US Army Corps
of Engineers®
Walla Walla District

Lower Boise River Interim Feasibility Study, Idaho

Water Storage Screening Analysis

August 2010
Revised

Table of Contents

Figures

Tables

Technical Appendices

Note: Additional Technical Appendices are not included as part of this document. However, they are available upon request. Submit request to:

U.S. Army Corps of Engineers
Walla Walla District
ATTN: Boise GI Study Manager
Boise Outreach Office
720 Park Boulevard, Suite 255
Boise, Idaho 83712

A Geology
B Hydropower
C Environmental
D Cost Index

1 INTRODUCTION

The U.S. Army Corps of Engineers (Corps) has been authorized to conduct a General Investigation of the Lower Boise River to review various water resource problems, needs, and opportunities. General Investigation studies are typically conducted in two phases: (1) reconnaissance; and (2) feasibility. The purpose of the reconnaissance phase is to determine if water resource problems warrant Federal participation and, also, whether planning efforts should move forward to the more detailed feasibility phase. The purpose of the feasibility phase is to investigate and recommend solutions to water resource problems. The Corps completed reconnaissance studies in 1995 (*Lower Boise River and Tributaries, Idaho*) and 2001 (*Expedited Reconnaissance Study, Section 905(b) (WRDA 86), Boise River, Idaho*), both of which documented Federal support for pursuit of a feasibility study. Considerable interest was shown in the areas of flood damage reduction, aquatic and riparian habitat restoration, water quality and supply, and recreation safety.

In May 2009, the Corps and the Idaho Water Resource Board (IWRB) entered into an agreement to initiate the first, or interim, phase of a two-phased feasibility study. The first (interim) phase of the feasibility study is aimed at providing technical information regarding surface water storage potential in the basin, with a focus on water storage upstream of Lucky Peak Dam and reducing flood risk in the lower Boise River downstream of Lucky Peak Dam. Specifically, this interim feasibility study will: (1) evaluate and document existing conditions on the Boise River; (2) evaluate public safety issues related to flooding; (3) analyze surface water storage opportunities in the basin; and (4) develop a path forward to complete the feasibility study.

The interim feasibility study is focusing on water storage as one potential measure for addressing water supply and flood risk reduction planning objectives. The larger feasibility study requires evaluation of structural and nonstructural alternatives to address identified water resource problems. The second phase of the feasibility study will focus on alternatives other than surface water storage and evaluate whether a combination of strategies is appropriate to resolve water resource problems in the Boise River drainage.

The Corps developed this two-phased feasibility study approach to assist the IWRB with the Treasure Valley Comprehensive Aquifer Management Plan (CAMP), a planning effort initiated by IWRB to address future water supply and demand issues in the Lower Boise River basin over the next 50 years. The Treasure Valley CAMP process includes a series of technical studies to characterize surface and groundwater resources. The surface water storage assessment conducted during this Interim Feasibility Study is one of the technical studies associated with the Treasure Valley CAMP. Surface water storage is one of many strategies to meet future water demand that the IWRB will consider during the Treasure Valley CAMP.

The surface water storage evaluation used information contained in the *Boise/Payette Water Storage Assessment Report*, a Bureau of Reclamation (Reclamation) report compiled in July 2006. The Reclamation study identified 12 sites worthy of further investigation. In early 2010, the Corps reviewed existing information to narrow the 12 sites down to a short list of the most promising options, which will undergo a more in-depth evaluation during the Interim Feasibility phase and throughout the Feasibility Study. A more comprehensive analysis is required of the concepts contained in this document, in addition to other measures identified to meet planning objectives, before any alternative can be constructed.

This *Water Storage Screening Analysis* document describes the screening criteria and process used to rank these 12 storage sites and then details the results of the analysis. The scope of the screening analysis involved using available information that allowed comparison of any differences between proposed water storage sites and concepts for the purpose of narrowing the list to a few sites for more detailed analysis. It is not intended to be a comprehensive analysis of potential effects or benefits of the concepts. Additional information will be collected for the top recommended sites to compare surface water storage as a possible measure to other structural and nonstructural measures examined during the Feasibility Study.

The Corps and IWRB conducted four public information meetings during the June 29 through July 1, 2010 period to provide an overview of the Lower Boise River Feasibility Study and presented the preliminary results of the water storage screening analysis. Written comment was requested on the June 2010 *Draft Water Storage Screening Analysis* document. A total of 154 agencies, organizations, or individuals submitted written comments during June and July 2010. Comments were received through July 31, 2010. A summary of the written public comment submitted can be found in *Public Information Meetings and Public Comment Summary* (Corps, 2010). Public comment was considered by the Corps and IWRB Project Delivery Team (PDT) when finalizing the water storage screening analysis contained in this document.

1.1 STUDY AUTHORITY

Study authorization for the Corps is provided by Section 414 of the Water Resources Development Act (WRDA) of 1999, which authorized a feasibility study for flood control on the Boise River. Section 4038 of WRDA 2007 modified the 1999 authority to include ecosystem restoration and water supply as project purposes.

Study authorization for the IWRB is provided by bills and memorials passed by the 2008 Idaho Legislature. House Bills 428 and 644 established the Statewide Comprehensive Aquifer Planning and Management Program (42-1779) and the Aquifer Planning and Management Fund (42-1780). This legislation authorized characterization and planning efforts in ten different basins, including the Treasure Valley. The planning program requires performance of technical studies to evaluate ground and surface water resource management alternatives specific to each basin. Evaluation of additional surface water storage is one of the studies identified for the Treasure Valley planning effort. House Joint Memorial 8 encouraged the IWRB to initiate and complete a study of additional water storage projects in the State of Idaho including, but not limited to, Twin Springs Dam, located in the Boise River drainage. The legislation directs the IWRB to perform the study in coordination with other public and private entities.

1.2 STUDY AREA

The Lower Boise River watershed encompasses the Boise River drainage, from Lucky Peak Dam downstream for about 64 miles to its confluence with the Snake River in southeast Idaho (figure 1). The river drops approximately 650 feet in elevation over this length. The Boise River is located entirely in Idaho, and is a tributary to the Snake River. The Lower Boise River basin is located primarily within Ada and Canyon Counties, but includes small portions of Boise, Elmore, Gem, and Payette Counties, as well. Cities within Ada and Canyon Counties include Boise, Garden City, Meridian, Eagle, Star, Nampa, Middleton, Caldwell, Notus, and Parma.

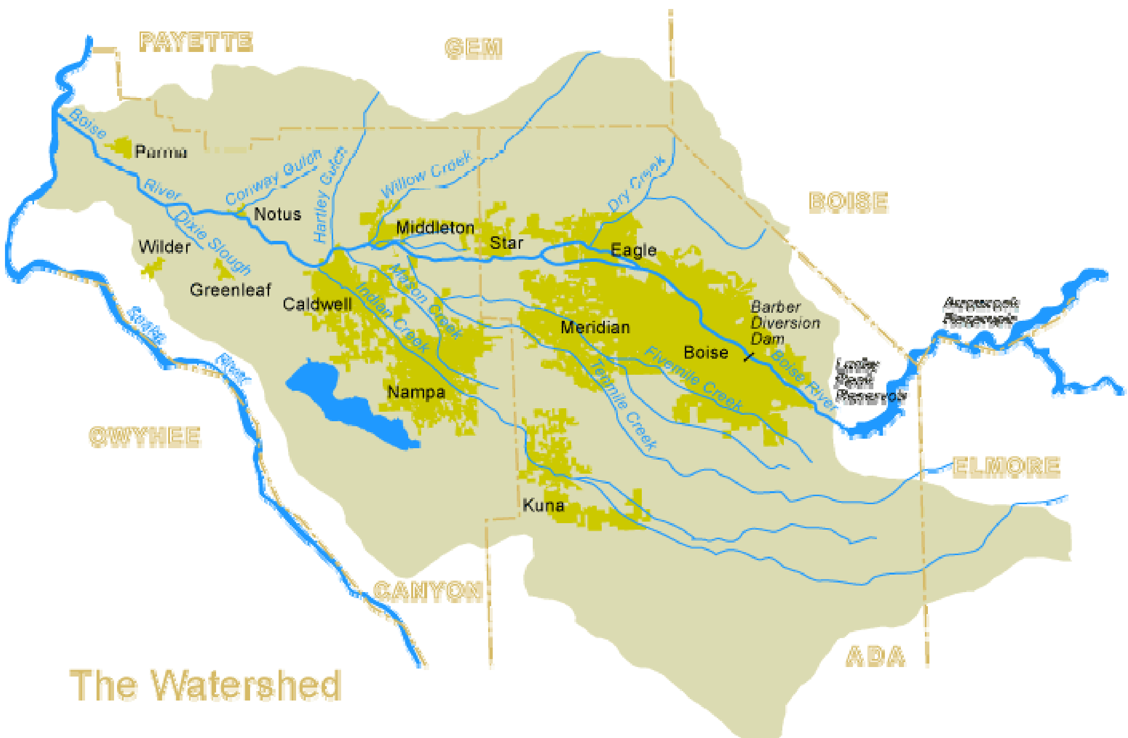

Figure 1. Lower Boise River Watershed
Source: Lower Boise Watershed Council,
http://www.lowerboisewatershedcouncil.org/01_who-we-are/watershed-map.html

The Lower Boise River Feasibility Study will examine problems and opportunities identified in the Lower Boise River watershed. However, alternatives located outside of the watershed may be identified, such as the proposed water storage sites described in this screening analysis.

1.3 BOISE/PAYETTE WATER STORAGE ASSESSMENT REPORT

In July 2006, Reclamation completed an assessment of new or enhanced storage capabilities within the Boise and Payette River basins. This assessment included both on- and off-stream reservoir facilities, as well as retrofitting existing reservoir facilities. (Note: Off-stream facilities refer to sites with an interbasin transfer component.) Existing information was used to conduct a preliminary survey of conceptual solutions. The assessment evaluated more than 109 sites in the Boise River basin identified in previous studies. An initial screening narrowed this site list to 20 potential sites within the basin. These 20 sites were then subjected to a process that narrowed them down even further to 12 sites that represented a starting point for future analyses. These 12 sites are shown on figure 2 and listed in table 1. More detailed information about this screening and ranking process is contained in *Boise/Payette Water Storage Assessment Report* (Reclamation, 2006).

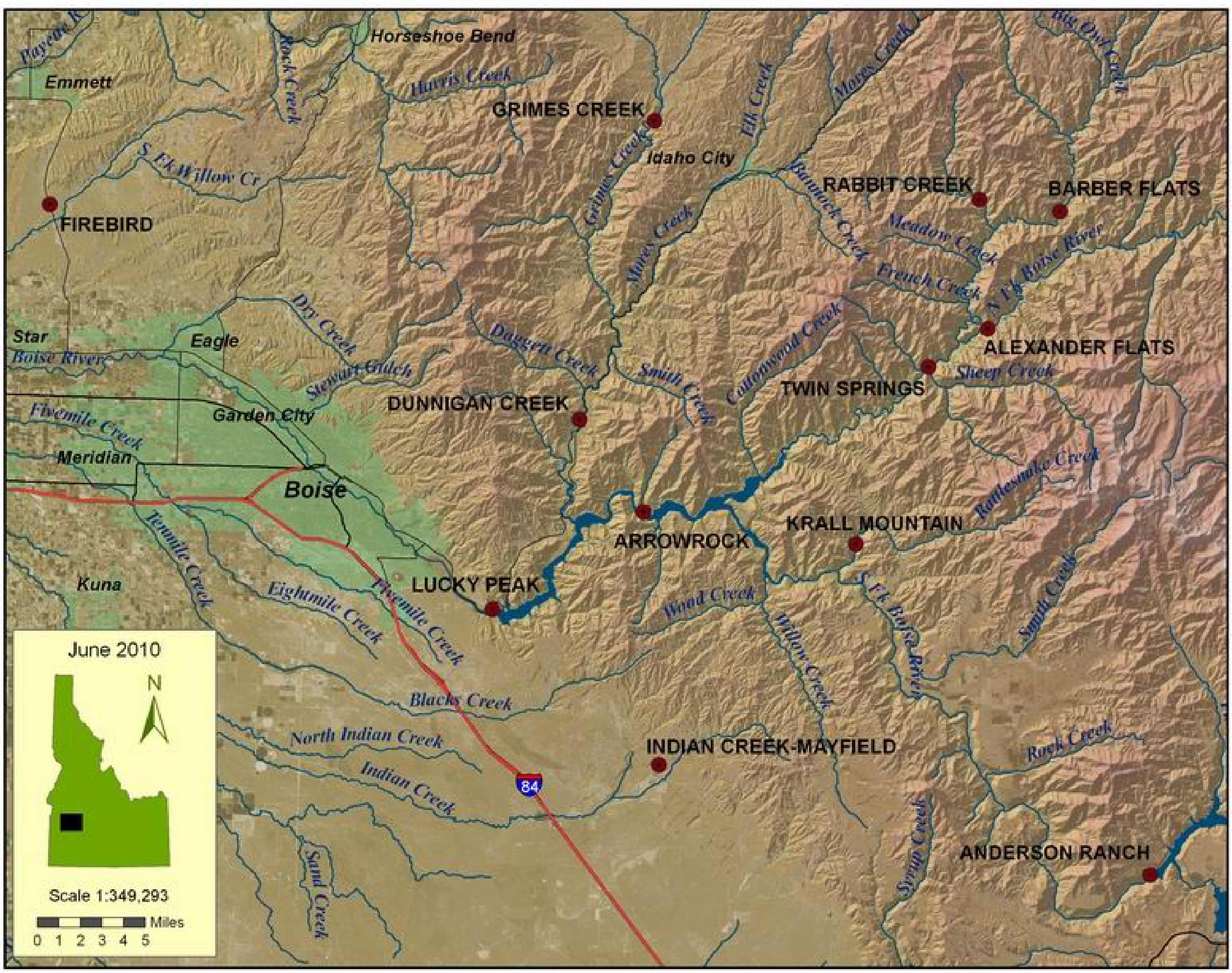

Figure 2. Twelve Storage Sites Identified in 2006 Reclamation Water Storage Assessment

Table 1. Summary of Storage Sites from Reclamation Assessment

Site	Drainage	Site Type/Source
Alexander Flats	Middle Fork Boise	on-stream[1]
Twin Springs	Middle Fork Boise	on-stream[1]
Rabbit Creek	North Fork Boise	on-stream[1]
Barber Flats	North Fork Boise	on-stream[1]
Anderson Ranch Dam	South Fork Boise	existing[2]
Krall Mountain	South Fork Boise	off-stream[1]
Lucky Peak Dam	Main Boise	existing[2]
Arrowrock Dam	Main Boise	existing[2]
Grimes Creek	Main Boise	off-stream[3]
Dunnigan Creek	Main Boise – Mores Creek	off-stream[3]
Indian Creek-Mayfield	Main Boise – Indian Creek	off-stream[3]
Firebird	Main Boise – Willow Creek	off-stream[3]

Source: Boise/Payette Water Storage Assessment Report. Reclamation, 2006
[1]New site that is filled by using water within the drainage.
[2]Presently developed site that could be retrofitted.
[3]New site located on or adjacent to drainage requiring filling by interbasin transfer.

The Reclamation assessment focused on storage sites that would supply enough water to meet future demands. Although flood risk reduction was considered, it was not a driver for the study. The following were the three primary criteria considered by Reclamation in their assessment:

- Physical volume necessary to meet future water demands.
- Hydrology necessary to refill reservoirs, based on watershed characteristics and water needs.
- Socio-economic and environmental constraints.

The 12 proposed sites include new facilities at nine sites and retrofits (e.g., dam raise) at the three existing Federal dams. Five of the sites proposed an interbasin transfer from the Payette River basin to fill facilities located in the Boise River basin.

2 CORPS SCREENING PROCESS – AN OVERVIEW

The Corps conducted a two-step screening analysis to narrow the list of 12 water storage sites identified in the 2006 Reclamation assessment to a list of only a few sites. These sites will be evaluated in more detail as part of the Interim Feasibility Study. Current, available information was used for the screening analysis.

The first-level screening identified six sites that best reduce flood risk downstream from Lucky Peak Dam and meet the future water supply needs of the basin. Section 3.1 details this first-level screening assessment.

Conceptual water storage designs and reservoir footprints were then developed for these six sites. A description of these concepts is contained in section 3.2.

The second-level screening analysis compared and scored the six sites identified during the first-level screening. Six categories of criteria were used to complete this analysis. Data for each category was gathered and/or developed by the PDT in order to compare and score the sites. The PDT was comprised of both Corps and Idaho Department of Water Resources (IDWR) staff. It included hydraulic, geotechnical, and cost engineers; economists; planners; biologists; and geographic information system (GIS) specialists. Along with future water supply and flood risk reduction, screening categories included hydropower potential, cost index, social effects, and environmental effects. This second-level analysis is described in more detail in section 3.3.

Technical memoranda are contained in a separate document. They describe the methods and analysis for individual screening criteria, and can be requested and obtained from the Corps.

3 SCREENING ANALYSIS

3.1 FIRST-LEVEL SCREENING ANALYSIS

The first-level screening analysis scored the 12 sites identified in the Reclamation assessment (Reclamation, 2006) for their ability to provide an additional water supply and reduce relative flood risk (table 2). The reliability of reservoir refill was a major consideration in the ability of a site to provide additional water supply. Flood risk reduction is a function of flow volume generated by the drainage catchment, as well as the available storage capacity at the site. Two sub-options were evaluated for Arrowrock (a minimum raise of existing dam and a new dam downstream) and two options Lucky Peak (a minimum and maximum raise of existing dam sites), creating a total of 14 potential storage scenarios.

Topographic maps and field observation of site conditions indicated that not all sites would provide significant flood risk reduction benefit. This was based on a preliminary estimate of the contributing drainage, the location of the site relative to potential damage center areas, and relative flow conditions at the sites.

Four criteria were used to score the sites during this first-level screening:

(1) Basin average annual inflow volume.
(2) Relative residual volume.
(3) Reduction of system average runoff volume.
(4) Annual refill volume.

If a site was considered best for a particular criterion, it was assigned a high score (e.g., 14), while sites that would not perform as well for that criterion were given lower scores. The following paragraphs contain a brief explanation of the data contained in table 2.

Table 2. First-Level Screening Analysis Summary for Proposed Water Storage Sites

Site	Concept	Basin Drainage Area (mi^2)	Maximum Additional Storage Potential (kAF[4])	Basin Average Annual Inflow Volume[1]		Relative Residual Volume		Reduction of System Average Runoff Volume		Annual Refill Volume[3]		Composite Score
				kAF	Score	kAF	Score	kAF	Score	kAF	Score	
Arrowrock–New Dam	New downstream dam with reservoir 74 feet deeper than existing	2,220	317[1]	1,733	12	0	14	317	14	60	11	**12.8**
Lucky Peak Dam–Maximum	Raise existing dam ~30 feet	2,690	96[1]	2,047	14	0	14	96	11	60	11	**12.5**
Twin Springs	New 365-foot dam	816	304[1]	846	10	0	14	304	13	50	7	**11.0**
Alexander Flats	New 265-foot dam	363	68[1]	376	8	0	14	68	10	50	7	**9.8**
Dunnigan Creek	New 345-foot dam	393	227[1]	169	6	58	5	169	12	225	14	**9.3**
Lucky Peak Dam–Minimum	Raise Existing ~4 feet	2,690	12[1]	2,047	14	0	14	12	6	12	3	**9.3**
Barber Flats	New 175-foot dam	313	58[1]	324	7	0	14	58	9	50	7	**9.3**
Anderson Dam	Raise existing dam ~6 feet	975	30[2]	721	9	0	14	30	8	10	2	**8.3**
Arrowrock Dam–Minimum	Raise existing dam ~2 feet	2,220	9[2]	1,733	12	0	14	9	5	9	1	**8.0**
Krall	New dam to store 60 kAF	38	121[2]	18	5	103	3	18	7	60	11	**6.5**
Grimes	New dam to store 225 kAF	133	1,500[2]	7	3	1,493	1	7	3	225	14	**5.3**
Firebird	New dam to store 300 kAF	62	67[2]	5	1	62	4	5	1	67	12	**4.5**
Indian-Mayfield	New dam to store 60 kAF	16	52[2]	5	1	47	6	5	2	52	8	**4.3**
Rabbit	New dam to store 50 kAF	30	152[2]	8	4	144	2	8	4	50	7	**4.3**

[1]Corps, *GIS analysis*, 2010.
[2]Reclamation, 2006.
[3]The annual refill volume is the lesser of the reported MODSIM 90% refill volume (Reclamation, 2006) or the maximum storage potential of a project.
[4]kAF= thousand acre-feet.

3.1.1 Basin Average Annual Inflow Volume

Basin average annual inflow volume is the average volume measured in thousand acre-feet (kAF) of water generated per year by the drainage basin that contributes to a particular storage site. This metric provided a way to estimate relative hydrologic performance (water storage and flood risk reduction impact) between the 14 storage alternatives. In general, the alternative intercepting the higher volume indicates a superior relative hydrologic performance.

The estimate of basin average annual inflow was derived by identified U.S. Geological Survey (USGS) flow gage sites with adequate years of record, hydrologic similarity, and appropriate spatial proximity. These records were adjusted, as necessary, and averaged to determine a yearly average volume of runoff.

The basins were scored from 1 to 14, and those generating the highest volume (superior option) received a high score (table 2).

3.1.2 Relative Residual Volumes

Relative residual volume is an indicator of sites most efficiently matched for maximum physical site storage and average annual inflow volumes. This index sought to highlight the storage options with less physical storage than average annual inflow volume. Although actual reservoir operations can compensate for a lower inflow volume than storage volume over time, a storage option with more inflow than storage is a superior option as measured by this criterion.

The average residual volume is determined for each site by calculating the difference between the site's maximum storage potential and average annual inflow volume. A negative residual volume (basin average inflow volume is greater than the maximum additional site storage) was reported in table 2 as 0. A higher number score in the table indicates the site performed better than those sites with lower number scores.

3.1.3 Reduction of System Average Runoff Volume

The reduction of system average runoff volume is an index that reflects relative flood benefit. The index shows how much flow volume can be intercepted by a storage site. The index is a function of its upstream hydrology (primarily the size of contributing drainage area and annual precipitation) and the additional physical volume added to the capacity of the Boise reservoir system (i.e., Lucky Peak, Arrowrock, and Anderson Ranch). Reservoir operations would be designed to provide optimum flood protection and storage opportunities.

The index value is the minimum of the basin average annual inflow volume or the maximum storage potential. The alternatives were ranked from 1 to 14. A score of 14 indicates the site is able to retain the largest flood volumes, while a score of 1 indicates a site retains the smallest volume.

3.1.4 Annual Refill Volume

The annual refill volume indicates the volume of water that, in a given year, will arrive at a proposed storage site at least 90 percent of the time. The value reported in table 2 is the lesser of: (1) the value calculated using Reclamation's MODSIM[1] model and reported in the 2006 assessment report; or (2) the maximum storage potential. Sites were scored from 1 to 14. A score of 14 indicates the greatest refill volume.

3.1.5 Composite Score

The composite score indicates site performance with respect to flood risk reduction and water supply (refill) objectives. It was calculated by averaging the scores for the four criteria: (1) basin average annual inflow volume; (2) average residual volume; (3) reduction of system average runoff volume; and (4) annual refill volumes. The higher the composite score, the better the site performed, with regard to both objectives.

The six sites with the highest composite scores (best performance for both flood benefits and water supply objectives) were recommended for further evaluation. The sites carried forward to the second-level screening analysis are: (1) Lucky Peak Dam, with both minimum and maximum raise; (2) Arrowrock–New Dam; (3) Twin Springs; (4) Alexander Flats; (5) Barber Flats; and (6) Dunnigan Creek.

3.2 DESCRIPTION OF WATER STORAGE CONCEPTS

Seven water storage concepts were developed for the six remaining sites (two for Lucky Peak). Conceptual designs were developed for the purposes of the screening analysis. As additional information and analyses are completed, concepts will be revised.

The concepts were developed using readily available information. The PDT incorporated information from previous studies and reports, observations made during a site visit (October 2009), published site topography (e.g., USGS quad maps, aerial mapping from Google Earth, Digital Elevation Models [DEMs], etc.), as well as geological mapping and reports (limited). Site-specific explorations did not occur, and the quality and quantity of information available for the different sites is inconsistent.

The water storage concepts include information regarding dam location, heights, crests, and invert elevations; type of construction; and additional storage volume. Preliminary stage-volume curves (e.g., volume of reservoir pool vs. height of dam) were based on USGS 10-meter DEMs. In order to determine storage reservoir footprints, storage volumes, and impacts to adjacent environmental and socially sensitive areas, GIS analysis was performed.

---

[1]MODSIM is a generalized river simulation model developed by Reclamation and Colorado State University. It addresses various operations and hydrologic processes affecting river flows. Water rights/contracts, as well as other operational impacts are taken into account when determining river gains (water budgeted flows) during a simulation run. The model is used extensively by Reclamation for long-range planning.

Concept-level design decisions and the corresponding hydrologic information are summarized in table 3 and described in the following paragraphs as well. Engineering assumptions and design constraints are noted, as appropriate. Figure 3 shows the location of the conceptual reservoir footprints for each water storage site.

Table 3. Preliminary Water Storage Concepts

Water Storage Site	Bottom Elevation	Top Elevation	Structure Height (feet)	Type	Additional Storage (kAF)
Lucky Peak–Minimum Raise	3077	3081	264[1]	RCC[3]	12
Lucky Peak–Maximum Raise	3077	3107	290[1]	RCC	96
Arrowrock–New Dam	2928	3290	368[1,2]	RCC	317
Twin Springs	3440	3811	371	RCC	304
Alexander Flats	3560	3831	271	Rockfill	68
Barber Flats	4140	4321	181	Rockfill	58
Dunnigan Creek	3120	3471	351	RCC	227

[1] Total structure height for proposed structures. Existing structure height for Arrowrock Dam is 257 ft, for Lucky Peak Dam, 254 ft.
[2] Concept was evaluated as a new structure just downstream of the existing dam.
[3] Roller compacted concrete

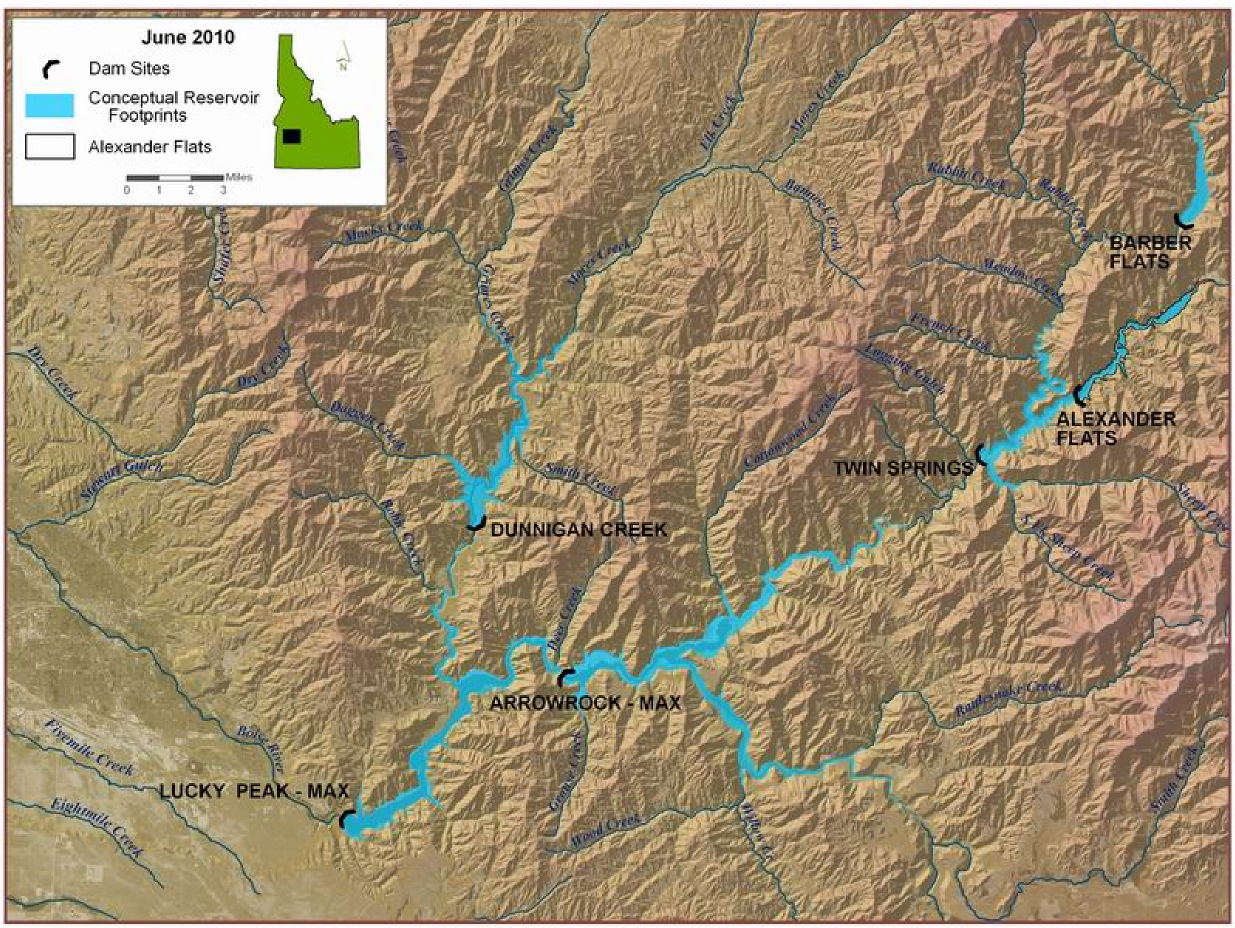

Figure 3. Conceptual Reservoir Footprints

3.2.1 Lucky Peak Dam

- **Minimum Raise**

  This concept assumes a 10-foot raise to the existing structure at Lucky Peak Dam, increasing reservoir depth by 4 feet. This is the maximum increase in structure height that could occur without necessitating significant changes to the existing Lucky Peak spillway, as well as the current machinery installations. This concept would provide approximately 12 kAF of additional storage space.

  Modifications to the existing dam would introduce a requirement to bring the structure in line with current design requirements and standards. Modifications would allow a higher (albeit not significant) reservoir capacity, while improvements to bring the dam into compliance with current standards would reduce risk to the public.

  Existing issues (i.e., foundation seepage and spillway performance) would require extensive study and potentially costly retrofit modifications.

- **Maximum Raise**

  A maximum raise at Lucky Peak Dam would involve a 36-foot raise to the existing structure, increasing reservoir depth by 30 feet. This concept would provide approximately 96 kAF of additional storage.

  Modifications to the existing dam would introduce a requirement to bring the structure in line with current design requirements and standards. Modifications would allow a higher pool elevation while reducing risk to the public.

  Existing issues (i.e., foundation seepage, spillway and intake tower performance, and impacts to Arrowrock Dam and hydropower facility) would require extensive study. Substantial modifications would likely be required.

  Large amounts of fill would be required, not only to expand the current dam base, but to construct the new raised component. The zoned fill of the existing dam would need to be tied into the additional dam prism. An extensive dike would also need to be built in order to extend the crest to an abutment on the left embankment.

  The current Corps risk-based design criteria would pose a significant cost factor for this particular measure. Raising the pool and reducing risk at the same time would require a prohibitively expensive subsurface cutoff wall to reduce foundation seepage.

  Additional impacts affecting cost are foundation repairs to the State Highway 21 Bridge across Mores Creek that would likely be required before the reservoir pool could be raised. Arrowrock Dam and the hydropower facility at that dam would need extensive modification. Lucky Peak's existing intake tower, outlet works, and spillway would also require rehabilitation.

Because Lucky Peak Dam is located on the edge of the Snake River plain, site geology and topography contributed to the relatively small size of the current dam structure when compared to reservoir size. The construction of a new dam downstream was considered infeasible because of low downstream topography.

3.2.2 Arrowrock–New Dam

This concept initially examined a maximum raise to the existing Arrowrock Dam structure. The concept was revised to propose replacement of the existing dam with a new, larger downstream structure. The new structure would result in a larger reservoir pool by constructing a new, 368-foot-high, roller compacted concrete (RCC) dam. The primary reason for replacing rather than raising the existing dam is its age (95 years). Raising the existing structure would require extensive and likely prohibitively expensive modifications. The new dam would be built downstream of the existing 95-year-old structure to minimize impacts to reservoir regulation operations (i.e., impacts to irrigators, etc.) during construction of the new structure.

The current concept assumed most of the current structure would be submerged and abandoned (in place). The old dam would be notched or holed to avoid trapping fish at low pool elevations and to allow water flow in the reservoir. Substantial costs would be involved if complete removal of the existing concrete structure is required. This would need to be examined in a later phase of the feasibility study.

3.2.3 Twin Springs

The concept developed for Twin Springs is an on-stream dam located on the Middle Fork Boise River, about 19 miles upstream of Arrowrock Dam. The concept includes a 371-foot-high RCC dam, and additional storage in the amount of 300 kAF.

Site explorations indicated that significant foundation excavation would be required due to deep weathering of the near-surface bedrock (Link, 2010).

3.2.4 Alexander Flats

The Alexander Flats concept consists of on-stream water storage on the Middle Fork Boise River, approximately 25 miles upstream of Arrowrock Dam. A rockfill dam was selected for the site, based on the following:

- Substantial volumes of sediment are available in the upstream flats portion of the inundation area.
- The dam height and local geography appear to offer suitable locations for spillways, either on the dam abutments or over a nearby ridge saddle.

- The presence of a fault near the site introduces a preference for a more flexible structure, which favors rockfill over RCC.

The proposed rockfill dam, approximately 271 feet high, would be zoned and have a separate spillway constructed on rock. The spillway could potentially drape over a ridge saddle on the right side of the pool, and drain into the Middle Fork Boise River.

3.2.5 Barber Flats

The Barber Flats concept would be an on-stream dam on the North Fork Boise River, about 33 miles upstream of Arrowrock Dam. A rockfill site was selected because:

- Substantial volumes of sediment were available in the upstream flats portion of the inundation area.
- The dam height and local geography appeared to offer suitable locations for spillways on the dam abutments or over a nearby ridge saddle.

Based on conceptual designs, this proposed storage facility would consist of a zoned rockfill dam approximately 181 feet high. A separate spillway would be constructed on rock.

3.2.6 Dunnigan Creek

The Dunnigan Creek site is located on Mores Creek, downstream of the Dunnigan Creek confluence. The conceptual design for this site assumed an RCC structure approximately 351 feet high. It would include an interbasin flow diversion structure, pump stations, and two 5.5-foot-diameter pipelines to divert water from the Lower South Fork Payette River into the Boise River basin at the headwaters of Grimes Creek (which flows into Mores Creek).

The proposed water storage site was sized to provide sufficient storage to meet future water demands, relying heavily on interbasin transfer from the South Fork Payette basin, as well as capture flow on Mores Creek. Transfers from the South Fork Payette River would be balanced with capturing high flows to reduce flood risk downstream.

3.3 SECOND-LEVEL SCREENING ANALYSIS

The second-level screening analysis compared and scored the water storage concepts using the six categories of criteria listed in table 4.

The PDT collected data for each storage concept relative to the criteria. Much of the collected data came in the form of GIS databases that identified land use and ownership, agency resource management classifications, natural resource values, roads, and utilities located within reservoir footprints. The majority of social and environmental data were obtained from other agencies (i.e., U.S. Forest Service, Reclamation [USFS], IDWR, etc.). The PDT completed GIS analysis from this acquired data.

Table 5 summarizes the second-level screening analysis results. Matrices are also included that document information compiled by the PDT for each criterion and concept (tables 7 through 14). The matrices also detail scores each concept received for each criteria category. These scores were used to calculate a final composite score. The following steps were used to develop the matrices.

- Criteria are scored on a scale of 1 to 7, with 7 representing the best performance (or least impact) for that criterion (tables 7 through 10, 12 and 13).Individual criteria are grouped into one of the six categories (table 4), and averaged (or weighted) to create a score for each category.
- Sites that tied for a specific criteria were given an average score, calculated by adding the consecutive score numbers. For example, if three sites were all ranked second, a score of 3 was given to each, calculated by adding (2+3+4) ÷ 3.
- A weighted composite score was calculated for each storage concept by applying a weighting factor to each category and summing the weighted category scores for each concept. The following weights were applied to each category in order to develop the composite weighted score:

Water Supply	1.0
Flood Control	1.0
Cost	0.8
Hydropower	0.3
Social Impacts	1.0
Environmental Impacts	1.0

- The weighted composite scores for each concept were then ranked, in order, from highest score to lowest score (table 5). Storage concepts with the highest score are recommended for further evaluation.
- The remainder of this report describes information collected for each criterion and the performance metrics and rationale used to develop scores for each criterion, as shown in tables 7 through 14.

3.3.1 Screening Results

Table 5 summarizes storage concept scores by criteria categories, and displays a weighted composite score. The final weighted composite scores were calculated by applying weighting factors to each criteria category. The category scores were then summed to create the final weighted composite score.

The PDT conducted a sensitivity analysis of criteria categories for different weighting factors before selecting the weighting factors described in the following paragraph. This analysis examined a range of values that expanded or decreased the spread between weighting factor values. Table 6 summarizes the sensitivity options considered and weighted composite scores.

Weighting factors of 1.0, 0.8, or 0.3 were applied to the criteria categories by the PDT. Flood risk reduction, water supply, and environmental effects criteria categories were assigned a 1.0 weight, recognizing the mission areas of the Corps and the Congressional authorization for this study. Social effects were also assigned a weight of 1.0 based on public comment. The cost index category was assigned a weight of 0.8, as it was felt that the study should focus on the more cost effective concepts. Hydropower potential was assigned a value of 0.3 as it was considered an incidental benefit from construction of a surface water storage facility but not a driver in selecting which concept to study more comprehensively.

Table 4. Second-Level Screening Categories and Criteria

Category	Criteria
Future Water Demand	Percent of future water demand met, based on: • Additional storage • Refill capability
Flood Risk Reduction	• System-level flood protection (measured at Glenwood Bridge gage, Boise, Idaho) • Percent chance storm protection resulting from each storage concept • Relative increase in flood risk over existing level
Hydropower Potential	• Average annual generation • Firm power generation • Average power generation • Distance to transmission/distribution lines
Cost Index	• Ratio of cost per 1 kAF of additional water supply • Ratio of cost per percent increase of flood benefit
Social Effects	Displacement of facilities/land uses • Number of residences impacted • Roads (miles and road type) • Recreation facilities/sites • Land ownership (acres) • Grazing allotments
Environmental Effects	• ESA species or critical habitat • Federal and State sensitive species or habitat • Idaho Department of Fish and Game (IDFG) fisheries management classifications • Stream miles inundated • Habitat/land cover • Big game winter range • Special river designations (Federal Wild River, State Natural River) • Cultural resources • Roadless areas

Table 5. Summary of Screening Analysis and Weighted Scores

Sites	Criteria Category Scoring[1]												Weighted Composite Score[4]
	Future Water Demand		Flood Risk Reduction		Hydro Potential		Cost index		Social Effects		Environ Effects		
	U[2]	W[3]	U[2]	W[3]	U[2]	W[3]	U[2]	W[3]	U[2]	W[3]	U[2]	W[3]	
Arrowrock–New Dam	6.3	6.3	7	7	5.9	1.8	5.5	4.4	3.2	3.2	3.3	3.3	25.9
Alexander Flats	3.0	3.0	3	3	4.0	1.2	5.5	4.4	5.4	5.4	4.1	4.1	21.1
Twin Springs	4.5	4.5	6	6	5.6	1.7	4.0	3.2	3.4	3.4	1.6	1.6	20.3
Barber Flats	2.5	2.5	2	2	2.3	0.7	7.0	5.6	4.8	4.8	4.3	4.3	19.9
Lucky Peak–Max Raise	4.8	4.8	4	4	4.6	1.4	2.0	1.6	2.6	2.6	5.0	5.0	19.3
Dunnigan Creek	6.0	6.0	5	5	2.0	0.6	3.0	2.4	2.0	2.0	3.2	3.2	19.2
Lucky Peak–Min Raise	1.0	1.0	1	1	3.3	1.0	1.0	0.8	6.6	6.6	6.6	6.6	17.0

[1] The higher the number, the better the site's performance for a criterion.
[2] Unweighted Score rank.
[3] Weighted scores calculated using the weighting factors listed in Paragraph 3.3 (Future Water Demand – 1.0, Flood Risk Reduction – 1.0, Hydropower Potential – 0.3, Cost Index – 0.8, Social Effects –1.0, and Environmental Effects – 1.0).
[4] Weighted composite score = sum of weighted scores for each criterion category. All values were rounded to the nearest tenth.

Table 6. Weighted Composite Scores and Sensitivity Analysis

Measure	Base (unweighted)[2]	Option A (weighted)[3]	Option B[1] (weighted)[4]	Option C (weighted)[5]	Option D (weighted)[6]
Lucky Peak–Minimum Raise	20.00	16.10	16.98	15.45	17.70
Lucky Peak–Maximum Raise	24.00	20.30	19.34	20.15	21.10
Arrowrock–New Dam	32.50	26.45	25.94	25.95	28.15
Twin Springs	25.00	19.60	20.34	19.10	21.20
Alexander Flats	25.50	20.05	21.05	19.10	22.35
Barber Flats	23.00	18.40	19.88	17.30	20.80
Dunnigan Creek	18.00	16.30	19.18	15.95	17.10

[1] Option B was chosen by the PDT as the sensitivity weighting that best reflected the impact of the categories on the study region.

[2]Base Condition Assigned Weights	
Water	1
Flood	1
Cost	1
Hydropower	1
Social	1
Environmental	1

[3]Option A Assigned Weights	
Water	1.0
Flood	1.0
Cost	0.7
Hydropower	0.5
Social	0.7
Environmental	1.0

[4]Option B Assigned Weights	
Water	**1.0**
Flood	**1.0**
Cost	**0.8**
Hydropower	**0.3**
Social	**1.0**
Environmental	**1.0**

[5]Option C Assigned Weights	
Water	1.00
Flood	1.00
Cost	0.60
Hydropower	0.55
Social	0.60
Environmental	1.00

[6]Option D Assigned Weights	
Water	1.0
Flood	1.0
Cost	0.9
Hydropower	0.5
Social	0.9
Environmental	1.0

Table 7. Second-Level Screening Matrix – Future Water Demand

Concept	Description				Water Supply					
	Bottom Elevation	Top Elevation	Structure Height (feet)[1]	Type	Additional Maximum Storage		Annual 90 % Refill Volume		Average Score	Composite Score
					kAF	Score	kAF	Score		
Lucky Peak Dam – Min	3077	3081	264	RCC	12	1	12	1	1.0	1
Lucky Peak Dam – Max	3077	3107	290	RCC	96	4	60	5.5	4.8	5
Arrowrock–New Dam[2]	2928	3296	368	RCC	317	7	60	5.5	6.3	7
Twin Springs	3440	3811	371	RCC	304	6	50	3	4.5	4
Alexander Flats	3560	3831	271	Rockfill	68	3	50	3	3.0	3
Barber Flats	4140	4321	181	Rockfill	58	2	50	3	2.5	2
Dunnigan Creek[3]	3120	3471	351	RCC	227	5	225	7	6.0	6

[1]Structure height includes 6 feet of freeboard above maximum pool water surface elevation.
[2]New dam would be constructed downstream of existing dam with a reservoir pool approximately 74 feet deeper than the existing.
[3]This site involves an interbasin transfer reservoir. Lower South Fork Payette River flows would be transferred via pumping and conduit conveyance to the Boise River watershed.

Based on the weighted composite scores shown in table 5, the water storage concept located at Arrowrock received the highest score, with a score of 25.9. Several concepts had scores grouped in the 21.1 to 19.0 range, including Alexander Flats, Twin Springs, Barber Flats, Lucky Peak–Maximum Raise, and Dunnigan Creek sites. The remaining site, Lucky Peak–Minimum Raise, received a weighted composite score of 17.0.

3.3.2 Future Water Demand

The future water demand criteria compared the ability of each storage concept to reliably provide water supply to meet future demands (table 7). The IWRB is currently conducting a Treasure Valley Future Water Demand Study as part of the Treasure Valley CAMP planning effort which will estimate future urban and agricultural water demands to the year 2060. The Treasure Valley Future Water Demand Study was not completed in time to incorporate into the water storage screening analysis.

Based on information provided by IDWR staff, the PDT assumed that 125 kAF of additional water would be required to meet future demands. This assumption was based on an analysis contained in IDWR's assessment and forecast of domestic, commercial, municipal, and industrial (DCMI) water demand for Ada and Canyon Counties to the year 2025 (IDWR, 2001). This study estimated that 76 to 96 kAF of additional water would be necessary to meet additional demands over the 25-year planning horizon. Reclamation's assessment (Reclamation, 2006) examined the IDWR study, and projected water demands over a 50-year planning horizon. Reclamation's study estimated the water need at an additional 125 kAF.

As shown in table 7, the top three sites for meeting future water demand are, in order of ranking, Arrowrock–New Dam, Dunnigan Creek, and Lucky Peak–Maximum Raise. A composite score was calculated by averaging the scores for criteria measuring additional storage supplied by a site and the percent of future water demand provided.

3.3.3 Flood Risk Reduction

Flood risk reduction criteria compared the ability of a water storage concept to reduce system-wide flood risk downstream of Lucky Peak Dam (table 8). For comparison purposes, the assessment assumed a minimum flood protection target level flood of a 1-percent annual chance flood event. Although the choice of a target flood protection is not mandated, it is consistent with the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) standard. The 1-percent annual flood event is a flood with a 1-percent chance of occurring in any given year. Flood inundation limits for a 1-percent storm are often used for assessing flood insurance rates, and are also used in FEMA flood damage assessment studies. For this study, the 1-percent annual flood is used to establish a relative ranking, and is not a measure of acceptable flood risk reduction.

Table 8. Second-Level Screening Matrix – Flood Risk Reduction

Concept	Description		Flood Risk			
	Additional Project Storage Volume (kAF)[1]	Total System Storage (AF)[2]	Flood Return Period (Years)	System Flood Protection (%)	Increase Flood Protection Relative to Existing (%)	Score
Lucky Peak Dam–Minimum Raise	12	995,000	36	2.8	3+	1
Lucky Peak Dam–Maximum Raise	96	1,079,000	44	2.3	27+	4
Arrowrock–New Dam	317	1,300,000	71	1.4	104+	7
Twin Springs	304	1,287,000	69	1.4	98+	6
Alexander Flats	68	1,051,000	41	2.4	19+	3
Barber Flats	58	1,041,000	40	2.5	16+	2
Dunnigan Creek	169	1,151,514	52	1.9	50+	5

[1]Current system capacity is 983 kAF which includes Arrowrock, Anderson Ranch, and Lucky Peak reservoirs.
[2]AF = acre-feet

To score relative flood protection benefits, the runoff volume that could be captured and stored for each proposed project was estimated. The amount of flood protection provided was a function of its location in the watershed (i.e., runoff captured), as well as potential reservoir storage.

The current level of flood protection downstream of Lucky Peak Dam has been estimated at approximately a 3-percent chance (35-year) storm event. Up to this event can be controlled while releasing a flow of 6,500 cubic feet per second (cfs) in the Boise River as measured at Glenwood Bridge. This flow rate is generally considered the maximum flow to avoid flooding downstream of Lucky Peak Dam (Corps, 1985a).

An estimate of the additional incremental flood protection provided by each concept, in terms of the percent chance storm, was made by interpolating between the current level of flood protection (3-percent chance storm [35-year]) and its corresponding system storage volume, and the 1-percent chance (100-year) storm volume. The current level of flood protection is known to be 983 kAF, and the 1-percent (100-year) runoff volume was calculated in *Boise Valley Project Boise River, Idaho, Design Memorandum No. 1, Justification Report* (Corps, 1958). It estimated the 100-year, 60-day runoff volume to be 2,485 kAF. Interpolating between the volumes and corresponding level of protection (percent chance storm event) allowed the calculation of annual percent change in flood protection for each measure, as summarized in table 8.

As shown in table 8, the top three flood risk reduction concepts, in terms of performance, are Arrowrock–New Dam, Twin Springs, and Dunnigan Creek.

3.3.4 Hydropower Potential

The criteria making up the hydropower potential category compared storage concepts in terms of the average power generation, firm power generation, average of power generation, and proximity to transmission or distribution lines for each concept (table 9). The following briefly describe each of the calculations used for the comparisons.

- Average power generation is a calculation of approximate average power generation (in megawatts [MW]) that each proposed storage concept could generate if all available flow is put through the turbines. This includes an estimate of head variation that would occur in a multipurpose reservoir.
- Firm power generation is a calculation of approximate power generation that could be expected, on a constant basis, through the low flow period within the gage record ("critical period"). It was assumed that electrical demand was constant throughout the year and all potential generation could be utilized.
- Average of power generation is the simple average between the average and firm power generation values. It was used as a criterion because, at this level of analysis, electrical demand is unknown. Therefore, it is undetermined whether average or firm power is more important than the other.

Table 9. Second-Level Screening Matrix – Hydropower Potential

Concept	Hydropower Potential: Generation – Average Annual Generation (MW)	Generation – Firm Power Generation (MW)	Generation – Average Power Generation (MW)	Generation – Power Score	Distance to Transmission – Kilometers	Distance to Transmission – Transmission Score	Weighted Score	Hydropower Potential Composite Score
Lucky Peak Dam–Min	0.6[1]	0.5[4]	0.55	2	0	6	3.3	3
Lucky Peak Dam–Max	4.6[1]	4.6[4]	4.6	4	0	6	4.6	5
Arrowrock–New Dam	9.5[2]	9.9[5]	9.7	6	0	6	5.9	7
Twin Springs	23.4	12.9	18.05	7	22.3	3	5.6	6
Alexander Flats	7.1	3.2	5.15	5	28.0	2	4.0	4
Barber Flats	4.0	2.0	3	3	36.5	1	2.3	2
Dunnigan Creek	-38.6[3]	-44.3[6]	-41.45	1	12.1	4	2.0	1

[1]In addition to existing 33.7 MW.
[2]In addition to existing 25.9 MW.
[3]Based on 12.0 MW hydropower minus 50.6 MW power used for interbasin transfer. (In-basin flow results in 5.4 MW only for current-sized dam.)
[4]In addition to existing 15.9 MW.
[5]In addition to existing 13.3 MW.
[6]Based on 6.3 MW hydropower minus 50.6 MW for pumping power for interbasin transfer.

- Proximity to transmission/distribution lines is a measurement of distance from existing high voltage transmission and distribution lines. It is assumed that additional distance from these power lines would increase the cost of distributing electricity generated from installed hydropower.

Installation of hydropower at a dam commonly occurs as an independent decision to construction of the dam itself, based on the cost of the hydropower installation and the potential benefit. Estimating the cost of hydropower installation would require much more extensive design than was performed at this phase of the analysis and was not included in this interim feasibility phase analysis. Hydropower in this phase is seen as an incremental benefit that may make some concepts more favorable, but was not a driver in the analysis. Power generation estimates ignored many flow losses (i.e., evaporation, seepage, spillway discharge, etc.) and head (hydraulic losses at the intake or penstocks, etc.) for simplification. This likely resulted in a slight overestimate of generation capacity, but estimating procedures were consistent for all storage concepts.

Raises in dam height were compared to new water storage concepts by subtracting the hydropower potential for the existing dam without the height increase (using the same analysis rather than the existing hydropower facilities, which may not have been built to full generating capacity). Existing dams may be retrofitted with hydropower facilities, but hydropower potential is highly dependent on existing infrastructure. For consistency within this report, existing and new facilities were considered equal. Therefore, actual hydropower potential may not match values produced by this analysis. However, a comparison to previous analysis for existing hydropower verified the methodology used. It should also be noted that the potential reduction in hydropower output at Arrowrock Dam caused by a maximum raise at Lucky Peak Dam was not included in the analysis. This is due to potentially complicated interaction of a tailwater increase at Arrowrock Dam.

The Dunnigan Creek concept requires pumping water from the South Fork Payette basin into the Boise River basin. Hydropower potential calculations for this concept included subtracting the average power estimate required for the interbasin transfer from the average and firm power generation for the concept, resulting in a negative net power.

Since no electrical demand studies were done for this analysis, there was no way to determine whether average or firm generation was more important. Average power generation and firm generation were averaged together for each concept. This value was then scored from 1 to 7 for electrical generation capacity, with a score of 7 for the highest values and 1 for the lowest. The distance to transmission lines was then scored from 1 to 7. Three of the concepts are located at existing reservoirs with existing transmission lines in place (Lucky Peak and Arrowrock); these three concepts were scored a 6 (average of 5, 6 and 7). The remaining reservoir concepts were scored from 1 to 4, with the furthest site, Barber Flats, scored the lowest.

A composite score was calculated by applying a weighting factor of 0.66 to electrical generation, and a factor of 0.33 for transmission distance. Totals were generated for each storage concept. The weighted scores were then ordered from highest to lowest. As shown in table 9, the top three storage concepts for hydropower potential, are Arrowrock–New Dam, Twin Springs, and Lucky Peak–Maximum Raise. A technical appendix describing scoring methodology in more detail is available from the Corps on request.

3.3.5 Cost Index

Cost index criteria compared storage concepts in terms of cost effectiveness for providing water supply or flood benefits (table 10). Limited cost estimate information was developed for the six water storage concepts. To ensure data comparability, the cost information relied on a level of detail that was approximately the same for all sites. Equal or similar material unit pricing and equal or proportional application of construction activities, were used to quantify materials, labor, and equipment for each concept.

The estimates are intended as order-of-magnitude costs for construction for comparison purposes only. The cost estimate information does not include design or construction oversight costs. Minor cost issues were generally not addressed. Some significant cost issues were not addressed because the available information did not support any discrimination from one site to the next.

The cost information used for the cost index is considered suitable for use in the screening process, but is not suitable for determining final costs for construction of a storage facility, or for seeking Congressional appropriations. Considerable site exploration and design effort would be needed to develop cost estimates meeting Corps requirements to seek construction authorization and appropriation.

For cost purposes, proposed dams were assumed to be symmetrical, prismatic structures. The crests are long and narrow, with wider, variable-length bases along the river axis. Aerial photo measurements were used as gross approximations of crest length and base width. Prism volume calculations were based on the measurements, assumed upstream and downstream slopes, crest widths, and established pool heights with 6 feet of additional freeboard.

Unit prices were based on internal estimates, similar diversion works projects, recent bid prices, published construction cost index resources, and the 2008 English cost book for MII cost estimating software. The methodology resulted in one set of quantity and cost calculations for each storage concept.

Table 10. Second-Level Screening Matrix – Cost Index

Concept	Cost Index							
	Storage				Flood Protection			Composite Cost Index (Average of Rank Scores)
	Project Cost ($Million)	Additional Potential Storage (kAF)	Storage Cost Index ($Million/ kAF)	Storage Cost Index Rank	Increase Flood Protection Relative to Existing	Flood Benefit Cost Index ($Million/ % Increase in Flood Benefits)	Cost Index Rank	
Lucky Peak Dam – Min	713	12	59.4	1	3	238	1	1.0
Lucky Peak Dam – Max	1345	96	14.0	2	27	50	2	2.0
Arrowrock – New Dam	852	317	2.7	5	104	8	6	5.5
Twin Springs	1106	304	3.6	4	98	11	4	4.0
Alexander Flats	166	68	2.4	6	19	9	5	5.5
Barber Flats	48	58	0.8	7	16	3	7	7.0
Dunnigan Creek	1231[1]	227	5.4	3	50	25	3	3.0

[1]Dunnigan Reservoir costs include ~$200 million for pumping and conveyance for interbasin transfer.

Three storage concepts included unique project- or site-specific conditions considered significant cost drivers. These issues were addressed by adding a lump sum cost to the estimate.

- Dunnigan Creek includes water diversion facilities for transferring water from the South Fork Payette River basin to the Boise River basin at Grimes Creek. This interbasin transfer requires a diversion works, pumps, and pipelines to move water 2 miles horizontally and approximately 1,000 feet vertically in order to get over the pass. The site-specific cost addition value was $194 million.
- Lucky Peak Maximum and Minimum Raises require upgrades to the dam to bring it in line with current design requirements. Both concepts would need to address foundation seepage to reduce risks to the public. The screening analysis assumed a subsurface cutoff wall would be required to address this issue, which is quite expensive. The site-specific cost addition value was $706.8 million.

All sites and reservoir concepts have site-specific conditions with cost implications. However, during the screening analysis it was felt these additional cost issues were either not unique to a site or outside of the scope of analysis for a screening level assessment. For example, geologic hazards, including landslides, faults, and seismic risks, were assumed to represent equal cost risks for all sites. Significant analyses and exploration would be required to determine appropriate risk mitigation measures for an identified geologic hazard. These issues would be evaluated in future feasibility study for those sites selected for additional analysis. Summary data, with line item estimates, can be found in a technical appendix available from the Corps upon request. In general, controlling cost items were directly related to the volume material needed to construct the dam structure. Several separate line items were incorporated into the estimates for each storage concept.

- **Relative Cost Contingency**

  A simplified Initial Cost and Schedule Risk Assessment was conducted during a meeting with the PDT members. Areas of concern that introduce risk to estimating costs were identified by the PDT, and include:

  - Funding uncertainties.
  - Unplanned work that must be accommodated.
  - Unknown seismic and geological issues at each proposed site.
  - Site access.
  - Changing political factors.

  A 35-percent contingency was determined to be reasonable for the screening analysis, and was applied to all concepts. Additional contingency costs were included to address the following site-specific issues:

- **Lucky Peak–Minimum Raise** requires an upgrade to the existing dam to bring it in line with current design requirements. A lump sum cost was added to account for a cutoff wall. An additional 25-percent contingency cost was added to the cost index to account for retrofit and modifications needed for the intake tower and spillway.
- **Lucky Peak–Maximum Raise** requires an upgrade to the existing dam to bring it in line with current design requirements. A lump sum cost was added to account for a cutoff wall. An additional 30-percent contingency cost was added to the cost index to account for retrofit and modifications to the intake tower and spillway, as well as modifications to Arrowrock Dam and the hydropower plant.
- **Arrowrock–New Dam** involves construction of a new dam just downstream from the existing dam. Once the new dam is complete, it would be necessary to notch, remove, or otherwise get around the existing dam. For this analysis it was assumed the existing dam would be notched. To account for this work, a 10-percent contingency was added to the cost index.
- **Dunnigan Creek** appears to have extensive columnar basalt bedrock zones in planned foundation areas. Costs for an extensive foundation grouting program were added to the cost index, using a 15-percent contingency.
- **Twin Springs** appears to have challenging foundation conditions (e.g., deep weathered bedrock). Based on a personal communication with Reclamation, considerable additional construction expense was initially anticipated.

Estimated construction cost, contingencies, cost additions, and total cost index for each storage concept is summarized in table 11.

Cost index ratios were calculated for each storage concept for cost per 1 kAF of additional water supply provided and the cost per percentage increase of flood benefit. The scores for each concept were then ranked from minimum to maximum value, with a score of 7 for the most cost effective and 1 for the least cost effective. A composite cost index was calculated by averaging the cost index score ranks for water supply and flood risk cost indexes. As shown in table 10, the top three concepts, based on lowest cost index criteria, are Barber Flats, Arrowrock–New Dam, and Alexander Flats.

Table 11. Summary of Cost Index Data

Site	Estimated Construction Cost ($Millions)	General Contingency	Estimated Construction Cost with Contingency ($Millions)	Site-Specific Contingency	Site-Specific Cost Additions ($Millions)	Total Cost Index ($Millions)
Lucky Peak Dam–Min	3.6	35%	4.9	25%	706.8	713
Lucky Peak Dam–Max	386.5	35%	521.8	30%	706.8	1,345
Arrowrock– New Dam	587.7	35%	793.4	10%		852
Twin Springs	819.1	35%	1105.7			1,106
Alexander Flats	122.6	35%	165.5			166
Barber Flats	35.6	35%	48.0			48
Dunnigan Creek	740.7	35%	999.9	5%	194.0	1,231

3.3.6 Social Effects

The social effects screening criteria compared each water storage concept in terms of the acres of public or private land, number of residences, miles and types of roads, number and type of recreational facilities, and acres of grazing allotment that would be inundated by the proposed storage facilities (table 12). Higher scores reflect less social impact. Information for this category was compiled through GIS analysis.

- **Land Ownership.** This criterion compared the acres of public and private land that would be inundated by a proposed storage facility. Sites that avoided impacts to private lands were considered more desirable and were, therefore, scored higher. Sites that included larger numbers of acres of private land would have a greater economic effect, because these lands would be removed from the county tax base. They would also likely involve greater land acquisition costs.
- **Residences.** This criterion compared the number of residences located within a proposed reservoir footprint. Lucky Peak and Dunnigan Creek are the only concepts that would impact residences, all located in Boise County. The number of residences impacted within the footprint and for a 300 foot buffer surrounding the proposed reservoir footprint was provided by Boise County (Adamson, 2010). Each site was scored based on the total number of residences affected.
- **Roads.** This criterion compared the miles and types of roads located within a proposed reservoir footprint (State Highway versus other road types). Impacts to State Highways were considered more significant than other road types (i.e., Forest Service, county, unimproved, etc.). All roads would require rerouting and likely add significant costs to the project. State Highway 21 is a designated State scenic highway, has greater traffic numbers, and would impact larger numbers of people.

Table 12. Second-Level Screening Matrix – Social Effects

Site	Social Effects											
	Land Ownership		Residences		Roads		Recreation Facilities		Grazing		Social Effects Average Score	Social Effects Composite Score
	Acres	Score	No.	Score	Miles	Score	Number	Score	Acres	Score		
Lucky Peak Dam –Minimum Raise	Same	7	0	5		7		7	0	7	6.6	7
Lucky Peak Dam –Maximum Raise	47 private 424 public	2	32[1]	2	1 SH[3]; 8 other	2	4-picnic; 5-boat access; 1-marina; 20 miles of trail	2	504	5	2.6	2
Arrowrock–New Dam	18 private 1327 public	3	0	5	25 other	3	3-CG; 2 boat access	3	1,533	2	3.2	3
Twin Springs	1,517 public	4	0	5	12 other	4	2-CG; 2 trailheads; 1.5 miles of trail	1	1,186	3	3.4	4
Alexander Flats	647 public	6	0	5	7 other	6	1-CG	4	211	6	5.4	6
Barber Flats	969 Public	5	0	5	8 other	5	1-rental cabin; 1-trailhead; 0.5 miles of trail	5	672	4	4.8	5
Dunnigan Creek	1,498 private 476 public	1	165[2]	1	9 SH; 27 other	1	Dispersed recreation activities	6	1,974	1	2.0	1

[1] Boise County assessed market values of $10.1 million.
[2] Boise County assessed market value of $34.8 million.
[3] State Highway.

- **Recreational Facilities.** This criterion compared the number of recreation facilities located within a proposed reservoir footprint, including boating access, campgrounds, trailheads, and cabins (table 12). Each storage concept was scored based on the total number and type of recreational facilities affected by a proposed water storage facility. The PDT did not consider potential recreation benefits offered by a reservoir at this time. The minimum raise at Lucky Peak was assumed to require only slight alterations to existing facilities, while the maximum raise would likely require extensive modifications, removal, or relocation of existing facilities.

  Dispersed recreation activity occurs outside of developed recreation facilities at all proposed reservoir sites. The screening analysis examined the number of developed recreation facilities affected by a proposed reservoir as quantitative information was not available to allow comparison between sites for dispersed recreation use. Future phases of the feasibility study will acquire dispersed recreation use data as part of a comprehensive analysis of recreation effects.

- **Grazing Allotments.** Proposed reservoir sites were compared and ranked in terms of the acres of grazing allotments and/or pasture that would inundated by the full pool reservoir. Two of the proposed reservoir sites, Twin Springs and Alexander Flats, would inundate grazing allotments that are currently closed to grazing. The acreage of these allotments was not included in the total acres that would be affected.

A composite score was determined by averaging the scores for all criteria. As shown in table 12, the top three sites, based on the fewest social impacts, are Lucky Peak–Minimum Raise, Alexander Flats, and Barber Flats.

3.3.7 Environmental Effects

The environmental effects screening criteria (table 13) compared the potential effects of the storage concepts on the following:

- ESA-listed species.
- Federal and State sensitive species.
- Special fisheries management areas.
- Miles of stream inundated.
- Land cover types.
- Big game winter range.
- Special river designations.
- Cultural resources.
- Roadless areas.

Table 13. Second-Level Screening Matrix – Environmental Effects

Site	Environmental Effects							
	Bull Trout Listed ESA Species		Federal/State Sensitive Species		Idaho Department of Fish and Game Fisheries Management		Stream Miles Inundated	
	Acres	Score	Species[1]	Score	Mgt Class	Score	Miles	Score
Lucky Peak Dam –Min Raise	No proposed critical habitat (CH) affected	7	Common loon 5 points	5	General – smallmouth bass, yellow perch, rainbow trout, kokanee	6.5	0	7
Lucky Peak Dam –Max Raise	No proposed CH affected	6	Common loon 5 points	4	General – smallmouth bass, yellow perch, rainbow trout, kokanee	6.5	2.8	6
Arrowrock – New Dam	6.5 mi. proposed CH habitat inundated	5	Bald eagle, mountain quail, Columbia pebblesnail 29 points	1	General – smallmouth bass, yellow perch, rainbow trout, mountain whitefish, redband trout; Put-and-take – rainbow trout	5	8.9	3
Twin Springs	20.5 mi. proposed CH inundated; Blocks migration to 397 mi. N. and Mid. Fork Boise	1	Yuma myotis, giant helleborine 9 points	3	Wild – redband trout; Put-and-take – rainbow trout; Quality – redband trout; General – redband trout, mountain whitefish, cutthroat trout, brook trout	1	20.5	1
Alexander Flats	7.0 mi. proposed CH inundated; Blocks migration to 189 mi. Mid. Fork Boise, weaker population.	3	Giant helleborine 5 points	6	Quality – redband trout; General – cutthroat trout, brook trout, mountain whitefish	2	8.3	4
Barber Flats	4.91 mi. proposed CH inundated; Blocks migration to 165 mi. N. Fork Boise	2	None identified 0 points	7	General – redband trout, mountain whitefish; Put-and-take – rainbow trout	4	4.7	5
Dunnigan Creek	Creates pool in 0.25 mi. proposed CH on S. Fork Payette; Blocks upstream migration Mores Creek	4	Yellow-billed cuckoo, mountain quail 28 points	2	Wild (SF Payette) - redband trout; General (SF Payette) – cutthroat trout, rainbow trout, brook trout, mountain whitefish; General (Mores Creek) – redband trout, mountain whitefish	3	14.6	2

[1]Refer to table 14 for sensitive species status and designation.

Table 13. Second-Level Screening Matrix – Environmental Effects (continued)

Site	Environmental Effects (continued)						
	Habitat/Land Cover		Big Game Winter Range		Special River Designations		
	Acres	Score	Acres	Score	Eligible Federal Wild and Scenic (miles)	State Protected River (miles)	Score
Lucky Peak Dam –Minimum Raise		7	0	7	0	0	6.50
Lucky Peak Dam –Maximum Raise	TOTAL – 957 Tree/shrub – 443 Grass/pasture – 266 Rock/Sand – 231 Developed – 16	4	Deer – 3,280 Elk – 3,322 Pronghorn – 60 TOTAL – 6,662	1	0	0	6.50
Arrowrock–New Dam	TOTAL – 1,588 Tree/shrub – 821 Grass/pasture – 591 Wetlands – 14 Rock/Sand – 154	3	Deer – 1,151 Elk – 1,693 TOTAL – 2,844	2	4 – Recreation 2 – Wild	4 – Recreation 3 – Natural	2.00
Twin Springs	TOTAL – 2,234 Tree/shrub – 1560 Grass/pasture – 657 Wetlands – 11 Rock/Sand – 6	1	Elk – 2,280 TOTAL – 2,280	3	11.5 – Recreation 6.7 – Wild	11 – Recreation 9 – Natural	1.00
Alexander Flats	TOTAL – 779 Tree/shrub – 579 Grass/pasture – 182 Wetlands – 12 Rock/Sand – 5	5	Elk – 704 TOTAL – 704	5	8 – Recreation	8 – Recreation	3.00
Barber Flats	TOTAL – 656 Tree/shrub – 483 Grass/pasture – 96 Wetlands – 77	6	Elk – 234 TOTAL – 234	6	0	5 – Recreation	4.00
Dunnigan Creek	TOTAL – 1,952 Tree/shrub – 1,315 Grass/pasture – 393 Wetlands – 15 Rock/Sand – 2 Developed – 227	2	Elk – 1,974 TOTAL – 1974	4	0.25 – Recreation	0.25 – Recreation	5.00

Table 13. Second-Level Screening Matrix – Environmental Effects (continued)

Site	Environmental Effects (continued)					
	Cultural Resources		Idaho Roadless Areas		Weighted Score	Environmental Composite Score
	Description	Score	Acreage	Score		
Lucky Peak Dam –Minimum Raise	Sites may be present	7	0	6.50	6.6	7
Lucky Peak Dam –Maximum Raise	Sites present on USFS lands unlikely to be affected. Sites may be present on other Federal, State, and private lands.	5	2.6	5.00	5.0	6
Arrowrock– New Dam	Arrowrock Dam is listed on the National Register of Historic Places	4	234	3.00	3.3	3
Twin Springs	Sites potentially eligible for the National Register are present. Entire reservoir footprint is of concern	2	1448	1.00	1.6	1
Alexander Flats	Sites of concern are present	6	419	2.00	4.1	4
Barber Flats	Sites eligible for National Register are present. Entire reservoir footprint is of concern.	1	0	6.50	4.3	5
Dunnigan Creek	Sites present on USFS lands unlikely to be affected. Sites may be present on other Federal, State, and private lands.	3	15	4.00	3.2	2

Most information used to evaluate the sites was obtained from agency Web sites and GIS analysis to determine which resources occur within the footprint of the projected full-pool elevation at each potential reservoir. Although the effects from any of the proposed concepts would extend beyond the reservoir footprint, the Corps determined that evaluating resource effects within the footprint is sufficient for the purpose of an initial screening of numerous concepts. Effects upstream, downstream, and surrounding the reservoir footprint will be considered in a future feasibility study phase when specific design and operational details are determined. Construction of a dam would result in significant impact to numerous environmental resources, including native fish species, wildlife habitat, vegetation, etc. The screening analysis selected the criteria listed above because it provided the ability to compare and distinguish between sites in this initial analysis. It is not intended to be a comprehensive evaluation of all environmental effects but a means of screening the most significant effects. A more comprehensive analysis of all pertinent environmental effects would occur during the second phase of the feasibility study

- **ESA-Listed Species.** Four species listed under ESA may be present within the footprint of the proposed reservoirs:
    - Bull trout – fish species – Threatened.
    - Slickspot peppergrass – plant – Threatened.
    - Canada lynx – mammal – Threatened.
    - Yellow-billed cuckoo – bird – Candidate species. (The yellow-billed cuckoo has no official status under ESA at this time, but is a candidate species for listing.)

  It was determined that each reservoir had an equal chance of impacting slickspot peppergrass and yellow-billed cuckoo. Therefore, all sites were scored equally for impacts to the habitats of these species. It is unlikely that Canada lynx inhabit any of the reservoir areas and, therefore, concepts were not scored for this species. Bull trout, however, were determined to be the only ESA-listed species that could be scored for the effects of a reservoir. The following criteria were considered, in the order presented, to score concepts for ESA-listed species:

    - Is the site located in proposed critical habitat for bull trout?
    - How many miles of critical habitat would be affected by a proposed reservoir?
    - Would the proposed storage concept block bull trout migration between spawning and overwintering habitat? (Because of the proposed dam height and the lack of functional fish ladder design criteria for bull trout, the PDT assumed that any new site option would likely block the upstream migration of bull trout.)
    - How many headwaters would the water storage concept block?

The Lucky Peak concepts have the least impact on bull trout because they do not occur in proposed critical habitat.

Although the Arrowrock concept is located in proposed critical habitat, it was determined that it would not result in any additional habitat being blocked despite changing up to 8.9 miles of proposed critical habitat from riverine to reservoir environment.

The Dunnigan Creek concept would block upstream migration, but is not located in proposed critical habitat. However, the interbasin transfer of water from the South Fork Payette River for the Dunnigan concept would affect proposed critical habitat. It was assumed that the structure needed for the interbasin transfer would be a relatively small structure on the South Fork Payette River, and therefore, would not block migration.

Concepts proposed for Alexander Flats and Barber Flats could potentially affect proposed critical habitat and would block migration to one headwater. The Alexander Flats concept was scored lower than Barber Flats concept because the Middle Fork population of bull trout is weaker than the North Fork population (Prisciandaro, 2010).

The Twin Springs concept would have the greatest impact on bull trout because it inundates the most miles of proposed critical habitat and would block upstream migration to two headwater areas (397 miles of proposed critical habitat in both the Middle and North Fork).

- **Federal and State Sensitive Species.** Federal and State sensitive species occurring within proposed reservoir footprints were identified (tables 13 and 14). Each concept was scored by assigning a point value to each State or Federal species and adding the points for all species to arrive at total points for each site. Sites were then ordered from lowest to highest for ranking.
- **Special Fisheries Management Areas.** Special fisheries management areas were noted to identify potential effects on fisheries, including native fisheries and their habitat. The Idaho Department of Fish and Game *Fisheries Management Plan, 2007 – 2012* identifies five fisheries management designations that occur within proposed reservoir footprints. These include: general, put-and-take, wild, quality, and conservation, listed in order of increasing resource importance. To score each concept for potential effects to fisheries, the following was considered:
    - Would fishery type be changed?
    - Would higher quality fisheries be impacted?

Table 14. Sensitive Species Potentially Affected by Water Storage Concepts

Concept	Species	State Rank[1]	BLM Rank[2]	USFS[3]
Lucky Peak–Minimum Raise	Common loon	S1	NA	S
Lucky Peak–Maximum Raise	Common loon	S1	NA	S
Arrowrock–New Dam	Common Loon Bald eagle Columbia pebblesnail Mountain Quail	S1 S3 S1 S1	NA 1 3 3	S T S
Twin Springs	Yuma myotis Giant helleborine	S3 S3	5 3	 S
Alexander Flats	Giant helleborine	S3	3	S
Barber Flats	None			
Dunnigan Creek	Yellow-billed cuckoo White-headed woodpecker Western toad Mountain quail	S2 S2 S4 S1	1 4 2 3	 S S S

[1]S1 – Critically imperiled, extreme rarity, especially vulnerable to extinction
S2 – Imperiled because of rarity, very vulnerable to extinction
S3 – Rare or common, but not imperiled
S4 – Not rare and apparently secure, but cause for long-term concern
[2]Type 1 – Threatened, Endangered, Proposed, and Candidate Species
Type 2 – Rangewide/globally imperiled species – high endangerment
Type 3 – Rangewide/globally imperiled species – moderate endangerment (plants) or regional/state imperiled species (animals)
Type 4 – Species of concern (plants) or Peripheral species (animals)
Type 5 – Watch list (plants and animals)
[3]S – Sensitive; T – Threatened

- **Miles of Stream Inundated.** Miles of free-flowing stream that would be inundated by a new or expanded reservoir were calculated using GIS. This information represented changes in habitat from free-flowing stream to reservoir as well as an indication of the amount of riparian habitat that would be affected.
- **Land Cover Types.** Data on land cover types was obtained from the 2001 USGS National Land Cover dataset, as provided by IDWR. Cover types considered in this analysis include trees and shrubs, grass and pastures, wetlands, rock and sand, and developed. The concepts were scored based on the amount of acres that would be inundated by a full reservoir. A score of 7 reflects the inundation of the fewest number of acres. Wetland acreage was multiplied by 2 to indicate the greater resource value of that cover type.
- **Big Game Winter Range.** Data on big game winter range was obtained from Idaho Department of Fish and Game, as provided by IDWR. The Corps totaled the acres of winter range impacted for all species (deer, elf, and pronghorn) for each storage concept, regardless of overlapping acres, in order to show the relative importance of that location as winter range. The concepts were then scored based on the total number of acres affected. A score of 7 indicates the least amount of impact on winter range.

- **Special River Designations.** Special river designations include eligible Federal Wild and Scenic River segments and Idaho State Protected River segments. Information on eligible Federal Wild and Scenic Rivers was obtained by IDWR from the 2002 Boise National Forest Plan. Several segments determined to be eligible for either wild or recreation designation under the Wild and Scenic Rivers Act would be inundated.

  Information on Idaho State Protected Rivers was provided by IDWR from their records. Two classifications of river that would be affected were identified: recreational and natural.

  The total miles of both Federal and State designated river segments inundated were summed for each site. The proposed dam sites were ranked on a scale of 1 to 7, with 1 impacting the greatest number of miles of designated or eligible river segments and 7 impacting the least number of miles. The number of eligible Federal Wild River miles and State Natural River miles was multiplied by two to recognize the more significant resources values of wild and natural designations.

- **Cultural Resources.** Cultural resources are buildings, sites, structures, objects, or districts that have significance in prehistory or history. For this discussion, cultural resources include the entire spectrum of resources of concern to archaeologists, other historic preservation specialists, and Indian tribes. Cultural resources already evaluated and meeting the criteria for listing on the National Register of Historic Places are referred to as historic properties.

  Public law protects the confidentiality of cultural resources information. The Archeological Resources Protection Act, as referenced in the Freedom of Information Act, protects the nature and location of archaeological sites from public disclosure. For this reason, numbers, type, and locations of cultural resources sites within the footprints of the proposed storage concepts are displayed only generally in table 13.

  Information on cultural resources was obtained by IDWR from the U.S. Forest Service and the Idaho State Historic Preservation Office (Osgood, 2010; Pengilly, 2010). A score of 7 indicates the least potential for impact to cultural resources.

- **Roadless Areas.** Information on roadless areas was obtained by IDWR from a December 2007 dataset compiled by the U.S. Forest Service Region 1 and Region 4 for the State of Idaho Roadless Rule Draft Environmental Impact Statement (DEIS) (U.S. Forest Service, 2010). The dataset is a compilation of the most recent roadless areas in National Forests in Idaho and the management prescriptions GIS layers for the current forest plans for each of those national forests. Reservoir concepts were scored based on the number of acres of roadless area that would be inundated by the full pool reservoir. The Dunnigan site would not impact roadless areas, but the pipeline transferring water from the

The composite score for all environmental effects was determined by weighting and combining the criteria for a composite score. Weightings were as follows:

- ESA-listed species (0.25).
- Federal and State Sensitive species (0.15).
- Special fisheries management areas (0.08).
- Stream miles inundated (0.1).
- Land cover types (0.1).
- Big game winter range (0.08).
- Special river designations (0.07).
- Cultural resources (0.10).
- Roadless areas (0.07).

Higher scores indicate less environmental impact than lower scores.

The top three storage concepts with the least environmental effects are Lucky Peak–Minimum Raise, Lucky Peak–Maximum Raise, and Barber Flats.

4 WATER RIGHT CONSIDERATIONS

An analysis was conducted by IDWR to estimate the amount of water in the Boise River basin that passes Lucky Peak Dam and could be captured for new storage and appropriation in accordance with existing water right priorities (Cuhaciyan, IDWR, 2010). The Boise River is considered fully appropriated, with active water rights for surface water that total more than 28,300 cfs during the irrigation season. In practice, natural flow is undiverted and passes out of the basin during many years. The IDWR analysis used output from a historical water rights accounting program for the last 11 irrigation years (October 1 through September 30, 1999 to 2009) to provide a rough estimate of undiverted natural flow each year.

Using a mass balance, the accounting program calculates reach gains/losses and the proportion of stored and natural flow passing through each reach of the Boise River below Lucky Peak Dam (Water District No. 63, from Lucky Peak Dam to Parma). Mass balance calculations determine the reach gains entering each reach. The accounting model adds the gains downstream in order to determine total natural flow in each reach. The *remaining natural flow* in a particular reach is the amount of natural flow left in the river after water has been allocated to natural flow water right holders with priority in that reach. A portion (or all) of the remaining natural flow may be needed to satisfy senior water rights downstream. As a result, the remaining natural flow in each reach fluctuates based on gains and diversions. Water released as flow augmentation for fish, and stored water released for streamflow maintenance, are counted as stored water for accounting purposes.

Based on water right accounting methods, the amount of natural flow available for storage above Lucky Peak Dam is constrained by the minimum remaining natural flow in all reaches below Lucky Peak Dam. Storing water in excess of the minimum downstream remaining natural flow would result in negative natural flow in that reach. This analysis compares daily remaining natural flows in each reach, and uses the minimum of these flows to represent the flow available for storage on that date. These daily natural flow minimums are then summed to reflect an annual total for the irrigation year.

Table 15 lists the total volume of natural flow not diverted in Water District 63, which actually exited the basin in each irrigation year (1999 to 2009). It is assumed this water could have been available for either new storage or appropriation. The table also presents the additional volume of storage identified for each potential storage concept, and the percentage of additional proposed reservoir volume that could have been filled, based on the amount of natural flow undiverted in a given year. It is important to note this analysis is based on historical accounting model output, and assumes all priority water right holders were diverting. Water District 63 does not use lags in their accounting, and reach gains are averaged over a 4-day period. These volumes should be considered a very rough estimate of what may actually have been available for new storage. However, this limited analysis demonstrates that, despite the fact that the basin's water supply is fully appropriated, there are many years in which additional system storage could be used to capture excess water.

For this second-level screening analysis, legal constraints in the area of water rights are considered uniform for all sites. Regulatory obligations (i.e., existing water rights, contracts, and other delivery commitments) were incorporated into the hydrologic analysis used to develop the refill volume estimates, as well as the analysis performed with IDWR's historical water rights accounting model. Further consideration of water management legal constraints will be applied to any water storage concepts recommended for study, as necessary.

5 CONCLUSIONS AND NEXT STEPS

This document describes screening analysis information, methods, and results for the initial comparison of storage concepts in the Interim Feasibility Study. This evaluation is intended to provide enough information to compare the identified sites. A short list of sites, based on these results will be forwarded to the IWRB for its consideration and recommended for more in-depth analysis. Engineering designs, cost estimates, and hydrologic analysis would be completed for the selected sites as part of the Interim Feasibility Study.

Table 15. Estimated Historical Volume of Natural Flow Exiting Water District 63 and Available for Storage (Irrigation Years 1999 through 2009)

		Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	
Concepts	**Additional Maximum Storage (AF)**[1]	**Historical Natural Flow Exiting Water District 63 (AF)**[2]	**864,890**	**240,386**	**0**	**0**	**31,671**	**32,476**	**16,965**	**1,216,155**	**19,798**	**111,431**	**185,168**	**Average Percent of Max Storage Filled (%)**
Lucky Peak Dam – Min Raise	12,000	Percent of Additional Maximum Storage Filled (%)[3]	100%	100%	0%	0%	100%	100%	100%	100%	100%	100%	100%	82%
Lucky Peak Dam – Max Raise	96,000		100%	100%	0%	0%	33%	34%	18%	100%	21%	100%	100%	55%
Arrowrock –New Dam	317,000		100%	76%	0%	0%	10%	10%	5%	100%	6%	35%	58%	36%
Twin Springs	304,000		100%	79%	0%	0%	10%	11%	6%	100%	7%	37%	61%	37%
Alexander Flats	68,000		100%	100%	0%	0%	47%	48%	25%	100%	29%	100%	100%	59%
Barber Flats	58,000		100%	100%	0%	0%	55%	56%	29%	100%	34%	100%	100%	61%
Dunnigan Creek	227,000		100%	100%	0%	0%	14%	14%	7%	100%	9%	49%	82%	43%

[1]Additional Maximum Storage of proposed water storage concepts (table 3).
[2]Estimated volume of natural flow exiting the Boise River basin (Lucky Peak Dam to Parma-Water District No. 63) annually from 1999 through 2009, based on the water rights accounting program.
[3]Percent of additional storage volume that could have been filled based on the amount of estimated natural flow available.

A preliminary version of the screening analysis was distributed at public meetings in June and July 2010 and posted on the Corps' Web site for public review. Public comments were incorporated into this report to the extent possible. Revisions to the screening analysis included incorporating additional available information about social and environmental effects into the matrices, revising criteria category weights to respond to public comment, and revising conceptual technical information and associated cost indexes.

Based on the results of this initial water storage screening analysis, the most probable large surface water storage site is a new dam constructed immediately downstream of the existing Arrowrock Dam. The concept evaluated in this report provides for a new 368-foot RCC dam with the potential for 317 kAF of additional storage in the system. The most probable small site based on these results is the Alexander Flats site which includes a new rockfill dam, approximately 271 feet high, with the potential to provide an additional 68 kAF of storage water to the system.

The next step for the Lower Boise River Interim Feasibility Study is to develop additional engineering and cost information for a short list of sites. The full Feasibility Study will evaluate additional measures and combine them into alternatives to meet multiple planning objectives. Other measures, in addition to water storage, will be considered to address flood risk concerns, including bypass channels, levees, and nonstructural options. Measures to improve water quality, restore or improve riparian and aquatic ecosystems, and provide additional recreational opportunities will also be examined. During the second phase of the feasibility study, extensive environmental and technical analyses to address social, natural resource, cultural, and other effects will be conducted. The second phase will be crafted to meet the requirements of the National Environmental Policy Act, Endangered Species Act, and other environmental laws and regulations. The benefits, impacts, and costs of constructing storage facilities will be compared to the benefits, impacts, and costs of pursuing other actions, both structural and nonstructural. Numerous opportunities for public review will occur throughout the feasibility study.

6 REFERENCES

Adamson, Brent, Boise County Assessor, 2010. July 19, 2010 electronic mail re: Parcels Affected by Proposed Dams.

Barker, Rosholt, & Simpson, LLP, 2007. Project No. 4556 – Idaho, Application for Amendment of License to Federal Energy Regulatory Commission, (Arrowrock Hydropower FERC license application). July 2007.

Bureau of Reclamation, 2006. *Boise/Payette Water Storage Assessment Report*. July 2006.

Bureau of Reclamation, 2004. *Biological Assessment of Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir*. Pacific Northwest Region, Snake River Area, 2004.

Idaho State, 2010. *Idaho Geological Survey*. Web site: <www.idahogeology.org/Services/MinesAndMinerals/searchmines.asp> accessed May 1, 2010.

Idaho Department of Water Resources, 2010. *Storage Availability Analysis for the Boise Basin*. Internal Memorandum from Cuhaciyan to Clark, April 7, 2010.

Idaho Department of Water Resources, 2001. *Domestic, Commercial, Municipal and Industrial Water Demand Assessment and Forecast in Ada and Canyon Counties, Idaho*. IDWR, December 2001.

Idaho Fish and Game, 2010a. *Idaho Conservation Data Center*. Web site: <fishandgame.idaho.gov/cms/tech/CDC> accessed April 13, 2010.

Idaho Fish and Game, 2010b. *Idaho Fisheries Management Plan, 2007-2012*. Web site: <fishandgame.idaho.gov/cms/fish/programs/fish_plan.pdf> accessed April 8, 2010.

Link, R., 2010. Personal communication between R. Link, Bureau of Reclamation, and M. Schaeffer, Corps, March 10, 2010.

Kiilsgaard, T.H., T.M. Stanford, and R.S. Lewis, 2001. *Geologic Map of Idaho City, 30 x 60 Minute Quadrangle, Idaho*. Idaho Geological Survey, 2001. Scale is 1:100,000.

Neitzel, S., 2010b. Personal communication between S. Neitzel, Idaho State Historic Preservation Office, and S. Thiel, IDWR, March 2010.

Novak, P., A.I.B., C. Moffatt, C. Nalluri, and R. Naravanan, 2007. *Hydraulic Structures, Fourth Edition*. Taylor and Francis Group, London, 2007.

Othberg, K.L. and R.S. Lewis, 1992. *Geologic Map of the Boise Valley and Adjoining Area, Western Snake River Plain, Idaho, 30 x 60 Minute Quadrangle, Idaho*. Idaho Geological Survey, 1992. Scale is 1:100,000.

Osgood, S., 2010a. Personal communication between S. Osgood, USFS, and S. Thiel, IDWR, March 2010.

Prisciandaro, A., 2010. Personal communication between A. Prisciandaro, Bureau of Reclamation and S. Shelin, Corps, May 21, 2010.

U.S. Army Corps of Engineers, 2010. *Public Information Meeting and Public Comment Summary.* Walla Walla District, August 2010.

U.S. Army Corps of Engineers, 2001. *Expedited Reconnaissance Study, Section 905(b) (WRDA 86), Boise River, Idaho*. Walla Walla District, 2001. Web site: <www.nww.usace.army.mil/boise/brifs/reports.asp>

U.S. Army Corps of Engineers, 1995. *Lower Boise River and Tributaries, Idaho*. Walla Walla District, May 1995. Web site: <www.nww.usace.army.mil/boise/brifs/reports.asp>.

U.S. Army Corps of Engineers, 1985a. *Water Control Manual for Boise River Reservoirs*. Walla Walla District, 1985.

U.S. Army Corps of Engineers, 1985b. *Engineering and Design – Hydropower.* Engineer Manual 1110-2-1701. Corps, 1985.

U.S. Army Corps of Engineers, 1978. *Lucky Peak Dam and Lake – Modification Study*. Feasibility Report. Walla Walla District, 1978.

U.S. Army Corps of Engineers, 1958. *Design Memorandum No. 1, Justification Report, Flood Control Improvements, Boise Valley Project*. Walla Walla District, 1958.

U.S. Fish and Wildlife Service, 2010. *Threatened, Endangered, Candidate and Delisted Species: Idaho*. Web site <http://www.fws.gov/idaho/species/IdahoT&E.htm> accessed April 3, 2010.

U.S. Fish and Wildlife Service, 2005. *Biological Opinion for Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir*. Snake River Fish and Wildlife Office, Boise, Idaho, 2005.

U.S. Forest Service, 2010. *State of Idaho Roadless Rule Draft Environmental Impact Statement*. Web site <fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gDfxMDT8MwRydLA1cj72BTVzMTAwjQL8h2VAQAzkRcqw!!/?ss=119930&navtype=BROWSEBYSUBJECT&cid=null&navid=101110000000000&pnavid=101000000000000&position=BROWSEBYSUBJECT&ttype=roaddocument&pname=Roadless-%20Proposed%20Rule%20Documents> accessed March 29, 2010.

U.S. Forest Service, 2004. *Interior Columbia Basin Ecosystem Management Project*. Spatial Data. USFS, 2004.

U.S. Forest Service, 2002. *Boise National Forest Plan, Final 2002*. Web site: <www.fs.fed.us/r4/sawtooth/arevision/boiseplan.htm> accessed April 3, 2010.

U.S. Geological Survey, 2007. *Streamstats in Idaho*. Web site: <water.usgs.gov/osw/streamstats/idaho.html> accessed March 17, 2007.

U.S. Geological Survey, 2001. *National Land Cover Database*. Web site: <*www.mrlc.gov/nlcd_multizone_map.php*> accessed March 29, 2010.