

Kunkle, S. (2001). Water Quality Monitoring Trip Notes: 31 p. + 46 p. of literature citations
Abstract: Contains three trip memos authored by Sam Kunkle (Watershed Specialist and Affiliate, Dept of Earth Resources, CSU) during water quality information-gathering trips in 2001. The first memo is dated July 1, 2001 and contains his notes about his June 17-22 2001 visits to ZION, PISP, CEBR, BRCA, CARE and other agency offices. The second memo is dated July 18, 2001 and contains his notes about visits to COLM, TICA, and several other agency offices. The third memo is dated August 22, 2001, and contains his notes from trips to CURE, BLCA, and the SEUG during August 5-10, 2001. Kunkle was interviewing water resource specialists and managers at the various parks, and collecting water resource maps, papers, literature, GIS data, project proposals, and management concerns and issues. His memos contain detailed notes about his meetings and the information he had gathered. The project he was involved with included summarizing water quality issues and monitoring needs for Northern Colorado Plateau Network (NCPN) parks, and developing monitoring plans and methods for these parks. Attached is a 46 page list of water resources literature citations, arranged by park unit and interspersed with Kunkle's comments and notes.

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TRIP MEMO 2

July 18, 2001

To: Lee MacDonald, Melinda Laituri, Freeman Smith, John Stednick, Dept of Earth Resources, CSU

cc: Angie Evenden, I&M
cc: Pete Penoyer, WRD
cc: Dave Vana-Miller
cc: Bill Jackson
cc: Dean Tucker
cc: Mark Flora
cc: TICA and COLM

From: Sam Kunkle, Watershed Specialist

Subject: Information gathering visits to Colorado NM; Timpanogos Cave NM; Grand Mesa National Forest, Delta, CO; USGS, Grand Junction; Uinta National Forest, Provo, UT; and the BLM, USGS, and State Dept of Environmental Quality in Salt Lake City.

Hello Lee and colleagues,

As agreed, I'll meet with you & others this Friday, July 20th at 1:00 pm and bring along the reports, maps, and other materials mentioned in this note that I collected last week. Please add these items to our 'master file' there.

Thanks for inviting the WRD folks to the meeting. Good idea.

As discussed, we also can meet for more time in late August (after my last trip and I assume yours) to compare notes, papers, questionnaire data, your other analyses, etc and summarize the WQ issues. I assume we can summarize: issues by parks; monitoring needs as perceived by the parks; issues common to multiple parks; key parameters; etc.

From there, I assume we can review monitoring approaches (nested, snapshot, rotating, what other?); our ideas for parameter/suite selection; ideas of techniques or instrumentation; options for cooperation; budget concepts; potential park staff roles; etc.

1.0. HIGHLIGHTS: MY STOP AT GRAND MESA, UNCOMPAHGRE AND GUNNISON NATIONAL FORESTS (JOHN ALMY, DELTA, CO)

Monday, July 9, I met with John Almy, Forest Hydrologist of the Grand Mesa, Uncompahgre and Gunnison National Forests at the Forest headquarters in Delta (970) 874-6698, jalmy@fs.fed.us. John's been on the job for about 11 years.

See the references and materials collected for CSU at Delta, in the list below.

- **Routine monitoring:** The Forest has no routine chemical or biological routine monitoring (belt-tightening eliminated routine monitoring of past years). Likewise, past work in sediment generally no longer continues.

- Timber harvesting and WQ: The Forest sampled streams in 1999 to evaluate the effects of timber harvesting on water quality, TOC, color, and common chemicals on the Uncompahgre NF (see the report by John, Feb., 2000, "Beaver Creek WQ monitoring report...") John noted that Louise O'Deen at the Forest Service Rocky Mt Forest & Range Exp Station in Ft Collins analyzed some of the samples (we can check with her on possible analysis and potential costs). Dr Bob Stottlemeyer of Michigan Tech University also had involvement in the study (note that Stottlemeyer also has worked with NPS on a number of projects in the past).
- Fish and WQ: Cutthroat trout protection is a special interest; therefore, the Forest has cooperative work using turbidity recorders, temperature recorders and nutrient analyses on the Uncompahgre NF. Bob Musselman, at the Rocky Mt Forest & Range Exp. Station in Ft Collins is John's contact on this research. (Note, John suspects this information re: WQ and fish is not in STORET or on the web). Mark Williams of the University of Colorado also is cooperating on atmospheric deposition measurements on the Uncompahgre NF.
- 303(d) polluted, "non-supporting" streams: John says that the State has been "after the Forest Service" to collect credible data on streams suspected as polluted and eligible for 303(d) listing (mainly from abandoned mine impacts). Mines seep metals and the tailings cause sediment impacts on aquatic life. State monitoring work around the three Forests is tied to the State's 303(d) listing of waters near abandoned mines.
- Mining & USGS: John notes that Tom Nash, USGS, Denver has many years of research on mining and WQ in SW Colorado for the State (tnash@usgs.gov). John also works in cooperation with Matt Sears of the State of CO (a person most likely relevant to CURE and BLCA).
- A side note: John refers to Polly Hays, FS Regional Hydrologist in Denver, (303) 275-5096, as a competent, capable person (I've talked with her and found her to be helpful and responsive).

1.2. SAM'S FOLLOW-UP CHORES FROM THE FOREST SERVICE, DELTA, CO VISIT

- Check into the "Water Quality Forum" group that John mentioned, headed by Paul von Guerard, USGS in Grand Junction and Mike Baker and Steve McCall of the US BuRec [mbaker@uc.usbr.gov, (970) 248-0637], to learn about monitoring efforts in western CO and the labs, individuals, and facilities involved.
- Before my visit to CURE, talk to Dennis Murphy of BLM in Montrose (970) 240-5342 (John says he's the principal BLM person with water quality involvement in western Colorado --worth a stop by?).
- Contact the State of Colorado water quality specialist Dan Beley (303) 692-3606 prior to my CURE visit --who John considers his key State contact.
- Talk to or visit with Louise O'Deen at the Forest Service Rocky Mt Forest & Range Exp Station in Ft Collins re: any possible analysis cooperation.

2.1. HIGHLIGHTS: VISIT TO COLORADO NATIONAL MONUMENT

On July 10 I visited the Colorado National Monument and met Dave Price (Chief, Resource Management), Judi Lofland (Cultural Resource Management Specialist), Jon Freeman (Seasonal Natural Resource Specialist), as well as Dave Butler, of the U.S. Geological Survey's local Grand Junction office. Dave Butler, USGS, has been collecting some water samples in the monument this year. Dave Price, COLM, has only been in the park for about a year. Jon is a temporary seasonal. Judi has long experience. The bullets below highlight the main points from my COLM stopover.

See references and materials collected for CSU in the list of Section 5, at the end

- Potholes: The monument rises about 2,000 feet above the Colorado River, with steep canyons and arroyos supporting intermittent streams and some springs, as well as potholes (tinajas) and larger canyon pools that retain critical water for wildlife in the spring to early summer or after storms. No Thoroughfare Canyon supports flow for a substantial part of the year, but most canyons dry up by late spring/early summer. Water quantity is naturally always key concern in this arid area.
- Flooding: Flash flooding occurs, sometimes threatening or affecting housing areas sited by the park's canyon mouths (along the park's northeastern boundary). The staff noted that the local USGS had estimated flood peaks (based on debris marks, slope, roughness, cross-section calculations) and found about 9,000 cfs flow out of No Thoroughfare and 4-5,000 cfs from Red Canyon --so the flash floods can be impressive.
- Fruita Waterline: A water supply pipeline traverses about 5+ miles of the park. This pipe supplies the City of Fruita with water from reservoirs upstream from the park at higher mountain elevations. Leakage from this poorly-maintained pipe supports exotic habitats in the park, bringing in tamarisks or other exotic organisms. The town apparently has little incentive to repair the pipe. If they did decide to institute major pipe repairs, soil disturbances in the steep topography would then be an issue. So the waterline continues to be perhaps the park's major water issue.
- Rural homes, roads, and WQ: The "Glade Park" area lies immediately to the west of the park. Glade Park consists of dispersed rural housing with septic tanks, some grazing, traffic with potential for spills of fuel or other materials, and road erosion. Apparently the Glade Park area is where precipitation infiltrates to feed springs in the park --although not much is known precisely about the recharge process, its rate, or effect of wells in the area. The USGS sampled for tritium in the area, to "date" the ground water; but those preliminary observations were inconclusive (Dave Butler, pers. comm. during park visit). Surface runoff from the Glade Park area and its roads feed into the park's major canyons, presenting the potential of sediment impacts. In summary, the Glade Park area's possible effect on water quality and quantity in park springs and canyons is a special concern.
- "The Horizon Report." The Horizon report offers information on sites at lower elevations in the nearby Colorado and Gunnison river valleys, generally downstream from the park. Generally little information has been available in the park itself.
- Dave Butler's work: The most important WQ activity at COLM this time and presumably in recent years is the work of Dave Butler of the USGS's Grand Junction

office. Dave has been receiving support from WRD (Gary Rosenlieb coordinating) this year to sample springs and runoff at COLM under a "Level I Inventory" activity of WQ reconnaissance. Dave sampled about 15 times at 8-10 springs during March and April of 2001, analyzing for temp, Q, FC, EC, about 20 trace elements (by ICP), the common ions, and basic nutrients. If the monsoon season reactivates any springs, he may take some additional samples later this summer. A report of all the work will appear in a USGS "Administrative Report."

- USGS data and maps: Dave Butler, USGS, graciously provided me preliminary information. So included in my box of materials for CSU is a 2 ft X 3 ft hard copy of Dave's ArcView map of the springs at 1:24,000 scale with topo lines, park boundaries, roads, major canyon names, and sampling sites for the surface and spring sites. Accompanying the map is a table of WQ data for the sites for Q, pH, temp, EC, DO, FCs, hardness, major cations/anions, Si, and metals. Dave found the Se levels a little high for wildlife, and some sulfate levels at canyon lower levels were slightly elevated, but in general the WQ is good.
- Visitor impacts in the backcountry: If park visitation continues to grow, backcountry waste problems from climbers and hikers could become an issue.

2.2. SAM'S FOLLOW-UP CHORES FROM THE COLM VISIT

- This fall I should contact Dave Butler, USGS, to discuss specific views on feasible surface sampling sites at COLM (canyons & springs).

3.1. HIGHLIGHTS: VISIT TO TIMPANOGOS CAVE NATIONAL MONUMENT AND UINTA NF, PROVO

On July 11 I visited the Timpanogos Cave NM, American Fork, UT and met with Kit Mullen, Superintendent, Mike Gosse, Chief Ranger, and Jon Jasper, Cave Resource Specialist. In the afternoon I visited with the Uinta National Forest, down in Provo, and met Ted Fitzgerald, Coordinator for Abandoned Mine Reclamation, American Fork Canyon.

Timpanogos Cave contains three small, decorated limestone caves situated northwest of Mt Timpanogos in the Wasatch Range, in steep terrain. The park's Visitor Center (VC) and offices are next to the river at 5,665 ft (the VC). The caves are a 1.5 mile hike and 1,065 ft climb south, at 6,730 ft.

The river is a perennial, mountain stream that flows for about 2/3 of a mile through the park. Because the valley is so narrow and steep, some of the park's restrooms and other facilities sit close to the stream, within the river's 500 year or in cases the 100 year floodplain.

The river's headwaters originate about a dozen miles northeast of the park in the alpine zone at over 11,000 elevation in the Wasatch Range, near the major ski areas. As seen on the Uinta NF map as well as the ArcView map from Jasper, the drainage basin above the park --much of it about 5-6 miles across-- is peppered with old mines and criss-crossed with roads, jeep trails, and other disturbances, and includes some reservoirs. Since the American Fork Canyon basin is only a short drive from urban areas, recreational use is very heavy and will presumably grow. The river's water is mainly used

for irrigation, although sprawl no doubt will continue to turn the "crop" from alfalfa to lawns.

Note: references and materials collected for CSU are list below in Section 5

- Too small an "area of protection:" The park encompasses about 250 acres. As shown on the map by Jasper and other documents collected for CSU, much of the cave's surface water source area or infiltration area lies outside the park boundary in the National Forest, where NPS has no direct control over activities. With only 0.7 mile of river passing through the park, nearly all the watershed lies upstream, outside NPS land. In summary, the creek and caves in the park are mainly affected by land and resource uses outside NPS land.
- Heavy park visitation: Heavy and growing visitation in the park --much of it concentrated along the creek area, by the road and near the Visitor Center, causes compaction/erosion of stream banks, erosion along trails, and probably contamination from human wastes. Older pit toilets also are not a modern waste disposal approach (vs composting toilets, for example, which the park would prefer).
- Recreational impacts upstream: Recreational activities are heavy in the headwaters and wilderness areas extending over 10 miles upstream from the park. Contamination of water by campers beside streams is an obvious problem, and popular rock climbing areas along the American Fork attract overnight camping. The Forest Service's four campgrounds and picnic areas have only pit toilets.
- Pollution from abandoned mines: As evident on the Uinta NF map, the headwaters of American Fork Canyon are filled with old mines, which contribute metals and other chemicals to waters and contaminated sediment to reservoirs. These chemicals are toxic to aquatic organisms. The maps, charts, and the report by Kimball et al. for CSU show sampling sites as well as some chemical data. Forest Service rehabilitation of the mined areas, now underway, is intended to improve water quality (about \$500,000 of effort this year). Fitzgerald's colored 20" X 30" chart with about 100 rows of sampling sites (mostly in the headwaters) also shows water quality data in the river just above and below the park area. The chart lists common ions, metals, physical parameters, turbidity, and nutrients. As would be expected, stream sites closest to the mines (at high elevations) are the most contaminated, and contaminants are more diluted in the downstream direction. This month, a new acting Forest Hydrologist was appointed on the Uinta NF (Chad Hermendorfer, (801) 342-5110 replacing Bob Gecy, at least temporarily). Ted Fitzgerald will continue to work on abandoned mine rehabilitation, including monitoring. The FS should have about \$700,000 for the mine restoration work in FY-02. Their monitoring will likely continue for about 10 years, according to Ted, to evaluate the restoration effort. The FS pays the State for the analyses. Macroinvertebrates were sampled in 1988 and 2000 by Fred Mangum, who is now with the FS in Ogden in other work (801) 625-5488.
- Some contaminated reservoirs: Sediment in reservoirs in the headwaters (e.g., Tibble Fork Reservoir a few miles above the park) contains metals. Dredging of reservoirs (which the ditch company would like) could release contaminants. The Forest Service has sampled fish for metals in headwater areas of the watershed and found fish flesh contamination close to the mine sites, where lead and zinc in fish exceed standards. Since the waters are classed "3-A, coldwater fishery," presumably the

stream will have to be added to the States 303(d) listing as non-supporting (apparently yet to happen).

- Opportunity to use Forest Service monitoring: From a water quality perspective, the Forest Service is monitoring not only for the mined areas in the American Fork headwaters, but also just above and just below the park. Since the park has good relations with the FS, they can take advantage of the FS monitoring above and below the park and consider what complementary monitoring work would be most valuable to the park.
- Hydroelectric impacts: As noted in the report by Martin and Jackson (1999), water is diverted from the creek just above the park for power generation and re-enters the stream below the park (approved by the Federal Energy Regulatory Commission, FERC). The present power operation provides only a 4 cfs minimum instream flow to meet natural stream values for aesthetics, recreation, and fish --in other words largely de-watering the stream. Martin and Jackson (1999) analyzed flow data and noted that the 4 cfs is lower than desirable --suggesting a 10 cfs minimum or more would be more natural. From a water quality perspective, dewatering the stream also reduces the dilution of any contamination by local activities within the park area and reduces stream aesthetics. The poorly maintained pipe also can break, causing local erosion and turbidity. The park has requested that FERC not re-license the operation --which from a water quality perspective is clearly desirable.
- Park's limited technical staffing: In terms of resource management, the park has limited staffing, with only one GS-7 technical position (primarily concerned with the caves) plus some seasonals. The present budget does not allow more resource staffing. Nonetheless, the staff is monitoring water passing through the cave system, to understand drip rates, relation of the caves to major storms, as other factors. Naturally the caves are the park's unique features, so they will want to continue some form of monitoring within the caves.
- Not a "municipal watershed:" The American Fork Canyon is a creek traditionally considered irrigation waters, so (contrary to what one would expect) is not classified as a municipal water supply ("culinary water") area. The watershed is not restricted to vehicles and land uses that might be prohibited in a municipal basin. Toxic spills of fuels or other materials upstream from the park or in the park therefore are a concern.
- Flooding: Martin and Jackson (1999) and the park's General Management Plan (1993) describe how the park has buildings, rest rooms, parking, trails, and other features within the creek's 100 or 500-year floodplain.
- Ski area expansion: A ski area lies just over the upper end of the American Fork Canyon watershed, and reportedly would like to expand skiing trails and lifts over into the watershed. It is not known what impacts on water resources could result.

3.2. SAM'S FOLLOW-UP CHORES FROM THE TICA AND UINTA NF VISIT

- In the fall, find out from Fred Mangum who is carrying out macroinvertebrate work around the state at this time (and in the past in the American Fork).

- In the fall, call Chad Hermendorfer, new person on the Uinta NF (he was away when I visited) and see what other monitoring is planned around the park area (aside from the abandoned mine work per se upstream).

4.1. HIGHLIGHTS: SALT LAKE CITY FEDERAL AGENCIES AND DEQ VISIT

Any NPS monitoring should dovetail with programs of other agencies or the State. I met with several people in Salt Lake City:

1. Bureau of Land Management: Heidi Hadley, Regional Hydrologist
 2. US Geological Survey: Steve Gerver and Bert Stolp, Hydrologists
 3. State Division of Environmental Quality (DEQ): Tom Toole, Carl Adams, and Bill Moellmer, Division of Water Quality, DEQ
- Cooperation with the Division of Water Quality, DEQ: We have the option to cooperate in some fashion with DEQ. They can provide some free analyses in specific cases where the samples "are useful to their program," that is, complements their ongoing monitoring, 303(d) listing follow-up, TMDL effort, or other work. In other cases, they would have to charge for analyses. We could see how our monitoring goals may or may not link with their goals and programs. The DEQ requires at least 10 samples yearly from a site, and preferably monthly. Toole notes they collect twice per month in the main spring runoff, but normally no samples in December.
 - Training: The DEQ provides (free) sampling training for all cooperators (done a few times a year at various sites around the state).
 - References: The prime references for CSU from the State: (1) the water quality standards (62 pp); (2) printout of some examples of cooperators and DEQ samples with about 150 pp showing parameters and data; and (3) the State annual report to Congress (shows streams around the state, about 200 pp. Note some of this information also appears on the web now.
 - Their coverage: As discussed with the State DEQ people Toole and Adams, about 75 percent of the state's perennial streams are assessed for water quality (they do not routinely assess intermittent streams).
 - A Workshop, Oct 22, 2001: Note that DEQ will hold a bioassessment workshop with EPA in Salt Lake on Oct 22, restricted to about 40 people. Toole suggested it might be good to have an NPS-WRD person there (I suggested possibly a WRD person, perhaps Vana-Miller, specialist in such things?). Toole would be interested (note, Tom Toole = (801) 538-6859).
 - Field measurements: In cases DEQ works with cooperators (e.g., BLM, FS, or NPS) where often the cooperator has a "Hydrolab" or similar gear to take EC, DO, pH, and temp field readings, at a cost of perhaps \$3,000 for gear; then the State provides the chemical analyses of the gathered samples. This type of arrangement would be one option for us to explore for certain parks. Note that Toole says turbidity and TDS are complex parameters and standards to use, often not used, since in many Utah areas natural conditions produce high turbidity or TDS at times.

- Heads up Melinda? Toole notes the DEQ has a new program to start this fall, where better narrative descriptions of watersheds will be presented along with presentation in ArcView (note, Tom Toole = (801) 538-6859).
- 303(d) reporting: Last year the State received "serious comments" on their 303(d) report, Toole noted, but he was able to respond and they avoided lawsuits after meetings with environmental groups (apparently few states avoid the lawsuits). Toole spent several months working on these responses.
- Carl Adams: Carl Adams, DEQ, may try and cross paths with me in Moab on August 7-9, when I'll see NPS, USGS, FS, and BLM.
- USGS research activities: My meeting with the USGS provided overview information on their activities, with research or technique development important (several reports are provided to CSU in the box of materials).
- BLM is "two groups:" A note, just fyi: The traditional BLM field and district offices operate as separate entities from the new Grand Staircase-Escalante group of BLM (best regard them as separate organizations I am told, and not assume they talk to each other about activities or programs).

4.2. SAM'S FOLLOW-UP CHORES FROM THE SALT LAKE CITY FEDERAL AGENCIES AND DEQ VISIT

- We could invite a person or two from the Utah Dept of Environmental Quality (and their Colorado counterparts) to take part in at least a portion of our scoping meeting this fall. (Toole and Adams both expressed possible interest). Perhaps a local USGS person could be invited as well?
- As we flesh out some monitoring ideas, we likely will want to determine if any free sample analyses from Utah DEQ are feasible, or what costs would be for cooperative monitoring. This would have to be a park by park determination.
- I should follow up with Arnie Hultquist, DEQ --who I am told is the main technical person on the field sampling.

5. REFERENCES AND MATERIALS COLLECTED FOR CSU

indicates apparent new addition to the bibliographic list provide to me by Margaret Beer; @@ = item copied for CSU; @ = excerpts of item copied for CSU.

5.1. MATERIALS COLLECTED FROM JOHN ALMY, FOREST SERVICE, DELTA:

--Almy, John. 2000. Beaver Creek water quality monitoring report: San Miguel River Basin. Feb. 15, 2000 in-house report, USDA Forest Service. Delta, CO. 19 pp. [charts of common ion data, plus TOC, DOC, nutrients, Q, temp, turbidity, and EC.

--Map: Grand Mesa National Forest, 1995, Scale: 0.5" = 1 mile (Forest closest to COLM).

--Map: Uncompahgre NF. 1993. Scale: 0.5" = 1 mile (near BLCA; also area where FS has done the color, TOC, and other studies recently).

--Map: Gunnison Basin Area. 1984. Scale: 0.5" = 1 mile (headwaters of CURE to the north largely in this Forest).

--Small Map: Grand Mesa, Uncompahgre, and Gunnison National Forests. Small overview map of all three Forests, illustrating locations of BLCA, CURE, and COLM in relation to the Forests.

5.2. MATERIALS COLLECTED FROM THE COLM VISIT (## indicates apparent new addition to the bibliographic list provide to me by M. Beer; @@ = copied for CSU; @ = excerpts copied for CSU).

--Brochure with small map of the park area

--(1) @@ COLM-I-004.004. Develop a Water Resources Management Plan (WRMP). 1997. 3 pp. Shows park recognition that water is critical in this arid park, however, little is known about the resource. Preparation of the WRMP would be a first step in addressing water issues at COLM, including growing visitation, development near the park, a water pipe traversing the park, etc.

@@ Livo, Laura. 1999. No Thoroughfare Canyon tadpoles. Note to the file at COLM, 6/29/99, from Biology Dept person L.J. Livo, University of Colorado. 2pp. Abstract: Note summarizes the sampling of pools areas in No Thoroughfare Canyon for tadpoles and toads in June 1999. At least two species were identified.

@@ Colorado National Monument. 1999. Survey of the Fruita Waterline, Colorado National Monument. Internal park report. 40 pp with attachments and photographs. Abstract: In 1998 volunteers at COLM conducted surveys of the Fruita Waterline, which consists of about 5+ miles of pipe crossing the park from the west central boundary up to the northern end of the park, to provide water to the town of Fruita. The volunteers took notes, pictures, GPS readings and prepared ArcView maps and photographs of the pipe. The pipeline is in poor condition, and leakages support exotic habitats in several areas in the park.

##@@ Butler, Dave. 2001. Map of spring and surface sampling sites in the Colorado National Monument, 2001. 2 ft X 3 ft ArcView map of the area. Abstract: Map at 1:24,000 scale with topographic features, park boundaries, roads, major canyon names, and sampling sites for surface and spring sites.

##@@ Butler, Dave. 2001. USGS multiple station analyses for water quality in the Colorado National Monument. 10 pp. Abstract: A table summarizing water quality data for about 10 springs and 2 surface sites in COLM.

##@@ Rosenlieb, Gary. 1994. Correspondence to Bill Jackson of March 10, 1994 regarding travel to COLM area to meet with the US Geological Survey. 3 pp. Abstract: Meeting of about 35 government water specialists summarized the basin-wide issues in the upper Colorado basin as: effects of mining (metals, etc); effects of agriculture (nutrients, pesticides, etc); effects of urbanization (sediment, etc); effects of natural geology (salinity especially); impacts of diversions, dams, or other structures.

5.3. MATERIALS COLLECTED FOR CSU FROM THE TICA AND UINTA NF VISIT (## indicates apparent new addition to the park's bibliographic list provide to me by M. Beer; @@ = copied for CSU; @ = excerpts copied for CSU).

5.3.A. MATERIALS FROM TICA'S FILES

--Timpanogos Cave NM. 1997. Park brochure: Official map and guide. (folding brochure). Abstract: provides an overview of activities and features of the monument.

@@ Jasper, Jon. 2001. Cave and watershed maps. ArcView and graphics maps of the American Fork Watershed and the cave watershed source area. Drawn partly on maps from the 1993 National Cave Management Symposium Proceedings. Map layers provide information on watersheds, pipelines, roads, streams, other features from Jon Jasper at TICA (801) 492-3647

@ Jensen, T.M. 1990. Hydrology study update. In-park file report. 4 pp. Abstract: Hydrologic studies have shown water dripping in the caves to respond to spring runoff and snowmelt, and to long-duration storm events, with about a 24-hour lag after a storm in Hansen Cave (one of the three). The amount of snow falling above the cave area affects the water volume passing through the cave system. (also I've copied parts of study proposals and project statements related to cave hydrologic study at TICA).

##@ Mayo, A.L. D. Herron, S.T. Nelson, D. Tingey, and M.J. Tranel. 2000. Geology and hydrology of Timpanogos Cave National Monument, Utah. pp 263-275 In Geology of Ujjah's Parks and Monuments, 2000 Utah Geol. Assoc. Pub. 28. 644 pp. Salt Lake City. Abstract: Describes the Timpanogos cave system, including discussion of water infiltrating into the cave system, especially in Hansen Cave, located near the cliff face.

@ Martin, Michael W. and William L. Jackson. 1999. Hydraulic modeling of low flows, American Fork Creek, Timpanogos Cave National Monument, Utah. Water Resources Division, NPS. Fort Collins. 22 pp + 130 pp graphs. Abstract: The creek is subject to dewatering by flows bypassed just above the park, for power generation. The present power operation only provides for a 4 cfs instream flow minimum, to meet natural stream values for aesthetics, recreation, fish, etc. The report analyzes flow data and questions if the 4 cfs is unnaturally lower than desirable --suggesting a 10 cfs minimum would be more natural.

5.3.B. OTHER MATERIALS, MAINLY FROM THE UINTA NF

@@ Uinta National Forest. 2000. American Fork Canyon and the Alpine Loop Scenic Backway. Brochure from USDA Uinta National Forest. Provo. 2 pp. Abstract: Describes recreational activities around the TICA area, especially in the headwaters and wilderness areas above TICA (which supply the surface and cave waters in the park).

@@ US Geological Survey. 1993. Timpanogos Cave, Utah quadrangle map at 1:24,000. Abstract: this quadrangle provides 40 ft contours of the headwaters immediately above the cave and shows part of the river's drainage basin, for about 6 miles above the cave (the rest of the basin appears in the Uinta NF map).

@@ Uinta National Forest. 1993. Map of Uinta National Forest at 1:26,720 scale (~.05" = 1 mile). Abstract: Provides overview of entire American Fork Canyon river drainage, which originates in the mountains east of the park at over 11,000 ft, showing position of mining

sites, reservoirs, wilderness areas, roads, and other key features affecting water quality in the river and cave.

@ Kimball, B. A., R.L. Runkel, and L.J. Gerner. 2001 (draft). Quantification of metal loading by tracer-injection and synoptic sampling, American Fork Watershed, Utah, October, 1999. (draft) U.S. Geological Survey Water-Resources Investigations Report un-numbered, in cooperation with the Uinta National Forest, Provo. 63 pp. Abstract: abandoned mines contribute metals to the streams and the sediment in the streams, which can be toxic to aquatic organisms. The study and map show sampling sites and results of chemical evaluations for metals, and discusses the concepts of rehabilitation of mined areas and implications for water quality.

@@ Fitzgerald, Ted. 2001. Draft chart of chemical analysis results for monitoring of the American Fork Canyon watershed. Abstract: this colored 20" X 30" chart with about 100 rows of sampling sites also provides water quality data in the river above and below the park for common ions, metals, physical parameters, turbidity, and nutrients.

5.4. PRINCIPAL MATERIALS COLLECTED FROM THE SALT LAKE CITY AGENCIES

--Directory of BLM staff in Utah, showing teams and specialists (14 pp).

--Burden, C.B. 2000. Ground-water conditions in Utah, spring of 2000. Coop. Investigations Rpt # 41. 140 pp.

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