Upper Gunnison Drought Contingency Plan: Task Force

Minutes

November 20th, 2024

Task Force Attendees:
Jon Hare (High Country Conservation Advocates)
Hannah Cranor (CSU Extension)
Cody Tusing (City of Gunnison)
Jonathan Houck (Gunnison County)
Shea Early (Town of Crested Butte)
Shannon Muenchow (USFS)
Steeve Moore (Coal Creek Watershed Coalition)
Susan Washko (Western State Colorado University)
Brandon Diamond (Colorado Parks and Wildlife)
David Gochis (Airborne Snow Observatory)
Shannon Hessler (Mount Crested Butte)
Carolyn De Groot (Town of Crested Butte)
Brinnen Carter (National Park Service)

Staff/Consultants:
Stacy Beaugh (Strategic by Nature)
Carrie Padget (Harris Water Group)
Savannah Nelson (Sunshine Creatives)
Sonja Chavez (UGRWCD)
Alana Nichols (UGRWCD)
Bailey Friedman (UGRWCD)

I. Agenda Overview and DCP Progress:

Stacy reviewed the agenda for today, which includes a review of the DCP drought monitor, the applicability of the Airborne Snow Observatory surveys to DCP and drought monitoring, and a review of the initial branding concepts for Upper Gunnison communications plan. Stacy mentioned that the Upper Gunnison DCP process has experienced some delays, with input from agricultural producers still pending. The admin team has narrowed the list of potential actions from 80 to 40, with plans to further reduce it to around 20 actions that can be completed within the next five years. The goal is to wrap up the DCP process by summer 2025.

II. Drought Monitor

Carrie reviwed the drought monitor dashboard and walked through the benchmarks used for seasonal drought tracking. The group was reminded of the five major monitoring benchmarks throughout the year: in November, focus is on assessing soil moisture and reservoir storage going into the winter; January and February mark the beginning of snow accumulation monitoring through snow water equivalent (SWE) data from SNOTEL sites; March and April are crucial months where forecasts can shift substantially and most snow accumulates in the Gunnison Basin; May and June are considered the "gut check" period to confirm trends seen earlier in the spring, accounting for rapid melt-off or heavy precipitation events; and summer through fall shifts to monitoring daily streamflows and monthly precipitation events. Carrie emphasized that April is likely the ideal month for the annual meeting to review drought monitoring and prior-year activity.

Regarding soil moisture conditions, Carrie presented data from the Colorado Basin River Forecast Center (CBRFC), which typically provides modeled soil moisture maps as of November 15 each year. However, the data had not yet been published, prompting Carrie to use precipitation data from November 2024 as a proxy to support discussion. She confirmed with the group that 2023's modeled soil moisture was below average, which was visually evident from last year's map showing yellow, orange, and red shades across the Gunnison Basin. Attendees, including Sonia and Dave, agreed this matched their observations and previous data from snow telemetry (SNOTEL) sites. Carrie noted that low soil moisture entering winter can reduce spring runoff by 15–25% in the Gunnison and San Juan Basins.

For this season, based on November 2024 precipitation data, Carrie observed that only the Tomichi and Cochetopa Creek sub-basins appeared to have above-average conditions, while the rest of the basin likely remains neutral or below average. Rebe Hazard had noted good streamflows in Cochetopa Creek, affirming the data's validity there. There was uncertainty about Tomichi Creek's broader conditions; no definitive input was available from Hannah, Sonia, or others at the meeting. Carrie reiterated that these preliminary checks are valuable for understanding pre-winter trends, even if the exact soil moisture data isn't yet available.

In terms of alternative data sources, Carrie referenced daily soil moisture readings from the National Integrated Drought Information System (NIDIS), though she acknowledged their limitation to 1-meter depth readings. She inquired whether these readings were

useful for agricultural operations, given varying recharge depths and water availability. Sonia commented that recharge depends on fall streamflows and water availability, low stream levels limit irrigation regardless of soil condition. Dave Gochis added technical details about soil moisture sensor placements, explaining that while one-meter readings are ideal, mountain sites often restrict depth due to bedrock. At monitoring stations in the Upper Taylor Basin, sensors typically measure at 5–10 cm (shallow) and 25–30 cm (deeper), as most sites cannot accommodate deeper probes. He noted valley soils, including ag fields and riparian zones, allow for deeper monitoring and potential groundwater interaction. These data are available through the NRCS Snowlite Network, which operates separately from SCAN. Susan mentioned that Billy Barr in the East River watershed publishes soil moisture data at four depths on his website. Carrie appreciated the reference and added that the Rocky Mountain Biological Lab (RMBL) also operates long-term soil stations in that region. These include sites in Almont, Gothic, Snodgrass, and Judd Falls and the data is available via RMBL and the Department of Energy archives. Carrie pointed out the importance of long-term datasets like those used by the CBRFC, which rely on SNOTEL data, for establishing historical trends.

Shifting focus to the second benchmark—reservoir conditions—Carrie outlined the reservoirs currently tracked: Taylor Park Reservoir, Lake San Cristobal, Meridian Lake, and Blue Mesa Reservoir. For Taylor Park, she used CBRFC's current condition report showing approximately 110% of average storage, considered favorable and within the desired range (classified as "neutral" or 0 in their table). For Lake San Cristobal and Meridian Lake, both augmentation sources, Carrie assumed neutral/normal status pending further benchmarking with Sonia and district data. Blue Mesa was also classified as neutral using CBRFC's current data. Carrie noted that the Gunnison Basin storage figure for Blue Mesa was not yet added to the summary table and would be included in future drafts. She shared the November drought tracking table showing soil moisture and storage ratings, where storage values across all basins were classified as neutral (0), and only Cochetopa and possibly Tomichi were above average for soil moisture. Carrie emphasized that these early-season indicators are anecdotal but valuable for contextual awareness.

Carrie asked if the group had recommendations for additional data inputs to improve the pre-winter snapshot. One participant mentioned that the Doppler Gap weather radar station is currently in the electrical installation phase and expected to be operational soon. Once online, it may provide more localized precipitation data for the Gunnison Basin. Another participant mentioned that the Lake Fork drainage has seen a good amount of snow already this season, prompting Carrie to double-check the soil moisture anomaly in that region. Cloud seeding was also discussed. It was noted that early-season storms with warmer temperatures tend to have higher supercooled liquid water content, making them more amenable to seeding. However, quantifying the effect remains challenging.

Dave Gochis explained that modeling and atmospheric studies, including work by NCAR as part of a reclamation-funded project, may eventually offer better estimates of

cloud seeding impact. Overall, while cloud seeding is assumed to be beneficial, it remains difficult to validate due to environmental variability and a lack of natural control conditions.

Carrie encouraged anyone with further data suggestions to follow up with her. She plans to verify the availability of the November 15 soil moisture data from CBRFC and will continue to refine the benchmark tables, especially for Lake San Cristobal and Meridian Lake. The drought tracker will eventually be transitioned from Excel into a more user-friendly public-facing platform with support from Savannah. The Task Force also expressed interest in incorporating Doppler radar data once the station comes online.

III. ASO Drought Forecasting

Dave Gochis presented emerging drought forecasting products designed to support real-time drought preparedness and adaptation, specifically for the Upper Gunnison Basin. ASO (Airborne Snow Observatory) currently conducts two aerial LIDAR flights per year for the East and Taylor Basins. These flights typically occur in late March or early April—around peak snow water equivalent (SWE)—and again midway through the melt season to track snowpack evolution. The timing of these flights is structured to answer key hydrologic questions such as whether a "miracle May" has occurred or if dust events have accelerated melt. LIDAR-observed snowpack has become the gold standard for snowpack measurement due to its precision. The airborne surveys provide localized snow depth error of about one centimeter—significantly more accurate than satellite retrievals, which may have errors up to a foot. This degree of accuracy is critical, as even small errors can significantly affect water accounting over an entire basin.

The ASO team is structured into two primary groups: the snow products and remote sensing team—responsible for flying aircraft and retrieving snowpack data—and a hydrologic modeling group. In addition to SWE, ASO surveys also retrieve snow albedo data across multiple spectral channels to track snow aging and impurity deposition, both of which strongly influence melt rates in central and southwestern Colorado. ASO also collects data on water surface elevations, ice cover on lakes and streams, vegetation structure (e.g., canopy height, greenness, and density), terrain features, and surface roughness. Repeat flights over time allow for analyses of changing landscape morphology, channel movement, inundation patterns during flood events, and field-scale changes. ASO is also working to integrate an infrared (IR) camera into its airborne platform to collect stream and lake temperature data. While the program traditionally focuses on winter and spring due to snow monitoring priorities, there is growing interest in conducting summer flights to support applications such as vegetation monitoring and surface water temperature assessments.

In 2024, ASO operationalized a hydrologic forecasting service that had previously been developed in a research context at NCAR. This system assimilates ASO LIDAR snowpack data and, when available, radar-derived precipitation data—such as the new

radar recently installed in the Gunnison Basin. Forecasting products include ensemble hydrologic and water supply outlooks, spanning from short-term flash flood risk to seasonal and potentially cross-season predictions. The system is designed for rapid turnaround: forecasts can be produced within 24 hours after an airborne survey is completed. These products are hosted online and made publicly accessible, aligning with ASO's mission as a Public Benefit Corporation.

The modeling system runs on Amazon Web Services and is physics-based and spatially distributed. It produces April–July and April–October runoff forecasts at over 320 locations across Colorado, California, and New Mexico. In the previous year, ASO released over 300 forecast reports, updated every two weeks and after each airborne flight. Select users, such as the Upper Taylor Users Group, also received late-season and low-flow forecasts to support reservoir management as conditions transitioned into the winter period. Dave emphasized that while historical snow indices and SNOTEL stations have served as useful proxies for forecasting runoff, their limitations in spatial coverage (e.g., only one SNOTEL station in the Upper East River Basin and a few in Taylor) restrict their effectiveness. LIDAR surveys provide precise snowpack accounting across the entire watershed, allowing water managers to shift from estimations toward exact measurements—an increasingly necessary shift in over-allocated systems like the Upper Colorado and Rio Grande Basins.

Dave also pointed out that climate variability—such as late-season heatwaves or dry spells—can drastically affect runoff timing and volumes. For instance, in the past year, high-elevation snowpack persisted into June before melting rapidly during a mid-June warm spell, even leading to localized flooding. Although the summer monsoon is important for soil moisture and vegetation, it contributes little to overall reservoir storage or perennial streamflow. Furthermore, forecasting future weather remains limited in skill, especially in the monsoon season, making precise snowpack measurement even more critical for improving runoff prediction. ASO's products aim to close that gap, providing better observational inputs for improved drought forecasting across seasonal and sub-seasonal timescales.

Dave then gave an overview of the WRF-Hydro Modeling System, which was initiated in 2003 during a postdoctoral appointment at NCAR and has since evolved into a community model adopted by the National Weather Service in 2016 as part of its National Water Model. The system incorporates complex physical processes with a focus on snowpack dynamics and soil moisture modeling, which serve as critical components of hydrologic forecasting, particularly in the context of drought monitoring and water resource management.

A major emphasis of the system lies in its simulation of snow-related processes, including snow depth, snow water equivalent (SWE), density, and thermal state, along with snow albedo and energy dynamics. These metrics allow for detailed tracking of snowmelt

evolution, with direct implications for reservoir inflow forecasts and drought analysis. Soil processes are also a major component, modeled with a multilayer soil matrix that enables tracking of soil saturation at different depths. The model also simulates evaporative fluxes, which are important for understanding natural and managed landscape water use.

The operational framework of the model includes assimilation of high-resolution meteorological data, real-time updates, and the incorporation of data from Airborne Snow Observatory (ASO) flights. These airborne surveys, conducted at 50-meter resolution, are integrated into the system to refine the snowpack state, from which ensemble forecasts are launched. These forecasts provide valuable guidance for key locations such as the Taylor Reservoir and East River at Almont, with complementary outputs to those produced by the Colorado Basin River Forecast Center (CBRFC).

Forecast performance during the past season showed promising results, with model accuracy within 5–10% of observed values at several California basins once ASO data were assimilated—demonstrating the model's effectiveness when accurate snow volume estimates are included. In Colorado, while the challenges are greater due to remoteness and data sparsity, similar forecasting improvements are being pursued. A case study in the Dolores Basin illustrated the limitations of relying solely on point-based SNOTEL measurements, as the WHRF model forecasted within 1% of the observed runoff volume for 2024, compared to a >45% error in the official forecast not informed by ASO data. Drought products derived from the system include animations and elevation-collapsed depictions of soil moisture saturation, both current and forecasted, along with model-derived anomalies which are more reliable than absolute values due to inherent variability in soil properties. The system also tracks evapotranspiration (ET), both observed and projected, which is critical in estimating landscape water use under drought conditions. These drought metrics are spatially explicit and of much higher resolution than traditional basin-wide metrics, allowing more nuanced interpretation of drought onset, severity, and spatial variability.

Additional product development efforts include soil saturation anomaly maps, snowmelt projections, and temperature modeling of the snowpack—an important factor in predicting runoff timing. Snowpack temperature modeling, informed by observational technologies like beaded temperature strands and downhole temperature sensors, is expected to become increasingly validated and operationalized.

In the East and Taylor Basins, new seasonal water supply forecasts were issued with high accuracy, often outperforming or complementing existing RFC forecasts. For example, the system captured nuanced elevational differences in snowpack between 2023 and 2024, revealing that while 2024 appeared to have less snow overall, certain subregions (like the eastern flank of the East River) had more late-season snow than the previous year—an insight not captured by aggregated basin-wide indices.

Looking ahead, several new products are in development. These include high temporal resolution flow forecasts, predictions of peak flow dates and magnitudes, and snow-off dates (defined as 95% depletion of snowpack). There is also ongoing research into the hydrologic impacts of wildfire, with parameters adjusted in the model to reflect vegetation loss and altered soil structure based on burn severity maps. Stream temperature modeling is also in progress to further expand the suite of drought and hydrologic monitoring tools.

The WHF-Hydro Modeling System offers a high-resolution, physics-based approach to hydrologic and drought forecasting. With its expanding integration of ASO data, real-time meteorological inputs, and new observational technologies, it stands to provide increasingly accurate and actionable insights for water managers and drought response efforts across varied terrain, including the complex mountain watersheds of Colorado.

The Task Force expressed interest in how to effectively communicate these findings to a broader audience.

IV. Communications

Savannah Nelson presented the branding strategy for the Upper Gunnison Drought Contingency Plan (DCP), emphasizing the importance of a cohesive brand to support clear communication, consistent presentation, and the use of visual cues that make data more accessible and actionable. She explained that effective branding strengthens engagement and stakeholder buy-in, helping to build trust and clarity around the plan's goals and implementation.

The Task Force has agreed to adopt the name **"**Upper Gunnison Drought Plan" as the core identity for the DCP. Savannah outlined the two primary approaches to housing plan materials: using the existing district website or launching an independent site. Hosting on the district's platform offers advantages such as centralized access, established audience alignment, cost efficiency, and improved search engine optimization. In contrast, an independent website could provide a more tailored user experience, greater flexibility in design and functionality, focused messaging, and the potential for broader outreach.

The Task Force agreed on launching an independent website.

Savannah highlighted the strategic role of branding in building credibility and creating a unified language and visual identity that resonates with stakeholders. She emphasized that this approach can help convey a shared sense of responsibility in addressing drought-related challenges. The Task Force also engaged in a discussion on how to best involve the agricultural community in the planning process, including considerations for how the communication materials are framed and presented.

The Task Force expressed interest in ensuring that the resilience plan functions as a living document**,** with regular updates and evolving content. Savannah showcased several examples of drought plan websites from other regions, drawing attention to their clarity,

visual organization, and effective use of educational resources. She also introduced ten preliminary logo concepts, all of which incorporate water-centric imagery and are designed to visually reflect the goals of the project.

V. Next Steps

Stacy mentioned that participants can stay engaged with the Communications Committee or review materials sent via email to prepare for the January meeting. She encouraged the Task Force to reach out to the DCP admin team with any questions in the meantime. The Task Force will reconnect in the new year.

VI. Adjournment

The next Task Force meeting will be on Wednesday, January 15th, 2025.

The meeting was adjourned by Stacy Beaugh at 11:15 a.m.