

# Lake Howard

Lake Howard has high water clarity, moderate aquatic plants, and low phosphorus in the upper waters. However, the lake has high phosphorus levels in the bottom waters and regular algal blooms. Therefore, the lake appears to be at risk of future declines in water quality unless nutrient runoff from land development in the surrounding watershed is controlled.



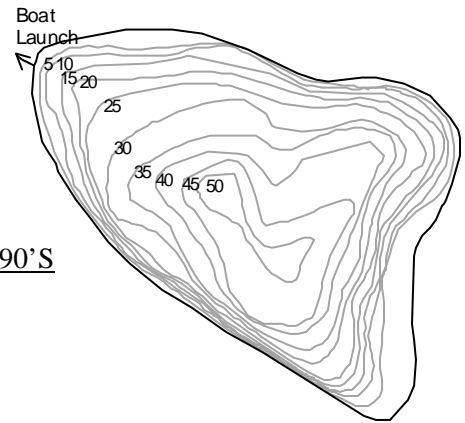
*State of the Lakes Report*  
*March 2003*

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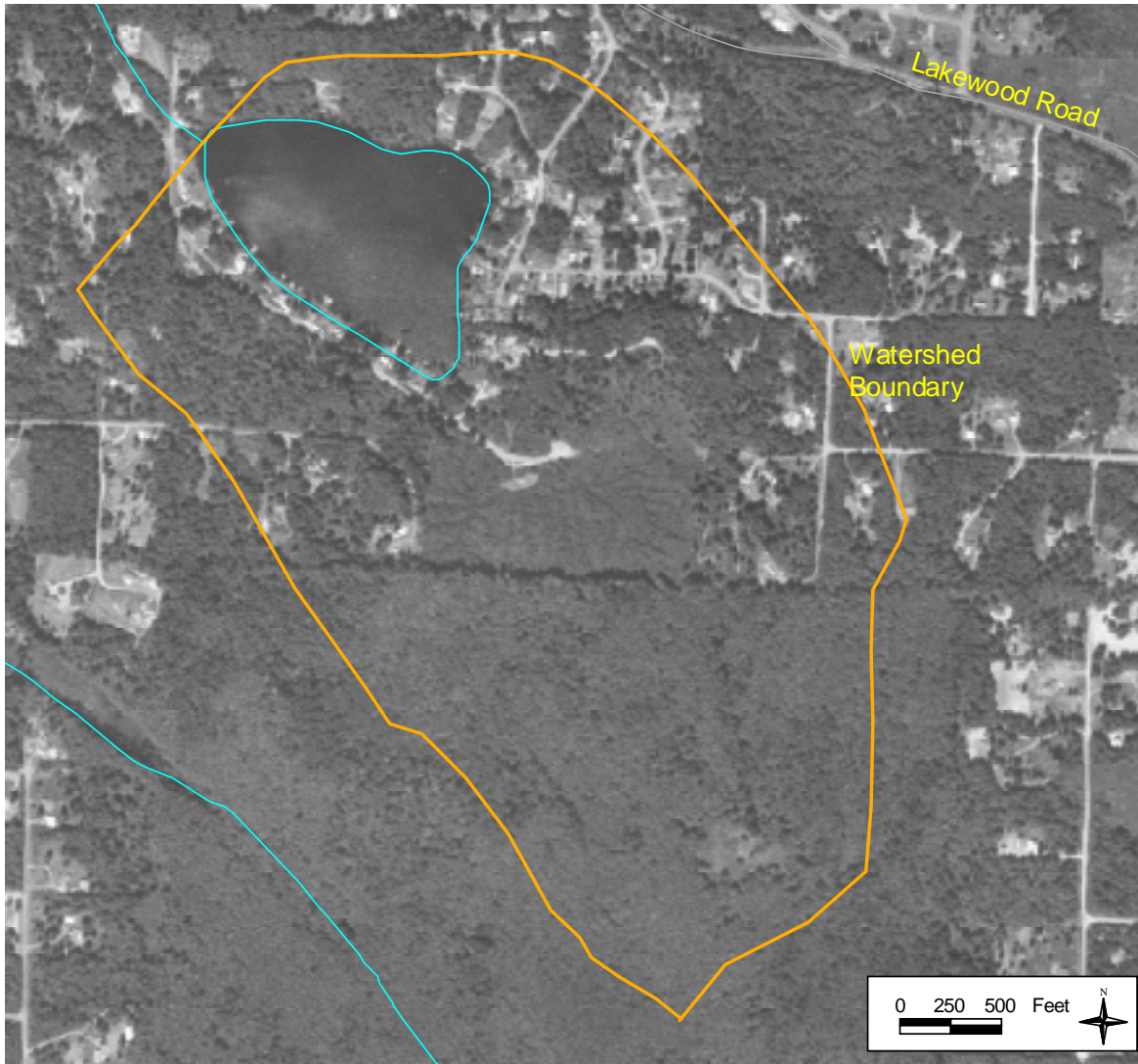
**Snohomish County Public Works**  
**Surface Water Management**

## LAKE AND WATERSHED DATA

Lake Area: 26 acres  
 Watershed Area: 265 acres  
 Watershed to Lake Area Ratio: 10.2  
 Maximum Depth: 50 feet (15.2 meters)  
 Average Depth: 29 feet (8.8 meters)  
 Lake Volume: 790 acre-feet  
 Length of Shore: 0.9 miles



	<u>1973</u>	<u>MID-90'S</u>
# of nearshore homes	22	32
# of homes/1000' of shoreline	4.8	7.0
% of homes with bulkhead or fill		50%
% of homes with some native vegetation near shore		10%
% of watershed developed (residential or commercial)	4%	15% (est.)



# LAKE ASSESSMENT

## DESCRIPTION

■ Location/Access – Lake Howard is located in the Seven Lakes area north of the Tulalip Reservation. There are no perennial streams entering the lake, so ground water is likely the main water source. Lake Howard flows into Lake Martha, which discharges to Port Susan. There is a public boat launch at the northwest end of the lake. Gas-powered boats are not permitted.

■ Size/Shape – The lake is 26 acres in size and relatively deep, with a maximum depth of 15.2 meters and an average depth of 8.8 meters. The lake volume contains 790 acre-feet of water. The lake lies in a protected bowl surrounded by wooded hills. This protection, combined with the lake's depth, contributes to strong stratification during the summer months.

■ Watershed – The Lake Howard watershed, including the lake, covers 265 acres. The watershed is 10.2 times the size of the lake, which is near the median for Snohomish County lakes. Much of the watershed is undeveloped. Only 4% of the watershed supported residential uses in 1973. By the mid-90s, development had expanded to 15% of the watershed.

■ Shoreline – The shoreline of Lake Howard is 0.9 miles in length. Along the shoreline, there were 22 homes in 1973 and 32 by the mid-90s, about average density for lakes in the county. Approximately 50% of the nearshore homes have modified the shoreline with bulkheads or fill. However, only 10% of the homes have retained some native vegetation along the shore. A zone of vegetation would help to filter out pollution before it can reach the lake.

## LAKE CONDITIONS

■ Water Clarity – Summer water clarity in Lake Howard is the second highest in the county, with a long-term average of 6.0 meters from 1993 to 2002. These values are higher than during the 1983 Entranco study (average 4.5 meters) and much



higher than readings in 1973 (average 2.5 meters). The reasons for the better water clarity in the last decade are unknown, but the lake may be recovering slowly from historic impacts, such as logging and clearing of the watershed.

■ Color – The lake is lightly colored by dissolved organic material (humic acids) from wetlands, making the water light to medium green or brown. This color has only a minor effect on water clarity.

■ Nutrients – Summer average total phosphorus concentrations in the epilimnion ranged from 4  $\mu\text{g/l}$  to 9  $\mu\text{g/l}$  between 1996 and 2002, which is relatively low for Snohomish County lakes. Values from the 1983 study were similar. However, sampling in 1973 produced an average of 32  $\mu\text{g/l}$  of total phosphorus in the epilimnion. This high average corresponds with the lower water clarity in 1973. Summer total phosphorus averages in the hypolimnion have been consistently high through the years, ranging from 94 to 157  $\mu\text{g/l}$  in 1973, 1983, and 1996-2001 (although the 2002 average was only 21  $\mu\text{g/l}$ ). This suggests that there is substantial release of phosphorus from the bottom sediments during periods of oxygen depletion. It is not clear if this hypolimnetic phosphorus is available for algal growth until after the lake turns over in the fall. However, it is possible that blue-green algae are migrating down to utilize the nutrients. Total nitrogen concentrations were moderately high and ammonia levels were high in the hypolimnion in 1973 and in 1981. Ammonia was also elevated in the hypolimnion during the

1983-84 study, indicating vigorous decomposition of organic matter in the lower waters. These data suggest that nitrogen is relatively abundant and that phosphorus availability probably limits algal growth.

- Alkalinity/pH– Data from 1983 and the early 1990s indicate that Lake Howard has a moderate buffering capacity. Data from 1994 through 2002 show frequent peaks of pH, up to 9.1 units, at a depth of several meters, which indicates vigorous algal growth at this depth.

- Oxygen/Temperature– Vertical profiles of dissolved oxygen and temperature for the summers of 1995 through 2002 show strong stratification between warm, oxygenated upper waters and cool, oxygen-depleted bottom waters. The graphs indicate that decaying organic matter in the lake bottom depletes the dissolved oxygen in the water below about 8 meters by mid to late summer. For most of the summer, there are spikes of higher dissolved oxygen about 4 to 5 meters deep, suggesting that algal growth is vigorous at this depth.

- Algae– Chlorophyll *a* data are available from the summers of 1973, 1981, 1983, 1994, 1995, and 2002. Values ranged from 0.1 µg/l to 9.9 µg/l, with an average of 3.9 µg/l during the 1983 study. These data suggest low to moderate amounts of algae in the lake. Analysis of three algae samples in 1994 and 1995 revealed low biovolumes, with diatoms, green, and gold-brown algae dominant in both abundance and volume. Blue-green algae, which are responsible for most algae problems, were only moderately abundant. Observations by SWM staff through the years (combined with spikes in pH and dissolved oxygen) indicate that algal blooms at several meters depth occurred regularly during summer months. Because strong stratification tends to limit the availability of nutrients from the hypolimnion during the summer, it is possible that some other source of nutrients, such as septic system effluent, is entering the lake at several meters depth.

- Aquatic Plants– Lake Howard has a moderate concentration of aquatic plants, dominated by the native plants—large-leaf pondweed, yellow water-

lily, and chara. Most of the plants are concentrated at the northwest and southeast ends of the lake where there is more shallow water. The south shore of the lake is quite steep with little habitat for aquatic plants.

## SUMMARY

- Trophic State– The high water clarity and low epilimnion total phosphorus concentrations in Lake Howard are oligotrophic characteristics. However, the lake experiences severe oxygen depletion, high hypolimnetic phosphorus, regular algal blooms, and moderate amounts of aquatic plants. Therefore, Lake Howard should be classified as mesotrophic.

- Current Conditions/Trends– Lake Howard is currently in satisfactory condition, but appears to be at risk of declining water quality. Although water clarity has been higher during the last decade than in the 1970s and 80s, the lake shows signs of eutrophication, such as high phosphorus and oxygen depletion in the hypolimnion. These characteristics may translate into poorer water quality in the future. In addition, the vigorous algal growth at several meters depth may be an indication of pollution entering the lake.

- Future Concerns/Targets– The primary concern with Lake Howard is for potential future impacts if the undeveloped portions of the watershed are rapidly developed. Maintaining current water clarity and reducing hypolimnetic phosphorus levels are targets for the lake.

- Recommendations– Monitoring of the lake should continue with special emphasis on understanding the build-up of nutrients in the hypolimnion and the algal blooms below the surface. New development in the watershed should take precautions to control runoff and reduce nutrient pollution.

## CITIZEN VOLUNTEERS

Thanks to Suzanne Cannon, Bill Crane, Tim Schmidt, and Trudi Adams for volunteer monitoring at Lake Howard.

## **DATA SUMMARY TABLE**

Source	Date	Secchi Depth (meters)	Total Phosphorus (ug/l)		Color (Pt-Co scale)	Chlorophyll a (ug/l)
			Surface	Bottom	Epilimnion	Epilimnion
McConnell, et al, 1976	Summer <b>1973</b>	2.3 - 2.7 (2.5) <i>n</i> = 3	14 - 60 (32) <i>n</i> = 3	110 - 190 (150) <i>n</i> = 3	0 - 10 (7) <i>n</i> = 3	1.8 - 2.0 (1.9) <i>n</i> = 3
Sumioka and Dion, 1985	<b>6/30/81</b>	6.4	20	310	-	2.3
Entranco, 1986	Summer <b>1983</b>	3.8 - 5.0 (4.5) <i>n</i> = 5	<5 - 17 (10) <i>n</i> = 5	70 - 359 (157) <i>n</i> = 5	-	1.0 - 9.9 (3.9) <i>n</i> = 5
DOE	Summer <b>1993</b>	5.0 - 7.3 (5.8) <i>n</i> = 11	-	-	-	-
SWM Staff or DOE	Summer <b>1994</b>	5.3 - 6.9 (6.0) <i>n</i> = 7	-	-	<5 - 10 (8) <i>n</i> = 2	0.1 - 1.3 (0.7) <i>n</i> = 2
SWM Staff	Summer <b>1995</b>	6.8	-	-	10	2.4
SWM Staff or Volunteer	Summer <b>1996</b>	4.6 - 6.8 (5.8) <i>n</i> = 5	3 - 5 (4) <i>n</i> = 2	76 - 122 (99) <i>n</i> = 2	-	-
SWM Staff or Volunteer	Summer <b>1997</b>	5.1 - 6.1 (5.6) <i>n</i> = 2	5 - 11 (8) <i>n</i> = 2	82 - 106 (94) <i>n</i> = 2	-	-
SWM Staff or Volunteer	Summer <b>1998</b>	4.0 - 6.9 (5.7) <i>n</i> = 8	6 - 10 (8) <i>n</i> = 4	89 - 150 (129) <i>n</i> = 4	-	-
SWM Staff or Volunteer	Summer <b>1999</b>	3.7 - 7.4 (5.4) <i>n</i> = 8	7 - 10 (9) <i>n</i> = 4	74 - 150 (126) <i>n</i> = 4	-	-
SWM Staff or Volunteer	Summer <b>2000</b>	5.1 - 7.3 (6.3) <i>n</i> = 7	3 - 11 (8) <i>n</i> = 4	58 - 175 (104) <i>n</i> = 4	-	-
Volunteer	Summer <b>2001</b>	6.0 - 8.0 (6.9) <i>n</i> = 5	7 - 13 (9) <i>n</i> = 4	27 - 88 (57) <i>n</i> = 4		
SWM Staff or Volunteer	Summer <b>2002</b>	3.7 - 7.3 (5.7) <i>n</i> = 8	7 - 9 (8) <i>n</i> = 4	9 - 30 (21) <i>n</i> = 4	-	0.8 - 2.1 (1.3) <i>n</i> = 4

### NOTES

- Table includes summer (May-Oct) data only.
- Each box shows the range on top, followed by summer average in ( ) and number of samples (n).
- Total phosphorus data are from samples taken at discrete depths only.
- DOE = Washington Department of Ecology

## **SUMMARY OF OTHER DATA**

■ **Total Phosphorus** – composite samples taken by the Department of Ecology in 1993 and 1994 ranged from 8 -- 28 µg/l in the epilimnion and 33 - 71 µg/l in the hypolimnion. These are not directly comparable to the discrete samples shown above, but confirm that Howard has low to moderate phosphorus levels in the epilimnion and high phosphorus levels in the hypolimnion.

■ **Nitrogen** – total nitrogen values from the summer of 1973 averaged 1.08 mg/l in the epilimnion and 1.29 mg/l in the hypolimnion; 1981 samples were 1.30 mg/l in the epilimnion and 2.0 mg/l in the hypolimnion; ammonia concentrations in the hypolimnion were high in 1973 (up to 0.95 mg/l); 1983-84 samples by Entranco also showed elevated ammonia concentrations in the hypolimnion (average of 0.558 mg/l and values up to 1.00 mg/l) and moderate nitrate levels (averages of 0.135 mg/l in the epilimnion and 0.115 in the hypolimnion, with values up to 0.496 mg/l in the epilimnion); Ecology total nitrogen composite samples in 1993-1994 averaged 0.36 mg/l in the epilimnion and 0.74 mg/l in the hypolimnion; these data suggest vigorous decomposition of organic matter in the hypolimnion and high availability of nitrogen for algal growth.

■ **Alkalinity** – data from 1983 ranged from 33 – 48 mg/l CaCO<sub>3</sub> while 1994 and 1995 data ranged from 36 -- 45 mg/l CaCO<sub>3</sub>, which suggests that Howard has a moderate buffering capacity.

■ **pH** – 1994-2000 data averaged 7.4 near the surface and 6.7 near the bottom, with numerous higher readings up to 9.1 indicating vigorous algal growth. Readings from 2002 were similar.

■ **Conductivity** – data from 1983 ranged from 72 – 139 µmhos; 1994-2000 data averaged 108 µmhos in the epilimnion and 128 µmhos near the lake bottom, indicating high levels of dissolved materials in the water. Readings from 2002 were similar.

■ **Iron** – limited 1973 and 1994-95 data showed moderate levels in the epilimnion (avg. 74 µg/l) and higher levels in the hypolimnion (avg. 339 µg/l, high of 670 µg/l), which indicates release of iron and phosphorus from the bottom sediments under low oxygen conditions.

■ **Algae** – the following table shows the total biovolume and percent biovolume of the main types of algae from three samples collected in 1994-95. The data show that the total algal volumes were low and that greens, gold-browns, and diatoms were most prevalent. Cell counts of the same samples revealed that blue-greens, greens, and gold-brown/diatoms were most abundant.

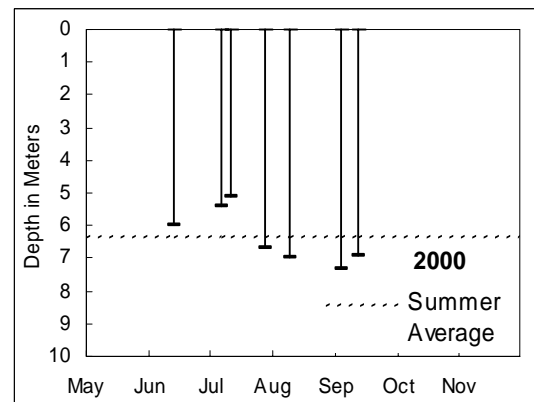
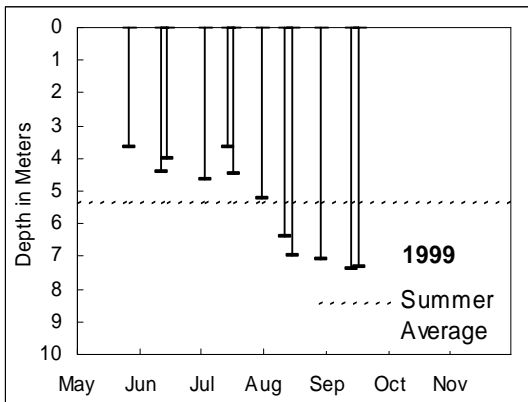
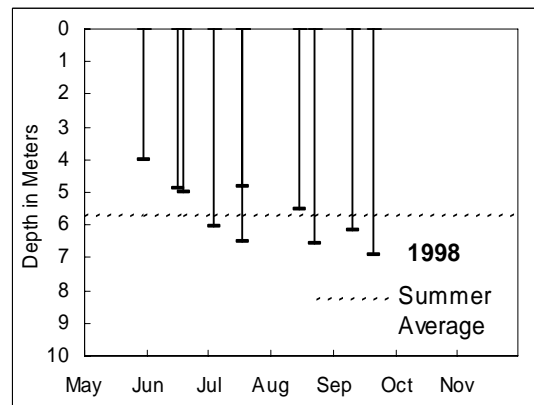
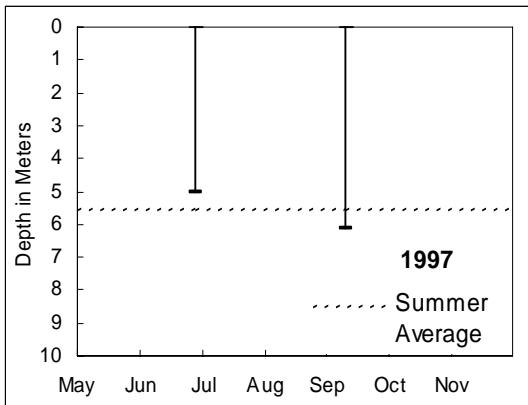
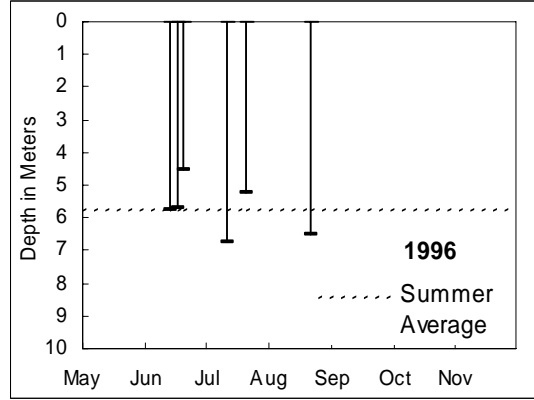
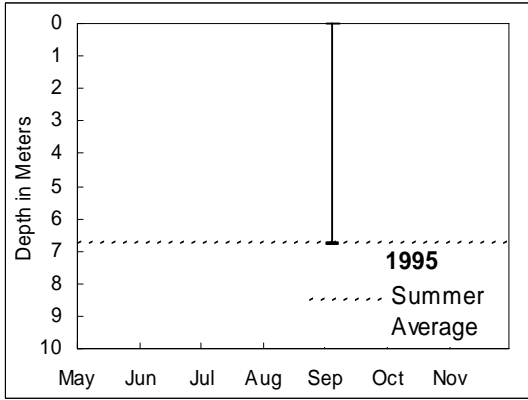
ALGAE TYPES	6/27/94	8/23/94	9/5/95
Cyanophyta (Blue-greens)	2%	2%	16%
Chlorophyta (Greens)	58%	8%	8%
Chrysophyta (Golden/diatoms)	36%	79%	35%
Cryptophyta (Cryptomonads)	3%	10%	16%
Euglenophyta (Euglenoids)	1%	0%	2%
Pyrrhophyta (Dinoflagellates)	0%	1%	23%
TOTAL BIOVOLUME (mm <sup>3</sup> /l)	0.397	0.508	0.26

■ **Fish** – according to the Washington State Department of Fish and Wildlife (WDFW), the main fish found in Lake Howard are rainbow trout, which are usually stocked each year by WDFW.

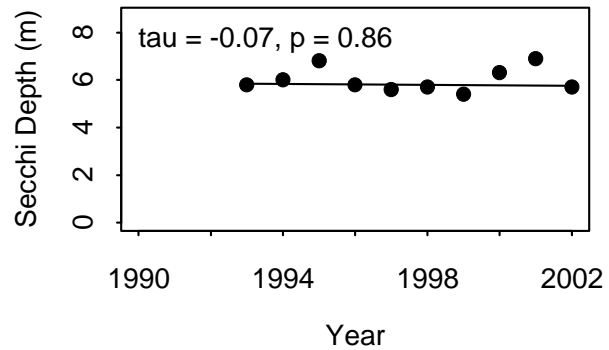
### **DATA SOURCES**

In addition to data from Snohomish County SWM staff and citizen volunteers, data for Lake Howard are also available from: Bortleson, et. al., 1976; Entranco Engineers, 1986; McConnell, et. al., 1976; Rector, 1996; Smith and Rector, 1997; and Sumioka and Dion, 1985. Please refer to the full list of references in the County-Wide Summary.

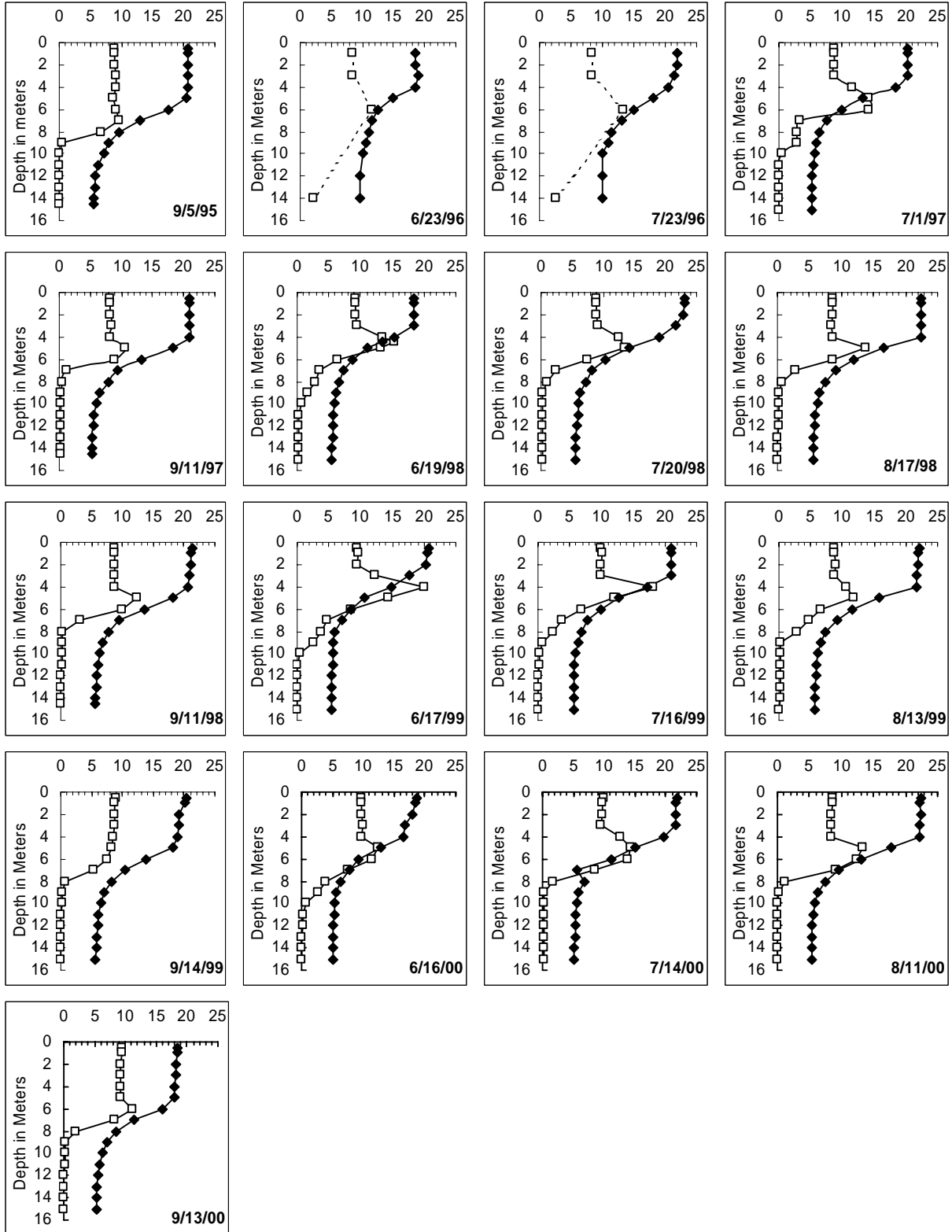
# WATER CLARITY



## TREND ANALYSIS



# DISSOLVED OXYGEN AND TEMPERATURE PROFILES (SELECTED YEARS)



—□— DO (mg/l)      —◆— Temp (°C)

# AQUATIC PLANTS



Area	Density	Dominant Plants	Other Plants
A	Moderate	<i>Potamogeton amplifolius</i> (Large-leaf pondweed)	<i>Elodea canadensis</i> (Common elodea) <i>Chara sp.</i> (Stonewort, Muskgrass)
B	Sparse	<i>Nuphar polysepalum</i> (Yellow water-lily)	<i>Elodea canadensis</i> (Common elodea) <i>Chara sp.</i> (Stonewort, Muskgrass) <i>Potamogeton amplifolius</i> (Large-leaf pondweed)
C	Patchy	<i>Chara sp.</i> (Stonewort, Muskgrass)	<i>Elodea canadensis</i> (Common elodea) <i>Potamogeton amplifolius</i> (Large-leaf pondweed) <i>Eleocharis sp.</i> (Spikerush)
D	Sparse		<i>Elodea canadensis</i> (Common elodea) <i>Potamogeton amplifolius</i> (Large-leaf pondweed) <i>Nymphaea odorata</i> (Fragrant water-lily)

## BASIC MONITORING DATA

1995									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
*09/05/95	6.8				90	light	calm	lt green	Strong H <sub>2</sub> S smell at 14m. Phantom midges and several zooplankton visible at surface.

1996									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
6/16/96	5.8	21	19	12	75	none	breezy		Slight algae, scum; moderate plants, 3 ducks/geese. Filamentous algae mats, 1-3 meter clumps at shore in some areas, especially north.
*06/20/96	5.8				0	none	breezy	grn brown	
6/23/96	4.6	16	19	11.5	100	light	light	yellow green	Slight algae, scum, no odor, moderate plants. 4 ducks. Road cut in over wetland drainage (outflow) of the lake along Olive Ave. - no permits, culverts, etc. Road covered in mud/water from developing property, no siltation barrier or drainage.
7/14/96	7.0	32.5	23		0	none	strong	grn brown	No algae, scum, plants, odor.
7/23/96	5.3	21.5	22	13	0	none	light	clear	No scum, odor, slight algae, moderate plants. 15 ducks/geese. Debris from fireworks. Fewer small bass - many smolt trout near shores. Increasingly, more large-leaf pondweed, in shallows by the boat launch.
*08/23/96	6.5				0	none	breezy	lt green	Plants in narrow littoral zone only, large-leaf pondweed dominant.

1997									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
*07/01/97	5.1				100	mod	light	lt brown	Lots of zooplankton, evidence of a lot of algae at 5-6m - high O <sub>2</sub> .
*09/11/97	6.1				100	light	calm	lt green	Gloeotrichia.

\*Indicates data collected by Snohomish County staff.

1998									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
6/2/98	4.0	21	21	14.3	0	none	breezy	yellowgrn	No algae scum, aquatic plants, odor; moderate to heavy algae in water. 6 ducks. **Lake level measured from Crane dock near boat.
*6/19/98	4.9				100	light	light	grnbrown	No scum; slight plants; moderate algae. 2 lots being cleared; 1 bare to water on steep slope.
6/22/98	5.0	22	21	15.8	0	none	calm	yellowgrn	No scum, aquatic plants or odor; slight algae; 4 ducks/geese.
7/6/98	6.1	27	21	15.3	0	light	calm	yellowgrn	Slight algae; no scum, plants or odor; 2 ducks/geese.
7/20/98	6.6	22	24	17	0	none	light	yellowgrn	slight algae & plants; no scum or odor; 5 ducks/geese.
*7/20/98	4.9				0	none	breezy	grnbrown	No, ducks/geese, odor, scum; slight plants; moderate algae.
*8/17/98	5.5				100	light	light	yellowgrn	No ducks/geese, scum; moderate plants, algae; heavy odor in bottom sample.
8/24/98	6.6	19	22	21.5	10	none	light	lt green	Slight algae and plants; no scum or odor; 4 ducks/geese.
*9/11/98	6.2				0	none	breezy	lt green	Moderate algae, odor in bottom sample; no ducks/geese, scum; slight plants.
9/21/98	7.0	15	18	23	0	none	light	lt green	Slight algae, plants. No scum, odor, ducks/geese.

1999									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
5/30/99	3.7	20	18	10	0	none	calm	peasoup	Severe algae bloom beginning to clear.
6/14/99	4.4	20	20	9.75	0	none	calm	medgreen	First year that geese have had babies.
*6/17/99	4	22	20.8		50	trace	light	medgreen	
7/5/99	4.7	21	19	9.25	0	trace	calm	medgreen	
*7/16/99	3.7	18.3	21		75	moderate	light	yellowgrn	Moderate odor from bottom sample.
7/19/99	4.5	22	21	9.75	0	moderate	light	medgreen	
8/2/99	5.3	29	23	11.5	0	none	light	lt green	
8/13/99	6.4	20	22		50	trace	breezy	medgreen	Heavy H <sub>2</sub> S odor from 13.5 m.
*8/17/99	7.1	25	24	11.5	10	light	light	lt green	
8/30/99	7.2	24	21	13	90	trace	calm	lt green	
*9/14/99	7.4	28	20.3		10	none	light	lt green	1 Coot. Moderate odor from bottom sample.
9/18/99	7.4	20	18	14	0	none	light	lt green	

2000

DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
*06/16/00	6	20	18.64		0	none	light	medgreen	Slight algae and aquatic plants and no algae scum.
7/9/00	5.5	23	22		10	none	light	dark brown	6 ducks, no algae or algae scum, and heavy aquatic plants.
*07/14/00	5.1	21	21.8		25	none	light	medgreen	No ducks, moderate algae, no algae scum, and slight aquatic plants.
7/30/00	6.8	23	22	14	0	none	light	gr-brown	7 ducks, slight algae, no algae scum, and moderate aquatic plants.
*08/11/00	7	22	22.35		75	none	calm	medgreen	No ducks, heavy algae, no algae scum, and moderate aquatic plants.
9/5/00	7.4	18	20	18	0	trace	calm	Moderate green	6 ducks, moderate algae and aquatic plants, and no algae scum.
*09/13/00	6.9	18	18.46		0	none	breezy	lt green	No ducks, heavy algae, no algae scum, and slight aquatic plants.

[Click here to view more recent data.](#)

## HOW YOU CAN HELP LAKE HOWARD

- Educate yourself about lake ecology and the lake's health.
- Use lawn and garden fertilizers sparingly; test your soil first; choose low or no phosphorus fertilizers.
- Retain or plant native vegetation adjacent to the water to protect the shoreline and filter pollution.
- Infiltrate or filter the runoff from rooftops, patios, and driveways rather than piping it to the lake.



- Cover or mulch bare soil areas.
- Use pesticides, herbicides, and household chemicals sparingly and never near the water.
- Maintain your septic system—have it inspected every two years and pumped when needed.
- Conserve water both inside and outside.
- Clean up pet wastes and keep livestock away from the lake shore.

- Learn to identify non-native invasive aquatic plants and animals; check your boat and trailer for invaders; never empty an aquarium into the lake.
- Do not feed geese or ducks.
- Join with neighbors or the local property owners' association to work together to protect the lake.



Contact Snohomish County Surface Water Management at 425-388-3464 for information about these topics or if you have questions about Lake Howard.

(TTY users call 425-388-3700)