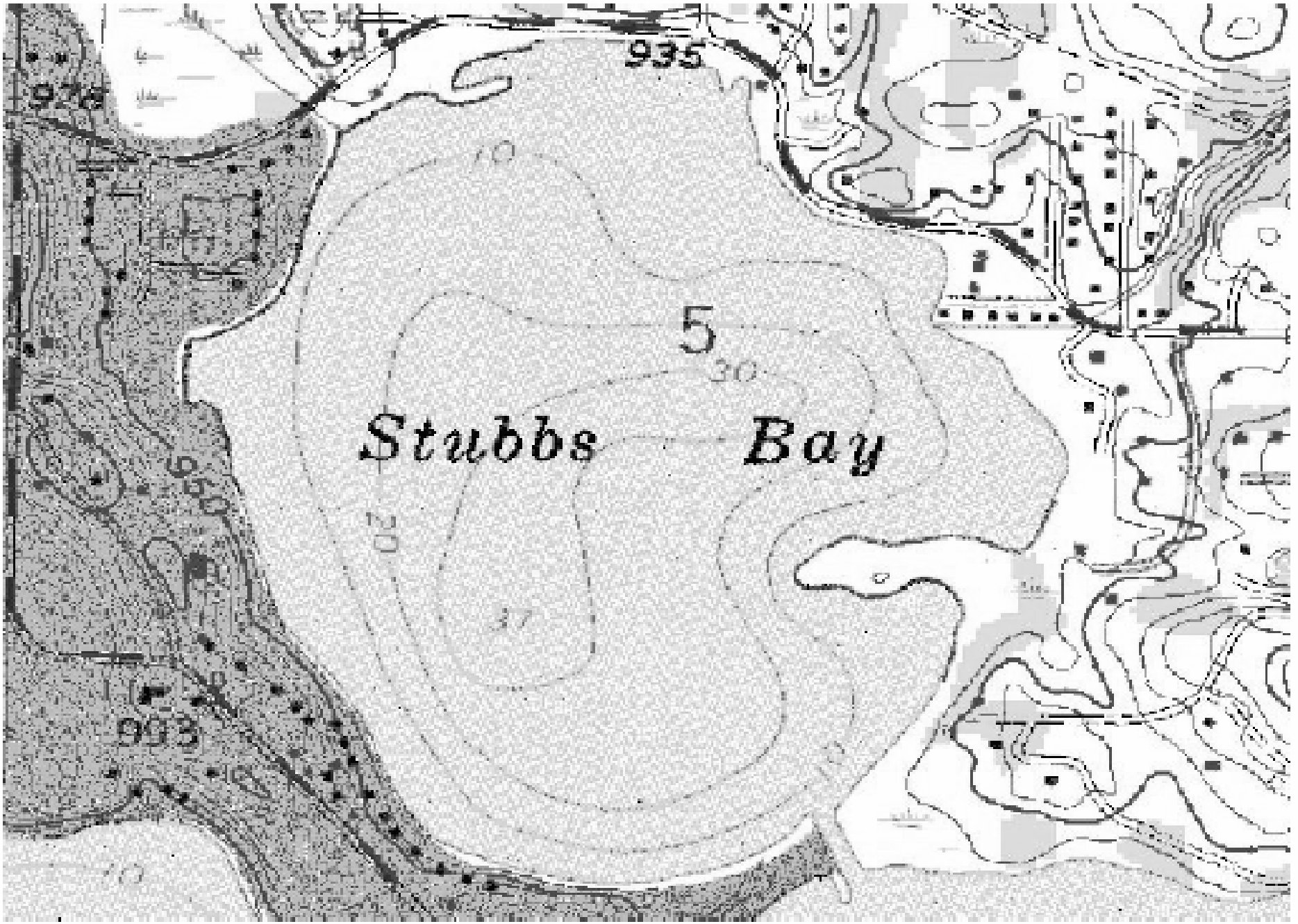
Stubbs Bay Feasibility Study

Completed for:
Minnehaha Creek Watershed District
By:
Barr Engineering
July 2004

Figure 1 Stubbs Bay morphometry



Stubbs Bay, Lake Minnetonka

- Lake surface area of 199 acres
- Maximum depth of 37 feet, mean depth of 15 ft.
- Fairly well sheltered from prevailing winds
- Stratifies in summer with thermocline at 12 – 15 feet
- Low densities of coontail, curlyleaf pondweed and Eurasian watermilfoil

Stubbs Bay, Lake Minnetonka

- Drainage area is predominately residential and undeveloped land
- Total watershed area of 1,749 acres
  - Classen Creek (994 acres)
  - Stubbs Bay Creek (507 acres)
  - Unmonitored area (248 acres)

Existing Lake Water Quality

- In-lake phosphorous (P) concentrations are variable with summer surface TP from

  41 – 63 ug/L
- 1997 goal of 50 ug/L; HHPLS goal of

  50 – 55 ug/L
- 1997 to 2003 average TP is 53 ug/L
- Chlorophyll-a average is 32 ug/L
- Frequency of nuisance algae blooms – 75%
- Frequency of severe algae blooms – 45 %
- Average summer Secchi depth – 0.76 m.

Diagnostic Results

- High internal P load – 8th highest bottom concentrations (of 43 District lakes)
- Summer internal load: 320 – 790 kg/yr (Jennings Bay – 570 kg/yr)
- Spring and fall over turn exacerbates internal mixing from bottom sediments
- External loads average 270 kg/yr (mostly from Classen Creek)

Water Quality Standards

North Central Hardwood Forest Ecoregion Use Designation	Phosphorus Concentration [µg/L]	Calculated Chlorophyll-a Concentration [µg/L]	Required Load Reduction [%]
Full Use	<40	26.4	55% or more
Partial Use	40-60	26-40	0 to 55%
Impaired	>60	39.6	NA

Average Annual P Load

Stubbs Bay Phosphorus Load	Average Load [kg]	Percent
Internal Phosphorus Load	577	63
Atmospheric Phosphorus Load	61	7
External Phosphorus Load	270	30
Total Phosphorus Load	908	100

Annual P Load – 2020 Land Use

Stubbs Bay Phosphorus Load--Full Development Land Use	Average Load [kg]	Percentage
Internal	567	48%
Atmospheric	61	5%
External	565	47%
Total	1193	100%

In-lake Improvement Options

- Hypolimnetic aeration
- Artificial de-stratification (i.e. mixing)
- Copper Sulfate
- Chemical treatment of anoxic sediments
  - Alum
  - Lime
  - Alum plus lime
  - Ferric chloride, with & without aeration
  - Calcium carbonate (spent lime)
  - Calcium nitrate (i.e. RIPLOX)

Undesirable

- Calcium nitrate
  - Limited use
  - Not well documented for long-term solution
  - Less effective than iron or alum
- Calcium carbonate – same as lime
- Lime
  - Not practical or useful in this application – added cost unnecessary

Undesirable

- Copper Sulfate
  - Short-term fix
  - Dead algae release toxins in water – deposit in bottom sediments
  - Algae species can shift to copper tolerant and equally undesirable species

Aluminum Sulfate (alum)

- Reduces alkalinity and pH (must be >6.0)
- Would require 2 doses over a 25 year period
- Sedimentation reduces effectiveness (2 cm)
- Estimated capital cost - $341,000 (1 dose)
- Annualized cost estimate - $36,000 (2 dose)
- Annualized cost/decrease in TP ($/ug/L) - $2,800

Hypolimnetic Aeration / Iron addition

- Draws water out of the hypolimnion, injecting it with air, then return it to hypolimnion with no appreciable temperature change
- Results in circulation of the of the bottom waters but maintains lake stratification – does not affect circulation of surface waters
- Improved habitat in hypolimnion
- May allow anoxia near top – discouraging fish migration

Hypolimnetic Aeration/ Iron addition

- Estimated capital cost - $510,000
- Estimated annual O&M cost - $40,000
- Total annualized cost - $76,000
- Annualized cost/decrease in TP ($/ug/L) - $5,600

Diffused Aeration / Iron Addition

- Intended to de-stratify the lake as a means of maintaining oxic condition in sediment
- Injects compressed air into the water from a diffuser on the lake bottom
- Results in circulation of lake and increased oxygenation
- May improve habitat
- Prevent vertical migration of algae – reduce scum on surface of water
- May increase P and decrease transparency

Diffused Aeration / Iron Addition

- Estimated annual cost - $250,000
- Estimated annual O&M costs - $20,000
- Total annualized costs - $38,000
- Annualized cost / decrease in TP ($ / ug / L) - $2,800

Artificial Circulation / Iron Addition

- Produce artificial circulation in each layer of the lake but maintain thermal stratification
- 5 solar powered up-flow circulators evenly spaced around the lake
- 4 mixing at or above the thermocline
- 1 over the deepest part – aerating hypolimnion
- Should improve habitat
- Reduce sediment P release
- Some assertions on milfoil control

Artificial Circulation / Iron Addition

- Estimated capital costs - $338,000
- Estimated annual O&M costs - $500
- Total annualized cost - $24,000
- Annualized cost / decrease in TP ($ / ug / L) - $1,700

BMPs

- Under 2020 fully developed conditions, 1/3 of area is conducive to infiltration
- Classen Creek P load decrease downstream of CLC-3
- Other ponding sites would require easements

Study Conclusions

- By 2020, residential land use will increase to 80% of upland area – 983acres (56% of sub-watershed); 314 acres appropriate for infiltration
- Average annual TP in Stubbs Bay will increase from 57 to 62 ug/L under 2020 conditions
- (Projected reduction of P load as outlined in Table B-1)

Recommendations

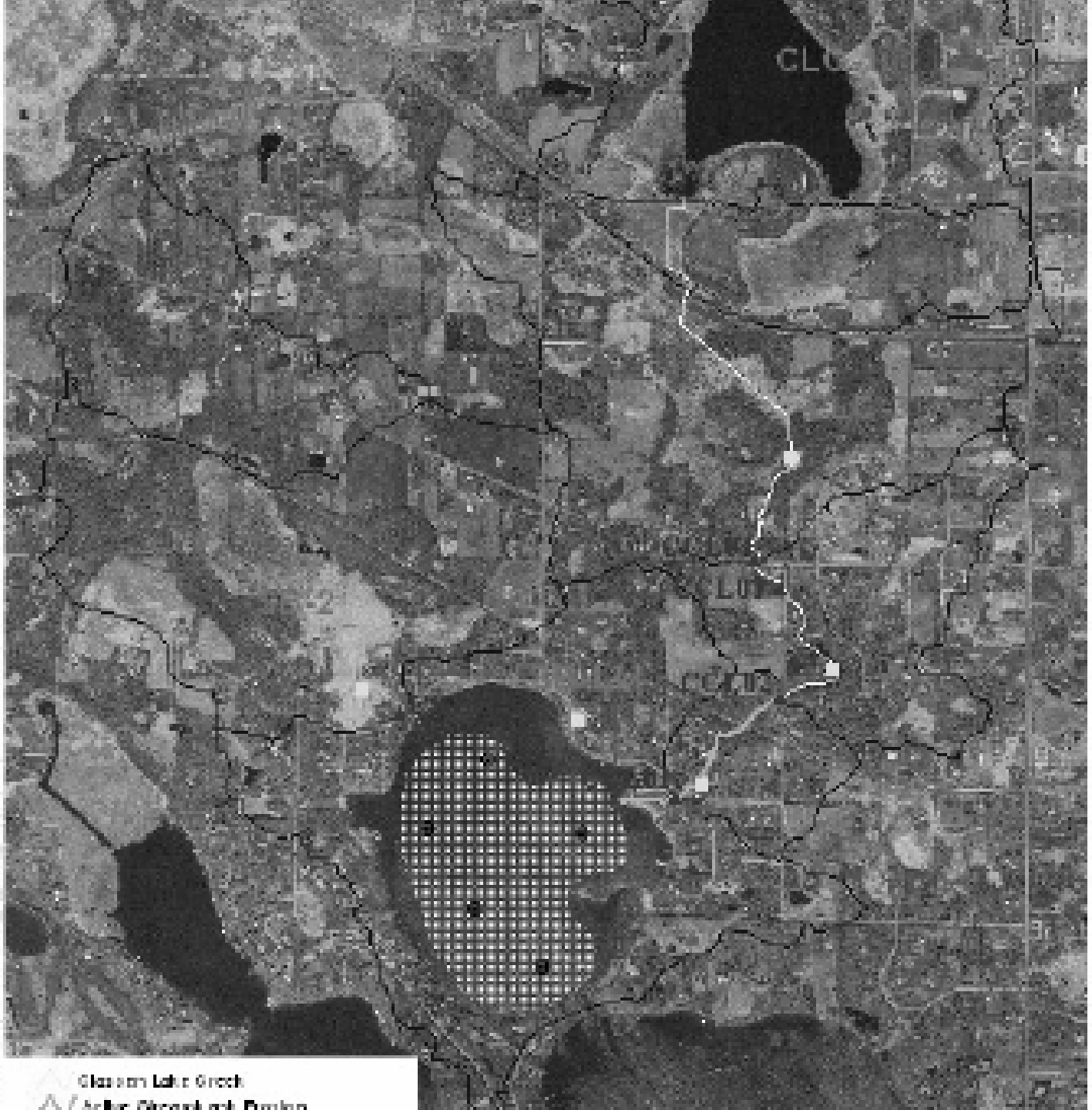
- Combination #13, Table –B1
  - Artificial circulation with iron addition
  - Promote BMPs – rain gardens, street sweeping, etc.
  - Detention pond at CLC-3
  - Deepen existing pond at CLC-4
  - Detention pond at SB-2

Estimated Costs & Benefits

WQImprovement	Predicted TP	Predicted Chl-a	secchi depth	Bloom %	Est. cost	$/ppb
Full land use	62	41	0.66	100		
Alum	49	32	0.76	65	$341,000.00	$2,800.00
Hypo aeration	48	32	0.77	62	$510,000.00	$5,600.00
Diffused aeration	48	32	0.77	62	$250,000.00	$2,800.00
Art.circulation	47	31	0.78	59	$338,000.00	$1,700.00

Estimated Project Cost / Benefit

WQ Improvement	Predicted TP	Predicted Chl-a	secchi depth	Bloom %	Est. cost	$/ppb
Option #13	43	28	0.82	44	$1,382,000.00	$8,200.00


Glassom Lake Creek

Q&A