

DRAFT

Nevada Irrigation District
Regional Water Supply Project

**Combie Reservoir
Need for a Biological Risk Assessment**

Technical Memorandum

December 2012

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Nevada Irrigation District
Regional Water Supply Project

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Executive Summary

ES 1 Introduction and Purpose

The proposed Nevada Irrigation District (NID) Regional Water Supply Project (RWSP) includes a separate raw water reservoir to supply the water treatment plant (WTP). The project will be completed in phases with the reservoir planned for a later phase. Until the new reservoir is placed into operation, Combie Reservoir, located on the Bear River and owned and operated by NID, is considered the domestic water supply reservoir for the RWSP WTP. In addition to serving as a diversion dam and providing water storage, Combie Reservoir is used for recreation, including swimming and other body-contact water sports.

The California Department of Public Health (CDPH) has prepared the November 15, 2000 Draft Guidelines for Evaluating Applications for Recreational Use Permits at Domestic Water Supply Reservoirs (CDPH Draft Guidelines). These guidelines require a biological risk assessment if swimming is allowed and the reservoir has 2.10 or more annual visitors per acre-foot (AF) of storage.

The purpose of this technical memorandum is to investigate the need for a biological risk assessment for Combie Reservoir by estimating annual visitors and determining reservoir volume.

ES 2 Findings

A formal count of annual visitors at Combie Reservoir has not been conducted. This memorandum estimates the total number of visitors per year at 14,400.

Combie Reservoir impounds approximately 3,500 AF and has a seasonal flow-through volume of 43,400 AF. The total of these two volumes, 46,900 AF, is considered the effective volume of the reservoir for purposes of evaluating biological risk.

These findings result in a ratio of annual visitors per AF of storage for Combie Reservoir of 0.31 (14,400 ÷ 46,900). This represents a significant factor of safety of 6.8 (2.10 ÷ 0.31) before a biological risk assessment is required.

At the request of CDPH, several “worst case” scenarios are investigated to account for temporal variations in visitor counts and variations in effective reservoir volume. The impact of possible short circuiting in the reservoir is also discussed. The worst case scenario occurs during the July 4 holiday and results in a reasonably significant factor of safety of 2.2 before a biological risk assessment is required.

ES 3 Conclusions

It is therefore concluded that a biological risk assessment is not required in order to use Combie Reservoir as the domestic water supply reservoir for the proposed RWSP WTP and that a more in depth study of annual visitors to Combie Reservoir is not warranted.

Nevada Irrigation District Regional Water Supply Project

Combie Reservoir Need for a Biological Risk Assessment Technical Memorandum

1. Introduction and Purpose

The proposed Nevada Irrigation District (NID) Regional Water Supply Project (RWSP) includes a separate raw water reservoir to supply the water treatment plant (WTP). The project will be completed in phases with the reservoir planned for a later phase. Until the new reservoir is placed into operation, Combie Reservoir, located on the Bear River and owned and operated by NID, is considered the domestic water supply reservoir for the RWSP WTP. In addition to serving as a diversion dam and providing water storage, Combie Reservoir is used for recreation, including swimming and other body-contact water sports.

The RWSP receives water from the Bear River via Combie Reservoir. Combie Reservoir diverts water into the Combie Phase I canal. An inverted siphon conveys water across the Bear River to the Combie Ophir I canal where the RWSP raw water pipeline turnout structure is located.

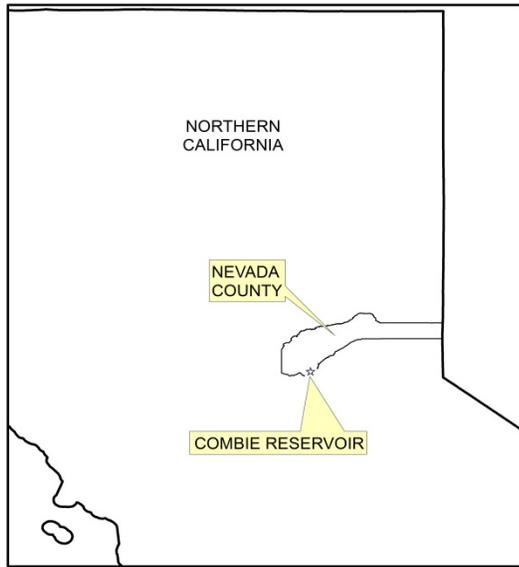
Figure 1 provides the location of Combie Reservoir within the state of California. **Figure 2** provides a vicinity map for Combie Reservoir and related facilities.

Body contact water sports at Combie Reservoir, as well as other casual visitors to the reservoir, may present a biological risk to the domestic water supply serving the RWSP and therefore, influence design criteria for the water treatment process. The requirement for a biological risk assessment is based on the number of visitors per year compared to the volume of the reservoir.

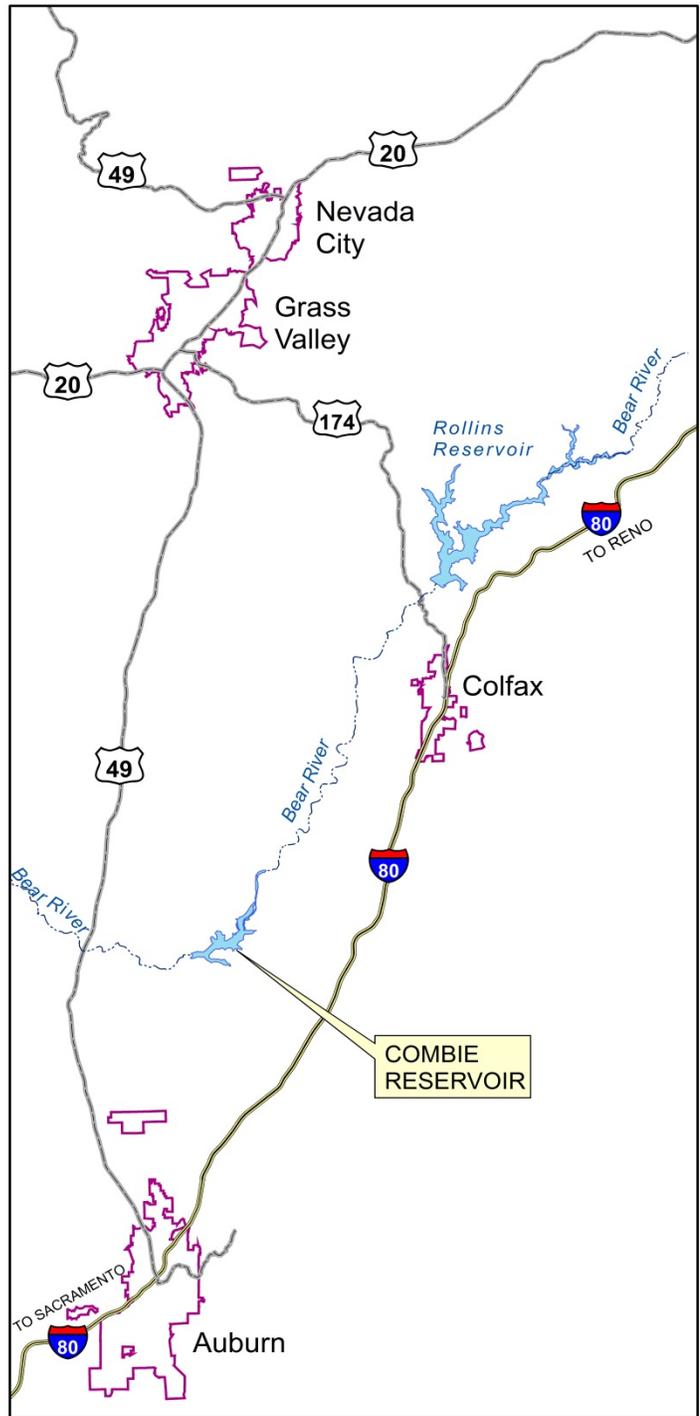
A conference call was held on May 4, 2009 with the California Department of Public Health (CDPH) (Richard Heinrich and Gary Schultz) and RWSP pre-design team members (Brian Powell, Gerry LaBudde, Dave Hunt, and Tim McCall). The purpose of the call was to discuss methods for estimating the number of annual visitors at Combie Reservoir in order to determine if a biological risk assessment is required. To date, a formal count of annual visitors has not been completed.

The California Department of Public Health prepared the November 15, 2000 Draft Guidelines for Evaluating Applications for Recreational Use Permits at Domestic Water Supply Reservoirs (CDPH Draft Guidelines). If a reservoir is used as the domestic water supply for a WTP, and swimming is allowed, the guidelines require a biological risk assessment if the reservoir has 2.10 or more annual visitors per acre-foot (AF) of storage.

The purpose of this technical memorandum is to investigate the need for a biological risk assessment for Combie Reservoir by estimating annual visitors and determining reservoir volume.



LOCATION MAP



VICINITY MAP

NEVADA IRRIGATION DISTRICT
REGIONAL WATER SUPPLY PROJECT
COMBIE RESERVOIR
NEED FOR BIOLOGICAL
RISK ASSESSMENT

FIGURE 1

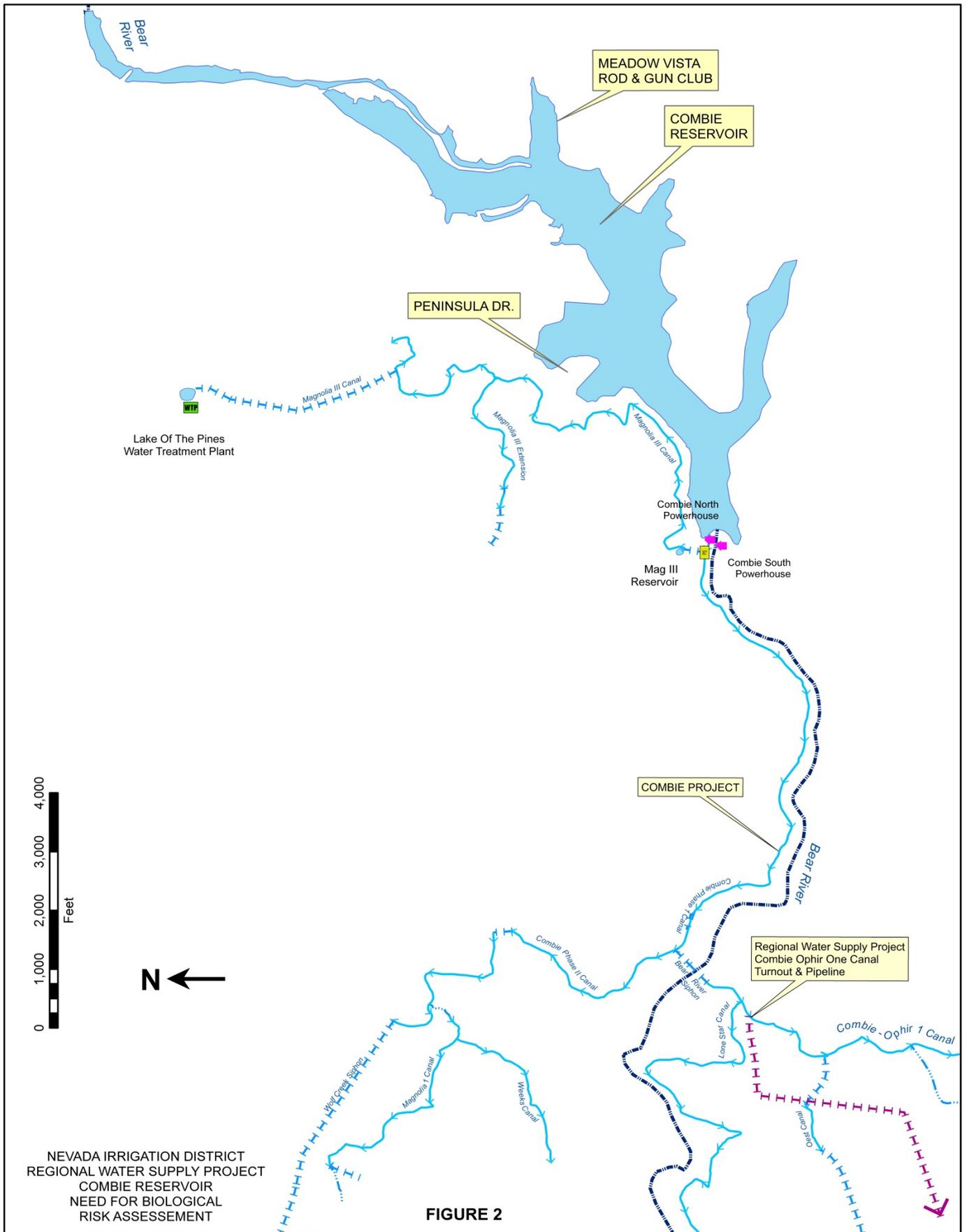


FIGURE 2

2. Background Information:

The following background information regarding Combie Reservoir is used as the basis for the findings in this report:

- Volume (nominal): ~ 3,500 AF (accounts for accumulated sediments)¹
- Relatively constant reservoir elevation during summer months¹
- Flow-through volume: ~ 43,400 AF per year (deliveries to Combie Phase I canal plus 5 cubic feet per second (CFS) minimum release to the Bear River environment.¹
- NID owns all inundated lands plus limited lands around the shore line above the high water mark.
- 120 parcels abut NID property around the shoreline.¹
- Reservoir recreational uses are primarily enjoyed by adjacent property owners and their guests.¹
- Other area subdivision lots in the immediate vicinity of the reservoir have access up to the NID property line through use of exclusive easements across private land.
- The Meadow Vista Rod and Gun Club boat ramp is available for use by members from outside the area.
- Homeowners on Peninsula Drive access the reservoir through a locked gate.²
- The upper end of Combie Reservoir is used as a take-out area for Bear River whitewater kayakers.³
- 2005 Memorial Day count identified 65 boats (ponton, motor, and jet skis) docked on the reservoir. The count also identified 18 docks without motorized boats.¹
- NID has adopted a Shoreline Development Permit System allowing docks and other improvements.
- NID has currently issued valid permits for 120 docks.²
- Boats are not permitted to tie up to or dock on buoys or trees.¹
- Swimming is permitted within 200 feet of the shore (Section 12.28.060. NC).
- Swimming is prohibited within 200 feet of the dam (Section 12.28.060. NC).
- The lake has no designated swimming areas.
- Maximum surface area: 276 acres.¹
- Area usable for boating: 77 acres.¹
- Safe Carrying Capacity criteria: one boat per five usable acres.¹
- Safe Carrying Capacity: 15.
- Placer County Sheriff's Department recommendation: no more than 20 boats per day with no more than 4 to 5 towing skiers at one time.¹
- Boat usage is self-policing: i.e. "Adjacent residents tend to use the reservoir when it is not crowded."¹
- Nevada County Deputy Sheriff observations:⁴
 - Summer weekend or summer holiday: 12 to 20 power boats per day (not all at one time)

¹ Combie Reservoir Shoreline Management Plan by MWH January 2006

² Peggy Davidson, NID Recreation Specialist, Personal conversation.

³ Web site at www.cacreeks.com

⁴ Easley, Deputy Sheriff, Personal conversation reported by Brian Powell

- Summer week day: 3 to 4 power boats per day
- Off season day: 1 to 2 power boats per day
- No fees imposed for day use or boat launching.

3. Assumptions:

Assumptions used to estimate the number of annual visitors to Combie Reservoir include:

- The active summer recreation season is May through September; therefore use:
 - Summer recreation season lasts for 22 weeks with 23 weekends
 - Three-day-holiday summer weekends: 3 (9 days)
 - Non-holiday summer weekends: 20 (40 days)
 - Non-holiday summer weekdays: 107
- Off season days: 209 (365 – 9 – 40 – 107)

Assumptions used to estimate impacts on reservoir water quality include:

- No thermo-cline due to overall shallow waters and high flow-through volume.
- Adequate sanitation facilities and refuse containers available. Provided by land owners.

4. Estimating Visitors:

The term “visitor” as used in the CDPH Draft Guidelines is understood to include a person in or on the lake, or using facilities adjacent to the lake shore, whether in contact with the water or not. This might include fishermen, hunters, swimmers, boaters, skiers, personal water craft operators, and those standing or lounging on a dock or visiting a beach or shoreline picnic area.

NID owns the land up to the high water mark plus, at a minimum, an additional five feet in elevation. In limited areas, where the ground cross slope is gentle, the 5 additional feet in elevation of ownership provides enough space to contain shoreline activities. People enjoying these shoreline activities are considered visitors to the lake according to the CDPH Draft Guidelines. Those areas with moderately steep to steep cross slopes are not conducive to shoreline activities; however can support a dock and boating activities. People associated with these activities are also considered visitors to the lake.

People associated with activities on lands not owned by NID are not considered visitors to the lake itself and therefore are not included in the estimate. In areas with steeper cross sections, people on adjacent lots could be relatively close to the waters edge but still not on NID property. These people are not considered visitors to the lake. For example, owners or guests of a home with a back yard adjacent to NID property, even in steep areas, who restrict their activities to areas within the owner’s back yard, are not considered visitors to the lake. Also, members and guests visiting the Meadow Vista Rod and Gun club are not considered visitors to the lake with the exception of members or guests who make direct use of the lake.

For the purpose of estimating the annual number of visitors at Combie Reservoir, visitors are categorized as follows:

- Those using power boats
- Swimmers
- Other sports enthusiasts
- Casual visitors

The number of visitors to the lake within each visitor category varies throughout the year depending on the season or if it is a weekday, weekend, or holiday. Each visitor category will be analyzed based on four (4) seasonal day classifications (see “Background Information”) including:

- Summer holiday weekends (9 days)
- Summer weekend days (40 days)
- Summer weekdays (107 days)
- Off-season days (209 days)

Each category of visitor is further defined below. The number of annual visitors for each visitor category is estimated for each seasonal day classification. The following estimates are ample enough so as not to underestimate the impact associated with visitors on reservoir water quality.

4.1 Power Boats

This category of visitors includes ski boats, personal water craft, and pontoon boats; all with their associated water sports including swimming, diving, and leisure activities. Non-power boats include sail boats, row boats, canoes, and kayaks, and are estimated to be very few in number. Non-power boats are included in the “Other Sports” category.

The vast majority of boats observed on the lake by the Sheriff’s Deputy are reported to be power boats. Four visitors are estimated for each ski boat. One to two visitors are estimated for a personal water craft. Parties larger than four are estimated for pontoon boats. It is estimated that the average number of visitors between personal water craft and pontoon boats is approximately four visitors per boat per day. Therefore, an average of four visitors per day is used for all power boats, including power boats, personal water craft, and pontoon boats.

Estimates of the number of power boats using Combie Reservoir are taken from observations by Nevada County Sheriff Department. They observed 12 to 20 boats per weekend day, 3 to 4 boats per weekday, and 1 to 2 boats per off-season day (includes weekends). The maximum number of boats reported for weekends is used for holiday weekends (20 power boats). The number of power boats used for summer weekend days, other than a holiday weekend, is estimated as the average of the reported observation of 12 to 20, i.e. 16 power boats per weekend day. The maximum number of boats reported for summer weekdays and off-season days are used for these two seasonal day classifications (4 & 2 power boats respectively). These numbers are consistent with the recommendations of the Placer County Sheriff’s Department (no more than 20 per day with no more than 4 to 5 skiers at one time) and the stated safe carrying capacity of the lake of 15 boats. **Table 1** estimates the annual visitors associated with power boats on the lake.

Table 1
Annual Visitors Associated with Power Boats

| Type of Day | Number of Days | Number of Power Boats | Visitors Per Power Boat | Annual Visitors |
|--------------------|-----------------------|------------------------------|--------------------------------|------------------------|
| Summer Holiday | 9 | 20 | 4 | 720 |
| Summer Weekend | 40 | 16 | 4 | 2,560 |
| Summer weekday | 107 | 4 | 4 | 1,712 |
| Off-Season | 209 | 2 | 4 | 1,672 |
| Totals | 365 | | | 6,664 |

4.2 Swimmers

This category of visitors is difficult to estimate as there are no designated swimming areas on the lake and swimming may take place in any of the many sheltered coves supporting dock locations. Swimmers that might be associated with power boats actively using the lake are included as visitors in the “Power Boats” category and are not included here. Docks with boats actively using the lake are not necessarily available for use by swimmers and therefore are not counted when determining the number of swimmers. It is estimated that approximately 25% of the docks that do not have boats actively using the lake would have swimming activities during summer holidays and summer weekends, and only 10% of the remaining docks would have swimming activities during summer weekdays. The average number of swimmers associated with any one of the docks is estimated to be two: one observer and one swimmer, or two swimmers. Visitors lounging on docks are included in the “Casual Use” category. No swimming activities are estimated during the off-season due to declining air and water temperatures.

In addition to swimming at the docks, there are a few swimmers associated with visitors using established beaches and picnic areas. These visitors are included in the “Casual Use” category.

Based on 120 docks with valid permits, **Table 2** estimates annual visitors to the lake associated with swimming activities.

Table 2
Annual Visitors Associated with Swimming

| Type of Day | Number of Days | Number of Power Boats | Total^(a) Docks Available | Per Cent of Docks Available | Docks Used for Swimming | Visitors/ Swimmers Per Dock | Annual Visitors^(b) |
|--------------------|-----------------------|------------------------------|--|------------------------------------|--------------------------------|------------------------------------|--------------------------------------|
| Summer Holiday | 9 | 20 | 100 | 25% | 25 | 2 | 450 |
| Summer Weekend | 40 | 16 | 104 | 25% | 26 | 2 | 2,080 |
| Summer Weekday | 107 | 4 | 116 | 10% | 12 | 2 | 2,482 |
| Off-Season | 209 | 2 | 118 | 0% | 0 | N/A | 0 |
| Totals | 365 | | | | | | 5,012 |

(a) 120 docks minus "Number of Power Boats"

(b) "Number of Days" X "Docks Used for Swimming" X "Visitors/Swimmers Per Dock"

4.3 Other Sports

This category of visitors includes people engaged in fishing, hunting, sailing, rowing, canoeing, and kayaking. None of these activities are prevalent on the lake; however, they are thought to exist on a limited basis throughout the year. Fishing likely takes place year-long and makes up the bulk of the visitors in this category. Hunting rarely occurs and consists of taking ducks or geese. The number of visitors sailing, rowing, and canoeing are estimated to be minor. According to the website www.cacreek.com, there are no public-access take-out points on the upper end of the lake for kayakers coming down the Bear River. Based on this, use of the lake by kayakers is thought to be minimal.

The number of visitors per fishing or hunting party, as well as passengers per non-power boat (sail, row, canoe, or kayak) is estimated to average two. The occurrence of fishing and hunting parties combined with the presence of the non-motorized boats is estimated to be 25% of, and in addition to the number of motorized boats on the lake as shown in **Table 1**. The exception is during the off-season days where non-power boating activities are estimated to be zero due to declining air and water temperatures. The occurrence of hunting and fishing during off-season days is estimated to be equal to 100% (rather than 25%) of the number of power boats estimated for the same time period. **Table 3** estimates annual visitors to the lake associated with other sporting activities.

Table 3
Visitors Associated with Other Sports

| Type of Day | Number of Days | Number of Power Boats | Percent of Power Boats | Units with Visitors | Visitors Per Unit | (a) Annual Visitors |
|----------------|----------------|-----------------------|------------------------|---------------------|-------------------|------------------------|
| Summer Holiday | 9 | 20 | 25% | 5 | 2 | 90 |
| Summer Weekend | 40 | 16 | 25% | 4 | 2 | 320 |
| Summer Weekday | 107 | 4 | 25% | 1 | 2 | 214 |
| Off-Season | 209 | 2 | 100% | 2 | 2 | 836 |
| Totals | 365 | | | | | 1,460 |

(a) "Number of days" X "Units with Visitors" X "Visitors per Unit"

4.4 Casual Use

Casual use visitors to the lake include those visiting the limited number of beaches for sunbathing, wading, or swimming; and those using the few available picnic areas or other established areas accommodating small groups of people interested in relaxing or participating in small group activities. This category also includes visitors enjoying leisure time or sun bathing on any of the 120 docks around the lake. Visitors to existing docks that also swim in the lake are included in the “Swimmers” category.

The “Power Boats” category reflects seasonal variations in recreational activities and is thought to be representative of the seasonal variation in the number of other activities on the lake. Therefore, the number of casual visitors is estimated to be generally proportional to the number of power boats on the lake. The number of visitors per group is estimated to average four. The number of groups

of visitors engaging in casual activities is estimated to be 25% of the number of power boats on the lake during the summer season. No casual use of the lake is estimated during the off-season due to declining air and water temperatures. **Table 4** estimates annual visitors to the lake associated with casual activities.

Table 4
Annual Visitors Associated with Casual Use

| Type of Day | Number of Days | Number of Power Boats | Percent of Power Boats | Groups with Visitors | Visitors Per Group | Annual Visitors ^(a) |
|--------------------|-----------------------|------------------------------|-------------------------------|-----------------------------|---------------------------|---------------------------------------|
| Summer Holiday | 9 | 20 | 25% | 5 | 4 | 180 |
| Summer Weekend | 40 | 16 | 25% | 4 | 4 | 640 |
| Summer Weekday | 107 | 4 | 25% | 1 | 4 | 428 |
| Off-Season | 209 | 2 | 0% | 0 | N/A | 0 |
| Totals | 365 | | | | | 1,248 |

(a) "Number of Days" X "Groups with Visitors" X "Visitors per Group"

5. Summary of Visitor Estimates:

Table 5 summarizes the information found in previous tables and estimates the total number of annual visitors to Combie Reservoir. **Table 5** also lists the average visitors per day for each seasonal day classification. This average is used for investigating worse-case scenarios.

Table 5
Total Estimated Annual Visitors

| Type of Day | Number of Days | Power Boat Visitors | Swimmer/Visitors | Other Sports Visitors | Casual Use Visitors | Total Annual Visitors | Average Visitors Per Day |
|--------------------|-----------------------|----------------------------|-------------------------|------------------------------|----------------------------|------------------------------|---------------------------------|
| Summer Holiday | 9 | 720 | 450 | 90 | 180 | 1,440 | 160 |
| Summer Weekend | 40 | 2,560 | 2,080 | 320 | 640 | 5,600 | 140 |
| Summer Weekday | 107 | 1,712 | 2,482 | 214 | 428 | 4,836 | 45 |
| Off-Season | 209 | 1,672 | - | 836 | - | 2,508 | 12 |
| Totals | 365 | | | | | 14,384 | |

6. Effective Reservoir Volume:

The CDPH Draft Guidelines require a biological risk assessment if swimming is allowed and the reservoir has more than 2.10 annual visitors per AF of storage. Swimming is a recognized activity at Combie Reservoir.

As stated in the background information, Combie Reservoir has a nominal storage volume of approximately 3,500 AF during the summer months. However, in addition to its nominal storage volume, Combie Reservoir serves as a diversion from the Bear River for the NID Combie Phase I

canal. This reservoir function, plus a minimum delivery of 5 CFS to the Bear River environs below the dam, introduces an additional approximately 43,400 AF of water that flows through the reservoir each year. Most of this additional water meets summer irrigation demands downstream. Irrigation season, April 15 through October 15, corresponds to a large degree with the summer recreation season. This is also the season when the most people visit Combie Reservoir.

Raw water for the proposed RWSP WTP is diverted from the Combie Ophir canal which is supplied by the Combie Phase I canal, all downstream of Combie Reservoir. As such, 43,400 AF of flow-through water mitigates the biological risk associated with visitors to Combie Reservoir by adding to the total volume of water available to receive constituents causing the risk. For the purpose of assessing the impact visitors to Combie Reservoir have on the quality of the domestic water supply for the RWSP WTP, the effective volume of Combie Reservoir is 46,900 AF (3,500 + 43,400) (nominal reservoir volume plus flow-through volume).

6.1 Slug Flow

It should be noted that water transported to the RWSP WTP would receive the maximum load possible of visitor-associated biological risk constituents if it is assumed that the flow-through volume acts as “slug flow”, where slug flow is defined as 100% of the reservoir volume is flushed every time the flow-through volume equals the reservoir nominal volume.

Anything less than slug flow means that less mixing is taking place between flow-through water and biological risk constituents. Less mixing results in less loading of constituents downstream. This theory, in turn, suggests that the constituents tend to concentrate in the sheltered coves and back eddies of the reservoir and do not enter the flow-through volume. These constituents are likely flushed out during storm events when flow through the reservoir is at its highest. From a practical standpoint, slug flow is not probable and there are some constituents retained in the reservoir; therefore, waters downstream of the dam receive less than the maximum load of constituents during warmer seasons. So as not to underestimate the impacts of visitors on water quality, slug flow is assumed.

6.2 Winter Runoff

Natural winter runoff in the Bear River, which occur mainly in the months of November through April, are not included in the estimates of flow-through volume. If winter runoff was acknowledged, the flows would add significantly to the effective volume of the reservoir.

6.3 Future Increase in System Demands

It should also be noted that the flow-through volume of 43,400 AF is expected to increase over time based on increased demands on the proposed RWSP WTP, and increased irrigation water demands on the NID distribution system downstream of Combie. An increase in flow-through volume will increase the effective volume of Combie Reservoir. The number of visitors at Combie Reservoir is not expected to increase over time given the private ownership around the lake; therefore, an increase in flow-through volume over time will decrease the biological risk for the RWSP WTP.

7. Findings:

A formal count of annual visitors to Combie Reservoir has not been conducted. This technical memorandum estimates the total annual visitors at Combie Reservoir at 14,384 (See **Table 5**), and estimates the effective volume of Combie Reservoir at 46,900 AF (actual storage volume plus the total amount of water delivered through the reservoir for downstream consumption). The ratio of visitors per year per AF is calculated at 0.31 ($14,384 \div 46,900$). This ratio represents a substantial factor of safety of 6.8 ($2.10 \div 0.31$) before a biological risk assessment is required. **Table 6** summarizes these findings.

Table 6
Visitors per Year per Acre-Foot of Storage

| CDPH Draft Guidelines | | | | |
|------------------------------|---------------------------------------|------------------------|-------------------------------|-------------------------|
| Maximim Allowed | | | 2.10 | |
| | Effective Reservoir Storage AF | Annual Visitors | Annual Visitors per AF | Factor of Safety |
| Combie Reservoir: | 46,900 | 14,400 | 0.31 | 6.8 |

8. Worst-Case Scenarios:

The ratio of 0.31 visitors per AF is based on the number of visitors to the reservoir over the period of one year, divided by the reservoir nominal volume plus the volume of water that flows through the reservoir over the period of one year. However, the number of visitors and the effective volume of the reservoir vary over the course of a year and therefor, could produce peaks in the ratio of visitors per AF. Given temporal variations in both the amount of flow-through volume and the number of visitors based on the seasonal day classifications (summer holiday, summer weekend, summer weekday, or off-season), CDPH requested further investigation of reasonably perceived worst-case scenarios.

Worst-case scenarios investigated include:

- A seasonal peak
- The period following Labor Day when the reservoir volume is drawn down
- Off-season with no natural runoff
- Off-season with a partial outage on the Combie Phase I canal

The results of the worst-case scenarios in terms of visitors per AF are compared to the CDPH Draft Guidelines which allow not more than 2.10 annual visitors per AF of storage before a risk assessment is required. A factor of safety is computed based on the findings. If the resulting factor of safety is unity or less, a more in-depth analysis is warranted. Further analysis is not necessary if the resulting factors of safety exceed unity by a reasonable margin.

8.1 Seasonal Peak

An example of a worst-case scenario would be a seasonal peak in the ratio of visitors per AF caused by a high number of seasonal visitors on any one day in combination with a much diminished effective reservoir volume. These two events may or may not coincide on the calendar.

The CDPH Draft Guidelines allow a maximum of 2.10 annual visitors per AF, emphasis on “annual”. Further study for a seasonal peak worst-case scenario requires an analysis based on time periods shorter than a year. Day-to-day statistics are preferred; however, such detail in the number of visitors is not available. This study uses the average number of visitors per day for each seasonal day classification (summer holiday, summer weekend, summer weekday, and off-season). The average visitors per day is calculated in **Table 5**.

The average effective reservoir volume per day is estimated by using the daily average flow rates per month delivered into the Combie Phase I canal as reported by NID. Releases to the Bear River environs below Combie Reservoir of 5 CFS are added, plus a nominal amount of actual volume of the reservoir. A nominal amount of the reservoir volume is included by adding 1/365 of its actual volume.

The average effective reservoir volume per day for each month is then divided into the average visitors per day for each of the four seasonal day classifications. **Table 7** summarizes the results.

**Table 7
Worst Case Scenarios – Seasonal Peak**

| Average Visitors per Day (Table 5) | | | 160 | 140 | 45 | 12 |
|------------------------------------|--|--|--------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|
| Month | Average Flow per Day (CFS) ^{(a)(b)} | Effective Volume Per Day (AF) ^(c) | Daily Summer Holiday Visitors Per AF | Daily Summer Weekend Visitors Per AF | Daily Summer Weekday Visitors Per AF | Daily Off-Season Visitors Per AF |
| January | 43.4 | 106 | | | | 0.11 |
| February | 44.8 | 108 | | | | 0.11 |
| March | 50.1 | 119 | | | | 0.10 |
| April | 73.5 | 165 | | 0.85 | 0.27 | |
| May | 102.5 | 223 | 0.72 | 0.63 | 0.20 | |
| June | 117.2 | 252 | | 0.56 | 0.18 | |
| July | 129.1 | 276 | 0.58 | 0.51 | 0.16 | |
| August | 130.5 | 278 | | 0.50 | 0.16 | |
| September | 120.7 | 259 | 0.62 | 0.54 | 0.17 | |
| October | 84.7 | 188 | | | | 0.06 |
| November | 44.1 | 107 | | | | 0.11 |
| December | 36.1 | 91 | | | | 0.13 |
| (a) | Monthly flows delivered to Combie Phase I canal as reported by NID; converted to a daily average | | | | | |
| (b) | Does not include natural runoff caused by winter storms. | | | | | |
| (c) | Average flow per day plus 5 CFS environmental release to Bear River, all converted to volume; plus 1/365 of actual reservoir volume. | | | | | |
| | Highest seasonal daily ratio of visitors per day to effective reservoir volume. | | | | | |

Table 7 yields a maximum seasonal peak ratio of 0.85 daily visitors per AF (shaded). This occurs on a weekend in April. This weekend seasonal peak worst-case scenario still holds a strong factor of safety of 2.5 ($2.10 \div 0.85$) before a biological risk assessment is required.

It is argued that the concentration of biological risk constituents resulting from a peak loading of visitors per AF would not have an instantaneous adverse effect on the quality of water delivered to the proposed RWSP WTP, rather the peak loading of constituents would take several days to mix with the nominal volume of the reservoir plus flow-through water. The constituents from the peak loading would then be released from the reservoir over a period of several days rather than being released over the one or two days that they actually peaked. This would have the effect of averaging the constituent loading over the next few weekdays. Summer weekdays in April have only approximately 30% of the number of visitors contributing to the constituent loading as compared to a weekend in April (45 vs. 140). If this argument is accepted, the actual factor of safety during this weekend seasonal peak is significantly greater than 2.5.

8.2 Post Labor Day

Another worst-case scenario could be created by a fluctuation in the stage of the reservoir during a critical time of low flow-through volume combined with high daily visitor counts.

Combie Reservoir is held at a relatively constant elevation of approximately 5 feet below spill throughout the summer recreational season. Following the Labor Day holiday in early September, NID begins to lower the reservoir surface elevation. This draw down typically occurs over several weeks and typically marks the beginning of the end of the summer recreational season. Most docks and other amenities become isolated due to the falling water surface and the muddy shoreline becomes uninviting to most visitors. On the weekend following Labor Day, the number of visitors has fallen to near summer weekday levels versus weekend levels. The days immediately following the Labor Day holiday are weekdays. The average number of summer weekday visitors per day found in **Table 5** is 45.

During the post-Labor-Day draw down, NID maintains a flow of at least 75 CFS in the Bear River and through Combie Reservoir. The worst case during the post-Labor Day drawdown is when no natural runoff is available in the Bear River. At a minimum, the flow-through reservoir volume for this worst-case scenario is 75 CFS, or 149 AF per day. A nominal amount of the actual storage volume being discharged in order to lower the reservoir surface elevation could be added to the flow-through volume, but is not. Therefore, the effective reservoir volume remains at 149 AF for this scenario.

The ratio of daily visitors to effective reservoir volume for this scenario is calculated at 0.30 ($45 \div 149$). This produces a factor of safety during the days following Labor Day of 7.0 ($2.10 \div 0.30$) before a biological risk assessment is required.

8.3 Off-Season with No Runoff

Outside of the summer season, rain and snow melt events cause the reservoir elevation to rise and spill. Typically, these events trigger a startup of the Combie South Power House, a run-of-the-river operation that attempts to keep the reservoir just under its spill elevation. These events increase the

flow-through and therefore the effective volume of the reservoir; however, this scenario assumes no natural runoff in the Bear River. Note that **Table 7** does not include natural runoff and only includes deliveries to the Combie Phase I canal and water delivered to the Bear River environs downstream of Combie Reservoir. Therefore, **Table 7** calculations listed under “Daily Off-Season Visitors per AF” are valid for this scenario. The highest ratio of daily off-season visitors per AF in this category is 0.13, which occurs in December. This results in a factor of safety of 16.2 ($2.10 \div 0.13$) before a biological risk assessment is required.

8.4 Off-Season with Partial Outage on Combie Phase I Canal

The Combie Phase I canal is often taken out of service for a few days at a time during the off-season for maintenance or repairs. During these time periods, the Combie North Powerhouse or the Combie South Powerhouse is usually operating, or the dam is spilling, or all three. The worst-case scenario during these times is with no winter runoff in the Bear River. During these outages, the RWSP WTP is served by alternate sources of water other than Combie Reservoir. This would eliminate concerns regarding any biological risk associated with visitors to Combie during an outage.

For the purpose of this study, flows are diverted around the outage on the canal so as to continue service to the RWSP WTP from Combie Reservoir. This flow will contribute to the flow-through volume of the reservoir. In addition, the NID Lake of the Pines WTP is served using the Magnolia pumps during these outages which adds to the reservoir flow-through volume. Also, NID maintains at least 20 CFS in the Bear River above Combie Reservoir between November 1 and April 30. The combination of these sources produces a daily flow-through volume of 40 AF. The reservoir nominal volume for one day is estimated by adding 10 AF ($3,500 \text{ AF}/365$), for a total effective volume of 50 AF. **Table 5** estimates the number of off-season visitors per day at 12. The ratio of daily visitors to effective volume during the off-season partial outage on the Combie Phase I canal is calculated at 0.24 ($12 \div 50$). This produces a factor of safety of 8.8 ($2.10 \div 0.24$) before a biological risk assessment is required.

9. Short Circuiting

Short circuiting of the reservoir volume is also considered a potential worst-case scenario. The potential for short circuiting is thought to be present because the effective volume of the reservoir used in these calculations relies heavily on the flow-through volume, rather than the actual volume of the reservoir. (See discussion regarding slug flow in Section 6.) If the reservoir exhibited a tendency to short circuit during the summer recreational season, the initial affect would be a decrease in the amount of visitor-produced biological risk constituents in the water being delivered to the Combie Phase I canal, and in turn to the RWSP WTP. This decrease in constituents continues until the constituents concentrated in coves and back eddies begin to feed evenly back into the flow-through stream. At that point, the initial benefit of short circuiting is replaced by an increasing amount of constituents in the reservoir outflow for the balance of the recreational season. The effects of short circuiting would not be seen until later in the season, say June through October. It is difficult to estimate the degree to which short circuiting might affect water quality without conducting extensive model testing. For the purposes of this analysis, the effective volume of the

reservoir is reduced by 40% to account for the negative impacts of a buildup of constituent loading due to possible short circuiting. Each of the worst-case scenarios discussed above will therefore be analyzed again with short-circuiting taken into consideration.

9.1 Seasonal Peak with Short Circuiting

The information contained in **Table 7** is modified to find the peak ratio of daily visitors to effective volume given a modified season (June through October) and a modified effective volume to account for possible buildup of constituents due to short circuiting (40% less than those found in **Table 7**). **Table 8** provides a summary of these calculations and the resulting ratios of daily visitors per AF of effective volume.

Table 8
Worst Case Scenarios – Seasonal Peak with Short Circuiting

| Month | Average Visitors per Day (Table 7) | | | 160 | 140 | 45 | 12 |
|-----------|--|----------------------------------|-----------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|
| | Effective Volume Per Day (AF) ^(a) (Table 7) | Short Circuiting Volume Modifier | Short Circuiting Effective Volume | Daily Summer Holiday Visitors Per AF | Daily Summer Weekend Visitors Per AF | Daily Summer Weekday Visitors Per AF | Daily Off-Season Visitors Per AF |
| June | 252 | 0.6 | 151 | | 0.56 | 0.18 | |
| July | 276 | 0.6 | 166 | 0.97 | 0.51 | 0.16 | |
| August | 278 | 0.6 | 167 | | 0.50 | 0.16 | |
| September | 259 | 0.6 | 155 | 0.62 | 0.54 | 0.17 | |
| October | 188 | 0.6 | 113 | | | | 0.06 |

(a) Average monthly flow, plus 5 CFS environmental release to Bear River, plus 1/365 of actual reservoir volume.
 Highest daily ratio of visitors per AF of modified effective reservoir volume.

The time period yielding the highest daily visitors per AF between June and October is 0.97, after including a short-circuiting modifier. This occurred on the July 4th holiday weekend. This worst-case scenario holds an ample factor of safety of 2.2 ($2.10 \div 0.97$) before a biological risk assessment is required.

9.2 Post Labor Day and Off-Season

The impact of possible short circuiting on the remaining three worst-case scenarios, i.e.: 1) Post Labor Day drawdown, 2) Off-Season with no runoff, and 3) Off-Season with a partial outage on the Combie Phase I canal are found by taking 60% of the effective reservoir volume and duplicating the calculations as done for the corresponding scenario. These calculations have been included in **Table 9**.

10. Worst-Case Scenario Summary

Table 9 provides a summary of each of the worst-case scenarios discussed above. It can be seen that the resulting factors of safety all sufficiently exceed unity.

Of the eight worst-case scenarios summarized in **Table 9**, the highest potential for water quality degradation would occur on the July 4th holiday assuming that short circuiting reduced the effective volume of the reservoir by 40%. The resulting number of visitors per AF at 0.96 remains well below the CDPH Draft Guideline of 2.10 and the factor of safety under these most extreme conditions remains satisfactory at 2.2 before a biological risk assessment is required.

Table 9
Worst-Case Scenarios – Factors of Safety Summary

| Description | Special Circumstances | Effective Volume (AF) | Daily Visitors | Daily Visitors per AF | Factor of Safety |
|--------------------------------|---|------------------------------|-----------------------|------------------------------|-------------------------|
| Seasonal Peak | Taken from Table 7 (Weekend in April). | 165 | 140 | 0.85 | 2.5 |
| Post Labor Day | Reservoir drawdown, 75 CFS min. inflow, weekday in Sept. | 149 | 45 | 0.30 | 7.0 |
| Off-Season | No runoff, taken from Table 7, Deliveries to CPI ^(a) only. | 91 | 12 | 0.13 | 16.2 |
| Off-Season | CPI partial outage, deliveries to LOP WTP only, no runoff. | 50 | 12 | 0.24 | 8.8 |
| Short Circuit - Seasonal Peak | Taken from Table 8 (July 4th Holiday) | 166 | 160 | 0.96 | 2.2 |
| Short Circuit - Post Labor Day | Reduce Post Labor Day effective volume (149) by 40%. | 89 | 45 | 0.51 | 4.2 |
| Short Circuit - Off-Season | No runoff. Reduce Off-Season effective volume (91) by 40%. | 55 | 12 | 0.22 | 9.6 |
| Short Circuit - Off-Season | CPI partial outage. Reduce effective volume (50) by 40%. | 30 | 12 | 0.40 | 5.3 |

(a) CPI = Combie Phase I canal

11. Conclusions:

Based on this technical memorandum, Combie Reservoir offers a ratio of 0.31 annual visitors per AF of effective volume. This ratio equates to a factor of safety of 6.8 ($2.10 \div 0.31$) when compared to the CDPH Draft Guidelines. In addition, all worst-case scenarios studied provide satisfactory factors of safety.

It is therefore concluded that a biological risk assessment is not required in order to use Combie Reservoir as the domestic water supply reservoir for the proposed RWSP WTP and that a more in depth study of annual visitors to Combie Reservoir is not warranted..