
- Geographic Information Systems (GIS)
- Supervisory control and data acquisition (SCADA)
- Colorado water law
- Environmental laws (Clean Water Act, National Environmental Policy Act)
- Hydrologic modeling
- Surveying

As a community, our ability to manage and protect water resources effectively is also influenced by public attitudes and decisions. With that in mind, interviewees were asked what they wished the general public and community leaders better understood about water. Answers included:

- The magnitude of anticipated water supply challenges
- The importance of water infrastructure
- Policies governing water

The next phase of the project will involve engaging CMU faculty to review this document and comment on how existing curriculum and capacities do and could respond to our local water community's workforce and community education needs.

Organizations and individuals involved in water management

This section provides an overview of the roles of various individuals and organizations involved in different aspects of water management in the Grand Valley and western Colorado. The subsequent section outlines workforce skill and knowledge needs for people with different roles in these organizations.

Irrigation water management

Irrigation water management involves building and maintaining diversions, canals and ditches; ensuring that available water is distributed according to legal rights and priorities; and applying irrigation water to the land. In addition to carrying out these basic functions, various entities assist with projects to enhance irrigation efficiency and reduce the environmental impacts of irrigation.

People and organizations involved in this work include the following:

- Farmers and ranchers – directly applying water to the land.
- Irrigation water providers – delivering water to farmers and ranchers, as well as to ditches and laterals serving multiple water users.
- Colorado Division of Water Resources – ensuring that water is delivered according to Colorado’s water rights system.
- US Bureau of Reclamation, Water Management Group - managing Reclamation dams and facilities, as well as programs to improve habitat, water quality and water use efficiency.
- US Natural Resource Conservation Service – assisting farmers and ranchers with the conservation and efficient management of resources on their properties, including irrigation water.
- Mesa Conservation District – setting conservation priorities and assisting local landowners with conservation issues, including water management.
- Realtors – educating new residents about how water is managed in our region, including irrigation water.

Water treatment

Water and wastewater treatment starts with the protection and collection of source water, proceeds to treatment and distribution of drinking water, and then ends with collection and cleaning of wastewater before discharging it back into the environment. Organizations involved include water and wastewater utilities from large to very small scales, regulatory agencies and organizations that provide assistance and training to treatment system operators.

- Municipal water utilities – collection, treatment and distribution of potable water, as well as collection, treatment and discharge of wastewater.
- CO Water Quality Control Division – inspection of water and wastewater facilities, as well as developing and updating water quality regulations.
- CO Source Water Protection Planning/ CO Rural Water – Colorado Rural Water works with the CO Source Water Protection and Planning Division to assist small utilities with source water protection and the operation of their utilities in compliance with regulations.
- Park facilities – Parks that provide potable water and toilet facilities have staff that carry out the same functions as water utilities for small communities.

Natural resource stewardship and regulation

Federal and state land management and regulatory agencies play key roles in managing and protecting water resources.

- US Forest Service – stewardship of natural resources, including water resources, and regulation/ permitting of activities carried out on the Forest by others, including entities involved in drinking and irrigation water management.
- US Army Corps of Engineers – regulation and permitting of activities with the potential to affect wetlands and waterways.
- US Bureau of Land Management – stewardship of natural resources on BLM lands and regulation/ permitting of activities carried out on these lands by others.
- US Bureau of Reclamation, Environment and Planning section – ensuring that activities on BOR land or that use BOR funds comply with environmental laws.
- CO Parks and Wildlife – stewardship of natural resources in parks, as well as management of water rights and infrastructure for fish hatcheries, parks, and park facilities.
- CO Natural Monument – stewardship of natural resources in the Monument, maintenance of facilities, and education of visitors.
- CO Water Quality Control Division – developing and enforcing regulations to protect water quality.

Consulting Firms

A variety of consulting firms provide technical services for other entities involved in the management and stewardship of natural resources. These types of services include the following:

- Civil Engineering – planning, design and assessment of water infrastructure.
- Hydrogeological consulting – assessing interactions between surface and groundwater and potential movements of pollutants as well as developing monitoring plans.
- Environmental Consulting – assessment of potential risks to water resources from built infrastructure, and planning and design of restoration strategies.
- Water Law and related technical investigations – assisting with the acquisition and defense of water rights.

Nonprofit organizations: education, advocacy and stewardship

A variety of nonprofit organizations work to protect and restore land and water resources in Mesa County and beyond, as well as provide outdoor and environmental education opportunities. These include Conservation Colorado, Colorado West Land Trust, Colorado Canyons Association, and RiversEdge West.

Workforce Skill & Knowledge Needs

Irrigation Management Organizations

This section outlines the skill and knowledge needs for different roles in irrigation water management.

Farmers and ranchers

Western Colorado farmers and ranchers grow a wide range of crops, with the majority of the region's acreage and water dedicated to hay production. Irrigation is necessary to produce crops in this arid climate, and each producer has their own unique combination of circumstances related to water availability, soils and crop needs.

Skill and knowledge needs

Irrigators need to understand the basics of Colorado Water Law, their own water rights, and how that relates to when and how much water they will get. If they have reservoirs or other infrastructure on public lands, they need to know how to comply with the relevant Forest Service or Bureau of Land Management regulations as they conduct maintenance and repairs. They also need to understand and be able to work with the other entities involved in managing irrigation water, including their local Water Commissioner and their ditch company or local water users' association.

Successfully applying water to the land to raise a crop requires substantial technical skill and knowledge of soil conditions and crop needs. In addition, keeping an agricultural operation financially afloat requires the ability to assess the operation financially and do cost-benefit analysis on crop and irrigation choices. There's a lot of risk involved in trying new crops and expensive irrigation systems, but these strategies may become necessary as the region faces drier conditions.

Irrigation water providers

Occupations with responsibilities for water management in the organizations that provide irrigation water (Districts, Associations and Companies) include Field Technicians/ Ditch Riders, Field Supervisors, Operations and Maintenance staff, Office Managers, Administrative Assistants and Managers/ Superintendents.

Skill and knowledge needs

Entry-level Field Technicians and Ditch Riders spend most of their time dealing with water distribution issues and broken infrastructure. They need to have some knowledge of plumbing, construction techniques, pipe installation, heavy equipment operating, and safety precautions, as well as how water works physically: basic hydraulics. They also need to have the "people skills" to be able to resolve issues between water users. It's also helpful if they have some knowledge of the kinds of legal issues that come into play in relation to managing irrigation water: water law, easements and property rights.

Field Supervisors and Operations Managers make sure that the necessary field activities and maintenance work are being done, as well as use newer technologies, like the supervisory control and data acquisition (SCADA) systems to manage large water distribution systems. They also need to know how hydraulics work in the river, canals and pipelines.

Office and administrative staff take care of business management, accounting and answering phones. They need to have basic knowledge of easements, water law, and how the district runs in order to handle shareholder inquiries.

Managers and Superintendents who oversee the entire systems need to not only understand their own systems, but also how their systems fit in with water law, basin dynamics, other water organizations, and the latest developments on the Colorado River. An emerging need relates to the conversion of large amounts of agricultural land to residential housing. According to one interviewee, irrigation providers have to figure out how to blend 19th century law, early 20th century infrastructure and 21st century expectations to keep their constituents happy.

Basic skills broadly needed across occupations for irrigation providers include basic writing skills and basic math: geometry, measurement, and calculating volumes.

Continuing education

Continuing education that is useful for the irrigation provider workforce involves strengthening and obtaining practical skills in areas like welding, heavy equipment, construction skills & safety, business management, accounting, rigging, safety, CPR and traffic flagging.

An orientation to water in the Grand Valley and on the Western Slope would also be useful for irrigation provider employees: the general “plumbing” of the Grand Valley, mixing classroom instruction and tours. This would help them do their jobs better and look more credible to the public they serve.

A water certificate program that could be useful for potential managers would cover water management skills, soil-water-plant relationships, practical applications of irrigation concepts, hydrology, river dynamics and easements.

For board members and supervisors, information on water management, policies and regulations is valuable.

Colorado Division of Water Resources

The Colorado Division of Water Resources has the responsibility for ensuring that water rights are administered in accordance with the state’s priority system. Entry-level Deputy Water Commissioners have permanent part-time, 6-9 month seasonal positions. They provide the boots on the ground for the agency, turning headgates and inspecting water court applications. Full-time Water Commissioners are responsible for an entire district, and Lead Water Commissioners supervise Water Commissioners and Deputy Water Commissioners. The Division of Water Resources also employs engineers, office staff and augmentation groups that review augmentation plans, collect diversion information, and manage reservoir releases to replace out-of-priority diversions and depletions.

Skill and knowledge needs

For Deputy Water Commissioner positions, people need a high school education and some kind of work experience in water use or water management. The Division needs people who understand the dynamic and variable nature of water, measurement of open flowing water and detained water, and basic information about water uses. The way water moves through each drainage is different, and Water Commissioners need to understand the hydrological particularities of their territory. Understanding the nature of flow, water, and basic hydrology helps with learning those local particularities quickly.

Any kind of extended work experience related to water is helpful, and knowing the terminology of water is a huge benefit. Education can replace work experience to some extent. The Division does hire new university graduates. A mix of a degree and experience is most competitive, as applicant pools get narrowed from around 50 to about half a dozen finalists for positions. Desirable degrees include Outdoor Resource Management, Forestry, Environmental Science, Engineering and Geology.

Basic knowledge of Colorado water law is important, but that can be taught on the job. The Division does a lot of in-house and on-the-job training. Great communication skills are important for communicating with water users, and those are harder to teach. One of the workforce challenges is finding qualified people who are willing to relocate to the basin they will serve, which can be remote, like the Plateau Valley.

Water commissioners can advance into roles in an Augmentation Group. It's possible to get hired into that job line from within or from outside. Key skills for this work include hydrologic modeling, being able to read and interpret a water right decree, GIS skills, and excel operation and manipulations in order to track different "colors" of water as they move through a system.

Most upper level management positions in the Division require some kind of Engineering degree. It's also important to have enough legal knowledge to interact with lawyers and help with water court applications, and to understand trespass and easement laws and a few key statutes.

Pathways

To break into employment with the Division is difficult, as there are a limited number of sought-after positions. It helps to be willing to start as a Deputy Water Commissioner and work your way up from there.

Internships are another potential opportunity, but they are tied to the state budget. There's also interest in having CMU students work as seasonal employees to develop the skills of people who would be interested in a career with the Division, and address the difficulty the Division has with finding people willing to relocate for seasonal, entry-level positions.

Continuing education

Existing Hutchins Water Center programming on topics like water shortages and demand management is helpful for Division employees. The "Water Law in a Nutshell" classes are useful for new employees both for the information and the networking opportunity. Getting to know water users and developing a professional relationship with them with respect and mutual understanding is helpful.

US Bureau of Reclamation – Water Management

Positions in the Bureau of Reclamation's Water Management Group include a Hydraulic Engineer or Hydrologist, Civil/ Hydraulic Technicians, Repayment/ Contracting people, and running the Bureau's Water Conservation Field Services funding program.

Skill and knowledge needs

Civil and Hydrologic Technicians, entry level positions, need basic civil engineering skills, hydrology, and geology knowledge. They need to be prepared for problem solving and know how to do field work and take measurements. A surveying background is also helpful for Technicians. Construction Management and Project Management skills are useful. They need to be comfortable with technology and

instrumentation out in the field, as well as basic information technology. GIS and GPS skills are useful for working in the Bureau, which is expanding its geospatial databases.

For the Hydrologist position, the Bureau needs someone who can run RiverWare, putting together daily operation models. They need to be comfortable writing code for that, setting up operation models and planning models that look at current year operations with a suite of different inflow scenarios and assess probabilities.

Communication skills are important, as is the ability to work with different stakeholders with different goals to come together to solve problems.

Continuing education

For continuing education, the Bureau sends people to classes on RiverWare at the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) at the University of Colorado. Water law classes, like “Water Law in a Nutshell,” are a good introduction. Something similar but more advanced and geared towards engineers and scientists would be useful. Water Course workshops are good for getting a bigger picture, bigger river perspective. Content tends to be similar from year to year, so the Bureau sends new people to these courses.

Leadership classes are good to learn how to work with other people with different objectives. Staff have done the Water Leaders course through Water Education Colorado and the Bureau’s internal leadership courses.

Partnership opportunities

- It would be beneficial to have someone who could get on the ground and work with the water resources organizations to identify opportunities for grants and how the Bureau could help fund some water conservation. This could be an opportunity to partner with Water Center – the Bureau needs to know what water users need, for delivery systems, not on-farm systems. The Bureau has done workshops and would like to have more to talk about the grant opportunities and how to apply and walk people through the process.
- The Bureau has a lot of old maps related to projects that they are working on putting into GIS. That’s an area for potential senior projects.

Career Pathways

Internships are available for students, and that’s a good way to get started with the Bureau and get exposed to different work areas. Most people come into the Bureau with a bachelor’s degree, and then advancement depends on what they learn along the way. A person who comes in with a technical background, basic problem-solving skills and a willingness to learn can do well. It’s nice if someone comes in with a Professional Engineer (PE) credential, but the Bureau helps people get that certification. A PE isn’t required for a lot of positions.

US Natural Resources Conservation Service

Personnel with the Natural Resources Conservation Service (NRCS) assist farmers and ranchers with the conservation and efficient management of resources on their properties, including irrigation water, by providing technical and financial assistance for voluntary conservation measures. Positions include Conservation Planners, Technicians and Engineers.

Skill and knowledge needs

Conservation Planners with the NRCS need to be able to identify resource concerns in the field, such as water distribution, quantity and quality challenges. They need to understand water law, basics of irrigation and irrigation water management. More detailed information on relative efficiencies of different irrigation systems can be learned after they are hired. It is helpful if they have an agricultural background. Range management positions are harder to fill than others. Requirements include a natural sciences degree with a certain number of soils credits. It is really helpful for candidates to have had direct experience with some kind of natural resource management through an internship or summer job, particularly if that experience involved working with private landowners in voluntary conservation, with a role involving facilitation and not regulation, with projects driven by landowner interests.

Technicians and engineers assess water rights and crop water needs and then design a system. They have to understand water law, water rights, crop needs and water volume and flow calculations. Some of that can be taught on the job. Technical skills include the ability to use auto-CAD computer-aided design software and survey equipment, including GPS.

Technicians don't necessarily need a college degree. To be an Engineer, you need to have an Engineering degree of some kind, but a Professional Engineer credential is not necessary. However, because engineers design systems to convey water, they need to understand hydraulics. Some in-house training is available for planners and technicians. Also, with increasing pressure for irrigation systems to become more efficient, there's a need for skills with designing sprinklers, which also requires an understanding of soil health, because that plays a role in what kind of system will work in a given location.

For technicians and planners, coming in with ARC GIS, AutoCAD and survey experience enables them to hit the ground running a lot faster, although training is available if they don't. Spreadsheet and database skills are also helpful. It's getting harder for the NRCS to find applicants with agricultural backgrounds and experience assessing resources and natural systems, particularly hands-on experience.

Career Pathways

The NRCS has Earth Team volunteer opportunities, and it is possible to get internship credit. Having this experience with the NRCS would make an applicant much more competitive. Student internships through the Pathways program are typically advertised in the middle of winter. In addition to working on irrigation systems, there is also a lot of potential for work on rangeland health and forest health.

Mesa Conservation District

Conservation Districts are special districts with elected boards. They have the latitude to work with federal, state, special district moneys, with corporations, schools, individuals, etc. with anyone who wants to help achieve conservation activities that the landowner wants to achieve. Typically, their main objectives relate to soil health and water, and they focus a large part of their energy on helping farmers and backyard gardeners understand efficient water use.

The Mesa Conservation District currently just has one, part-time employee but is working on grant applications to increase capacity. Important skills for working with the District include the ability to connect with landowners, build partnerships and bring disparate groups together who may not share

the exact same vision – but they share parts of their visions to get jobs done on the ground. Grantwriting and administration capabilities are also important.

Continuing education for board and staff

It is helpful for Conservation District board members and staff to understand who the players are in the local watershed and larger region.

Partnership opportunities

The District can get grants to give educational seminars and pay speakers, and they need to be able to promote these. The District could also potentially set up a mentoring program for people interested in getting into farming.

Realtors

Realtors play an important role in educating new landowners about how water management works in the Grand Valley – even though they aren't necessarily always very knowledgeable about the topic themselves. At the most practical level, irrigation needs and how to access irrigation water are most important: which water provider to contact for which locations, how to get access to irrigation shares, and negotiating dynamics between homeowners' associations and irrigation water providers.

Partnership opportunities

The Grand Junction Area Realtors Association (GJARA) has an education committee that puts together courses, which the Hutchins Water Center could help with and get accredited for continuing education credit. There's an effort to develop a "local expert" designation, and taking a course on water would be a requirement for getting that designation, an idea borrowed from Vail. Strengthening communication between the Center and GJARA would be helpful.

Water Treatment

Municipal water utilities

The collection, treatment and distribution of domestic water, as well as the collection, treatment and discharge of wastewater, are highly regulated activities with significant technical requirements. Utilities range from specialized entities serving larger populations to "jack of all trades" utilities that carry out all functions for smaller towns. Public lands agencies with visitor facilities also have to run small water treatment systems, so they need for people with similar skills.

Skill and knowledge needs

In municipal utilities, there are some occupations for which much of the training can be done in house, such as Plant Operators, Field Technicians, and people taking care of the watershed. For others, such as lab personnel, personnel running SCADA systems, electricians and engineers, employees have to come in with a good base of experience.

For a larger utility like the City of Grand Junction, entry level jobs include Operator positions in the water plant and pipeline maintenance. Both of these jobs have four levels of certification, and employees can move up as they pass tests. Many applicants come in with little experience and get training on the job.

To get hired, it is helpful to have some kind of water-related experience, such as working in a water lab or reading meters. Some kind of water or utility experience helps employees understand how a utility runs.

In smaller systems, every employee needs to be able to do everything to manage the system. People are cross-trained, getting trained on the job or via training from equipment salespeople on their products.

Water plants

For a water plant Operator, a certification shows that a person is willing to put in the work, but each plant has its own nuances that employees need to learn on the job. On the mechanical side, skills with SCADA and low voltage electrical systems are important. A person who has aptitude, a base of scientific understanding, which could come from a degree in math or science, good communication skills and a good work ethic can be trained to run the plant.

For water and wastewater systems, promoting from within the organization is common. Having certifications is helpful, and people can get those by studying manuals and then passing exams. College classes like those offered through Western Colorado Community College can be helpful, although in-person classes can be inconvenient for people who are working.

Distribution systems

Pipeline Maintenance is the entry level work for water distribution systems. This involves fixing water leaks, doing valve maintenance, flushing hydrants and installing pipelines. For this work, people need mechanical aptitude, and to be good at handling conflict and other interpersonal issues in a professional way.

Water quality lab

Water quality labs employ analysts and specialists, and these are middle-tier positions. Employees need to come in with lab skills. Hiring is based on skills applicants have already, because they can't be trained on the job. People with Chemistry majors and medical technology backgrounds are often hired, or people with experience working in other labs.

In-demand skills

It's hard to find applicants with skills in SCADA and electronics, as well as computer programming skills and the ability to display information in visually appealing and decipherable ways. A growing need for operators is to be able to do the paperwork to explain what they are doing and prove that it is working. It's a different skill than being able to operate the plant effectively.

Consultants

Consultants are occasionally hired to do SCADA and electronics work, meter calibrations, and hydraulic modeling, as well as engineering and project management and water modeling to calculate firm yields and distribution system modeling.

Continuing Education/ Hutchins Water Center programming

Hutchins Water Center programming and other seminars are useful to help staff understand the context they are working in, although it's hard to get people to attend evening programs. It would be useful to learn more about the historic user pool (HUP) and coordination of flows on the Colorado River.

CO Water Quality Control Division

Water Quality Control Division regulatory staff inspect drinking water systems and regulated dischargers for compliance with the Safe Drinking Water Act and the Clean Water Act. Another group focuses on stormwater management, and another group focuses on the protection of domestic water supply watersheds (source water protection).

Inspectors work with the regulated community to try to achieve compliance, as well as monitor for violations. They try to educate treatment plant managers and local governments about new regulations that are under development that could require plant upgrades so that sufficient funding is budgeted for necessary upgrades and new regulations don't come as a surprise. The Division also employs some Engineers to review design plans and check calculations.

Skill and knowledge needs

Inspectors should be well-versed in regulations, such as Regulation 11 under the Safe Drinking Water Act; Regulations 84 and 85 on biosolids and nutrients, as well as Regulation 100, which deals with professional guidelines for system operators and reporting issues. New issues on the horizon include temperature regulations on discharges from treatment plants, nutrients and algae.

New hires in the Division need to be curious and like to learn. Wastewater treatment plants use mostly mechanical processes and microbes to process waste, while drinking water treatment plants rely more on chemicals to treat raw water. Entry level workers don't have to have a science background, but they need to be observant and have some mechanical knowledge. For the chemistry and biology, there are "cheat sheets" to look up what is needed for key processes.

Continuing Education/ Opportunities for Students

New hires initially shadow experienced inspectors, and then get more involved as they gain more experience. Then the experienced person shadows the new hire. They start with inspecting simpler systems.

The ability to interpret regulations is important, and is addressed with regular meetings and continuing education on the job. The Rural Water Association and other organizations give seminars for which participants can obtain continuing education units, which are required for license renewals.

The City of Grand Junction Utilities sets up a training for distribution operators, and there are seminars for backflow protection and other issues for operators. These could be open to students, too, which would be helpful in exposing them to current practices. The Western Colorado Water Users Conference is another good venue for learning. Vendors bring out hardware that attendees can see and touch, and it provides an opportunity to learn about current, real world issues operators are dealing with.

Southwestern Colorado Community College is developing a type of operator training that would be useful to have locally, which provides hands-on learning with a working plant.

CO Source Water Protection Planning/ CO Rural Water

Colorado Rural Water serves water utilities in a couple of ways: providing free source water protection planning for rural communities (paid for a grant from the Colorado Department of Public Health and Environment), technical assistance and continuing education for system operators.

Skill and knowledge Needs

To create source water protection plans, CO Rural Water Source Water Specialists gather stakeholders who, as a group, identify potential threats to raw water supplies for drinking water (source water) and what to do to protect the source water from those threats.

The job requirements for a Source Water Specialist are to have a degree in a water-related field, and then experience with how to apply it. They need to have enough technical and scientific knowledge related to water and wastewater treatment to be able to have conversations with stakeholders about these topics. They also need facilitation skills and the ability to handle heated conversations. Finally, it's important to have very strong writing skills, with the ability to produce writing that can be understood by people with no more than a high school level of education.

Providing technical assistance to rural water systems involves supporting individuals who are juggling a lot of different tasks. They may have to run emergency response, dispatch, firefighting and drinking and wastewater treatment. Recognizing the stress these folks are under and finding ways to help communities fill in for each other can help a lot, as can helping them find and apply for grants.

Natural Resource Stewardship and Regulation

State and federal agencies with natural resource stewardship and regulation responsibilities often have to carry out a blend of both kinds of activities: promoting the health the resources on their agencies' lands as well as making determinations about whether to issue permits for activities on those lands and monitoring for compliance.

Grand Mesa and Uncompahgre National Forest

The first step in a Forest Service career is to be a Resource Specialist. Later steps involve becoming more of a generalist or manager, looking at the landscape as a whole. For the Grand Mesa and Uncompahgre National Forest, the Realty Specialist is responsible for working with the water companies that own the 300 reservoirs on the Grand Mesa on maintenance and reconstruction permitting. The Realty Specialist also has to track flows and understand the needs of the water users as well as the needs of the Forest Service. If there is any accelerated erosion due to flow rates, for example, they may ask the reservoir owners to adjust those. They also work closely with dam safety inspectors to be aware of any problems and work with the dam owner to address them.

There are several Realty Specialists across the GMUG, but only one in this district. There are 5 district level ones now in the GMUG. Other Forest Service positions which also require water knowledge include:

- Fisheries specialists, who need to understand stream flows and water quality.
- Range specialists, who need to understand erosion, different range types, and surface and subsurface flows of water.
- Foresters need to understand, when looking at a timber sale, how much buffer a wetland needs, and how to lay out a road to avoid accelerated erosion.

Skill and knowledge needs

The Realty Specialist is in the federal government's "general natural resource specialist" 401 series of positions, which requires a bachelor's degree in a science-based field. Formal requirements can be

found on the federal Office of Personnel Management (OPM) website at: <https://www.opm.gov/policy-data-oversight/classification-qualifications/general-schedule-qualification-standards/0400/general-natural-resources-management-and-biological-sciences-series-0401/>.

All Resource Specialists need to have an understanding of basic concepts from the beginning; they will learn how to apply these concepts on the job.

The ability to write clearly is also very important. Following inspections, it is important to clearly define what was found in the inspection. Clear verbal communication with supervisors and water users is also important, as is interacting in a personable way that avoids unnecessary friction.

Other helpful knowledge to have includes the basics of Colorado water law and the general land management laws passed over the years, and why they were created.

In the scientific and technical arena, the most important abilities are critical thinking and how to collect information and draw reasonable conclusions from it. A good foundation in natural resource management and how one resource affects another to keep a landscape functioning is also important. Personnel need to know how a nearby timber sale could affect hydrology, or how roads could affect flows, how subsurface and surface flows interact, and how geology influences those interactions.

Specific technical skills and knowledge needs include:

- Geographic Information Systems (GIS)
- Understanding how to do different types of modeling.
- Vegetative sampling.
- Water quality parameters.
- Seasonality of natural and human-influenced streamflows.

Emerging knowledge needs include an understanding of the impact of climate change on the National Forests. Impacts are already being observed on the landscape. It is important to pay attention to the results of scientific modeling at both local and global scales. For example, models indicate that in many of our mountains in Western Colorado, aspens will be gone by 2060. On the Uncompahgre Plateau, modeling shows that spruce will be gone, and ponderosa pine and douglas fir will remain, so it makes more sense to invest funding and effort in the health of those species.

Continuing Education

Continuing education is provided through informal and agency trainings on water law, agency operations, budget and leadership.

Career pathways

Seasonal jobs and practical field experience are an almost imperative stepping stone for getting into Resource Specialist positions. Rarely is a new graduate going to be competitive without some field skills and previous experience. Summer internships can be helpful, as can volunteering or temporary work. Particularly valuable experience includes building trail, firefighting, or doing recreation type work. Most jobs get tasked with things beyond the description: fire crews can build trail, recreation crews end up doing bird surveys. It is helpful to build familiarity, broaden horizons, see what work aligns with the person's interests. These experiences also provide the opportunity to obtain professional references, and agency professional references count for a lot.

Before moving into a management role, employees need a really solid foundation in their specialty. After 3-5 years in that specialty, they can grow professionally and spread out. They get the necessary knowledge through exposure, working with peers, moving around to different parts of agency and resource types, and trainings. It is critical to learn the landscape you are responsible for, see impacts, and make positive change. It is important to develop relationships, learn political realities and discover who the partners are that have similar goals.

Partnership Opportunities

Many of the companies that own reservoirs on the Grand Mesa are small and lack the financial resources to do dam maintenance and repairs and don't understand how the transport of that water can affect other aspects of the landscape. They also often don't understand permit requirements for doing construction on reservoirs. The Hutchins Water Center could help educate them, so they aren't surprised by regulations once a project is already underway and are better prepared for long-term planning.

US Army Corps of Engineers

The US Army Corps of Engineers (USACE) is the lead agency for permitting activities involving discharges to surface waters and impacts to wetlands.

Skill and knowledge needs

USACE hires Biologists, Ecologists, Hydrologists and Engineers and looks for those kinds of degrees right out of school. USACE staff need a good understanding of the natural environment, so a background that provides an understanding of plant ecology, soil science, or aquatic habitats is helpful. Strong written and oral communication skills are important, because people have to write a lot of environmental assessments and talk to a wide variety of people. Employees also need to be able to juggle multiple projects and make decisions efficiently. Employees need to understand the relevant regulations and be able to review permit proposals with applicants and try to help find a way the applicant can achieve their goal, but also protect the aquatic environment.

At a technical level, employees need to be able to work outdoors, read a map and use GIS and related tools. They also use survey equipment. Using remote tools, like LIDAR and Google Earth are also becoming increasingly important.

Continuing Education

The USACE provides many on-the-job training opportunities, including in-house training on issues like wetland delineation, regulations, the National Environmental Policy Act, Endangered Species Act and cultural resource protection requirements. New hires work with other project managers at first, and later there's peer review, so people are always working with a team. Each project manager has their own area of responsibility (geographic territory). There is a lot of teamwork and sharing of knowledge between people with different backgrounds.

Career Pathways

The local USACE office occasionally has Student Assistant positions, for which the office can hire and train a local student, bringing them into the agency without competition. This is a good opportunity, because Colorado positions are competitive.

Partnership Opportunities

While the USACE has many of their own courses for employees, there is a gap that the Hutchins Water Center can help fill, and that is to provide Colorado-specific trainings on issues like Colorado Water Law, as well as opportunities to learn the landscape of players in Colorado water law. Remote learning opportunities could be particularly useful, although opportunities for networking are helpful, too.

Consultants

The USACE also occasionally hires outside consultants. Field skills are very important for consultants, as the USACE is starting to do less direct fieldwork. On the West Slope, there is a lack of water quality consultants, and expertise on Environmental Impact Statements for big water projects, particularly to address secondary and indirect downstream effects of projects.

US Bureau of Land Management

The Bureau of Land Management (BLM) has soil, water and air programs. A Hydrologist for the Grand Junction Field Office oversees those three programs. The BLM's Grand Junction Field Office, like others, has Resource Management Plans with goals and objectives for each of these programs. Staff take those plans, and then based on current administration priorities (which are set every year), they try to achieve national goals through local plans. Soil, water and air goals don't normally change significantly.

BLM staff also have responsibilities under the Colorado River Salinity Control Act with Congressionally designated funds for BLM to help with reducing salt levels in the river. BLM helps to develop and complete programs for erosion control and sediment on lands adjacent to saline areas. This work involves travel management, stream alterations and bank stability issues. Many historical detention basins are unraveling. Work in this area is also related to soil.

Skill and knowledge needs and career paths

The Hydrologist develops a plan of work, and often gets enough funding to hire seasonal employee or intern. The BLM has an agreement with CMU with funding for summer interns. These positions provide a good opportunity to get a foot in the door to get a career in the agency.

Hydrologic Technician positions (1316 in the federal government's classification system), which are typically seasonal, are the entry-level positions. People in these positions work under the direction of a professional Hydrologist (1315 in the classification system). These positions provide an excellent opportunity to integrate theory with real world settings. Formal requirements can be found at OPM.gov.

Moving up to qualify for the 1315 series requires at least 6 semester hours of physics and 6 of calculus, and 3 of those must be integral. A lot of young interns don't have that higher level of math and physics. Students can use OPM.gov to learn about the requirements for positions that may not currently be advertised, and use that knowledge to plan their courses. If they do that and also get experience through seasonal positions or internships, that will put them in a good position for a career with the agency.

Even seasonal field positions are becoming increasingly competitive, and field seasons are short, so it is desirable not to have to spend a lot of time training seasonal staff. Because of this, having specific training, skills and abilities really improves a candidate's chances of getting hired. Having experience

doing science and hydrologic-related measurements in the field is desirable and not common among students.

With the intern program, sometimes a goal is to hire people with minimal experience. The agency usually does this when it can pair less-experienced interns with people who have more experience.

Emerging skill needs

The BLM needs more personnel with a fundamental understanding of modeling and statistical information. There are models now that are highly informed and artificially intelligent, but if people aren't trained in the modeling theory, they could use one of these advanced models without understanding its limitations. With statistics, there are hundreds of different statistical methods tested for water resources, but they can be manipulated and misinterpreted. Misuse of models and statistics could lead to misinforming important decisions, especially with a hotter and dryer future.

Continuing education

Both interns and seasonal employees gain exposure to other programs, like archeology and range management. BLM supports individual professional development through both internal and outside trainings (more internal; they host a lot of trainings). If it's local and free, BLM will allow seasonal employees to take additional training.

Useful trainings include BLM protocol trainings to make sure formally trained on BLM standard protocols; supervisory training, Rosgen stream classification and restoration design courses. Employees do trainings that match their work needs and interests.

Modeling and statistics training is also useful. It is important to bring scientific rigor to validate the assumptions of the impacts that dealt with in NEPA processes.

Hutchins Water Center programming is useful to BLM employees. Getting together with other people in the local water community is valuable.

Partnership Opportunities

The Colorado River Valley Field Office in Silt has a great partnership with Middle Colorado Watershed organization – the Grand Valley doesn't really have an equivalent. BLM seeks out those kinds of partnerships. The Grand Junction Office works with RiversEdge West to complete projects and is working with them on a Dolores River comprehensive restoration planning document. The relationships BLM has built in the community have helped BLM do what it needs to do cooperatively.

Nongovernmental organizations with goals that align with BLM's can bring technical expertise, workforce and engage larger groups of people to complete projects.

BLM is mandated to do things in a certain way, while for private organizations and consulting firms it's different – that can make it hard for groups to mesh together. Understanding roles of different folks in this space is helpful. For instance, CO Parks and Wildlife (CPW) is state, while BLM is federal; BLM manages the land, and CPW manages the animals. BLM tries to manage the land to benefit animals, but CPW is actually managing the animals, so with restoration, each has different role to make a whole project complete. With water rights, BLM manages the land, but the state manages water rights. Someone may need to go through a BLM process to access a point of diversion, but work with state on the water right.

Bureau of Reclamation – Environmental and Planning Group

In addition to managing dams and facilities, the US Bureau of Reclamation (BOR) also has an Environmental and Planning group that makes sure that whenever anything is done on BOR land, by its contractors or that involves federal action or funding complies with the National Environmental Policy Act (NEPA). NEPA requires analyzing and disclosing environmental impact of actions, and NEPA documents help inform decision maker on whether a project would have a significant impact or not and what mitigation options are. The Environmental and Planning group also does permitting.

Skill and knowledge needs

People that work in the BOR's Environmental and Planning Group include a Biologist, a NEPA specialist, an Engineer and an Administrator. The Biologist does field surveys, helps with habitat replacement plans, writes consultation memos and biological assessments with endangered species consultations and carries out a wide range of other tasks related to wildlife and vegetation impacts and management.

The NEPA Specialist (at the time of this interview, a CMU Environmental Science graduate) pulls all the necessary information together for the required documents, working with engineers, other staff and partners that manage areas around BOR reservoirs. Some documents are written by environmental consultants and BOR staff review them.

An Engineer with a Professional Engineer credential helps come up with engineering ideas/ solutions to minimize project impacts. It's helpful for all staff in the group to learn to read and understand engineering drawings, which comes with experience.

Having analytical and scientific foundation, whether biology or environmental science, is critical for all personnel in the group. Field skills are also very useful, and good writing skills are important.

An awareness of the regulatory framework is helpful in order to be able to assess a project's compliance with federal regulations. A skill that tends to be missing with new hires is the practical application of environmental laws and regulations to real projects.

Continuing Education

Federal employment offers numerous opportunities for training. The Group puts together individual development plans with employees, and sometimes will pay for people to attend conferences and other relevant outside training opportunities.

Career Pathways

BOR has an internship program through which students can try out different aspects of the work and get on-the-job training. Getting experience through part-time employment while in college is more helpful to prepare for obtaining water-related employment with the Environmental and Planning group than any particular credential or certification.

Emerging Skill Needs

GIS skills are increasingly important.

Colorado Parks and Wildlife – Park Focus

State parks have responsibilities for managing park facilities, natural resource stewardship, law enforcement, and hosting visitors. There are several levels of positions that require some knowledge of water.

Skill and knowledge needs

Entry level Park Resource Technicians are essentially “handyman” positions, with few opportunities to move up. Each park has its own water distribution and wastewater systems, and the people that run those need skills similar to those for municipal utilities, as well as licenses: Class D water distribution licenses and small systems licenses for sanitation.

Mid-level positions in the parks need an understanding that those certifications are necessary, as well as a little about regulations and laws pertaining to water. Higher level positions include water lawyers, engineers, dam safety and water quality personnel and people who hold water assets for the agency need more advanced and specialized knowledge.

The agency does habitat restoration as well, sometimes carrying out that work in-house and sometimes hiring outside firms. For the reclamation of wetlands, consultants have been hired for design, implementation and looking at the water table relief for groundwater. Even when consultants are hired, staff needs to work with them, drawing on their experience, background and knowledge of the history of the site, as well as knowing which entities to work with for permits or other issues.

For Rangers, Senior Rangers, and Park Managers, the mix of natural resource management vs. law enforcement work depends on the character of the specific park. In the Grand Valley, most parks are former gravel pits, so there’s a significant amount of work to do on habitat quality.

Understanding water quality and the fact that water quality matters is important, and the more employees advance, the more important it gets. Water quality ties into whether or not fish can be stocked or whether to do a fishing closure. For entry-level Parks and Wildlife staff, having a good work ethic, customer service skills and knowing that the water issues matter and need to be considered is enough. They will learn the additional information they need to know gradually. Some water-related skills and knowledge they will have to learn include monitoring for algal blooms, converting units, understanding volumes and pressures, water tables and how to test for water quality.

Career Pathways

For entry-level positions, the parks hire people with natural resource-related degrees and exclude criminal justice degrees, because they want personnel to focus on the natural resource issues and do law enforcement in support of that.

Colorado Parks and Wildlife – Water Management Focus

In addition to managing parks, Colorado Parks and Wildlife (CPW) also employs temporary Fisheries staff, Fisheries Biologists and Water Resource Specialists.

Skill and knowledge needs

Entry-level, temporary Fisheries staff have basic skills and will work several years before they get an opportunity for full-time, permanent employment with CPW. Most higher-level Fisheries staff people have Master’s Degrees in fisheries management.

The Water Resource Specialists work to protect and optimize the agency's water rights. They also compile and organize data from other agency personnel and make sure it complies with plans, as well as work with technicians to gather the information on diversion structures and meters necessary to optimize the agency's decrees and portfolio of water rights for its needs. It's important for the Technicians and the Water Rights Specialist to have GPS, GIS and basic field skills.

Water Resource Specialists also work with Fisheries Biologists employed by the agency, gathering information from them and drawing on that to represent the agency in community meetings and planning processes.

Most people in the Water Resource Specialist position have law or engineering degrees or Master's degrees in water-related fields. They need to be able to understand the science involved in agency projects and research, as well as the cultural and social side of managing water in Colorado.

Career Pathways

A common route into a career with CPW is to get a degree in Biology or Fish and Wildlife. Many people come in through the training programs and then branch out: new park ranger training, and new district wildlife managers trainings every year. CPW does those training programs one time/ year when they recruit. Seasonal jobs are stepping stone to get into training classes. Seasonal jobs include labor jobs, aquatic nuisance species inspections, and seasonal ranger positions.

District Wildlife Managers (DWM) can be hired with a Bachelor's degree, but Master's degrees are important to advance to higher level positions. Peo DWM lets you get in with a bachelors, and then decide where you want to go. People take DWM's to learn and then go back to school for a Master's degree. There's a pretty clear progression from DWM to Area Wildlife Manager, and generally responsibility and pay go up with area size.

CPW Professional Biologists and Researchers need Master's or Ph.D. degrees.

Colorado National Monument

At Colorado National Monument, positions include Interpreters and Natural and Cultural Resource Managers, an Archeologist and Biological Technicians. Biology Technician is a type of job across the federal government. Recently, there has been a lot of emphasis on non-native species and restoration work. That work intersects with geosciences and hydrology. Trail maintenance is another team. Those doing maintenance are in facilities division. Everyone has to come together to plan a project.

Most of the science that happens in the park is coordinated by Northern Colorado Plateau Inventory and Monitoring Program, which is made up of National Park Service employees that do research monitoring, traveling between the different parks.

Skill and knowledge needs

For interpretation, water isn't seen, but it is relevant to the natural history of the park. Interpreters talk with students about weathering and erosion. They teach a lesson in which they go out on the trail and find evidence for weathering and erosion, and they create simulations. They also bring in the human element: how do you build Rimrock Drive with all the natural hazards involved with bringing the built

and natural world together? There's also an engineering element: 200 historic culverts – if they weren't there, the road wouldn't be there.

For working in the Monument, having some knowledge about water rights and water politics is beneficial. The Monument experiences the downriver effects from different kinds of uses, including being just below an agricultural community. As temperature and drought impacts go up, having surface water less available leads to resource management concerns. There's a connection between hydrology and how cottonwood seedlings germinate, so changes make a big difference. Understanding the human dynamics of resource management, and different stakeholders is important.

Facilities staff have to manage water and wastewater treatment, just like other system operators.

Resource management and science are pretty standard at most parks. There are a couple of priority areas, like managing non-native species. Interns to help with specific projects and guide research projects.

Monument staff partner with researchers on specific topics of concern. On the day of our interview, they were working with hazardous spill experts, using microbes to help with the cleanup from a vehicle crash.

The agency has a growing focus on resilience and adaptation, as well as on human dynamics, knowing how to work in interdisciplinary teams. Communication is important.

Continuing Education

A lot of training happens with webinars within a network of experts. The National Park Service works closely with other federal agencies. There's been a push nationally on learning how to be resilient and adapt to a changing future. There are a lot of different methods for risk assessment and create different projects of what might happen, under different scenarios. A whole branch of the National Park Service helps parks put together risk assessments.

Water Engineering Consultants

Some of the activities water engineering consulting firms carry out include characterization of water supplies and water quality. They can support land use authorities on expanding water supplies, reviewing developments that require water, and doing pump tests. They can also do engineering design work to build drinking water and wastewater treatment facilities that comply with the Safe Drinking Water Act and Clean Water Act, as well as other water infrastructure.

Skill and knowledge needs

For engineering drinking water systems, personnel need strong chemistry knowledge and an understanding of how to get water to the plant and then out into the distribution system. Wastewater systems require more biological knowledge. Entry level engineers need to understand foundational concepts in those areas.

Entry level duties at a water engineering consulting firm include drafting and hydraulic modeling. Employees need to understand the fundamentals of engineering and have a degree in engineering. A

Professional Engineer (PE certification) is usually required within six months. GIS and auto-CAD certifications are helpful, as well as an understanding of stormwater management requirements.

Higher level employees need to have experience and relationships in the industry. A good foundation in technical writing is also important, as are other “soft skills” like project management, interacting with teams, having appropriate conversations, scoping issues correctly, and managing projects profitably.

Emerging skill and knowledge needs include an understanding of how climate change influences water use and discharge requirements, as designs need to consider diminishing water supplies as well as potential reductions in the water available to dilute discharges. Water re-use technologies will probably become more prominent on the western slope.

Continuing Education

For continuing education, the short courses that CMU puts on are helpful. Information on industry-specific data and experiences and anything that broadens the employee’s understanding of the market and the community is helpful: grant funding available, types of organizations that are involved, state and federal planning efforts. This knowledge helps employees understand what types of projects will be appropriate and fundable. Water law and policy knowledge are also helpful for understanding the landscape.

Related areas of expertise

Water engineering firms also often employ or partner with geotechnical engineers on projects, as well as partnering with land surveyors. It is helpful to have a local surveyor, because they can find benchmarks. There are a couple of firms, but if CMU put together an accredited surveying program, there would be opportunities.

Hydrogeology Consulting

When a person or company wants to obtain a new water right or drill a well, there are often complex technical issues involving groundwater movement and chemistry that can affect the viability of the project, and whether it will affect other water users or resources. Consulting firms can be hired to do the studies to identify and resolve these issues. Surface and ground water quality monitoring can also be required for permits, so consultants develop monitoring plans. Government agencies are also often clients for hydrogeological consulting work.

Skill and knowledge needs

Entry level employees in firms doing this kind of work need a well-rounded understanding of scientific applications, the scientific approach and mathematical calculations, which is knowledge people usually get with a science degree. A good understanding of geology is also important, because geology is so connected to hydrology, and it’s harder to find people with that understanding. GIS work is also done frequently. Entry level employees learn a lot of skills on the job by getting pulled in for short lessons. To be ready to learn the specific technical skills they can learn on the job, they should have gone through all the calculus courses and differential equations.

It would be useful for CMU to offer a course with a section on water rights applications – most entry level hires don’t have much knowledge of water rights. A basic understanding of numerical groundwater modeling would also be useful.

Continuing Education

Employees are encouraged to go out and find on-line webinars, seminars, and courses, and the company will pay. Water Center programming offers a bigger picture opportunity to learn what's going on in the basin and get oriented to the various players in the water community.

Career Pathways

For projects with a lot of basic fieldwork, the firm has hired a lot of CMU students with BS degrees in Environmental Science. They fit in well and had enough knowledge of water issues and water projects to be able to hit the ground running with groundwater well sampling and related activities. CMU's Environmental Science has come closest to providing the skills people need for entry level positions; on occasion the firm has looked at individuals with Geology degree individuals, especially those who have had some hydrology, but often they aren't interested because positions don't involve enough geology.

Environmental Consulting

Environmental consulting firms perform work related to compliance with environmental laws, carrying out tasks such as wetland delineation and surveys related to compliance with the Endangered Species Act and National Environmental Policy Act. Environmental consulting firms employ seasonal field technicians, environmental scientists, hydrogeologists and civil engineers.

Skill and knowledge needs/ Career Paths

Many field technicians come out of CMU with Environmental Science or Biology degrees. Environmental Science majors tend to have wider variety of skills that they can use right away. Understanding water quality measurements and GPS and GIS mapping systems are important for conducting field work. Students that take CMU GIS courses are well-prepared for field work. Understanding a variety of ecosystems is also important.

The firm looks for an understanding of how to implement policy learned in school and take it to the ground. The important laws to be familiar with are the National Environmental Policy Act (NEPA) and the Clean Water Act (CWA). Education on the policy side could be strengthened at CMU. NEPA drives the demand for a lot of what environmental consultants do.

Seasonal field technicians can move into higher level positions if there's enough work to sustain new positions.

Growing Skill Needs

Water modeling is a growing field. Seth Mason, Lotic. Locally, there's a hole in expertise with endangered fish species act expertise related to fish, due to retirements.

Water storage is going to become so crucial that things will have to get moving with it, so being able to delineate wetlands, id waters of the US, fens, types of wetlands. Knowledge of dams and hydrology from engineering will also be important.

Continuing Education and Partnership Opportunities

The networking at Water Center conferences are useful, and getting stakeholders together is helpful. Smaller breakout sessions might be helpful for a little more time to talk with folks. Having various topics, including more locally-focused topics would be good.

Water storage is a concern for a lot of folks. Getting it to implementation will be a challenge. Getting the users, agencies etc together. People ask about how to get storage on federal land.

Water Lawyers

Water lawyers are essential members of the water community in Colorado, participating in the acquisition and defense of water rights, as well as policy discussions. A science background and good writing skills provide a good background for going into law, and new lawyers often begin with general practice work and then become more specialized. Water lawyers commonly partner with professional engineers and hydrologists.

Nonprofit Organizations

A variety of nonprofit organizations are engaged in working to educate the public about water resource issues, as well as advocacy and restoration activities to enhance the health of water resources and riparian habitats.

Conservation Colorado

Conservation Colorado advocates for environmental protection. The organization has a government affairs team, an organizing team, a communications team, and a digital team. Those are the four teams that would work on water. The lead water advocate is based in Denver and works with statewide coalition partners, diving deep into policy needs, different policies being crafted, and creating strategies for how to support those policies. Then organizers, communications and digital teams help with enacting the strategies. There are organizers all across the state.

It is useful for organizers and the community to understand how water law works in Colorado. The prior appropriation doctrine is so fundamental to how it is possible to protect water, especially water quantity. It's also important for them to understand what the state has already done. Who are the basin roundtables, what is the Colorado Water Plan, and how can it be a solution for communities and state overall? It's also important for them to understand the role that agriculture plays and the history of the agricultural sector and their rights to water in order to learn how they can work with ag communities on conservation efforts.

Colorado West Land Trust

The Colorado West Land Trust works with water in a couple of different ways. For conservation easement transactions, water is an important component. The easements restrict how water can be used off the property and ensure that the water rights are not severed from the land. Part of the initial transaction is doing due diligence on the water rights. For each easement that the land trust holds, as part of monitoring the property, the land trust has to look at water use as well, to make sure it is not severed from the property. Understanding resources for tracking if there have been changes of use would be helpful.

The way land trusts treat water has changed significantly over the years. In the past, conservation easements simply stated that water shall remain with the land. Recently, conservation easements have become more nuanced. Some landowners have requested the flexibility to use their water to augment

in-stream flows, and land trusts are seeking out opportunities for that. Some easements allow for leasing water for use on other properties.

Colorado West Land Trust is also contemplating an alternative transfer method (ATM, a temporary transfer alternative to “buy and dry”) with a landowner in Whitewater who holds a senior water right downstream from the city’s intake. Under an ATM, in dry years the landowner could lease water to the city. In northern Colorado, there’s an example of an easement that allows leasing to municipalities in drought years to avoid buy and dry. There is a potential role for the land trust when looking at Demand Management (temporary, voluntary and compensated transfers); land that stays in agriculture ensures that there are water rights that could be temporarily dedicated to other purposes, which is not necessarily the case when land is converted to a residential subdivision. This is all in brainstorming, strategizing with the stresses on the water we’re facing with least harm to west slope and economies.

These kinds of water issues are being looked at by mid and senior level staff, and require learning the legal and practical nuts and bolts of water management. Other staff can benefit from basic water information, like how ditches work and basic water law.

In general, it’s helpful for the land trust to have opportunities to understand the Colorado Water Plan process and other water policies in order to ascertain how the land trust may be able to get involved, and what opportunities there may be for the land trust to add value to conserving landscapes, habitats and water resources and further local resiliency in western Colorado.

Opportunities vary from place to place. Palisade farmers don’t think about availability as much as those in Cedaredge. In Cedaredge, it may be useful to have a water bank or water sharing arrangement to keep water going to fruitgrowers who would be devastated if went a year without water.

Partnership opportunities

It could be useful to convene small groups of thought leaders to discuss these issues surrounding demand management, other water policies, nongovernmental organization activities and community resilience. Some trainings also useful, in addition to convening a meeting like this, include water law, water management (how water moves through the system – nuts and bolts), and the legal and policy framework for managing water.

Colorado Canyons Association

Colorado Canyons Association (CCA) is a “friends” group to the local National Conservation Areas, which promotes stewardship and education about the areas and their resources. CCA has a land education program and a river education program.

The river education program lead does curriculum development, planning, coordination with partner organizations and supervision of seasonal river educators/ guides. The guides need to have rafting and safety skills as well as the knowledge to educate kids in river-related science. CCA also does some restoration work, so it is also helpful to have employees who have knowledge in that area as well.

RiversEdge West

RiversEdge West (REW) advances the restoration of riparian lands through education, collaboration and technical assistance. Staff plan and carry out the replacement of invasive plants with native plant

species, conduct research on best practices, educate partners on best practices, and coordinate with a wide range of partners.

REW staff need both technical knowledge on riparian ecology and restoration and the ability to communicate that knowledge to others. GIS, grantwriting and project management are also key skills.

Community Knowledge Gaps

When the water professionals interviewed for this project were asked what they wished the community better understood about water, several themes emerged.

Water Supply Challenges

Interviewees felt that residents are not sufficiently aware of the impacts our region is likely to experience from increased water demand and shrinking availability, and the related need for long-term planning, especially given how complex it is to go from project conception to a finished project.

Water Infrastructure

Interviewees noted that domestic water quality is a front-line public health issue, and noted that the need to continually invest in maintaining and upgrading water infrastructure is not sufficiently appreciated. For small, financially strapped systems, regionalization could be a solution. Providing more information on how water treatment plants and other infrastructure works was mentioned as potentially helpful.

Different Perspectives

Interviewees highlighted how different water stakeholders don't always appreciate each others' importance. For example, the economic impact of river-based recreation and the environmental and recreational benefits provided by irrigated agriculture may both be under recognized. An agency interviewee noted that it would be helpful if people better understood how stakeholder input and science come together in decision making.

Hydrology

Areas where interviewees felt public knowledge was lacking included an understanding of groundwater resources, the connections between forest/ watershed health and water in communities, and how one person's actions can affect others downstream or downgradient. Stormwater management needs and requirements were mentioned as another area where public knowledge is lacking.

Water Law and Administration

At the local level, interviewees mentioned that even law enforcement officers don't always understand easement issues related to cleaning ditches for water delivery and draining tailwater. At a larger scale, some interviewees wished the general public and leaders had a better understanding of water law and the various policies governing how the Colorado River is managed, as well as the limits to the resources.

Relevance of selected water-related subject areas covered at CMU

Current Offerings

Water management and regulations

General knowledge of water management and regulations is helpful for a wide range of water professionals, including employees at the Natural Resources Conservation Service, Bureau of Reclamation and managers and board members for irrigation entities and domestic water providers, as well as the consulting engineers who provide services to these entities. The Bureau of Land Management also has water rights and helps administer others' water rights, so BLM staff need to understand the Colorado water rights system. Colorado Parks and Wildlife also need to understand water laws and regulations. Even people in highly scientific and technical occupations need to be aware of the water management and policy environment, since it influences the context of their work.

More specifically, interviewees mentioned the following:

- A basic understanding of the Colorado River Compact and Colorado water law is important for people involved in managing water and working with farmers and ranchers.
- An overview of the Clean Water Act is sufficient for most people involved in managing water, with more depth helpful for people working in environmental regulation, permitting, water treatment plant operation and design. Provisions related to stormwater management are important for managers at municipal utilities. For people involved in water quality regulation, it is helpful to know why the regulations were put in place and to have an overview; they can learn the details that are most important for their work on the job.
- Knowledge of the Safe Drinking Water Act is important for water treatment system operators, designers and regulators.
- Understanding the National Environmental Policy Act (NEPA) is important for people involved in environmental consulting and federal permitting. analysis, stewardship and water treatment plant operation and design.

Basic Concepts in Biology and Chemistry

An understanding of basic concepts of biology and chemistry related to water is important for many water-related professions, particularly those whose work relates to water treatment and other aspects of water quality, including irrigation projects designed to improve water quality in rivers and streams. These basic concepts are also part of the general background needed by engineers involved in water projects and employees of land management and regulatory agencies, including the US Army Corps of Engineers and the Bureau of Reclamation.

Hydrology

A solid understanding of hydrology, including surface water, groundwater flow, cones of depression and interaction between surface and groundwater, is of primary importance for most water professionals, including in entry-level occupations for the Colorado Division of Water Resources and the Natural Resources Conservation Service. Understanding the concepts and being able to use field equipment to measure the discharge and velocity of streams and ditches is very important.

Personnel involved in irrigation efficiency and water quality programs need to understand the flow of pollutants through ground water in order to address problems with salt and selenium loading to local waterways.

Staff at land management agencies like the Bureau of Land Management and Colorado Parks & Wildlife need to understand hydrology in order to understand potential impacts of proposed projects and to manage for wildlife habitat and recreation. Personnel with the Bureau of Reclamation need to understand forecasted inflows and snowpack and model that to determine how to operate facilities to meet environmental requirements and avoid public safety problems.

Understanding the effects of drought and climate change on hydrology is becoming increasingly important for many water professionals. It is helpful for water treatment plant operators and inspectors to understand how drier conditions can affect not only the quantity, but the chemistry and biology of their raw water supplies in order to solve problems.

Watershed Assessment

Watershed Assessment is a fundamental skill needed by personnel involved in regulation and landscape stewardship, including the US Army Corps of Engineers, the Natural Resources Conservation Service, US Forest Service, CO Parks and Wildlife, Bureau of Land Management, and engineering firms involved in environmental assessments and mitigation planning. The Rosgen stream classification system is used by many of these entities.

BLM adopted the Assessment, Inventory and Monitoring (AIM) protocol about 5 years ago. This is BLM's new protocol to understand condition of BLM lands nationally. Designed to collect quantitative data to assess condition of water and uplands. BLM and DOI is required by Congress to report every year on condition of BLM lands, did qualitatively and sporadically for years, now have a systematic and scientific way to do this. Landscapetoolbox.org is a website that explains the protocol and provides data.

Water Quality

Knowledge of methods for management and monitoring of water quality is important for a broad range of water professionals, particularly for those involved in treatment plant design, operation and regulation, but also for personnel involved in environmental stewardship. It can also be helpful for employees at the Natural Resources Conservation Service, depending on what resource concerns they address with landowners. Personnel with the Bureau of Reclamation also take water samples at their facilities. Employees at regulatory agencies also need to be well-versed in this area.

The ability to sample and test for water quality parameters is most important for personnel involved in water treatment, inspection and, to some degree, public agencies engaged in land and water stewardship, such as the US Forest Service, Bureau of Land Management, and CO Parks and Wildlife.

Wetlands/ Riparian Ecosystems

Understanding wetland ecology, and particularly wetland delineation, is very important for people involved in land and water stewardship and regulation, as well as consultants who work on environmental assessments and mitigation planning. The ability to apply this understanding in the field is important in all these sectors. People involved in providing irrigation and domestic water don't need detailed knowledge, but they do need to be able to recognize when wetlands could be disturbed by a project, and who to contact for more information, so they don't get into regulatory trouble.

Treatment Techniques and Technology

Learning about water treatment techniques and technology is most important for people directly involved in water treatment and regulation as well as some consultants and some personnel with land and water stewardship responsibilities. Regulatory and stewardship agencies, like the US Army Corps of Engineers and Bureau of Land Management, need to understand enough about these techniques and technology to recognize if a permit applicant is taking a reasonable approach to any relevant water quality issues.

Engineering

Engineering knowledge in the water community is important for activities like dam maintenance and inspection and designing and reviewing plans for water treatment systems. The combination of environmental engineering and hydrology is important for personnel at agencies and consulting firms involved in stream restoration.

Environmental Politics

A good basic background in environmental politics is helpful for people involved in managing and regulating public facilities and activities on public lands in order to understand the big picture these facilities and projects fit into, as well as different perspectives on them.

Environmental Economics

A good basic background in environmental economics is important for people involved in making decisions about federal projects, like Bureau of Reclamation personnel. Natural Resources Conservation Service personnel have to make decisions about what conservation projects make economic sense, and they have some in-house training on that. Understanding the economic impact of regulations is also helpful for people involved in inspecting treatment plants and attempting to help systems comply with them.

Environmental History

It is helpful for people involved in natural resources stewardship and regulation, as well as managing federal facilities like dams, to have some background in how and why their agencies were founded, the history behind the relevant regulations, and why the facilities were built and came to be managed with the guidelines that currently exist. When looking at a disturbed system, understanding how it got into its current state is important.

Geographic Information Systems (GIS)

GIS was among the most commonly-cited desired skills across a wide variety of water occupations.

General Skills

Technical writing and oral communication skills were mentioned as highly important by almost every interviewee. Many water-related professions require writing inspection reports that communicate what is happening in the field into reports. In addition, many water professionals need to interface with the public in one way or another, whether through one-on-one conversations with water users and customers, public presentations on reservoir operations or working with stakeholders and partners with different points of view. Technical reading in order to be able to understand regulatory documents and technical reports was also cited as important for water quality inspectors. Grantwriting is particularly

useful for consultants, who can help smaller water entities apply for grants to supported needed projects.

For agencies that have to prepare documents pursuant to the National Environmental Policy Act (NEPA), like the Bureau of Land Management, being a good writer is really important in order to efficiently convey knowledge to members of the public, so that they can understand the documents and provide comments.

Project management and adapting to variable conditions was also frequently cited as important.

Field experience was frequently mentioned by interviewees as important in a wide variety of occupations, both in terms of comfort level and the ability to apply classroom knowledge in real-world situations.

Subject areas that could be strengthened

The interviewees mentioned the following areas where they perceived that CMU could strengthen its water-related curriculum.

- An understanding of Colorado Water Law and how to navigate the state's water rights system are important for personnel involved in providing irrigation and ditch water and developing new projects that require water, as well as some water efficiency projects.
- Understanding the National Environmental Policy Act (NEPA) process is important for people involved in permitting projects, whether as an applicant or a regulator.
- A hydrology field camp like one that CSU has, to provide more hands-on learning, would be valuable, as would a 400-level hydrogeology course.
- Numerical groundwater modeling was mentioned as a desirable skill for water professionals to have.
- If there's room to study basic methods by which state regulators design and author regulations, there would be something to learn there. In consulting business, understanding those regulations and where there might be room for change, will be a step ahead.