Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601 • www.barr.com *An EEO Employer*

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO • Bismarck, ND

Memorandum

To: Grass Lake Watershed Management Organization (GLWMO) – Board of Managers

From: Scott Sobiech, PE & Jennifer Koehler, PE – Barr Engineering Compnay

Subject: Addendum to the Lake Owasso UAA – Evaluation of Best Management Practice (BMP) Scenario 14 and Summary of Final Recommendations

Date: September 16, 2009

Project: 23/62-0946

This memo summarizes the evaluation of an additional BMP scenario (Scenario 14) at the request of the GLWMO Board of Managers as well as a summary of the final recommendations from the Lake Owasso UAA (April 2009). Figure 1 shows the location of the final recommendations from the Lake Owasso UAA.

Discussion of BMP Scenario 14

BMP Scenario 14 includes evaluation of the implementation of the recommended BMPs on the overall water quality in Lake Owasso, including Curlyleaf pondweed management, alum treatment of Lake Owasso, and implementation of infiltration practices throughout the watershed.

To estimate the combined impact of the BMPs in Scenario 14, it was assumed that the ultimate impact of infiltration in the Lake Owasso watershed on lake water quality would be similar to that of BMP Scenario 8 (from the UAA). It should be noted that the location of the regional infiltration practices evaluated generally considered the availability of open space, topography, and proximity to existing storm sewer, but additional investigations should be performed during the design phase for all infiltration opportunities considered. It was assumed that 50 percent of the flows from the first 0.5 inches of runoff (the "first flush") from the impervious surfaces within the entire contributing area would be treated by infiltration, resulting in an expected 2 – 3% reduction in the total phosphorus (TP) concentrations in the lake. It was assumed that the impact of the in-lake treatments on the water quality in Lake Owasso would

be similar to that predicted in Scenario 13 (of the UAA) which considered Curlyleaf pondweed management and alum treatment.

Table 1 summarizes the impact of the various BMP scenarios evaluated as part of the Lake Owasso UAA, updated to include the evaluation of BMP Scenario 14, for wet, dry, and average climatic conditions. This combination of BMPs is expected to result in a 36 – 48 percent reduction in the TP concentration in Lake Owasso. Figure 2 shows the predicted in-lake TP concentrations as well as Secchi depths for each of the BMP scenarios for wet, dry, and average climatic conditions, as compared to existing conditions and the GLWMO and MPCA water quality goals for Lake Owasso.

Final Key Recommendations for the Improvement of the Water Quality in Lake Owasso

A number of recommendations were included in the Lake Owasso UAA. The following is a summary of these recommendations. Additional details and discussion about each recommendation can be found in the Lake Owasso UAA. Figure 3 below summarizes the various BMP recommendations as well as the estimated costs for each BMP over a 5-year implementation period.

Additional Studies and Investigations

One of the key recommendations from the Lake Owasso UAA is to conduct additional monitoring and studies within Lake Owasso and its watershed. The monitoring and modeling from the UAA (from 2007 and 2008), identified several potential sources of TP to Lake Owasso that are not fully-understood at this time. Before BMPs for these sources can be recommended, additional investigations to quantify the extent and magnitude of these sources are needed. The recommended investigations include the following:

- Additional water quality monitoring in the Central Park – East and West Wetlands and in the Charlie Pond system
- Study evaluating the impact of the fisheries on water quality – with a focus on the impact of carp in Lake Owasso and the adjacent wetlands. The study should be coordinated through the University of Minnesota and the Minnesota Department of Natural Resources (MDNR).

- Collection & analysis of sediment cores in the Central Park – East and West wetlands, Bennett Lake, and the Charlie Pond system – to help better understand the potential loading from the sediments in these water bodies to Lake Owasso
- Water quality monitoring in the shallow areas of Lake Owasso – to help understand the water quality and mixing dynamics in the shallow areas of the lake

Watershed Source Reduction Efforts

The majority of the watershed runoff from the Lake Owasso watershed passes through a pond or wetland, receiving some level of water quality treatment before reaching the lake. However, the watershed and in-lake water quality modeling of Lake Owasso has demonstrated that the cumulative impact of infiltration of stormwater runoff throughout the watershed can reduce the total phosphorus load to the lake and improve the overall water quality in Lake Owasso.

We recommend that the GLWMO and the Cities of Roseville and Shoreview continue to promote the use of infiltration BMPs throughout the watershed to reduce the watershed nutrient loading to Lake Owasso as opportunities associated with redevelopment and road reconstruction arise and where site conditions are conducive to infiltration. Several potential locations for regional infiltration were evaluated as part of the UAA (generally considering availability of open space, topography, and proximity to existing storm sewer). The potential infiltration locations shown on Figure 1 would require additional investigations during the design phase to fully understand and maximize the infiltration potential of the individual sites and optimize the potential project costs.

In-Lake Treatments

Because internal phosphorus loading is a large fraction of the total phosphorus load to Lake Owasso (rougly 50 percent), two in-lake BMPs were recommended as part of the Lake Owasso UAA including the following:

- Treatment of Curlyleaf pondweed as part of a four-year management plan including permitting, herbicide treatment, aquatic plant, biomass, turion, and herbicide residue monitoring, and annual reporting to the MDNR.

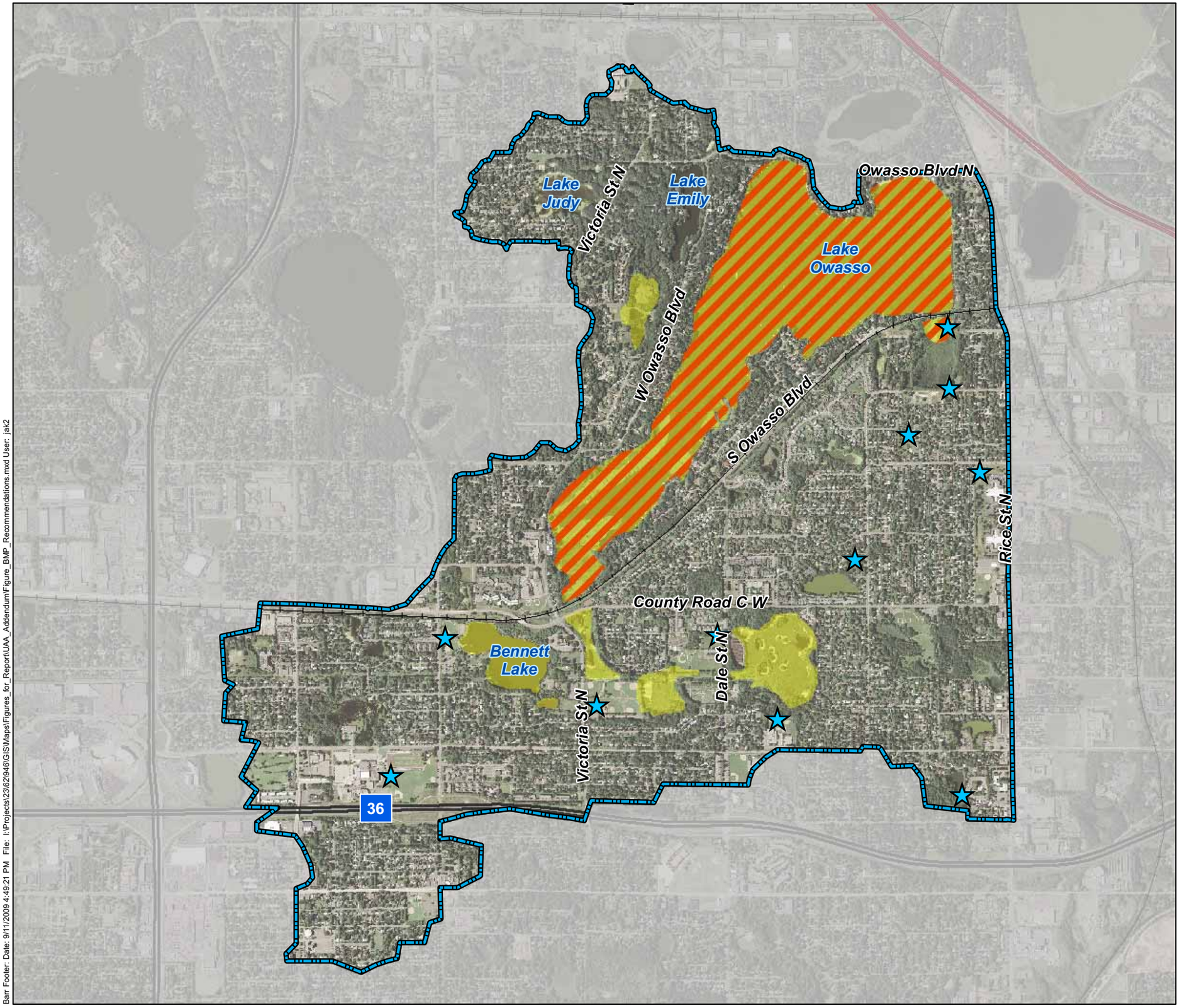
- Whole-lake alum treatment to minimize release of phosphorus from the lake's bottom sediments – recommended if the management of Curlyleaf pondweed does not result in the desired water quality in Lake Owasso

Because the management of Curlyleaf pondweed is estimated to have the most significant impact on Lake Owasso's water quality, it is the primary in-lake water quality BMP recommended.

Additional BMPs and Efforts

There are a variety of nonstructural BMPs that can have a positive impact on lake water quality. Examples of effective nonstructural BMPs that would be appropriate for the Lake Owasso watershed include:

- Continue public education programs to inform the residents of the Lake Owasso watershed of ways to reduce phosphorus loading through proper handling of yard fertilizers and wastes, pet wastes, soaps and detergents. Additionally, education and outreach efforts can promote the creation of vegetated buffers between yards and the shore of Lake Owasso and upstream ponding areas (to minimize direct runoff and shoreline erosion) as well as discouraging the feeding of waterfowl in shoreline areas around Lake Owasso and its upstream ponds, as water fowl feces can add a significant amount of phosphorus to a lake system.
- Routine maintenance of the storm water ponds located throughout the watershed as well as of the storm sewer system within the watershed to ensure optimal performance of the system.
- Continue the existing street sweeping program, including an early spring sweeping, a late fall sweeping, and additional sweepings as needed



Further Investigations & Monitoring, such as:
- Water Quality Monitoring
- Sediment Core Analysis
- Fisheries Study

In-Lake Treatments: Curlyleaf Pondweed Management & Alum Treatment

Potential Infiltration Sites

Lake Owasso Watershed - Promotion of Infiltration as Opportunities Arise

Additional Recommendations:

- Public Education and Outreach
- Routine Maintenance of Storm Sewer System & Ponds
- Continuation of the Existing Street Sweeping Program

Feet
1,750 0 1,750

Figure 1

LAKE OWASSO
SUMMARY OF RECOMMENDED BMPs

Lake Owasso UAA - Addendum
Grass Lake Watershed Management Organization

Table 1: Lake Owasso Summary of BMP Scenarios

	Scenario	Summer Average Water Quality							Reduction in TP (%)	Estimated BMP Cost ($)
		Wet 2001-2002		Dry 2007-2008			Average 2004-2005			
		TP (µg/L)	SD (m)[10]	Site[1]	TP (µg/L)	SD (m)[10]	TP (µg/L)	SD (m)[10]		
1	Existing Conditions[2]	32	2.4	5403	41	2.0	45	1.5	--	--
				5401	32	2.1				
2	80% Reduction in Curlyleaf Pondweed[6]	21	3.7	5403	29	2.6	33	2.3	27 - 39%	$649,000
				5401	19	4.2				
3	10% Reduction in the Internal Loading from Watershed Waterbodies	31	2.4	5403	38	2.0	44	1.8	2 - 4%	N/A[12]
				5401	31	2.4				
4	50% Reduction in the Internal Loading from Watershed Waterbodies	28	2.6	5403	29	2.5	42	1.9	7 - 13%	N/A[12]
				5401	30	2.5				
5	Treatment of All "Untreated" Discharges to NURP Standards[5]	32	2.3	5403	40	2.0	45	1.8	0 - 3%	$350,000
				5401	31	2.4				
6	Extended Detention in Ladyslipper Park Pond (Replace outlet under the Railroad)[7]	32	2.3	5403	41	1.9	45	1.8	0 - 3%	$55,000
				5401	31	2.4				
7	Infiltration of 0.5 inches of Runoff from ALL Impervious Surfaces in the South and East Drainage Districts[3,8,11]	25	2.9	5403	15	6.9	37	2.1	4 - 20%	$4,770,000
				5401	30	2.5				
8	Infiltration of 0.5 inches of Runoff from Select Impervious Surfaces in the South and East Drainage Districts[3,9,11]	31	2.4	5403	37	2.1	44	1.8	2 - 3%	$389,000
				5401	31	2.4				
9	Alum Treatment (80% Reduction in Internal Load from Sediments)	28	2.6	5403	40	2.0	43	1.9	6 - 11%	$198,000
				5401	30	2.5				
10 (2 + 3)	80% Reduction in Curlyleaf Pondweed & 10% Reduction in the Internal Loading from Watershed Waterbodies[6]	20	3.9	5403	26	2.8	32	2.3	29 - 39%	N/A[12]
				5401	19	4.2				
11 (2 + 4)	80% Reduction in Curlyleaf Pondweed & 50% Reduction in the Internal Loading from Watershed Waterbodies[6]	17	5.4	5403	17	5.1	29	2.5	35 - 47%	N/A[12]
				5401	18	4.6				
12 (2 + 8)	80% Reduction in Curlyleaf Pondweed & Infiltration of 0.5 inches of Runoff from Select Impervious Surfaces in the South and East Drainage Districts[6,3,9]	20	3.9	5403	25	3.0	31	2.4	31 - 38%	$1,038,000
				5401	20	4.1				
13 (2 + 9)	80% Reduction in Curlyleaf Pondweed & Alum Treatment (80% Reduction in Internal Load from Sediments)[6]	17	5.1	5403	28	2.6	30	2.4	33 - 46%	$847,000
				5401	18	4.6				
14	80% Reduction in Curlyleaf Pondweed & Alum Treatment (80% Reduction in Internal Load from Sediments)[6] & Infiltration of 0.5 inches of Runoff from Impervious Surfaces (as opportunity arises)[13]	17	5.7	5403	25	3.0	29	2.6	36 - 48%	$1,236,000
				5401	18	4.6				

TP: Total Phosphorus Chl*a*: Chlorophyll *a* SD: Secchi Depth

1 - For 2008 (Dry Climatic Conditions), Lake Owasso was modeled as 2 separate basins (5403 - Southern Basin, and 5401 - Northern Basin) as there was water quality data available for both areas of the lake. For 2002 (Wet Climatic Conditions) and 2005 (Average Climatic Conditions), the water quality data was only collected at basin 5401 and the lake was modeled as a single basin.

2 - Existing land use and 2008 watershed/BMP conditions. Very few changes are expected in land use as the Lake Owasso watershed is fully-developed. Therefore, it was assumed that existing land use is also reflective of future land use conditions.

3 - Internal loading from the watershed was modified for the infiltration scenario based on the reduction in water load to the wetlands.

4 - It is not feasible to treat all currently untreated direct discharges to Lake Owasso using a single NURP pond. This analysis was performed to demonstrate the impact that treating each discharge to NURP standards would have on overall lake water quality

5 - This scenario is not physically feasible as the currently "untreated" direct discharges are distributed around the entire shoreline of Lake Owasso. Additionally, there is not sufficient space to incorporate NURP ponds in each of the direct discharge watersheds. This scenario was evaluated to demonstrate the impact of treating all direct discharges on the overall water quality in Lake Owasso. This cost estimate is based on the construction of a single, hypothetical NURP pond sized to treat all "untreated" discharges to Lake Owasso.

6 - The estimated cost of the Curlyleaf Pondweed Treatment includes the MDNR variance to treat the entire littoral area of Lake Owasso, 4-years of herbicide application to the Lake, as well as 4-years of detailed macrophyte monitoring to track the herbicide treatment on the Curlyleaf pondweed coverage

7 - Development of an extended detention basin in Lady Slipper Park (in subwatershed LO_E_1k) along with the replacement of the outlet under the railroad embankment with a weir structure were evaluated as part of the 1991 *Report on the Diagnostic-Feasibility Study of Lake Owasso, Lake Wabasso, and Snail Lake.* Since 1991, the City of Roseville developed infiltration and sedimentation ponds in this area as part of the South Owasso Boulevard road reconstruction project in 2006. This study evaluates replacing the outlet under the railroad embankment only.

8 - Infiltration of 0.5" from all impervious surfaces in the South and East Drainage Districts is not feasible. This scenario was evaluated to estimate the maximum impact infiltration could potentially have on Lake Owasso's water quality.

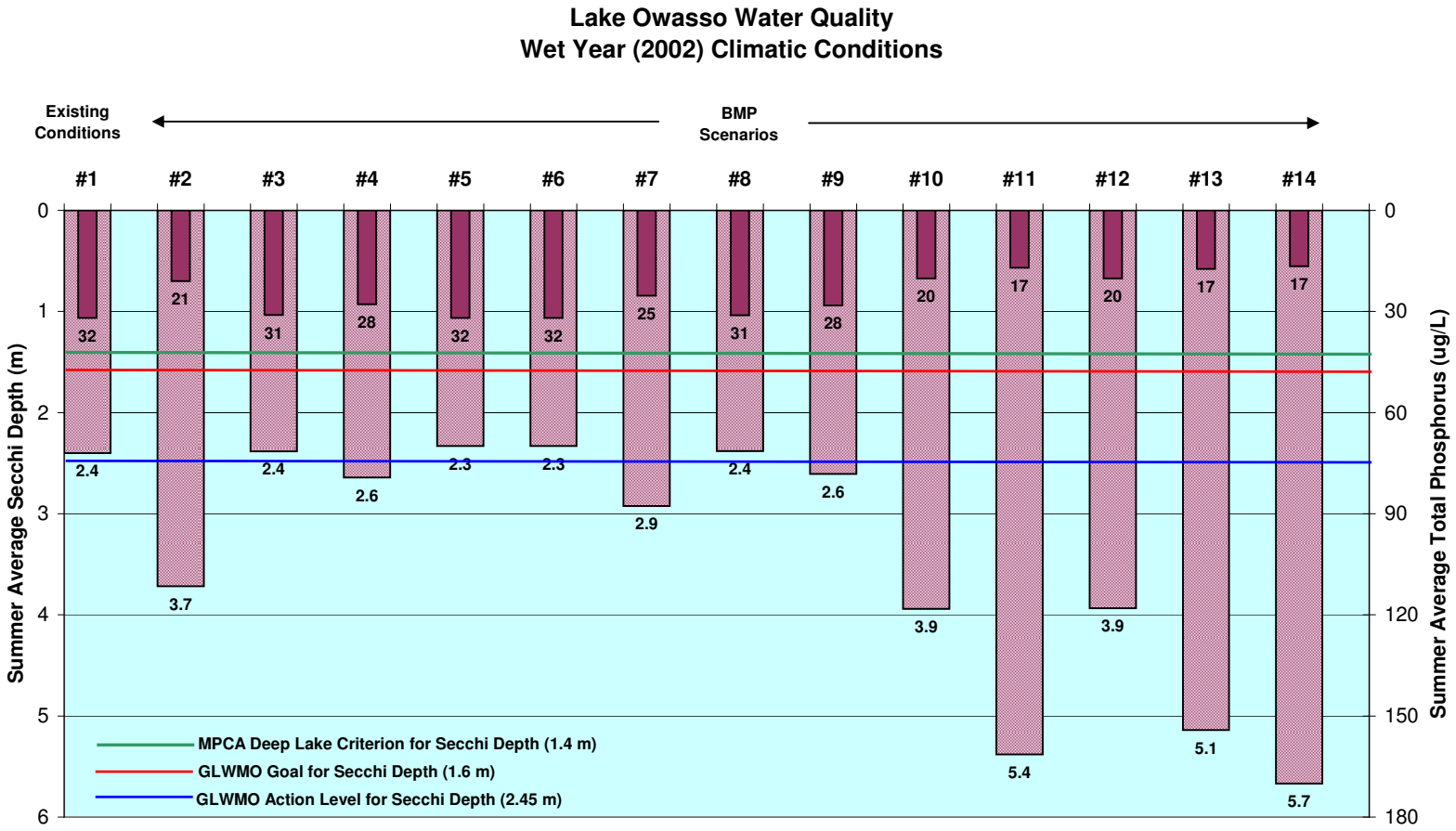
9 - Selected potential infiltration sites include 11 preliminary locations within the South and East Drainage Districts. Sites were selected based on the presence of open space, proximity to existing storm sewer (potential to reroute or divert flows), and topography. Available soils data were condsidered although much of the Lake Owasso is classified as undefined hydrologic soils group. These are planning level cost estimates and each site would require a more complete feasibility study before final design.

10 - Existing Condition summer average Secchi depth based on 2008 monitoring data; For all BMP scenarios, estimated based on the Secchi Depth versus Total Phosphorus Regression Relationship for Lake Owasso (See Fi

11 - The estimated cost of infiltration BMPs is based on typical unit costs ($13/sq.ft.) estimated for the construction of rain gardens plus 30 percent for engineering and design. Depression storage was assumed to be 18 inches. This cost does not include any potentially significant changes to the storm sewer system/additional piping that may be needed.

12 - Because specific BMPs to address the internal loading in the waterbodies within the watershed are not recommended until further studies of the internal loading can be completed, no costs have been estimated for these scenarios.

13 - Scenario 14 assumes that infiltration in the watershed will be promoted as opportunities arise. The impact of infiltration evaluated making the same assumptions as BMP Scenario 8.



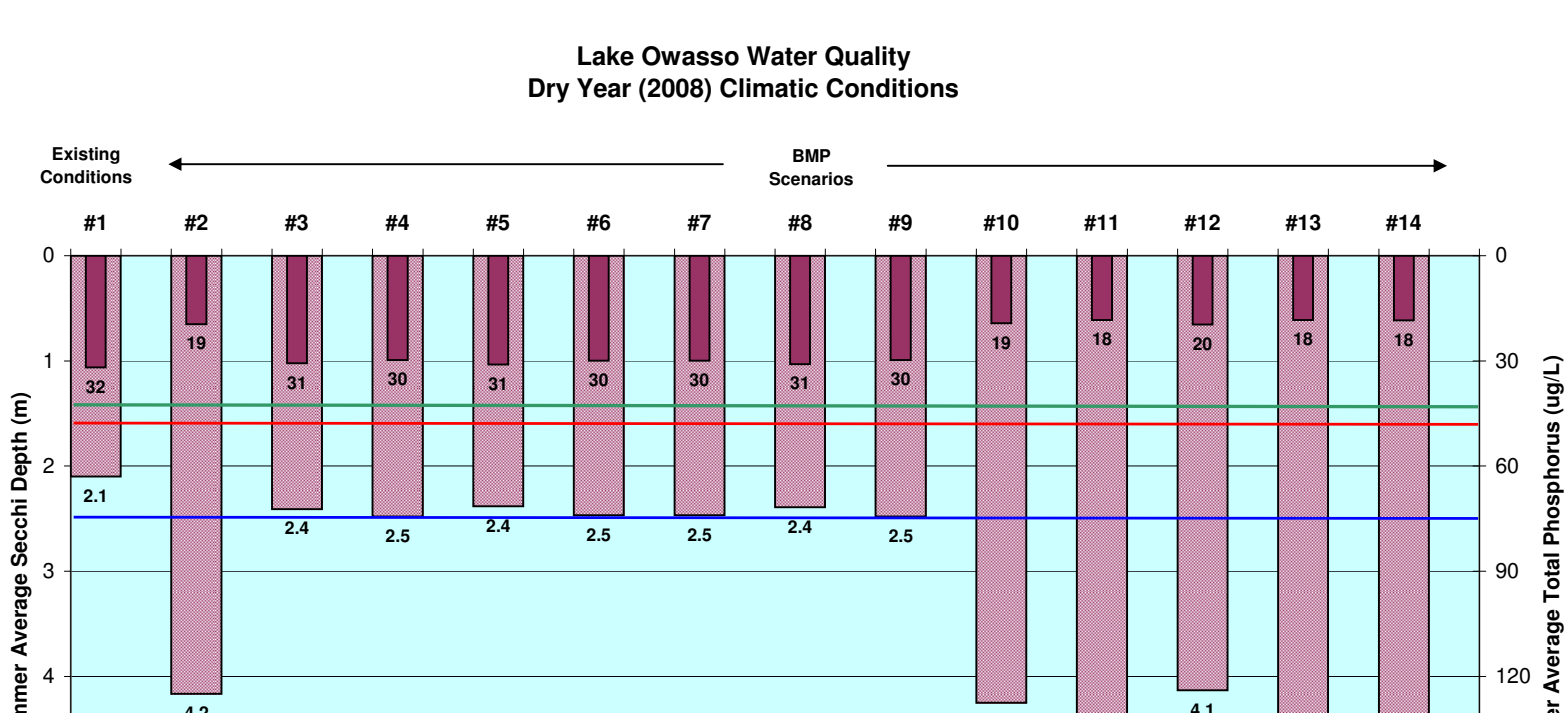
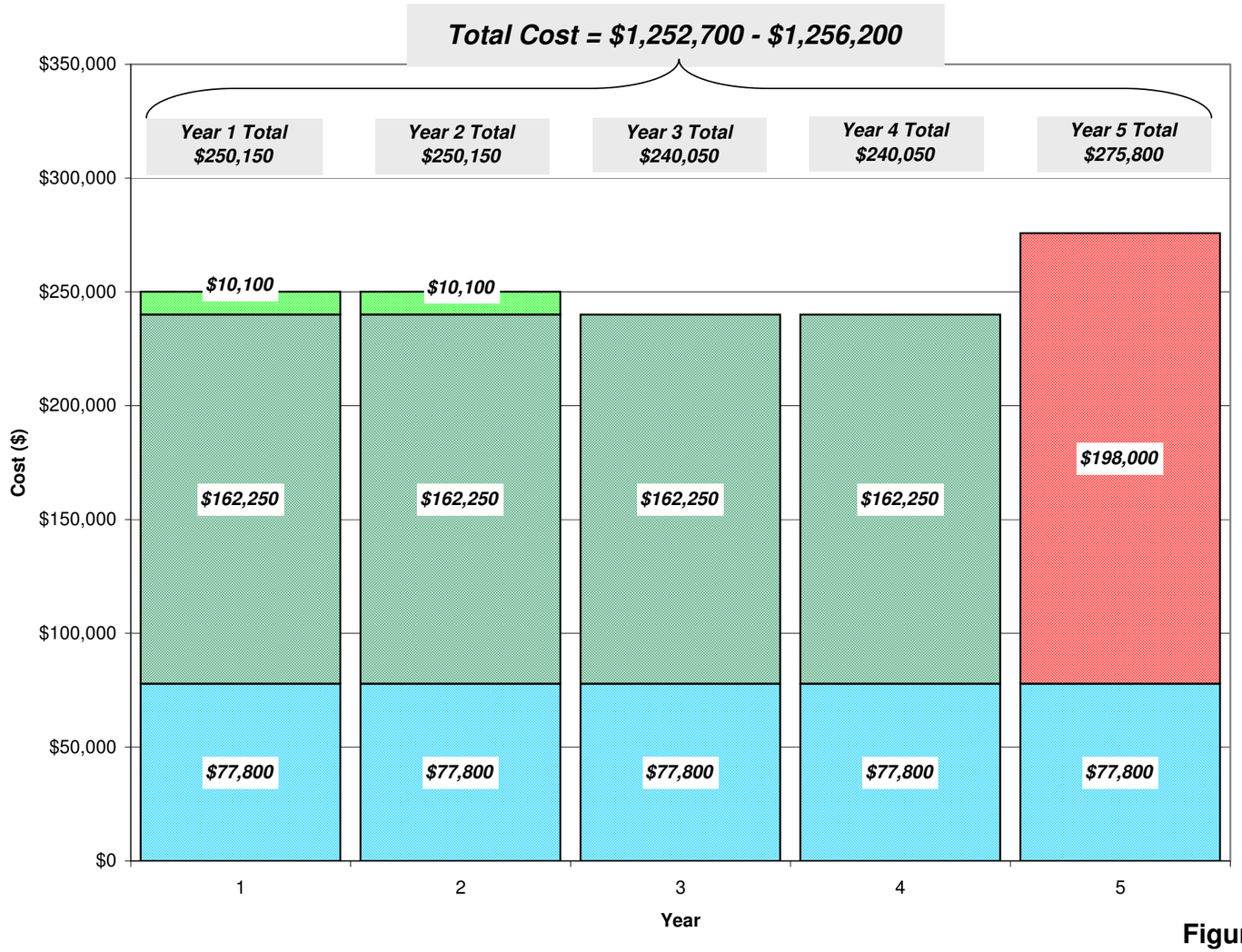


Figure 2
Lake Owasso Summary of BMP Scenario Results and Comparison with MPCA and GLWMO Goals



Lake Owasso UAA Final Recommendations

Studies/Investigations
Total Cost = $8.800 - $20.200

- Water quality monitoring in the Central Park and Charlie Pond systems ($7,000 - $9,500)
- Fisheries study ($TBD) - not included in costs shown
- Sediment core analysis in Central Park, Charlie Pond, and Bennet Lake systems ($7,900)
- Water quality monitoring in Lake Owasso shallow areas ($1,800 - $2,800)

Watershed Infiltration
Total Cost = $389,000

Actual locations, cost, and timing of infiltration projects to be determined by the Cities as opportunities arise. Does not include costs of feasibility studies or excavation and construction required to reroute flows to proposed infiltration practices.

Curlyleaf Pondweed Management
Total Cost = $649,000

Costs include herbicide treatments, monitoring, and reporting

Alum Treatment
Total Cost = $198,000

Alum treatment contigent upon the impact of the Curlyleaf pondweed management on water quality

Additional Recommendations

- Public Education and Outreach
- Routine Maintenance
- Street Sweeping Programs

Costs for Public Education and Outreach, Routine Maintenance, and Street Sweeping Programs included in Cities' annual budgets. Actual costs not shown.

Figure 3: Recommended BMPs and Estimated Costs