VIII. Discussion

The measurements of nutrient concentrations in the reservoir combined with the observed abundance of aquatic vegetation provide ample evidence to classify Emery Reservoir as eutrophic. The geologic and geographic characteristics including the erosion patterns within the watershed suggest it is likely the most significant contributing factor to the reservoir's eutrophication. The correlation between the increase in barren soils and the abundance of aquatic plants since the property's subdivision and subsequent development further suggests that activities such as the building of roads, housing pads and the maintenance practices of denuding creeks and drainage ditches of vegetation have exacerbated the contribution from the watershed. Further investigation of phosphorous total maximum daily loads (TMDLs) from the creeks, septic systems, atmosphere and internal recycling should be done by a specialist to provide quantitative evidence of the watershed's contribution.

Providing educational experiences and materials to increase the property owners' awareness of how they impact the reservoir both in and around the water should be a priority going forward. The understanding of the specific aquatic plant species present in the reservoir will be paramount to determining suitable methods for control and prevention. Further education of stakeholders, committee members and visitors will also help to ensure that actions taken on private properties are in line with the management goals and policies to reduce the amount of nutrient-laden runoff from the watershed.

The recommendations are meant to provide site-specific solutions that are in accordance with an IPM philosophy, an approach that places emphasis on preventative and restorative activities. A balance of control methods should be employed to encourage all stakeholders to participate and to demonstrate a desire from the Board for cooperative management of the reservoir. Establishing routine monitoring and reporting of management activities in the reservoir and watershed are an important component of the IPM and a necessary part of a sustainable and successful management plan. Records will help determine the effectiveness of activity and provide structure and guidance for future generations of property owners.

Eutrophication, as with other forces of nature, is unceasing and dynamic. Others have successfully stemmed these inevitable propensities of nature, though a relentless diligence is required. Actions taken to halt or reverse these forces should not be seen as one-time activities; rather, they are a continuous process that requires organization, patience and a steadfast commitment. Caring for the lake is everyone's responsibility: actions on private property, the Board and its committees, lake users and visitors all play important roles in the management of the lake.

"Property in this country is held under the implied obligation that the owners use of it shall not be injurious to the community."

- Justice Oliver Wendell Holmes, Jr., U.S. Supreme Court 1902-1932

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Appendix A

Calculations for Reservoir Volume & Average Depth

Volume when lake is full in late winter – *reservoir's surface at high water mark.*

Depth (ft)	Area (sq ft)	Al + A2	√ (Al * A2)	Volume (Cubic ft)
Shore - 4'	1,379,943	2,304,792	1,129,707	5,151,749
5' - 9'	924,849	1,603,650	792,331	3,593,972
10' - 14'	678,801	1,109,174	540,498	2,474,507
15' - 19'	430,373	624,010	288,680	1,369,035
20' - 24'	193,637	227,677	81,187	463,297
25' - 28'	34,040	34,045	413	51,686
>28'	5	5	-	8
				13,104,254
			Acre Feet	**301**

Table 3: Reservoir volume, high watermark

Volume at lowest level in late summer – *reservoir's surface at the first 5-foot contour below the high water mark.*

Depth (ft)	Area (sq ft)	Al + A2	√ (Al * A2)	Volume (Cubic ft)
Shore - 4'	0	0	-	-
5' - 9'	924,849	1,603,650	792,331	3,593,972
10' - 14'	678,801	1,109,174	540,498	2,474,507
15' - 19'	430,373	624,010	288,680	1,369,035
20' - 24'	193,637	227,677	81,187	463,297
25' - 28'	34,040	34,045	413	51,686
>28'	5	5	-	8
				7,952,505
			Acre Feet	**183**

Table 4: Reservoir volume, lowest level

Average depth of Emery Reservoir

Depth (ft)	Average depth	Area (sq ft)	% of total area	Weighted average depth
Shore - 4'	2.5	1,379,943	38%	0.95
5' - 9'	7.5	924,849	25%	1.90
10' - 14'	12.5	678,801	19%	2.33
15' - 19'	17.5	430,373	12%	2.07
20' - 24'	22.5	193,637	5%	1.20
25' - 28'	26.5	34,040	1%	0.25
		3,641,643		**8.69 feet**

Table 5: Average depth

Appendix B

Aquatic Plants & Algae

Common Name(s)	Scientific Name	Type	Lifecycle	Propagation	Presence, extent, distribution
Sago Pondweed Fennel-leaf pondweed	Stuckenia pectinatus	Submersed	Perennial	Seed, Tubers, Vegetatively from zhizomes and stem fragments	Moderate, small patches mostly on eastern half of lake.
Small Pondweed Slender Pondweed	Potamogeton pusillus L	Submersed	Perennial	Seed, Vegetatively from zhizomes and stem fragments	Moderate, invididual plants or small colonies dispersed throughout the lake.
Illinois Pondweed	Potamogeton illinoensis	Submersed	Perennial	Seed, Vegetatively from zhizomes and stem fragments.	
American Pondweed	Potamogeton Nodosus	Emergent	Perennial	Seed, Vegetatively from zhizomes and stem fragments.	Moderate, closer to shore than the ribbon leaved pondweed. The emergent version is seen on shore surrounding the lake.
Floatingleaf Pondweed	Potamogeton Natas	Floating	Perennial	Seed, Vegetatively from zhizomes and stem fragments.	Moderate, closer to shore than the ribbon leaved pondweed. The emergent version is seen on shore surrounding the lake.
Variable Leaf Pondweed	Potamogeton gramineus	Floating	Perennial	Seed, Vegetatively from zhizomes and stem fragments	
Leafy pondweed	Potamogeton foliosus Raf.	Floating	Perennial	Seed, Vegetatively from zhizomes and stem fragments	Low, Small patch near Mona's dock (Maze dock)
Ribbon-Leaf Pondweed	Potamogeton epihydrus	Floating	Perennial	Seed, Vegetatively from zhizomes and stem fragments	HIgh, visible from shore throughout the lake. Primarily in coves and shallow areas (< 10 ft).
Water-Thread Pondweed	Potamogeton diversifolius	Floating	Perennial	Seed, Vegetatively from zhizomes and stem fragments	Low, individual plants located in various areas
Curly leaved Pondweed	Potamogeton crispis L	Submersed	Perennial	Mostly by Turions but also via Seed, and Vegetatively from zhizomes and stem fragments,	Low, small patch in coots cove

Aquatic Plants & Algae

Common Name(s)	Scientific Name	Type	Lifecycle	Propagation	Presence, extent, distribution
Waternymph, Naiad	Najas (spp.)	Submersed	Annual	Seed, Sprigs	Medium. small patches near shorelines. Primarily near recreation sites in very shallow areas (< 2 ft).
Creeping Water-Primerose	Ludwigia peploides	Floating	Perennial	Seed, Vegetatively from creeping stems and stem fragments	High
False Loosestrife	Ludwigia palustris	Submersed	Perennial		Low, small patches near shorelines. Primarily near recreation sites in very shallow areas (< 2 ft).
CoonTail, Coon's Tail, Hornwort	Ceratophyllym demersum L.	Submersed	Perennial to Annual	Seed, Sprigs	Very High, throughout most of the lake at depths of > 10 ft.
Waterstarwort	Callitriche palustris L.	Floating	Perennial	Seed, Sprigs	Low, small patches scattered around the lake near the shoreline
Watershield, dollar bonnet, water target	Brasenia schreberi	Floating	Perennial	Seed, Vegetatively from zhizomes and stem fragments, winter buds	HIgh, visible from shore throughout the lake. Primarily in coves and shallow areas (< 10 ft).
Chara, muskgrass, stonewort, muskwort	Chara (spp.)	Algae, Submerged or floating	Annual	Spreads by spores transported by wildlife and also will form new plants from vegetative fragments.	High, visible around docks throughout the lake.
Nitella, brittlewort	Nitella (spp.)	Algae, Submerged or floating	Perennial	Spreads by spores transported by wildlife and also will form new plants from vegetative fragments.	High, visible around docks throughout the lake.

Appendix C

Expanded History

This appendix is a narrative of some of the interesting information that was uncovered about Emery Reservoir. This information is perhaps not relevant for the thesis but is noteworthy from a historical perspective. There were several important people associated with the reservoir and since no other publications directly link these people to the reservoir, it seemed appropriate to formally acknowledge those relationships here.

The region Emery Reservoir resides in is well known for its history during the California Gold Rush. According to the records of the California Department of Water Resources, Division of Safety of Dams, Emery Dam was built in 1850. Two years earlier, gold had been discovered about 50 miles north on the American River. Miners were staking claims throughout the region, known as the Mother Lode, drastically altering the landscape of California forever.

The Calaveras County Archives contain documents showing the property was originally referred to Pillsbury Reservoir, named for the first owner Daniel Hackett Pillsbury. While researching Pillsbury, a short story written by Pillsbury's daughter, Kate Emily Pillsbury, surfaced. She reveals that her father had in fact owned two reservoirs and miles of ditches (most likely Treat's Ditch) in the area. According to her testimony, both of his dams failed in 1862, leaving them destitute.[1] This year corresponds to the Great Flood, the largest recorded flood in California history[2].

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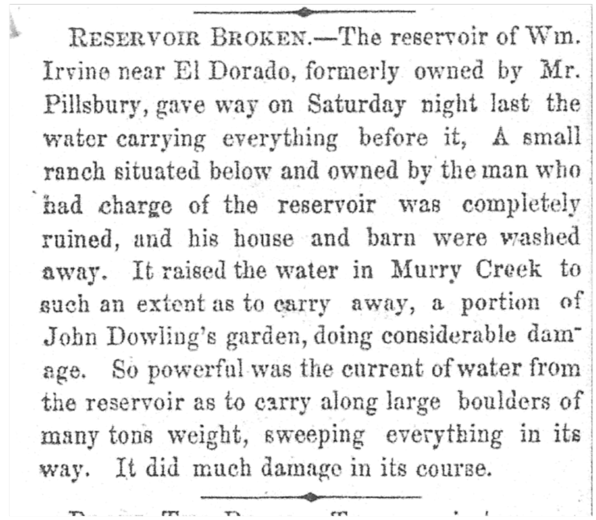
[1] http://grammytsamazingadventures.blogspot.com/p/aunt-kates-story.html

[2] http://en.wikipedia.org/wiki/Great_Flood_of_1862

Shortly after, Pillsbury sold the property in 1864 to William Irvine and moved to the nearby town of Railroad Flats where he lived out the rest of his life. As a young man Pillsbury had left his two brothers on the East Coast in order to seek his fortune, his brothers built a prosperous flourmill that eventually lead to the establishment of the Pillsbury Company (now well known for both its pastry products and its mascot, the Pillsbury Dough-Boy). This ironic development lead to a stark division in the socioeconomic status of succeeding generations of the Pillsbury family, who publicly discuss their fortune/misfortune on genealogy websites like Ancestry.com[3]. It's rather entertaining and can be found by performing an Internet search for "The infamous Pillsbury brother split........."



RESERVOIR BROKEN.—The reservoir of Wm. Irvine near El Dorado, formerly owned by Mr. Pillsbury, gave way on Saturday night last the water carrying everything before it, A small ranch situated below and owned by the man who had charge of the reservoir was completely ruined, and his house and barn were washed away. It raised the water in Murry Creek to such an extent as to carry away, a portion of John Dowling's garden, doing considerable damage. So powerful was the current of water from the reservoir as to carry along large boulders of many tons weight, sweeping everything in its way. It did much damage in its course.

Picture 21: Newspaper clipping - San Andreas Register, 3/31/1866

The next owner of the property, William Irvine, also experienced the failure of the dam. He was also an almost famous man in his own right, at one point the current city of Carson Hill was named the City of Irvine after him, but its name was changed around 1914. The city of Myford, CA appropriated the name Irvine for itself, in honor of its founder, William's more famous nephew James Irvine. Today, Myford is still known as the City of Irvine.[4,5] William's granddaughter, Edith Irvine who grew up in nearby Sheep Ranch became a famous photographer well known for shooting the 1906 San Francisco's earthquake and documenting mining activity throughout Calaveras County.

In 1898 the Emery Gold & Water Company purchased the land and improved the dam in order to augment the supply of water for mining activity in the region. The company's

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[3] http://boards.ancestry.co.uk/surnames.pillsbury/120.1/mb.ashx

[4] http://www.calaverashistory.org/post/carson-hill

[5] http://irvineranchhistory.com/chapter_3.html

president was Lewis Emery Jr.; a successful statesman and oilman[6], he served as the Pennsylvania State Senator from 1892-1900 and was somewhat of a local hero there for competing against John D. Rockefeller's Standard Oil Company. The Bradford Landmark Society in Pennsylvania has a wealth of information on him, his family and the several businesses he started which are now historical landmarks[7].

Emery's water was transferred through the Emery Pipeline - at the time the most extensive conveyance system in the county. Remnants of this pipeline can still be seen east of the dam's spillway. The water provided by this pipeline served the of residents of El Dorado mining camp, now named the city of Mountain Ranch, and also Cave City, now the privately owned California Caverns - an extensive network of caves that was once a dwelling for miners and their families. The Emery family was very influential in the development of Mountain Ranch, several buildings and parcels of land were deeded to the city to create a community center and other civic buildings that are still in use.

Picture 22: Lewis Emery Jr.

The older residents of the towns and surrounding areas near the lake still refer to it as Brown's Lake, and early maps also attribute this name, though it is unclear to whom to attribute this name.

A current resident of M-24, Jack West, recounts visiting the lake from his childhood

[6] http://minardrunoil.com/History.aspx

[7] http://www.bradfordlandmark.org/

home in nearby Mountain Ranch. From approximately1940 to 1955, Mr. West attended the local school district and remembers field trips to the lake and walking there with his friends. During the summers, the lake was a popular picnic and swimming spot for locals. In the late 40s the property changed hands again and the new owner, after making an addition to the dam, closed the reservoir to the public.

Picture 23: Photo of kids playing at emery reservoir, year unknown. Courtesy of Aileen Price

Mr. West now lives on the south side of the lake near Shady Cove, where he used to swim as a child. He recalls the claustrophobic feeling of being tangled up in lily pads similar to those seen now (Watershield), though he is hesitant to identify them as the same, he believes that they may be. A childhood friend of his, Sheldon Bissel, also recalls seeing lily pads near Coot's cove to the northeast where McKinney Creek enters the lake. Mr. West was one of the first to purchase property after the subdivision in 1965, the year before a second major dam failure. During this time he was the secretary of the HOA board and spent most of that time in litigation against the developers over who should assume responsibility for the dam's failure and reconstruction. More information on the dam failure and history can be found on the association's website[8].

Mr. West did not recall that aquatic plants were ever a topic of discussion during 60's and 70's, though he was not a full time resident at the lake until after his retirement in 1996. By that time, the HOA had already begun addressing the overgrowth of aquatic plants and was under

[8] http://m24ranch.com/Brief History of Emery Dam.pdf

the assumption that the Watershield had been transported to the lake by helicopters dipping water-buckets in the lake to fight the old gulch fire in 1993. Neither Mr. West nor Mr. Bissel believes this to be that source. Based on a review of available historic aerial photography of the region, Watershield was present in several of the nearby ponds and reservoirs and could have been transported (and most likely would have been) by waterfowl, personal watercrafts, or other means.

Appendix D

Water Quality Data

Kids Beach									
Date	Temp (C)	Alkalinity (mg/L)	Carbon Dioxide (mg/L)	Hardness (mg/L)	Dissolved Oxygen (mg/L)	PH	Nitrites (mg/L)	Phosphates -PO4 (mg/L)	Phosphorus - P (mg/L)
3/30/13	18	51.33	10	51.33	7	8	<.01	0.3	0.1
4/7/13	21	51.33	5	68.44	8	8	<.01	0.3	0.1
4/21/13	21	51.33	5	51.33	8	8	<.01	0.3	0.1
5/3/13	23	51.33	10	51.33	5	8	<.01	0.3	0.1
5/30/13	24.5	51.33	10	51.33	5	8	<.01	0.3	0.1
6/19/13	26	68.44	5	51.33	7	8	<.01	0.3	0.1
6/23/13	27	68.44	10	51.33	5	8	<.01	0.3	0.1
7/8/13	27	68.44	5	51.33	8	8	<.01	0.3	0.1
7/25/13	28	68.44	5	51.33	8	8	<.01	0.3	0.1
8/4/13	28	68.44	10	51.33	4	8	<.01	0.3	0.1
8/21/13	29	68.44	10	51.33	9	8	<.01	>4	>10
9/7/13	27	68.44	10	51.33	8.5	8	<.01	0.3	0.1
9/22/13	23	68.44	5	51.33	8	8	<.01	0.3	0.1

Coots Cove									
Date	Temp (C)	Alkalinity (mg/L)	Carbon Dioxide (mg/L)	Hardness (mg/L)	Dissolved Oxygen (mg/L)	PH	Nitrites (mg/L)	Phosphates -PO4 (mg/L)	Phosphorus - P (mg/L)
3/30/13	18	51.33	5	51.33	6	8	<.01	0.3	0.1
4/7/13	21	51.33	15	68.44	5	8	<.01	0.3	0.1
4/21/13	21	51.33	5	34.22	9	8	<.01	0.3	0.1
5/3/13	23	51.33	15	51.33	4	8	<.01	0.3	0.1
5/30/13	24.5	51.33	15	51.33	4	8	<.01	0.3	0.1
6/19/13	26	68.44	5	51.33	7	8	<.01	0.3	0.1
6/23/13	27	68.44	10	51.33	8	8	<.01	0.3	0.1
7/8/13	27	68.44	10	51.33	8	8	<.01	0.3	0.1
7/25/13	28	68.44	5	51.33	7	8	<.01	0.3	0.1
8/4/13	28	68.44	5	51.33	8	8	<.01	0.4	0.1333333
8/21/13	29	68.44	10	51.33	9	8	<.01	>4	>10
9/7/13	27	51.33	10	51.33	10	8	<.01	0.4	0.1333333
9/22/13	23	51.33	5	51.33	8	8	<.01	0.5	0.1666667

Fishermans Landing									
Date	Temp (C)	Alkalinity (mg/L)	Carbon Dioxide (mg/L)	Hardness (mg/L)	Dissolved Oxygen (mg/L)	pH	Nitrites (mg/L)	Phosphates -PO4 (mg/L)	Phosphorus - P (mg/L)
3/30/13	18	51.33	5	51.33	9	8	<.01	0.3	0.1
4/7/13	21	68.44	5	51.33	4	8	<.01	0.3	0.1
4/21/13	21	68.44	5	51.33	8	8	<.01	0.3	0.1
5/3/13	23	51.33	10	51.33	4	8	<.01	0.3	0.1
5/30/13	24.5	51.33	10	51.33	4	8	<.01	0.3	0.1
6/19/13	26	68.44	5	51.33	7	8	<.01	0.3	0.1
6/23/13	27	68.44	10	51.33	8	8	<.01	0.3	0.1
7/8/13	27	68.44	5	51.33	8	8	<.01	0.3	0.1
7/25/13	28	68.44	5	51.33	7	8	<.01	0.3	0.1
8/4/13	28	68.44	10	51.33	7	8	<.01	0.3	0.1
8/21/13	29	68.44	10	68.44	9	8	<.01	>4	>10
9/7/13	27	68.44	10	51.33	8.5	8	<.01	0.4	0.1333333
9/22/13	23	68.44	5	51.33	8	8	<.01	0.2	0.0666667

Two-Colvert Cove

Date	Temp (C)	Alkalinity (mg/L)	Carbon Dioxide (mg/L)	Hardness (mg/L)	Dissolved Oxygen (mg/L)	PH	Nitrites (mg/L)	Phosphates -PO4 (mg/L)	Phosphorus - P (mg/L)
3/30/13	18	51.33	5	51.33	6	7	<.01	0.3	0.1
4/7/13	21	51.33	5	51.33	9	7	<.01	0.3	0.1
4/21/13	21	51.33	5	51.33	9	7	<.01	0.3	0.1
5/3/13	23	51.33	10	51.33	5	7	<.01	0.3	0.1
5/30/13	24.5	51.33	10	51.33	4	7	<.01	0.3	0.1
6/19/13	26	51.33	10	51.33	7	7	<.01	0.3	0.1
6/23/13	27	51.33	10	51.33	8	7	<.01	0.3	0.1
7/8/13	27	68.44	5	51.33	8	7	<.01	0.3	0.1
7/25/13	28	68.44	5	51.33	8	7	<.01	0.3	0.1
8/4/13	28	68.44	10	51.33	5	7	<.01	0.1	0.0333333
8/21/13	29	68.44	10	51.33	7	7	<.01	4	1.3333333
9/7/13	27	68.44	10	51.33	8.5	7	<.01	0.6	0.2
9/22/13	23	68.44	5	51.33	8	7	<.01	0.2	0.0666667

Shady Cove

Date	Temp (C)	Alkalinity (mg/L)	Carbon Dioxide (mg/L)	Hardness (mg/L)	Dissolved Oxygen (mg/L)	pH	Nitrites (mg/L)	Phosphates -PO4 (mg/L)	Phosphorus - P (mg/L)
3/30/13	18	68.44	5	51.33	9	7	<.01	0.4	0.13
4/7/13	21	68.44	5	51.33	5	7	<.01	0.4	0.13
4/21/13	21	68.44	5	51.33	9	7	<.01	0.4	0.13
5/3/13	23	51.33	10	51.33	5	7	<.01	0.4	0.13
5/30/13	24.5	51.33	10	51.33	4	7	<.01	0.4	0.13
6/19/13	26	68.44	15	51.33	7	7	<.01	0.4	0.13
6/23/13	27	68.44	10	51.33	8	7	<.01	0.4	0.13
7/8/13	27	68.44	5	51.33	8	7	<.01	0.4	0.13
7/25/13	28	68.44	5	51.33	7	7	<.01	0.4	0.13
8/4/13	28	68.44	5	51.33	7	7	<.01	0.2	0.07
8/21/13	29	68.44	10	51.33	8	7	<.01	>4	>10
9/7/13	27	51.33	10	51.33	8.5	7	<.01	>4	>10
9/22/13	23	51.33	5	51.33	8	7	<.01	0.2	0.07