June 14, 2022
Town of Morrison
Kara Winters, Town Manager
321 Highway 8
Morrison, CO 80465

Re: Request for Scoping Comments, Bear Creek Study

U.S. Army Corps of Engineers
Omaha District
ATTN: CENWO-PMA-C (Bear Creek Study)
1616 Capitol Avenue
Omaha, NE 68102

Thank you for the opportunity to comment. The Town of Morrison is west of and adjacent to the Bear Creek Lake Park (BCLP). Many Morrison residents use the Park regularly, and Park visitors patronize the Town's shops and restaurants, thereby contributing to the Town's economic vitality. Morrison participated in the October 14, 2021 Scoping Meeting as a Stakeholder Agency. Additionally, numerous concerned residents participated in the Public Scoping Meeting conducted by the U.S. Army Corps of Engineers (USACE) that evening.

On April 19, 2022, the Morrison Board of Trustees unanimously approved Resolution No. 2022-04, *A Resolution of the Town of Morrison, Colorado, stating opposition to a significant reallocation of the Bear Creek Reservoir and requesting alternative water storage solutions that allow for preservation of the Bear Creek Lake Park*. (See Exhibit A)

Section 1: Request for an Environmental Impact Statement (EIS)

While a notice of intent (NOI) to prepare an Environmental Impact Statement (EIS) has not yet been published, the signs posted in the Park by the USACE are titled, "Bear Creek Lake Reallocation Feasibility Study and Environmental Impact Statement," leading the public to believe that an EIS will be conducted. The National Environmental Policy Act (NEPA) requires proposals for "major Federal actions significantly affecting the quality of the human environment" to include an IES. 42 U.S.C. § 4332(C).

The Town of Morrison asserts that potential reallocation levels ranging from Elevation 5575.6 PD (~2,500 acre feet) to Elevation 5622.7 PD (~20,000 acre feet) would have a "significant impact" on the human environment. Therefore, the Town requests an EIS to be conducted as part of the Reallocation Study.

An EIS was required for the Chatfield Reallocation Study, and the environmental and recreational impacts of a significant reallocation of Bear Creek Lake would be arguably more severe than those at Chatfield Reservoir. An expectation of a similarly rigorous environmental review is reasonable for the Bear Creek Reallocation Study.

Your evaluation of this project pursuant to NEPA is not discretionary. The procedural requirements of the NEPA evaluation include consideration of alternatives (40 CFR 1502.14); public review and comment (40 CFR 1506.6); a clear statement of purpose and need (40 CFR 1502.13); and adherence to the substantive requirements of related environmental and resource statutes including but not limited to The Endangered Species Act, The Clean Air Act, and the National Historic Preservation Act. Inherent in the process is the consideration of the implications of the project in a cohesive and comprehensive manner, not one broken into pieces where the implications are considered individually rather than comprehensively. The

segmentation of a project in a fashion where the outcome is being pre-determined by consideration of portions of the study before the NEPA process formally begins, with a view toward feeding pre-NEPA comparted data into the NEPA process, is a flawed approach, particularly where reasonable alternatives are rejected prematurely and without an opportunity for public review and comment before the complete project data are available for consideration. We are particularly concerned that your evaluation is focused on a pre-determined result and that the purpose and need component will be constrained to preclude consideration of otherwise reasonable alternatives.

A determination of "significant impact" should be made, triggering a comprehensive EIS. Anticipated impacts of a 20,000 acre-feet reallocation are listed below, but given the relatively flat topography of the site, significant impacts can be expected for a reduced reallocation as well.

1. Recreational impacts as assessed by Lakewood staff: *Likely result in change to character of park recreation from land-based to water-based. Trail changes will impact multiple special events, likely causing permanent cancellation of several. Unpredictable water levels may severely impact future recreation. Could significantly impact environmental education programming, and overall recreational use as many participants and users visit the park specifically for the shaded riparian habitat (walkers, cyclists, runners, bird/wildlife viewing).* Bear Creek Lake Park Recreational Impacts; 10/14/21; City of Lakewood; https://www.lakewood.org/files/assets/public/community-resources/parks/bclp/bear-creek-reservoir-expansion-impacts.pdf

2. A 20,000 ac-ft expansion would impact ~70% of BCLP trails and ~75% of the riparian areas. It was noted by Lakewood staff, during the 2nd Planning Iteration Meeting (Exhibit B), that there is probably not enough space within the Park to relocate existing recreational resources such as boat ramps, parking areas, equestrian areas, etc.

3. The 20,600 ac-ft reallocation approved at Chatfield authorized a ~39% increase in the surface area of Chatfield Reservoir: an 11% inundation on a 5,300-acre site. By comparison, a 20,000 ac-ft expansion of Bear Creek Lake would increase the surface area of the Reservoir by ~450%, inundating nearly 1/3 of the 1800 acres of parkland west of the dam. The scope and severity of these impacts within BCLP are much more significant than corresponding impacts in Chatfield State Park.

4. Impacted Stream Length of Bear Creek (USACE Scoping Meeting Presentation 10/14/21)
   - ~5,813 ft (20,000 ac-ft increase)
   - ~3,886 ft (10,000 ac-ft increase)

   Impacted Stream Length of Turkey Creek
   - ~3,900 ft (20,000 ac-ft increase)
   - ~3,095 ft (10,000 ac-ft increase)

5. **The combined stream lengths of Bear and Turkey Creek impacted by a 20,000 ac-ft reallocation is approximately 1.8 miles.** A 10,000 ac-ft reallocation would inundate approximately 1.3 miles of stream. "Riparian habitat supports a higher diversity of wildlife year-round than any other habitat in the Front Range and these riparian habitats also provide corridors that link habitat patches and wildlife populations allowing movement through urban matrix." (*Environmental Assessment for the Bear Creek Dam and Lake Project Master Plan;* 4.10.1; September, 2012)

6. Impacted Wetlands (USACE Scoping Meeting Presentation 10/14/21)
    - ~72.29 acres in a 20,000 ac-ft increase
    - ~50.59 acres in a 10,000 ac-ft increase

7. Significant Pool Elevation Fluctuation would likely have negative impacts including:
    - Development of extensive mud flats,
    - Loss of vegetation and wildlife habitat,
    - Introduction and spread of noxious weeds,
    - Wind erosion and deposition of exposed soil/sediment,
    - Decreased accessibility to land and water-based recreation, and
    - Decreased aesthetics.

8. Social Well-Being: A significant reallocation of the Bear Creek Reservoir would negatively impact the mental and physical health of regular park users, as well as future generations of BCLP users. A widely circulated study published in the online science journal *PLOS One* in March of 2022 underscores how essential nature is for mental and physical well-being. (https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0261056) For urban and suburban populations, parks like Bear Creek Lake Park are a primary source for experiencing nature. The University of Vermont study integrated research from the Gund Institute for Environment, the Spatial Analysis Lab, and the MassMutual Center of Excellence for Complex Systems and Data Science to measure the mood-boosting benefits of urban nature. A strong happiness benefit from time spent in nature was recorded by positive mood spikes among park visitors. The study gathered a massive amount of data from social media to quantify this mood-boosting benefit. Not surprisingly, larger parks offer a greater benefit than smaller parks. "The ability to immerse yourself in a larger, greener natural area had a greater effect than smaller paved city parks," says UVM professor and researcher, Chris Danforth.

Section 2- Scope of EIS

Authorizations

- The Corps should discuss:
    - How the reallocated storage capacity will be filled and managed, particularly relative to analysis of dependable yield potential,
    - Effects on operational changes to other reservoirs in the South Platte Watershed, and
    - Effects of water level fluctuations on resources including aquatic resources, fisheries, wildlife habitat, vegetation, water quality and recreation; and
    - Effects of operational changes in the downstream channel during both routine and flood operations.

Alternatives Analysis

- The Corps should consider:
    - More extensive conservation, including restrictions on watering and additional incentives for municipal and residential water-saving measures,

    - Offsite water storage alternatives such as off-channel sand and gravel pits along the South Platte, closer to the primary municipal partners interested in acquiring storage rights in Bear Creek Lake, and through which substantial water storage capacity is created every year;

- Whether the Municipal Partners interested in additional Bear Creek Lake storage have water-conservation policy measures in place;

- On-site alternatives such as (1) excavating the reservoir to remove accumulated sediment and deepen the reservoir, and (2) excavating forebays upstream of the reservoir to increase storage capacity within a smaller footprint than maps of proposed increases depict; and

    - Note: On-site alternatives listed above had been eliminated from consideration during the 2nd Planning Iteration Meeting (see Exhibit B). However, those alternatives were retained for further consideration after the October 14, 2021 Scoping Meetings.

- The feasibility of constructing a secondary pool south of the current reservoir, along the south embankment, to minimize the impact of additional storage in the riparian corridors. Note that disruption of grasslands south of the current pool would significantly impact wildlife habitat; however, this may be a viable trade-off for reduced disruption of riparian areas.

    - Note: Construction of a secondary pool was not discussed during the 2nd Planning Iteration Meeting on August 31, 2021; however, it was suggested during the October 14, 2021 Public Scoping Meeting and in subsequent public comment.

<u>Dam Safety / Flood Control</u>

- The Corps should:
  - Disclose clearly, in plain English, how the project would affect dam safety and flood control, especially considering the potential for more frequent extreme weather events caused by climate change, and
  - Describe project modifications and infrastructure that may be necessary to mitigate increased flood risk of reallocation, especially if the Study recommends trading flood risk management benefits for water storage benefits.

<u>Mitigation</u>

- The Corps should:
  - Consider that, given the relatively flat topography of the proposed inundation zones and limited space within the Park, on-site mitigation for a large reallocation would be extremely limited;
  - Recognize that relocating trails and picnic areas within the Park would likely involve replacing shaded trails and picnic areas, currently in the riparian areas along Bear and Turkey Creek, with trails in grasslands adjacent to the roads and highways on the Park's periphery. Many Park users specifically seek the forested, creekside areas of the Park, which could not be comparably mitigated on-site.
  - Consider if (and how) mitigation could be accomplished to compensate for the ecosystem services provided by the riparian corridors and wetlands that would be impacted, which comprise only 2% of Colorado's land area but provide critical services and have significant natural and economic value, including but not limited to:
    - Filtering water and trapping pollutants,
    - Absorbing CO2,
    - Buffering hydrologic extremes during floods and droughts,
    - Providing habitat for wildlife, and
    - Supporting local biodiversity and the health of adjacent ecosystems.

Pool Elevation Fluctuation

- The Corps should address the fluctuation impacts of mud flats, noxious weed spread, wind erosion and deposition, decreased accessibility to land and water-based recreation, decreased aesthetics; and
- The Corps should provide maps depicting areas within potential fluctuation zones, showing the specific topography that would be be impacted by fluctuation for each pool volume that remains under consideration, and
- Storage yield analyses should be disclosed to the public, particularly as low dependable yield increases the extent and impact of fluctuating pool levels.

Water Quality

- The Town of Morrison relies on the Bear Creek Watershed Association (BCWA) for Water Quality guidance regarding Bear Creek Reservoir.
- BCWA noted that "at maximum elevation, the reservoir probably would no longer meet the Aquatic Life Cold 1 Standards and classification because there would be significantly more shallow water area in the reservoir."
- Consider how the water quality of a significantly larger pool, with more shallow areas and potentially warmer temperatures, would impact the green-belt downstream and into the South Platte River.
- Consider how managing a larger pool to reduce fluctuation during periods of minimal inflow will impact water quality in the Bear Creek Lake and potentially reduce flows and degrade water quality through the greenbelt and riparian corridor downstream.
- An EIS should consider how significant loss of beaver habitat in the project area would impact water quality, as beaver dams and adjacent wetlands filter and store water.

Aquatic Life and Fisheries

- The Corps should identify aquatic impacts above and below the reservoir, including impacts to amphibian species whose life cycles rely on aquatic environments; and
- The Corps should address impacts to stream and reservoir fish populations.

Riparian Habitat, Ecosystem, Wetlands

- The Corps should include analysis identifying a number of species for consideration, including special status plants and animals, migratory birds, water birds, sport fish, and non-sport fish.

- The Corps should address:
    - The loss of habitat caused by the increased and fluctuating water levels,
    - The negative effects that fluctuating water levels could have on breeding and spawning, bird migration; and
    - The effects of inundation around, upstream, and downstream from the reservoir.

Vegetation

- The Corps should address:
    - Impacts on riparian habitats around, upstream and downstream from the reservoir,
    - Impacts on threatened/endangered T/E species and species of concern such as the Colorado butterfly plant and Ute ladies'-tresses orchid, and
    - The need for a noxious weed control plan because pool elevation fluctuations would likely aid the spread of noxious weeds.

Wildlife

- The Corps should address:
  - Impacts to riparian habitats, important to migratory birds and songbirds; and,
  - Threatened/endangered species and state species of concern, including the bald eagle, western burrowing owl, short-eared owl, northern leopard frog, lined snake, black-tailed prairie dog and others as appropriate; and
  - The USFWS IPaC Report, cited in the Oct. 14, 2022 USACE Public Scoping Presentation, page 22, which noted, "Six known T/E species may be in the directly affected area."

Environmental Justice

- The Corps should consider the social well-being benefits that BCLP provides to surrounding communities in its current configuration and operation. The BCLP provides local, affordable access to the natural environment and educational opportunities for all people throughout the Denver Metro Region. How would the project comply with Executive Order 12898?

Social Well-Being

- At the October 14 Public Scoping Meeting, Greg Johnson, USACE Plan Formulation Section Chief said, "There is some special emphasis on social affects and social well-being considerations in the decision-making process that came out of the Assistant Secretary of the Army within the last calendar year, so it is being elevated to a higher level of consideration in the decision-making process versus just pure economics anymore....It's one of the reasons we are trying to keep the Lakewood community engaged in the process, because you'll know better than we will in terms of how those effects translate into your own back yard." (96 minute mark of recorded meeting) Please state how this special emphasis will be addressed within the Bear Creek Study.
- The Corps should consider the number of people who visit the Park, including those who enter from numerous access points surrounding the Park and are not included in the official count. Visitation data from 2020, largely based on vehicle entries at one location, estimated over 650,000 visits to the Park that year. Annual visitation rates are likely over 800,000.
- The Corps should note that those who patronize the Park's water-based recreational opportunities are more likely to drive in, as they are hauling boats, kayaks, beach picnics and the like. However, those who access the Park on foot or bicycle are not adequately counted in the currently available data, and these Park users favor the central region of the Park which would be inundated in an expansion of the Reservoir.

Recreation

- The Corps should consider:
  - How there may not be enough space within the Park to relocate many of the trails and facilities that would be impacted, and
  - How the recreational and social well-being benefits provided by shaded, forested trails along a running creek; amidst abundant wildlife; immersed in the sounds of moving water, songbirds, and rustling leaves cannot be adequately mitigated on-site; and
  - How relocating trails and facilities from forested riparian areas to the periphery of an expanded pool, closer to the traffic and noise of surrounding highways, will impact the quality of the recreational experience; and
  - How fluctuating water levels could affect access to boating, fishing, swimming, bird watching, wildlife viewing and handicapped access; and

- How, compared to other nearby parks in steeper, more rugged terrain, the relatively flat terrain and variety of trail surfaces at BCLP allows a broad base of users to enjoy the outdoors (young-old, beginner-expert, more-less mobile).

Economics

- Considering the likely loss of recreational opportunities at BCLP, we are concerned about how visitation and revenue at businesses in the Town would be affected. As a small town that is a popular tourist destination, we rely for the majority of our general fund revenue on sales tax and other collections, mostly from visitors. For the 2022 budget year, $1.2 million of our $2.3 million in budgeted revenue is projected to come from sales tax. We also expect to receive abut $500,000 from museum tickets and sales, parking fees, traffic fines, and other revenue directly attributable to out-of-town visitors. Altogether, this represents about 75% of theTown's general fund revenue. Any decrease in visitation at BCLP and our businesses would cause a significant decrease in revenue to the Town.
- The Corps should analyze potential changes in visitation to the park and how that would affect sales tax and other revenues in the Town of Morrison, as well as the City of Lakewood and Jefferson County. How would the Corps mitigate this potential negative impact on the budget of the Town and other local governments?

Population Projections and the Water Storage Gap

- The Colorado Water Plan's statewide storage goal of 400,000 ac-ft, reflects predictions of Colorado's population *doubling* between 2008 and 2050 (from 5.1 million to somewhere between 8.6 and 10.5 million). That was according to a study commissioned by the Colorado Water Conservation Board in 2010, but that trajectory has fallen far short of predictions (https://dnrweblink.state.co.us/cwcb/0/doc/144800/Electronic.aspx?searchid=c1469548-e589-49df-a54f-6b03612a38e3).

- The State Demography Office found the number of people moving into Colorado has been declining since 2015, putting the state's current population around 5.8 million. The DMO's updated projections, prepared in October 2021, estimate Colorado's population will reach 7.56 million in 2050 (https://demography.dola.colorado.gov). That's 2.5 million fewer people than projected when the 400,000 ac-ft storage goal was set. Current models predict a roughly 50% increase from 2008-2050, not the 100% increase that, in part, led to authorization of the Bear Creek Reallocation Study.

- Published notes from the 2nd Planning Iteration Meeting indicate the Bear Creek Study will not include further development of water supply alternatives that do not involve Bear Creek Dam or Reservoir, but that these alternatives will be compared to storage reallocation at Bear Creek Reservoir. Consideration should also be given to how the potential benefits and impacts of a reallocation at Bear Creek Reservoir fit within the priorities and urgencies of Colorado's water storage gap.

Thank you for providing the Town of Morrison with this opportunity to comment.

Kind regards,

Kara Winters
Town Manager

EXHIBIT A- MORRISON RESOLUTION NO. 2022-04 ATTACHED

TOWN OF MORRISON
BOARD OF TRUSTEES

RESOLUTION NO. 2022-04

A RESOLUTION OF THE TOWN OF MORRISON, COLORADO, STATING OPPOSITION TO A SIGNIFICANT REALLOCATION OF THE BEAR CREEK RESERVOIR AND REQUESTING ALTERNATIVE WATER STORAGE SOLUTIONS THAT ALLOW FOR PRESERVATION OF THE BEAR CREEK LAKE PARK

WHEREAS, the US Army Corps of Engineers (USACE) is investigating the feasibility of reallocating capacity in the Bear Creek Reservoir to add Water Storage as an authorized purpose to the previously authorized purposes of Flood Control, Recreation, and Fish and Wildlife Enhancement; and

WHEREAS, alternatives under consideration range from no change to a 20,000 acre feet expansion of the current maximum storage volume of 2,000 acre feet; and

WHEREAS, the proposed expansion of the Bear Creek Reservoir would reduce the land area of the Bear Creek Lake Park (BCLP) by over 500 acres; and

WHEREAS, the potential areas for inundation include the riparian corridors of Bear Creek and Turkey Creek, miles of forested trails, and significant wildlife habitat; and

WHEREAS, expanded water storage in the Reservoir would result in significant fluctuations in pool levels, which would increase the acreage of "mud flats" that surround the Reservoir at lower levels; and

WHEREAS, the 10,000 and 20,000 acre feet reallocation alternatives assessed by the USACE are not risk-neutral and result in increased flood risk; and the assessment also concluded that risk mitigating project modifications and risk neutral alternatives likely exist; and

WHEREAS, the primary municipal partners currently interested in additional water storage in Bear Creek Reservoir are the Cities of Brighton, Berthoud and Dacono; and a growing number of sand and gravel pits are being created and repurposed for water storage along the South Platte, closer to those municipalities; and

WHEREAS, the Bear Creek Lake Park hosts an estimated 800,000 visits annually, which is expected to increase as new residential development in the Rooney Valley increases Park use; and

WHEREAS, the USACE is required to consider project impacts on social well-being in the Feasibility Study; and

WHEREAS, the portions of the BCLP that would be inundated in an expansion of the Reservoir provide significant quality of life and social well-being benefits to the people of Morrison and the greater region;

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF TRUSTEES OF THE TOWN OF MORRISON, COLORADO, AS FOLLOWS:

Section 1. The Town urges the US Army Corps of Engineers to take full consideration of both on-site and off-site water storage alternatives which can preserve the core of Bear Creek Lake Park's land-based recreational and environmental assets, including the riparian corridors of Bear and Turkey Creeks.

Section 2. The Town, as a Stakeholder Agency, directs this Resolution to the US Army Corps of Engineers and the Colorado Water Conservation Board.

INTRODUCED, READ, PASSED and ADOPTED this 19th day of April, 2022, by a vote of 5 ayes and 0 nays.

TOWN OF MORRISON SEAL COLORADO

TOWN OF MORRISON

Chris Wolfe, Mayor

ATTEST:

Ariana Neverdahl, Town Clerk

EXHIBIT B- 2nd PLANNING ITERATION MEETING NOTES ATTACHED

Bear Creek Reservoir Reallocation GI Study

2nd Planning Iteration Meeting
31 August 2021 (Conducted Virtually)

Tuesday, 31 August (All times MDT)	
8:00 – 8:15	Introductions
8:15 – 9:30	Review Study to Date • Background • Progress to Date • Problems & Opportunities • Without Project Condition • Objectives & Constraints • Key Questions • Key Uncertainties • Decision Criteria
9:30 – 9:45	Break
9:30 – 10:30	Review Alternative Measures Initial Screening
10:30 – 11:30	Further Develop Alternative Measures
11:30 – 12:30	Lunch Break
12:30 – 1:30	Further Develop Alternative Measures (continued)
1:30 – 2:00	Review & Identify Key Questions & Uncertainties (specific to alternative measures) • What, if anything, is preventing us from recommending this alternative? • What are the unique questions we have or should ask about this alternative? • What gaps to we need to address to get to a Tentatively Selected Plan?
2:00 – 2:15	Break
2:15 – 3:30	Review & Identify Key Questions & Uncertainties (specific to alternative measures) (continued)
3:30 – 4:00	Wrap-up and Discuss Next Steps • Develop Alternative Plans (initial array of alternatives) • Evaluate Alternative Plans • Compare & Select a Recommended Plan

Participants:

NWO
Chris Fassero – Lead Planner/Project Manager
Rachel Schulz – Hydraulic Engineer
Katie Seefus – Hydraulic Engineer
Roger Kay – Hydraulics Branch Chief
Ben Letak – Dam Safety Engineer
John Shelman – Environmental Specialist
Sandy Barnum – Cultural Resources Specialist
Brad Thompson – Planning Branch Chief

Greg Johnson – Plan Formulation Section Chief
Joe Maxwell – Tri-Lakes Operations Project Manager

CWCB
Erik Skeie – Project Manager

Andrew Rickert – Program Manager
Lauren Ris – Deputy Director

Colorado Department of Water Resources
Tim Buckley – Water Commissioner

Lakewood Parks Department
Drew Sprafke – Bear Creek Park Supervisor
Jim Haselgren – Park Manager

Bear Creek Watershed Association
Russell Clayshulte - Manager

Brown & Caldwell
Meg Frantz – Water Resources Engineer

Notes:

Summary of Measures Screening Discussion:

1) Retained for further consideration – No action.

2) Retained for further consideration – Reallocation of various amounts of Bear Creek Reservoir storage from the flood control and/or flood surcharge zones to the conservation zone.

   - Reallocation from the flood control zone would result in loss of flood control storage. Reallocation from the flood surcharge zone would potentially impact flood risk and/or dam safety risk. Reallocation from either zone would require consideration of impacts on flood risk and dam safety risk.

   - Would require significant confidence in hydrology.

   - May require significant recreational and operational modifications.

   - If the reallocated pool level exceeds the elevation of the outlet works intake door, the intake structure will require modification. Maximum pool level without requiring intake structure modification is 5563 Project Datum (PD).

   - May require raising the upstream toe of the dam so that the access road around Mount Carbon can still be used. Would probably require raising the upstream riprap up to the top of the reallocated pool anyway.

   - Chatfield designated a joint use storage allocation for M&I storage, but during wet years, USACE can release from this allocation to mitigate flood risk. For the Chatfield risk assessment, the joint use storage was assumed to be full – conservative assumption. May consider a similar approach for Bear Creek.

3) Retained for further consideration – Reallocation of all or part of the multipurpose zone for all beneficial uses, including water supply.

   - Would not result in loss of flood control storage.

- The State already administers the water rights in the reservoir below elevation 5559 (1 foot into flood control zone).

4) Retained for further consideration – Structural modifications to Bear Creek Dam (e.g. dam raise and spillway raise) to increase reservoir storage.

   - Would be expensive.

   - Would change the dam's breach risk.

   - The maximum dam raise without exceeding the elevation of the left dam abutment and having significant impacts on the golf course is approximately 5-8 feet. The maximum dam raise without requiring construction of training dikes is approximately 6 feet. The maximum dam raise that could be tied off without requiring raising the left dam abutment is approximately 16 feet. The maximum dam raise that would be possible with a crest wall versus significant modifications to the embankment is approximately 20 feet.

5) Retained for further consideration – Structural modifications to Bear Creek Dam (e.g. lower spillway, widen spillway, raise spillway with fuse plug) to increase dam freeboard.

   - Would be expensive. The spillway is in bedrock, so lowering or widening it would require rock excavation.

   - Would change the dam's non-breach risk.

   - Lowering and/or widening the spillway would likely increase the population at risk, but analysis would be required to determine whether this would increase life loss risk. (It would increase non-breach risk, but the analysis would be required to determine whether the risk is acceptable.) A fuse plug would decrease the frequency of spillway flow but could increase the volume of flow (more flow more rapidly; hydrograph may show flood onset delayed but peak of flooding reached more quickly). Difficult to know if increased warning time would be offset by increased flow.

6) Retained for further consideration – Structural modifications to Bear Creek Dam (e.g. modify outlet works) to increase discharge capacity.

   - Without modifying the outlet works conduit or adding an additional conduit, it would be difficult to increase discharge capacity significantly. Modifications to the conduit or adding a conduit would require major dam construction (i.e. completely breaching the dam), which would be very expensive.

   - Potentially construct a morning glory flood tunnel through one of the gates; keep one set of gates to control low-level releases/water rights releases. Similar to Lake McConaughy/Kingsley Dam outlet works. Note that, at some point, the conduit capacity will control the discharge capacity, so the discharge capacity to be gained with a morning glory flood tunnel may be limited.

7) Retained for further consideration – Modify the Bear Creek Reservoir Water Control Plan and the Tri-Lakes System Regulation Plan (e.g. release more water from Bear Creek Reservoir sooner as part of existing stair-step release rule curve) to increase freeboard at Bear Creek Dam. This may include the need to increase the maximum flow target at the Denver gage. There may also be other ways to refine the Water Control Plan in such a way that storage in Bear Creek Reservoir could be reallocated to other beneficial uses.

- This would require consideration of channel capacity limitations (e.g. Lakewood, sewer line crossing) and could be challenging due to the significant development and recreation between Bear Creek Dam and Denver.

- The current maximum flow target is 5000 cfs at the Denver gage as long as Cherry Creek Reservoir is below elevation 5590 feet Project Datum. The Bear Creek Dam physical maximum release is larger than the existing rule curve; however, uncontrolled runoff downstream of Bear Creek Dam could limit the ability to release more. Would need to consider whether reallocation at Bear Creek Dam would negatively impact Chatfield or Cherry Creek Dams.

8) Eliminated from further consideration – Excavate Bear Creek Reservoir (remove accumulated sediment or deepen reservoir) to increase in-pool storage.

   - This would probably be prohibitively expensive, and haul and disposal cost is a large part of the cost.
     Example:
     1 ac-ft = 43,560 ft^3 = 1,613 yd^3
     1,613 yd^3 @ \$20/yd^3 = \$32,267/ac-ft
     5,000 ac-ft @ \$32,267/ac-ft = \$161,333,333 ≈ \$160M

   - A dam raise would be much less expensive than dredging for the same amount of additional storage, especially because a foot of elevation at the dam crest will yield far more additional storage than a foot of excavation at the reservoir bottom (elevation-capacity curve).

   - Dredge material could possibly be disposed of on site if used to raise the dam; however, if a dam raise is under consideration, there are other on-site sources of more suitable material than dredge material.

9) Retained for further consideration – Excavate forebays upstream of Bear Creek Reservoir to increase storage capacity. This may also help improve reservoir water quality.

   - The same points as above for excavating the reservoir apply to excavating forebays upstream of the reservoir.

10) Retained for further consideration – Nonstructural measures downstream of Bear Creek Dam to decrease potential consequences. Decreasing potential consequences may allow a higher pool without increasing overall dam safety risk.

    - Nonstructural measures alone would be unlikely to allow Bear Creek storage reallocation; however, they could possibly be used in conjunction with other measures to help mitigate non-breach flood risk.

11) Note that there are various alternatives for providing additional water supply that do not involve Bear Creek Dam or Reservoir (e.g. water conservation or development of new reservoirs). This study will not include further development of such alternatives. However, these alternatives will be compared to reservoir storage reallocation at Bear Creek Reservoir to determine whether storage reallocation is the most efficient way to provide additional water supply.

<u>Summary of Potential Reallocation Levels Discussion</u>:

1) Elevation 5622.7 PD (5625.7 NAVD88) ~20,000 ac-ft

- City of Lakewood Bear Creek Lake Park – this would be a significant impact, but it is the level of potential impact that Lakewood initially expected. (Note that this does not mean that this level of impact is acceptable to the city.) Would impact ~70% of Bear Creek Park recreational trails and ~75% of riparian zone. Would dramatically change the character of Bear Creek Park and how the park is managed would need to be reconsidered. There probably is not enough space within the park to relocate existing recreational resources (boat ramps, parking areas, equestrian areas, etc.).
- Lost riparian areas probably could not be mitigated on site, so would require off-site mitigation.
- Aeration system is sized for current reservoir level and would need to be upsized for reservoir raise, including upsizing compressors and adding aerators. At this elevation, the reservoir probably would no longer meet the Aquatic Life Cold 1 Standard because there would be significantly more shallow water area in the reservoir.
- Would impact several acres of wetlands on Coyote Gulch.
- Would require significant intake tower raise (~60' raise).
- Would impact dam upstream face access and maintenance road.
- Would impact dam instrumentation.
- Would inundate Harriman Canal cleanout manhole. Denver Water would need to comment on impacts.
- Would require additional riprap on upstream slope of main embankment and may require riprap on south embankment.
- Would require updated seepage, stability, and settlement analyses to determine impacts of higher operating pool.

2) Elevation 5613.6 PD (5316.6 NAVD88) ~15,000 ac-ft

- City of Lakewood Bear Creek Lake Park – impacts are similar to 20,000 ac-ft, except that equestrian facility would not be impacted.
- Lost riparian areas probably could not be mitigated on site, so would require off-site mitigation.
- Aeration system is sized for current reservoir level and would need to be upsized for reservoir raise, including upsizing compressors and adding aerators. At this elevation, the reservoir probably would no longer meet the Aquatic Life Cold 1 Standard because there would be significantly more shallow water area in the reservoir.
- Would impact several acres of wetlands on Coyote Gulch, similar to 20,000 ac-ft.
- Would require significant intake tower raise (~50' raise).
- Would impact dam upstream face access and maintenance road.
- Would impact dam instrumentation.
- Would inundate Harriman Canal cleanout manhole. Denver Water would need to comment on impacts.
- Would require additional riprap on upstream slope of main embankment, but probably not on south embankment.
- Would require updated seepage, stability, and settlement analyses to determine impacts of higher operating pool.

3) Elevation 5602.2 PD (5605.2 NAVD88) ~10,000 ac-ft

- City of Lakewood Bear Creek Lake Park – impacts are similar to 15,000 ac-ft, except that a couple minor resources (e.g. turtle pond) would not be impacted. Therefore, recreational resource impacts are nearly the same.
- Lost riparian areas probably could not be mitigated on site, so would require off-site mitigation.
- Aeration system is sized for current reservoir level and would need to be upsized for reservoir raise, including upsizing compressors and adding aerators. At this elevation,

the reservoir probably would no longer meet the Aquatic Life Cold 1 Standard because there would be significantly more shallow water area in the reservoir.
- Would impact significantly fewer acres of wetlands on Coyote Gulch than 15,000 ac-ft, and it might be possible to mitigate lost wetland acreage on site in upstream areas of Coyote Gulch.
- Would require significant intake tower raise (~40' raise).
- Would impact dam upstream face access and maintenance road.
- Would impact dam instrumentation.
- Would not inundate Harriman Canal cleanout manhole.
- Would require additional riprap on upstream slope of main embankment, but not on south embankment.
- May require updated seepage, stability, and settlement analyses to determine impacts of higher operating pool. (Perhaps not required below 10,000 ac-ft.)

4) Elevation 5586.9 PD (5589.9 NAVD88) ~5,000 ac-ft

- City of Lakewood Bear Creek Lake Park – impacts are similar to 10,000 ac-ft, except that one facility is not impacted. Therefore, recreational resource impacts are nearly the same.
- Lost riparian areas probably could not be mitigated on site, so would require off-site mitigation.
- Aeration system is sized for current reservoir level and would need to be upsized for reservoir raise, including upsizing compressors and adding aerators. At this elevation, the reservoir probably would no longer meet the Aquatic Life Cold 1 Standard because there would be significantly more shallow water area in the reservoir.
- Would impact significantly fewer acres of wetlands on Coyote Gulch than 10,000 ac-ft, and it might be possible to mitigate lost wetland acreage on site in upstream areas of Coyote Gulch.
- Would require significant intake tower raise (~25' raise).
- Would impact dam upstream face access and maintenance road.
- Would impact dam instrumentation.
- Would not inundate Harriman Canal cleanout manhole.
- Would require additional riprap on upstream slope of main embankment, but not on south embankment.
- May require updated seepage, stability, and settlement analyses to determine impacts of higher operating pool. (Perhaps not required below 10,000 ac-ft.)

5) Elevation 5575.6 PD (5578.6 NAVD88) ~2,500 ac-ft

- City of Lakewood Bear Creek Lake Park – impacts are similar to 5,000 ac-ft. Therefore, recreational resource impacts are nearly the same.
- Lost riparian areas could possibly be mitigated on site, but this would require additional site survey to determine habitat that would be impacted and whether suitable mitigation areas are available.
- Aeration system can run at approximately this elevation, so compressors would not need to be upsized, but some additional aerators would be required.
- Impact on Coyote Gulch wetlands similar to 5,000 ac-ft, and it might be possible to mitigate lost wetland acreage on site in upstream areas of Coyote Gulch.
- Would require significant intake tower raise (~15' raise).
- Would impact dam upstream face access and maintenance road.
- Would impact dam instrumentation.
- Would not inundate Harriman Canal cleanout manhole.
- Would require additional riprap on upstream slope of main embankment, but not on south embankment.

- May require updated seepage, stability, and settlement analyses to determine impacts of higher operating pool. (Perhaps not required below 10,000 ac-ft.)

6) Elevation 5563.0 PD (5566.0 NAVD88) ~550 ac-ft

   - City of Lakewood Bear Creek Lake Park – significantly reduces recreational resource impacts compared to 2,500 ac-ft, but there are still some impacts to trail system.
   - Lost riparian areas could possibly be mitigated on site, but this would require additional site survey to determine habitat that would be impacted and whether suitable mitigation areas are available.
   - Would not require modification of aeration system.
   - Would significantly reduce Coyote Gulch wetland impacts compared to 2,500 ac-ft, and it might be possible to mitigate lost wetland acreage on site in upstream areas of Coyote Gulch.
   - Would not require intake tower raise.
   - Would not impact dam upstream face access and maintenance road.
   - May impact dam instrumentation.
   - Would not inundate Harriman Canal cleanout manhole.
   - Would not require additional riprap on upstream slope of main embankment or south embankment.
   - May require updated seepage, stability, and settlement analyses to determine impacts of higher operating pool. (Perhaps not required below 10,000 ac-ft.)

7) General consideration – If the future condition will require more exact releases, then the operating plan will need to be revised, and the outlet works intake structure and/or low flow gates will need to be modified to allow for more accurate releases and more frequent changes in releases.

8) General Consideration – Consider range of reservoir elevations (low to high) that may be experienced (exceedance curve). How do we build recreational facilities to handle potentially large swings in reservoir elevation?

9) Consider 20,000, 15,000, 10,000, 5,000, 2,500, and 550 ac-ft since the level of effort required for preliminary screening of each additional alternative is relatively small.