2007

Annual Sanitary Survey Report

Comprehensive Sanitary Survey

Of

Upper Lake Park Beach

Port Washington, WI 53074

City of Port Washington
Ozaukee County Planning, Resources and Land Management
Ozaukee County Public Health Department

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Executive Summary

In 2006 the City of Port Washington requested that the Ozaukee County Public Health Department pilot a comprehensive survey of sanitary and storm water impacts on Upper Lake Park Beach (ULP). Together with staff from the Ozaukee County Planning Resources and Land Management Department an application, project work plan and quality assurance plan was submitted to the U. S. Environmental Protection Agency (EPA). The EPA approved these plans and the project was funded for the 2007 beach season. The field project which ran for 100 days from May 28th to September 3rd involved the collection of water samples and environmental data (see Information on Sampling Location and Appendix I). Water samples were analyzed by the City of Port Washington both for bacteria (*E. coli*) and nutrients (total phosphorous and ammonia-nitrogen). *W*ater samples were evaluated for *E. coli* 18 hours after collection and the results were used to determine beach advisories using Wisconsin Department of Natural Resources (WDNR) guidelines (persistence model). Two interns were employed with grant funds to conduct field and lab work.

Upper Lake Park Beach is approximately a 2000 foot long stretch of public beach located in Port Washington, Wisconsin. The beach area averages about 100 feet in width and is located north of the Port Washington Waste Water Treatment Plant and east of the Upper Lake Park bluffs. Significant rain events in July and August provided evidence that rainfall acts as an important vehicle to wash contaminants down local creeks and into Lake Michigan. Of the two creeks in the study area, the impact of Valley Creek (located adjacent to the Wastewater Treatment Plant) appeared as a primary source of *E. coli* and total phosphorous contamination to Upper Lake Park Beach. However, before any remediation plans can take place, a sanitary survey or further investigation of Valley Creek is recommended. Specific point sources of contamination within this watershed need to be identified before appropriate remedial actions can occur.

No *E. coli* predictive model was utilized during the project. One predictive model for beach advisories and closures was developed for Upper Lake Park Beach using data collected in the sanitary survey. This 'rain flow' model is based on rainfall events greater than 0.21 inches, Valley Creek stormwater flow and beachwater quality data. Model validation will require several years of continued beach sampling and environmental data collection and compilation. Listed below is a table containing the number of postings, advisories, and closures for the 2007 beach season at Upper Lake Park.

Total # postings	Total closures	Total advisories	Total preemptive	Ratio postings to known sources
100	12	2	3	17:17

Description of the Beach / Swimming Area

Aerial view of Upper Lake Park Beach. A is southern sample location. B is northern sample location.

Upper Lake Park Beach is a public beach located within the City of Port Washington. Total beach length is approximately 2000 feet long with an average width of 100 feet. Upper Lake Park Beach was monitored from May 28th to September 3rd. The beach itself is relatively shallow, sandy and narrow. Waves deposit zebra and quagga mussels, algae, and organic material on the beach.

During the sanitary survey, two sample locations were located to get greater spatial coverage of the water quality at Upper Lake Park Beach. These samples were composited in the lab and *E. coli* results were posted the following morning.

From 2003 through 2006 beach advisories at Upper Lake Park have been determined by averaging the *E. coli* results from the same two sampling sites monitored in 2007. During this period, Upper Lake Park Beach was categorized as a 'high priority' beach and BEACH Act funds were used to finance monitoring activities. The table below lists a history of beach advisories since 2003.

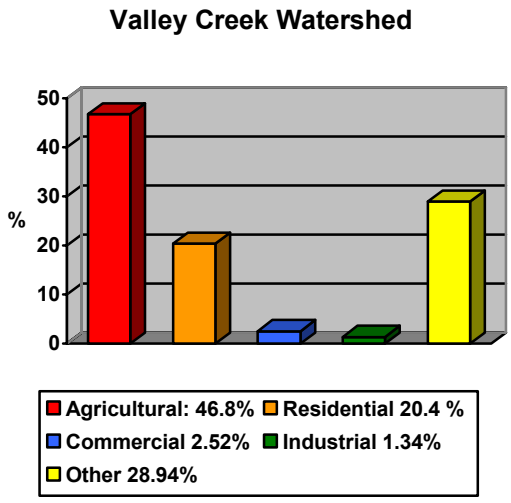
Year	# Closure Advisories	Advisories	Preemptive Advisories	Days open	% Total Advisories
2006	2	8	14	38	38.7%
2005	5	2	11	57	22.6%
2004	8	14	4	49	34.6%
2003	4	22	0	59	30.6%

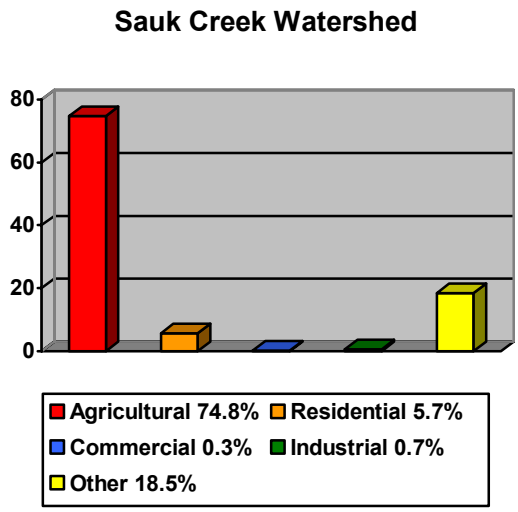
Land Use

Geographic Information System (GIS) and Global Positioning System (GPS) based mapping layers were used to locate individual sampling points, calculate percent land use types for specific watersheds impacting the beach and estimate beach erosion/accretion rates.

Land use data included a GIS 2007 Land layer provided by the Southeast Wisconsin Regional Planning Commission, a GPS underground stormwater pipe / flow map provided by the City of Port Washington, a GIS Wisconsin sub-watershed boundary layer provided by the Wisconsin Department of Natural Resources and several GPS line and point shapefiles generated by the Ozaukee County Planning, Resources and Land Management and Land Information Departments.

The GIS 2007 Land use layer for Ozaukee County was clipped to show only the land uses within the Sauk Creek and Lake Michigan sub-watersheds (see Appendixes II and III) that drain into the study area. The land use data for each sub-watershed was then used to estimate percent land use types and percent developed / undeveloped. A GPS line file with flow directions was utilized to estimate the additional watershed area that drains into the study area based on the City of Port Washington storm sewer system. Correlations between land use types and *E.coli* concentrations were not calculated. Land use type percentages were only estimates. The EPA sanitary survey workgroup recommends follow up sanitary surveys in both watersheds for more accurate and updated land use type information.





Weather Conditions

Daily weather data was collected from the Grand Avenue weather station in downtown Port Washington, which is less than one mile from the beach. Weather measurements included air temperature (°F), water temperature (°F), wind direction (vector), wind speed (mph) and cloud cover (estimated by percent). Listed in the table below are monthly averages. Additional weather data was collected from the National Oceanic and Atmospheric Administration (NOAA) National Data Buoy Center. NOAA Station PWAW3 is located within the harbor in Port Washington. Wind speed (m/s) and wind direction (degrees) measurements were available from this station every 10 minutes.

Month	Rainfall (inches)		Air temp °F		Water temp °F		Wind (mph)	
	Total	Max	Average	Max	Average	Max	Speed	Direction
May*	0	0	55.9	88.6	50.1	52.0	3.1	SE
June	2.71	0.53	65.8	87.5	55.2	65.6	1.8	SSE
July	5.28	2.61	69.2	93.8	59.2	70.8	1.6	SSE
August	8.88	2.19	69.5	90.1	66.8	72.8	1.3	SE
September*	0	0	62.6	86.2	67.4	68.3	1.8	S

*May was May 28th -31st; September was September 1st – 3rd

Month	Cloud Cover*					
	Sunny	Mostly Sunny	Partly Cloudy	Mostly Cloudy	Overcast	Rainy
May	0	2	0	2	0	0
June	9	11	4	2	4	0
July	13	6	3	4	5	0
August	6	8	2	6	4	5
September	3	0	0	0	0	0

*Cloud cover was observed at 7-8am and may not represent the entire day.

Listed below is the EPA provided cloud cover guidance chart.

	Sunny	Mostly Sunny	Partly Cloudy	Mostly Cloudy	Overcast	Rainy
Percent Cloud Cover	0%	12.5%-25%	37.5%-50%	62.5%-87.5%	100%	Rainy Conditions Present

Meteorological data was analyzed for any relationships to Valley Creek and Sauk Creek stream flow and *E. coli* levels at Upper Lake Park Beach. Listed below are observed correlations of rainfall (inches) and flow rate (mgd).

Month	**Sauk Creek flow (mgd) & 24hr rainfall (in)**		**Valley Creek flow (mgd) & 24hr rainfall (in)**	
	Correlation	**Average flow**	**Correlation**	**Average flow**
May-June	0.50	3.19	0.83	0.372
July	0.37	10.43	0.91	1.10
August-September	0.29	30.47	0.62	4.21

Correlations between 24 hour rainfall totals and flow rates were stronger for Valley Creek than Sauk Creek which supports the conclusion that Valley Creek is a stronger point source of contamination for Upper Lake Park Beach than Sauk Creek.

The table below shows monthly correlations between *E.coli* concentrations and rainfall at Valley Creek and Upper Lake Park Beach.

Month	**Upper Lake Park *E.coli* & 24hr rain(in)**	**Valley Creek *E.coli* & 24hr rain(in)**
May-June	0.46	0.44
July	0.53	0.24
August-September	0.61	0.58

Correlations between Upper Lake Park *E.coli* and rainfall were moderate; this shows that a model including rainfall data might be useful in predicting advisories at Upper Lake Park Beach. With the exception of July, correlations were also moderate for Valley Creek *E.coli* and rainfall, which may be explained by low rainfall during the month.

The table below shows monthly correlations between Upper Lake Park *E.coli* concentrations and Valley Creek *E.coli* concentrations.

Month	**Upper Lake Park *E. coli* & Valley Creek *E. coli***
May-June	0.07
July	0.04
August-September	0.48

Weak correlations for May-July may be explained by relatively low rainfall amounts, thus low flows at Valley Creek. Conversely, moderate correlations were noted during August-September when flows were highest. This data supports the development of a rainfall inclusive model that may be useful in predicting advisories at Upper Lake Park Beach.

Physical Beach Conditions

The data collected at the beach during this survey included beach dimensions, water levels, longshore currents (speed and direction), slope, wave height, water turbidity and water temperature. This information was used to characterize the beach and test for relationships between beach conditions and water quality results (*E. coli*).

Beach dimensions were collected with a GPS unit that generated line / point shapefiles. Water levels (i.e. lake bed depth) were measured from a boat with a GPS unit onboard. Several GPS line files were generated for the beach area at the beginning and end of the study period. Longshore currents were measured by placing wood blocks in the water and timing the distance and determining the direction traveled. Wave height, water turbidity and water temperature measurements were collected daily. Longshore current and wave height measurements were not performed on days when wave heights were greater than three feet or when weather conditions were considered hazardous.

Daily wave height, longshore current, water turbidity, and water temperature measurements were compared to daily beachwater quality results (*E. coli*). When considered as single variables, the daily measurements of wave height, longshore current and water temperature were not found to correlate with *E. coli* concentrations in beachwater. Water turbidity results were found to correlate significantly with *E. coli* concentrations in beachwater and are discussed in following sections.

Beach dimension data collected at the beginning and end of the survey were compared and any changes were noted. Slope of the near-shore lake bed was determined by combining water level measurements with beach dimension data compared to daily water quality results (*E.coli*). Changes noted in the near-shore lake bed indicate that weather conditions can significantly affect the morphology of this beach. The lake bed gradient extending from Upper Lake Park into Lake Michigan had a 1.4% slope. Beach erosion/accretion rates were determined using GPS lines for four sections of the beach (bluff toe, high water, waters edge, and 2.5' deep). These GPS lines were generated on 6/15 and 9/4/07. Beach accretion dominated beach erosion during the survey period. This beach accretion was partially due to a 0.5 ft. drop in the lake level. The bluff toe remained relatively static and no bluff failure or slumping was observed during the survey period.

Bather Load

Bather counts were collected during the beach sampling period (usually in the early morning). Consequently, the data below does not account for higher bather loads observed later in the day.

Bather counts were performed Monday through Sunday from May 28th to September 3rd. The table below lists the monthly average and the monthly total number of persons at Upper Lake Park Beach observed during the sample collection period.

Month	Average # people at beach	Total # of people at beach
May - June	3	108
July	5	115
August - September	3	110

Since bather counts were generally taken early in the morning these statistics represent people who were walking along the beach and were not in the water. For that reason no correlation between the human bather load and bacteria levels in beachwater was calculated.

Beach Cleaning

Upper Lake Park Beach was not cleaned by municipal employees during the study period. A Dumpster was placed at the entrance to the beach and four large lined waste baskets were placed along the length of the beach for citizen use. Municipal employees emptied the waste baskets and Dumpster once per week and prior to the weekend. A local citizen group conducted some organized beach trash / debris pick up activities during the sampling period.

Estimates of daily trash and organic debris area percentages were taken each day. Listed below are monthly totals of each category. Organic debris, such as fish and mussels, were grouped with other debris such as trash and metal.

Month	**Trash / Debris on beach**				**Trash / Debris in water**			
	None <1%	**Low 1-20%**	**Moderate 21-50%**	**High >50%**	**None <1%**	**Low 1-20%**	**Moderate 21-50%**	**High >50%**
May-June	1	33	0	0	0	0	0	0
July	3	27	1	0	30	1	0	0
August-September	3	24	5	2	28	4	2	0

No analysis was performed on the preceding data, as the relatively low area percentages of trash/debris did not suggest that there was any relationship between trash types and *E. coli*. Trash and debris however is a significant aesthetic feature of the beach.

Listed in the table below are the algae area percentages that were observed and estimated at Upper Lake Park Beach. High area percentages of algae occurred four times during the entire sampling period. A high algae area percentage on the beach occurred on August 22nd (see Advisories / Closures p. 20). Nearshore algae included algae attached to the lake bottom or floating in the water. No analysis was performed.

Month	**Nearshore Algae**				**Algae on beach**			
	None <1%	**Low 1-20%**	**Moderate 21-50%**	**High >50%**	**None <1%**	**Low 1-20%**	**Moderate 21-50%**	**High >50%**
May-June	15	18	1	0	34	0	0	0
July	12	11	6	2	25	5	1	0
August-September	11	16	6	1	27	4	2	1

Information on Sampling Location

The following table contains information about each sample location.

Name	Location	Type	Start date	End date	Flow monitored?
North Beach	Upper Lake Park	Beachwater	5/28	9/3	n/a
South Beach	Upper Lake Park	Beachwater	5/28	9/3	n/a
PW Waste Water Plant	Upper Lake Park	Sanitary effluent outfall	5/28	9/3	yes
Valley Creek	Upper Lake Park	Creek and storm outfall	5/28	9/3	yes
Valley Creek	Offshore from outfall	Creek & lake water confluence	8/1	9/3	n/a
North slip	Harbor marina	Marina and storm water	5/28	7/31	no
West slip	Harbor marina	Marina and storm water	5/28	7/31	no
Sauk Creek	Harbor channel	Creek and storm outfall	5/28	9/3	yes
WE Energies Plant	Harbor Channel	Plant discharge water outfall	5/28	9/3	yes
Channel site	Harbor channel	Marina, storm, plant discharge, sanitary effluent & creek water confluence	8/1	9/3	n/a

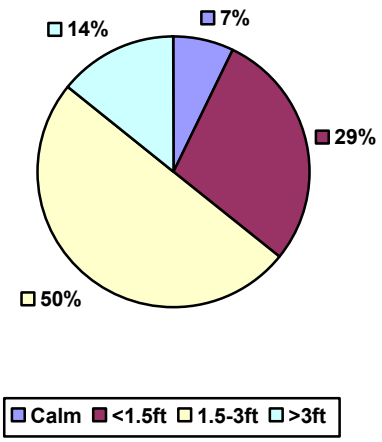
The list above gives an indication of what potential contamination sources are present at some of the sampling locations.

The following table shows data collected in the field.

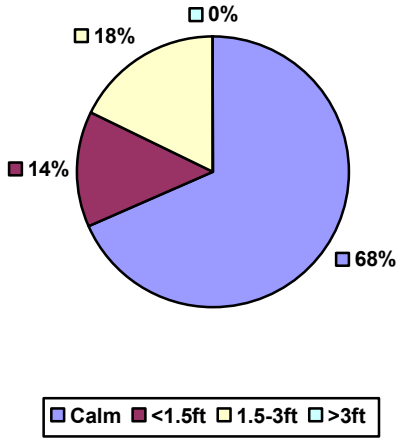
Weather	Water	Hydrometric	Living loads	Pollution (%)
Cloud cover	Water temp (°F)	Wave height (ft)	Bather count	Gen. trash
Rainfall (in)	pH	Wave direction	Bird count	Metal (cans)
Air temp (°F)	Turbidity (NTU)	Longshore current (ft/sec)	Dog count	Plastic
Wind speed (mph)	Odor	Flow rate (mgd or mgm)	Algae area assessment (%)	Wood & plant material
Wind direction	Color			Dead fish & Mussels

Analysis of selected field data follows. Additional results analyses are discussed in the Water Quality Section of this report. Hydrometric data was analyzed using quartiles. Quartiles were derived from the entire data set then compared to days when *E. coli* concentrations in beachwater were ≥235CFU/100mL and <235CFU/100mL. This analysis indicates that when wave heights or longshore current are considered alone, there is not a significant correlation with *E. coli* at Upper Lake Park Beach. However, some conclusions can be made about Valley Creek flow, 24 hour rainfall and 48 hour total rainfall. Relationships between the data sets are shown in the graphs below.

Wave Height (feet)
≥235CFU/100mL

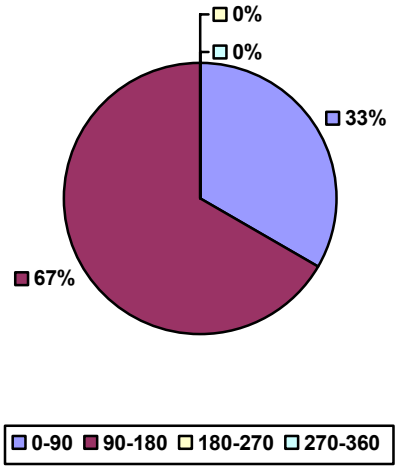


Wave Height (feet)
<235CFU/100mL

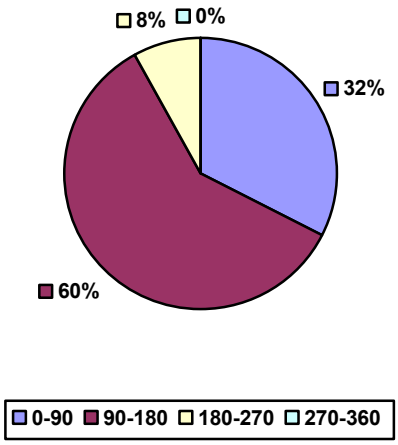


Calm conditions were dominant. However, wave conditions have a limited impact on beachwater quality as represented by *E. coli* levels. It is hypothesized that waves in excess of 3 feet may have a direct impact on beachwater. Further data is needed to verify this hypothesis.

Wave Direction (degrees)
≥235CFU/100mL

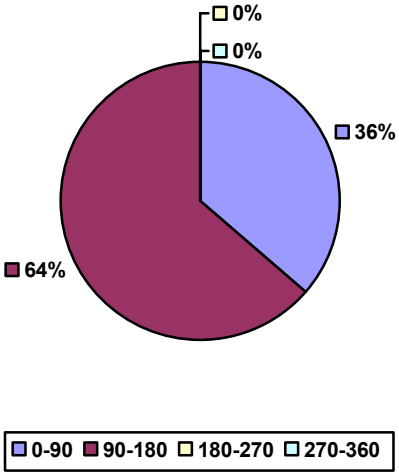


Wave Direction (degrees)
<235CFU/100mL

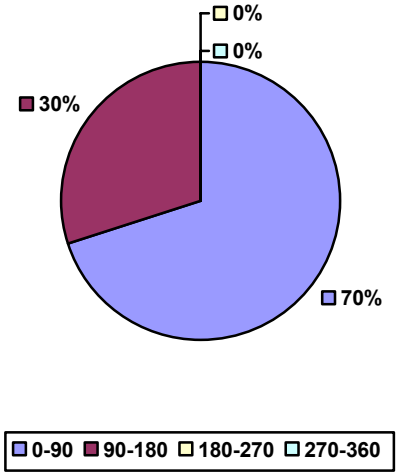


Wave directions alone did not correlate with impacts on beachwater quality. Waves were predominately from 90-180° approximately 60% of the time.

Longshore Current Direction (degrees)
≥235CFU/100mL



Longshore Current Direction (degrees)
<235CFU/100mL



As with wave height and wave direction, the direction of the longshore current does not have a strong correlation with beachwater quality. During the study period longshore current directions were primarily noted from the north or south, while a few days had easterly currents or none at all. Moreover, longshore current was only measured once per day in three lake locations and it is not known if this dynamic condition changes in direction or speed throughout the day. Further data would have to be gathered to validate any relationship between longshore current direction and beachwater quality.

24hr Rainfall (inches) ≥235CFU/100mL			
<0.1075	**≥0.1075 & <0.21**	**≥0.21 & <0.5225**	**≥0.5225**
3	2	3	6
21.4%	14.3%	21.4%	42.9%
24hr Rainfall (inches) <235CFU/100mL			
<0.1075	**≥0.1075 & <0.21**	**≥0.21 & <0.5225**	**≥0.5225**
69	6	7	3
81.2%	7.1%	8.2%	3.5%

24 hour rainfall has a definite impact on beachwater quality. During the days that Upper Lake Park Beach was greater than or equal to 235CFU, rainfall was equal to or exceeded 0.21 inches 64.3% of the time as opposed to 11.7% when the beach was open. Conversely, rainfall was below 0.21 inches 88.3% of the time when the beach was open and 35.7% of the time when an advisory was posted. This analysis supports the use of 24 hour rainfall totals in the 'rain flow' model.

48hr Rainfall (inches) ≥235CFU/100mL			
<0.12	**≥0.12 & <0.28**	**≥0.28 & <0.71**	**≥0.71**
0	0	3	11
0.0%	0.0%	21.4%	78.6%
48hr Rainfall (inches) <235CFU/100mL			
<0.12	**≥0.12 & <0.28**	**≥0.28 & <0.71**	**≥0.71**
58	13	11	3
68.2%	15.3%	12.9%	3.5%

Rainfall was also analyzed for a two day period or 48 hour rainfall. This data set further supports that rainfall had an impact on the quality of beachwater. For example, 78.6% of the days when advisory conditions were present 48 hour rainfall totals were above or equal to 0.71 inches, compared to only 3.5% when beaches were open. Conversely, there were no days when the beach was under an advisory that 48 hour rainfall totals were less then 0.28 inches. 83.5% of the time that 48 hour rainfall was below 0.28 inches, Upper Lake Park Beach was open. This analysis supports the use of 48 hour rainfall totals in the 'rain flow' model.

Valley Creek Flow (MGD) ≥235CFU/100mL			
<0.042	**≥0.042 & <0.18**	**≥0.18 & <0.899**	**≥0.899**
1	1	1	11
7.1%	7.1%	7.1%	78.6%
Valley Creek Flow (MGD) <235CFU/100mL			
<0.042	**≥0.042 & <0.18**	**≥0.18 & <0.899**	**≥0.899**
24	23	24	14
28.2%	27.1%	28.2%	16.5%

The outfall of the nearest adjacent stream was also analyzed. Valley Creek flows above 0.899MGD have a relationship with elevated levels of *E. coli* at Upper Lake Park Beach. Flows above 0.899MGD were present during 78.6% of beach advisory days, while only 16.5% of non-advisory days. This analysis supports the use of daily Valley Creek stream flows in the 'rain flow' model.

Turbidity (NTU) ≥235CFU/100mL			
<0.95	**≥0.95 & <1.6**	**≥1.6 & <3.25**	**≥3.25**
0	0	2	12
0.0%	0.0%	14.3%	85.7%
Turbidity (NTU) <235CFU/100mL			
<0.95	**≥0.95 & <1.6**	**≥1.6 & <3.25**	**≥3.25**
25	23	24	13
29.4%	27.1%	28.2%	15.3%

Analysis of beachwater turbidity revealed 85.7% of the time that the beach was under an advisory, turbidity readings were above 3.25NTU's as opposed to 15.3% when beaches were open. There were also no days when turbidity readings were below 1.6NTU's when the beach was under advisory. This analysis supports the use of beachwater turbidity in the 'rain flow' model.

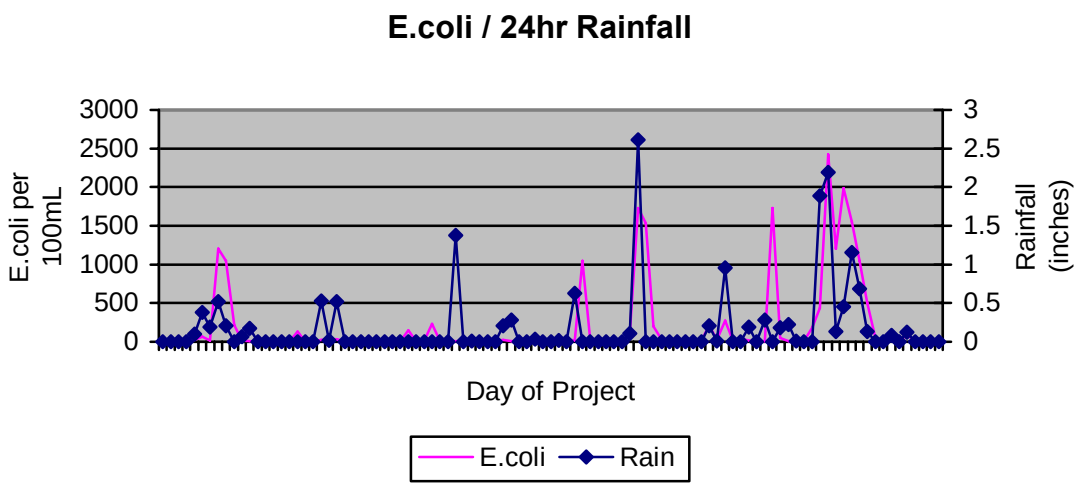
Water Quality Sampling

Beachwater samples were analyzed for the following water quality parameters. Two samples were collected at the northern and southern monitoring locations of the beach. These samples were then combined to make a composite sample for a holistic representation of beachwater quality.

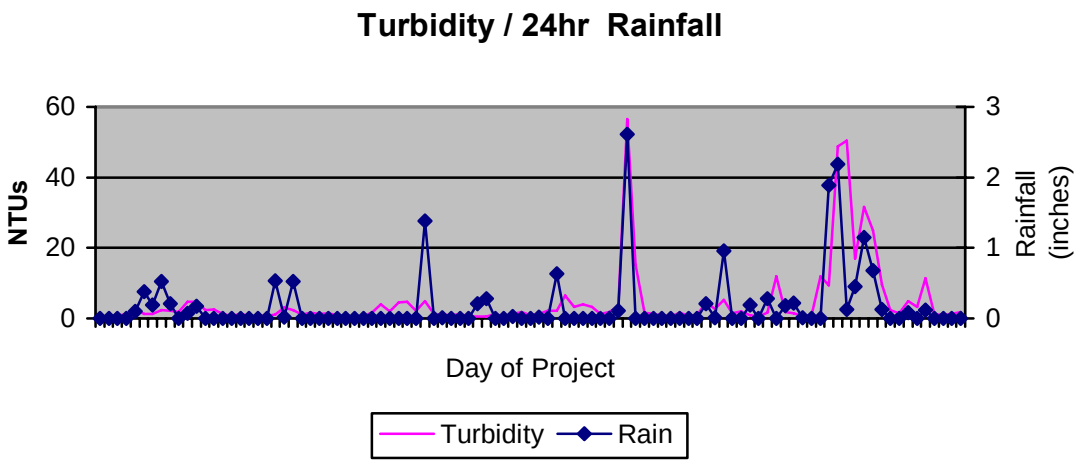
Parameter	Method	Sample Type
E.coli	MPN	Composite
Turbidity	NTU	Composite
Ammonia Nitrogen	Electrode method	Composite
Total Phosphorus	Ascorbic acid method	Composite
Water Temperature	Portable digital thermometer	Single
pH	Portable pH meter (YSI – 100)	Single

Given considerable time and resource constraints, water parameters that were lab analyzed were limited to ammonia nitrogen, total phosphorus, *E.coli* and turbidity. Water temperature and pH were analyzed in the field.

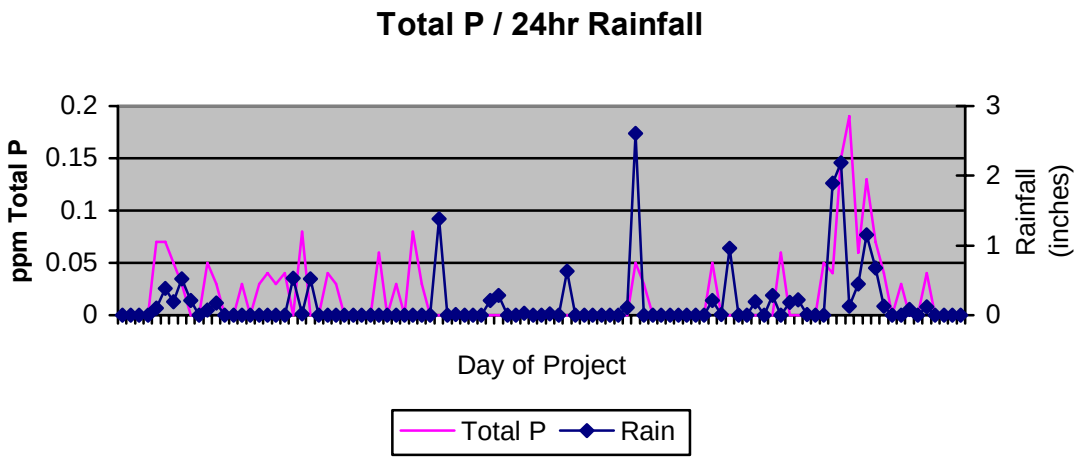
Depicted below are graphs showing the relationship of beachwater parameters to rainfall. Graphs not listed include ammonia nitrogen and water temperature due to their lack of significant correlation.



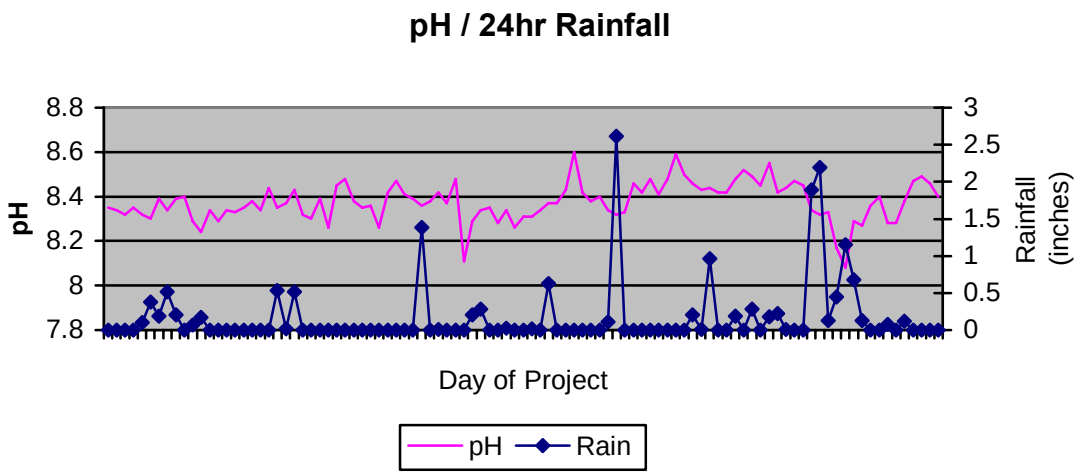
Rainfall can be related to elevations of *E.coli* at Upper Lake Park Beach. Shown in the graph above is rainfall (blue line) and *E.coli* (purple line). Spikes in *E.coli* are almost always preceded by a rain event.



Turbidity is also affected by rainfall. Sediments washing down from Valley Creek, runoff from Upper Lake Park and wave action could explain the increase of turbid water.



Increases of total phosphorus correlate with increases in rainfall.



An analysis of pH shows that the pH of the beachwater has a weak inverse relationship to rainfall.

The table below contains beachwater data analysis correlating water parameters with rainfall.

Parameter	**Correlation to 24hr Rainfall**	**Significance**	**95% Confidence**
E.coli	0.57	Moderate	$0.423 \leq p \leq 0.691$
Turbidity	0.68	Moderately Strong	$0.564 \leq p \leq 0.776$
Ammonia Nitrogen	0.10	Very Weak	$-0.095 \leq p \leq 0.294$
Total Phosphorus	0.39	Weak	$0.206 \leq p \leq 0.542$
Water Temperature	0.11	Very Weak	$-0.091 \leq p \leq 0.298$
pH	-0.22	Weak inverse	$-0.398 \leq p \leq -0.023$

Modeling

No model was used during the project. However, a 'rain flow' model is in development but will require further validation. A computer program is also in development that will determine advisory conditions based on the model's parameters.

The 'rain flow' model that has been developed uses the following parameters; 24 and 48 hour rainfall totals, turbidity of beachwater, and the flow rate of Valley Creek. The 'rain flow' model was developed using the 2007 sanitary survey data. The model predicts beach advisories using the following steps;

1. All data is entered into a computer program.
2. The data is then put into quartiles.
3. Each parameter is weighted based on the significance of Pearsons' r correlation coefficient. The weight of each parameter is as follows;

    1. Turbidity – 4
    2. 48 hr rainfall – 3
    3. Valley Creek flow – 2
    4. 24 hr rainfall – 1

4. These values are then multiplied and then compared to a constant of 2072 which was derived from the 2007 sanitary survey data. If the number is greater or equal to the constant, the model will predict that the beach will be under an advisory.

The 'rain flow' model will take several years to validate. Data gathered from future beach seasons should be incorporated into the model to further improve accuracy and precision.

Advisories / Closures

Upper Lake Park Beach had a total of 17 postings made during the 2007 beach season (May 28th thru September 3rd). The advisories consisted of 12 closures, 2 water quality advisories, and 3 preemptive advisories. Listed below is each advisory and conditions that were present.

Date	Posting	Conditions
6/5/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
6/6/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
7/21/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
7/27/2007	*Advisory*	***Preemptive**, rain* 1732.9CFU/100mL
7/28/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
7/29/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/8/2007	Advisory	Elevated E. coli (≥235CFU 100mL)
8/13/2007	*Advisory*	***Preemptive**, turbidity* 1732.9CFU/100mL
8/14/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/19/2007	*Advisory*	***Preemptive**, rain*, 435.2CFU/100mL
8/20/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/21/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/22/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/23/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/24/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/25/2007	Closure	Elevated E. coli (≥1000CFU 100mL)
8/26/2007	Advisory	Elevated E. coli (≥235CFU 100mL)

These data sets support the development of the 'rain flow' model. On three occasions preemptive advisories were made based on rain related conditions; beaches were closed the following day (see italicized text in table above). Using the persistence model and assuming an 18-24 hour lag of notification, beaches would have remained open when potentially harmful conditions were present.

<235CFU/100mL

≥235CFU/100mL & < 1000CFU/100mL

≥1000CFU/100mL

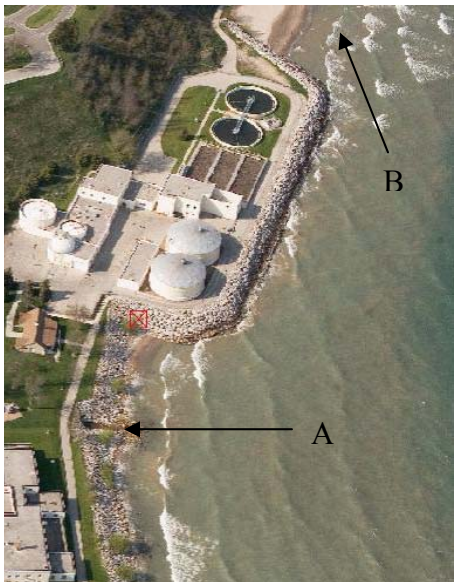
Potential Pollution Sources

Valley Creek and Sauk Creek were identified as two potential sources for bacterial contamination. Samples from each of these creeks yielded elevated levels of *E. coli* bacteria with high frequency. Samples from the Waste Water Treatment Plant did not yield elevated levels of *E. coli* with significant frequency. Three potential sources were identified for nutrient contamination; 1) Valley Creek, 2) Sauk Creek, and 3) the Waste Water Treatment Plant. All three sources have continuous flows or discharge; Sauk Creek had the highest volume, followed by Valley Creek and then the Waste Water Treatment Plant. The Valley Creek outfall is located directly south of Upper Lake Park Beach and outside the harbor. The Sauk Creek outfall and the Waste Water Treatment Plant discharge are both located within the harbor. Sauk Creek flows and discharges from the Waste Water Treatment Plant mix with high volume continuous discharges from the WE Energies Plant. This mixture of waters then must flow outside the breakwater, further mix with ambient surrounding lake water, drift north and mix with Valley Creek outfall flows, and then further drift north past the Waste Water Treatment Plant to have a direct effect on beachwater quality. Due to continuous high volume (.250 MGM) diluting discharges from the WE Energies plant and the impact of surrounding ambient lake water only heavy sustained rainfall events affecting Sauk Creek flows may ever have an impact on beachwater quality. Valley Creek remains as a primary concern for both bacterial and nutrient contamination of Upper Lake Park beachwater.

Listed below is 2007 flow data for Valley Creek, Sauk Creek, and the Waste Water Treatment Plant.

	Valley Creek Flow MGD		**Sauk Creek Flow MGD**		**WWTP Flow MGD**	
Month	**Average**	**Max**	**Average**	**Max**	**Average**	**Max**
May-June	0.372	1.60	3.19	19.90	1.53	2.39
July	1.10	20.60	10.43	97.70	1.37	3.10
August-September	4.21	27.20	30.47	168.40	2.43	6.66

Four arguments give Valley Creek its elevated status of concern; its close proximity to the beach, dye testing showed that Valley Creek outfall flows directly toward the beach vicinity, 76 of 100 Valley Creek water samples had *E. coli* levels that exceeded 235 CFU per 100ml, and the data analyses presented in the information on sampling location, water quality, and potential pollutant source sections of this report.



The aerial photograph to the left shows the proximity of Valley Creek to the beach area. Valley Creek outfall (A) and Upper Lake Park Beach (B) are separated only by the land associated with the Port Washington Waste Water Treatment Plant.

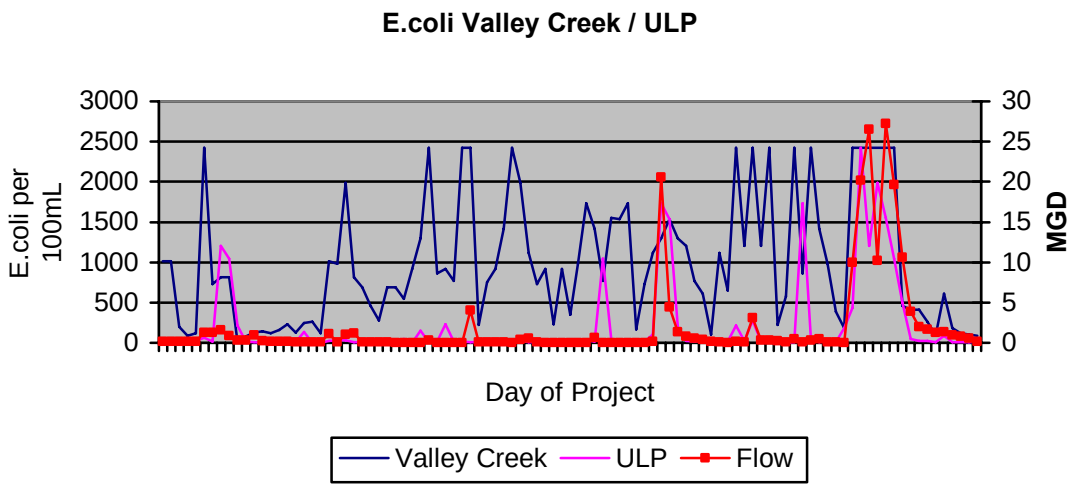
Dye testing was conducted on both Valley and Sauk Creeks on August 7, 2007. Hydrometric conditions present that day were as follows; longshore current had a north flow of 0.22ft/sec. and waves were around one foot out of the southeast. 16 oz. of Norlab Liquid Powder (yellow-green) was used in each creek. The results of dye testing indicate that Valley Creek outfall can drift directly towards the beach area, whereas Sauk Creek outfall was quickly diluted by the adjacent WE Energies power plant discharge.

Valley Creek

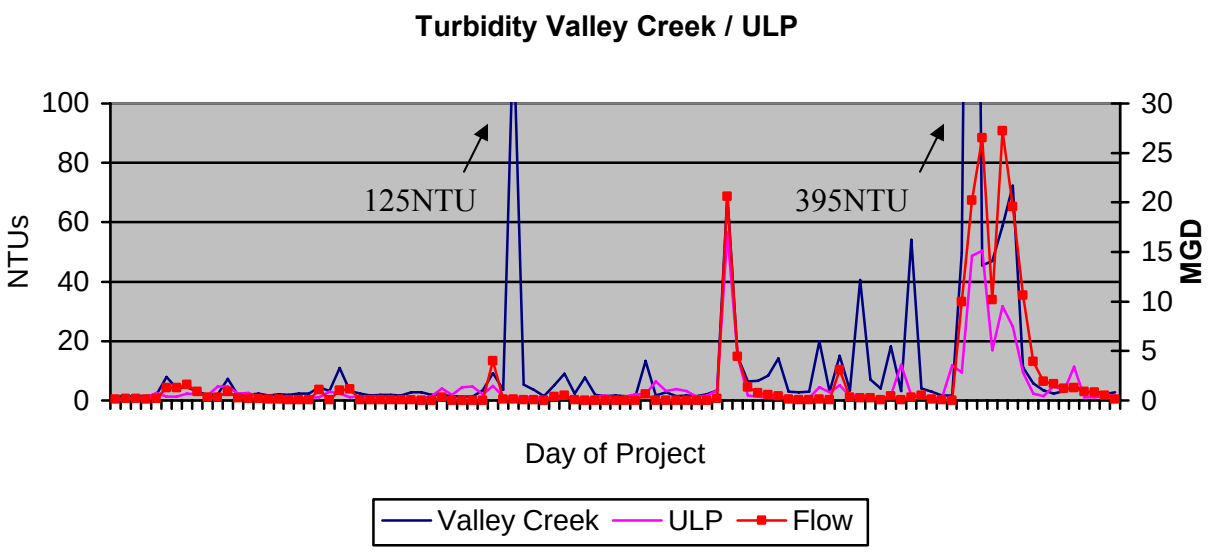
Northeast View

Sauk Creek

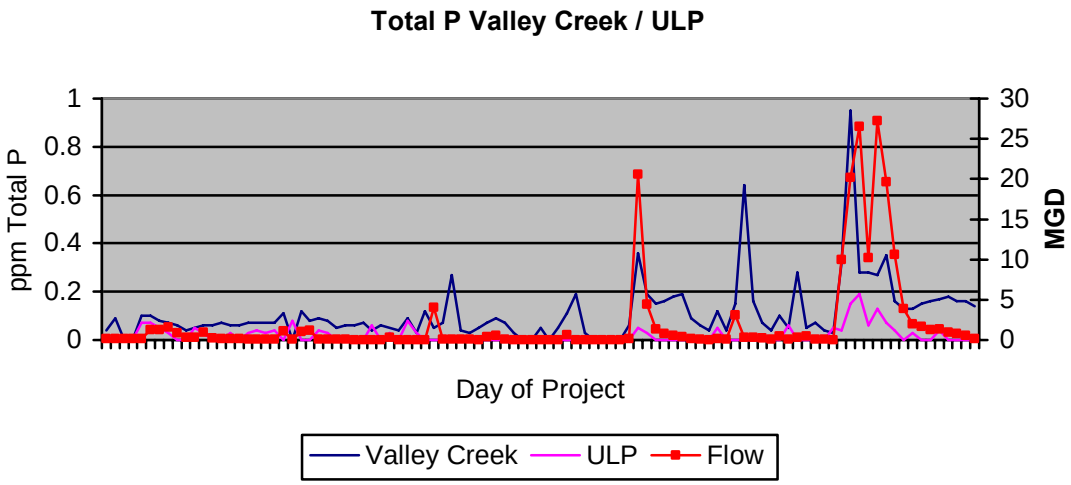
Northeast View



High levels of bacteria alone in Valley Creek do not necessarily contribute to beachwater contamination. Flows must also be above normal rates of 0.04 to 0.90MGD. Spikes in *E.coli* at Upper Lake Park (ULP, purple line) are concurrent with spikes in Valley Creek *E.coli* (blue line) and spikes of Valley Creek flow (red line). Contaminated flows of 0.90MGD and 235CFU can be related to elevated levels of *E. coli* bacteria in beachwater.



As with the relationship of Valley Creek *E.coli* to Upper Lake Park Beach *E.coli*, turbidity at the two locations are dependent on the flow of Valley Creek. Increases of turbidity at Upper Lake Park Beach are concurrent with high flows at Valley Creek.



Consistent with turbidity and *E.coli*, measurable levels of phosphorus are present at Upper Lake Park Beach during high flow events at Valley Creek. Valley Creek and Upper Lake Park Beach often had concentrations near the detection limit of 0.03ppm; any concentration that did not meet this detection limit was reported as 0ppm on the graph above.

Correlations between Valley Creek and Upper Lake Park Beach parameters are listed below:

Parameter	Correlation	Significance	95% Confidence
E.coli	0.35	Weak	$0.165 \leq p \leq 0.512$
Turbidity	0.63	Moderately Strong	$0.494 \leq p \leq 0.735$
Total Phosphorus	0.45	Moderate	$0.277 \leq p \leq .593$

Description of Sanitary Facilities

There were two portable restroom facilities that were within the beach vicinity.

Location	One restroom was located on the walkway down to the beach. The second was located near the parking lot entrance.
Condition	Both restrooms were generally in a sanitary condition although some over turning of restrooms was noted during the study.
Distance from beach	150 and 900 feet
Frequency of cleaning	Restrooms are sanitized, emptied and re-stocked weekly

Due to the lack of permanent sanitary facilities at Upper Lake Park Beach, no analysis or correlations was performed.

Description of Other Facilities

Beach access is limited to two walkways around the Waste Water Treatment Plant.

Location	Around the east and west sides of the Port Washington Waste Water Treatment Plant.
Condition	Both walkways are in good repair, (#1) concrete and (#2) asphalt. (#2) is often littered with small quantities of dog waste.
Distance to beach	#1 = 775 feet #2 = 1,150 feet
Frequency of cleaning	Pet waste bags are available and clean up is the responsibility of dog owners

Due to the lack of facilities at Upper Lake Park Beach, no analysis or correlation was performed.

Overall Summary and Conclusions

Upper Lake Park Beach is a 2,000 foot stretch of public beach located in Port Washington, Wisconsin. The beach area is situated north of the Port Washington Waste Water Treatment Plant and east of Upper Lake Park bluffs. Public access to the beach is limited to two walkways around the treatment plant. A parking lot located south of the treatment plant is available for beach users. There are no permanent sanitary facilities for beach users. Several trash containers are located on and near the beach which City Park staff emptied weekly. The location of the beach relative to the treatment plant and the park bluffs may have hindered public access. Likewise, the lack of facilities at Upper Lake Park Beach may have also hindered its public use.

Beach monitoring commenced at this public beach in 2003 funded by the BEACH Act. Since 2003, these activities have continued to provide advisories to protect public health. The total number of postings has varied year to year.

During the sanitary survey, postings of advisories or closures occurred in response to 17% of sampling events, all of which were related to rainfall. Rainfall affects the flow of two outfall points within the survey area, Valley and Sauk Creek. Samples analyzed from Valley and Sauk Creeks show periodically elevated amounts of *E. coli* bacteria and total phosphorus, usually during rainfall events. During rainfall events increased turbidity was also observed. Unlike the creek outfalls, the Waste Water Treatment Plant discharge is diluted by rainfall due to clear water infiltration from inter-connected storm water pipes.

The primary goal of the U.S. Environmental Protection Agency (EPA) sanitary survey is to determine what the primary sanitary and stormwater impacts are on beachwater quality. Water contaminants flowing from Valley Creek, in conjunction with rainfall appear to have a significant impact on Upper Lake Park Beach water quality.

Steps to Remediation

The EPA Sanitary Survey work group recommends the following steps to remediation.

Source Location	Recommendations
Valley Creek	Complete sanitary survey to: investigate city infrastructure for defects / issues locate contamination point sources Feasibility study
Sauk Creek	Complete sanitary survey to: investigate city/county infrastructure for defects / issues locate contamination point sources Feasibility study Promote public education regarding: conservation buffer strips conservation tillage techniques diverse crop rotation application of organic and chemical fertilizers
City of Port Washington	Implement Beach plan with facilities upgrades i.e. permanent restrooms beach house with showers beach access stairway regular beach cleaning regular beach grooming

Changes to Monitoring and Notification Plan

The only change to the monitoring and notification plan was the frequency of advisories. During the 2007 beach season advisories were made 7 days a week. Previous beach seasons funded by the BEACH Act required 4 or 5 advisories per week for a 'high priority' beach.

The Ozaukee County Public Health Department recommends piloting daily real time advisories using the model developed from the data of the sanitary survey. These real time advisories would be determined using the following data:

Parameter	How to Measure	Standard
Rainfall	Rain Gauge	≥0.21in
NTUs	Portable Analyzer	≥3.25NTUs
Valley Creek Flow	Staff Gauge	TBD*
Wave Height	Wave Stick	≥3ft
Algae	Visual Inspection	≥50% area
Meteorological	Local Weather Station	TBD*

- To be determined

Real time advisories would either leave the beach open or under an advisory condition. Closures would be posted only under adverse conditions. Advisories would be posted on the beachhealth website, the Ozaukee County beach hotline phone number and local signage. Composite water samples would be taken to validate the 'rain flow' model. Advisories would be posted anytime algae area percentages exceeded 50% or during inclement weather.

The Ozaukee County Public Health Department recommends to the EPA that for the 2008 beach season adequate funding be made available to continue the development of the predictive model and to apply real time advisories.

Next Steps

Public information and outreach:

Target Audience	Presentation Type
City of Port Washington - Common Council	PowerPoint
Ozaukee County Health and Human Services Board	PowerPoint
Wisconsin Department of Natural Resources Beach Group	PowerPoint

Recommendations to EPA

We would suggest a general template project proposal, work plan and quality assurance project plan be made available early in the application process specifically for smaller jurisdictions. We would also recommend developing training digital versatile discs (DVD) for both field and lab staff.

The EPA sanitary survey workgroup recommends the development of site specific sanitary survey data sheets, as each sampling location has its own unique characteristics and not all sampling sites are public beaches. We would suggest that trash be separated into human generated trash (plastic, soda cans, food wrappers, etc.) and natural debris (dead fish, mussels, and feathers).

The EPA sanitary survey workgroup would specifically recommend collecting only longshore current direction data. Accurate longshore current speed and direction measurements were difficult and time consuming to obtain.

Lastly the EPA sanitary survey workgroup would like to see the EPA develop a funding schedule based on jurisdiction population size, and allocate project funds accordingly. Continued project funding should be made available to jurisdictions that have demonstrated progress in completing BEACH Act related activities; monitoring, development of a predictive model, source tracking and remediation.

Recommendations to Wisconsin Department of Natural Resources

For some years the WDNR has allocated BEACH Act funds to local health departments for the monitoring and posting of public beaches. This collaboration has been welcomed in Ozaukee County. The WDNR Beach Group has provided leadership, organization, technical focus and much needed funding to local beach programs. In addition, WDNR's collaboration with the U.S. Geological Service for the development and implementation of the Beachhealth website has been a great step forward to inform the public of daily beach advisories and conditions in Wisconsin.

This department has greatly appreciated WDNR efforts to manage the state beach programs. For constructive purposes we would like to highlight the following concerns and put forth some recommendations. From the onset the allocated funding was decreased and then remained at a lower level. This funding situation has affected the overall performance of beach monitoring activities. One ramification has been the decrease in daily sampling activities, initially high priority beaches were sampled five days per week and now that has been reduced to four days per week. Funding considerations have influenced our decisions to eliminate the monitoring of low priority beaches and the opening of new public beaches within our jurisdiction has compounded this financial challenge. Lately, as a way to reduce costs without compromising results, composite water sampling has been discussed.

The sanitary survey workgroup recommends the WDNR develop an internal policy to prioritize BEACH Act funding allocations. Most importantly, we suggest public beaches in the southeast region receive primary funding considerations due to obvious human use issues. We would also recommend that WDNR identify public beaches with obvious sanitary or stormwater impacts and earmark specific funds for the monitoring of those beaches. These actions would basically place funding sources where they are most needed. We believe acting on these recommendations will further protect public health and assist in the development of state beach programs.

The sanitary survey workgroup also is in consensus that not every beach sanitary survey necessarily be conducted as a research project. After years of previous research in many Midwestern communities, we feel the general contaminant nature of storm and sanitary water sources is generally understood. Our point is simply that for some jurisdictions that either lack stormwater controls or have compromised sanitary lines, the beach sanitary surveys should be approached as public utility projects rather than as research projects. In this regard the sanitary survey workgroup feels strongly that the WDNR has a major duty and responsibility within its various to departments to assist in addressing above mentioned conditions. Cooperation between the WDNR and local jurisdictions is essential for the sharing of technical and regulatory information. In addition, WDNR has the knowledge, experience and resources to affect issues which cover broad areas and cross jurisdictional boundaries.

Methods

This section will detail the methods of control, quality assurance / quality control, and the equipment that was used in the Sanitary Survey of Upper Lake Park Beach.

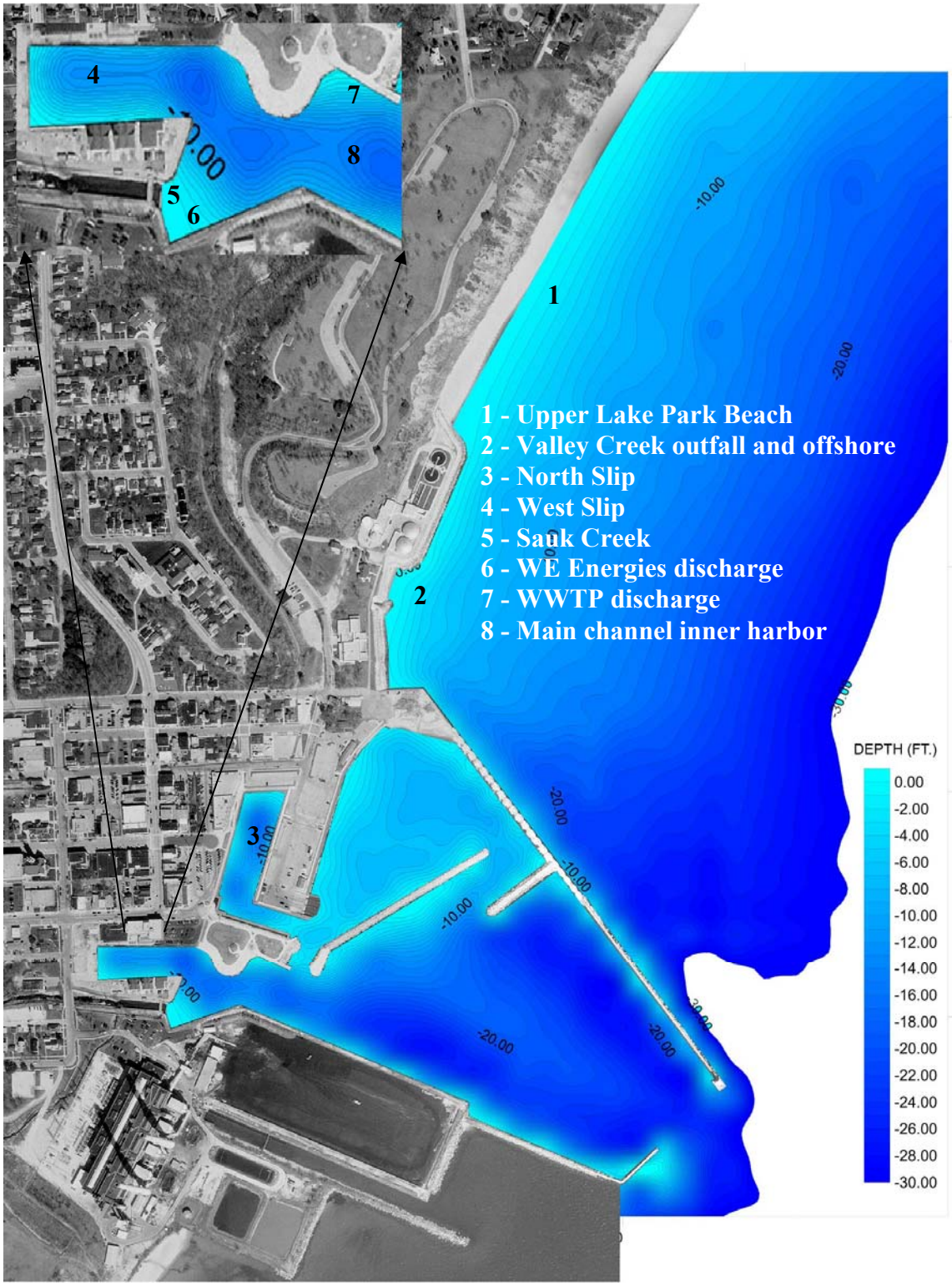
Field Equipment	
Item	**Model Number / Company**
Portable pH meter	YSI-100
Digital thermometer	ERT600
Sludge Judge	CO9247
100mL sterile sample bottles	IDEXX
1L sample bottles preserved with H_2SO_4	Nalgene
Wave stick	Graduated Pole
100ft tape measure	Landscapers Tape
Flow meter	American Sigma 950 Flow Meter
Stopwatch	Lab Safety 7JB-95961
Compass	SUUNTO A-10

Laboratory Equipment	
Item	**Model Number**
Spectrophotometer	Thermo Spectronic Genesys 10VIS
Ammonia probe	Thermo Electron 9512BNWP
Autoclave	Market Forge Sterilmatic
Incubator	Thermo Electron 6LM
Turbidity meter	HACH 2100N

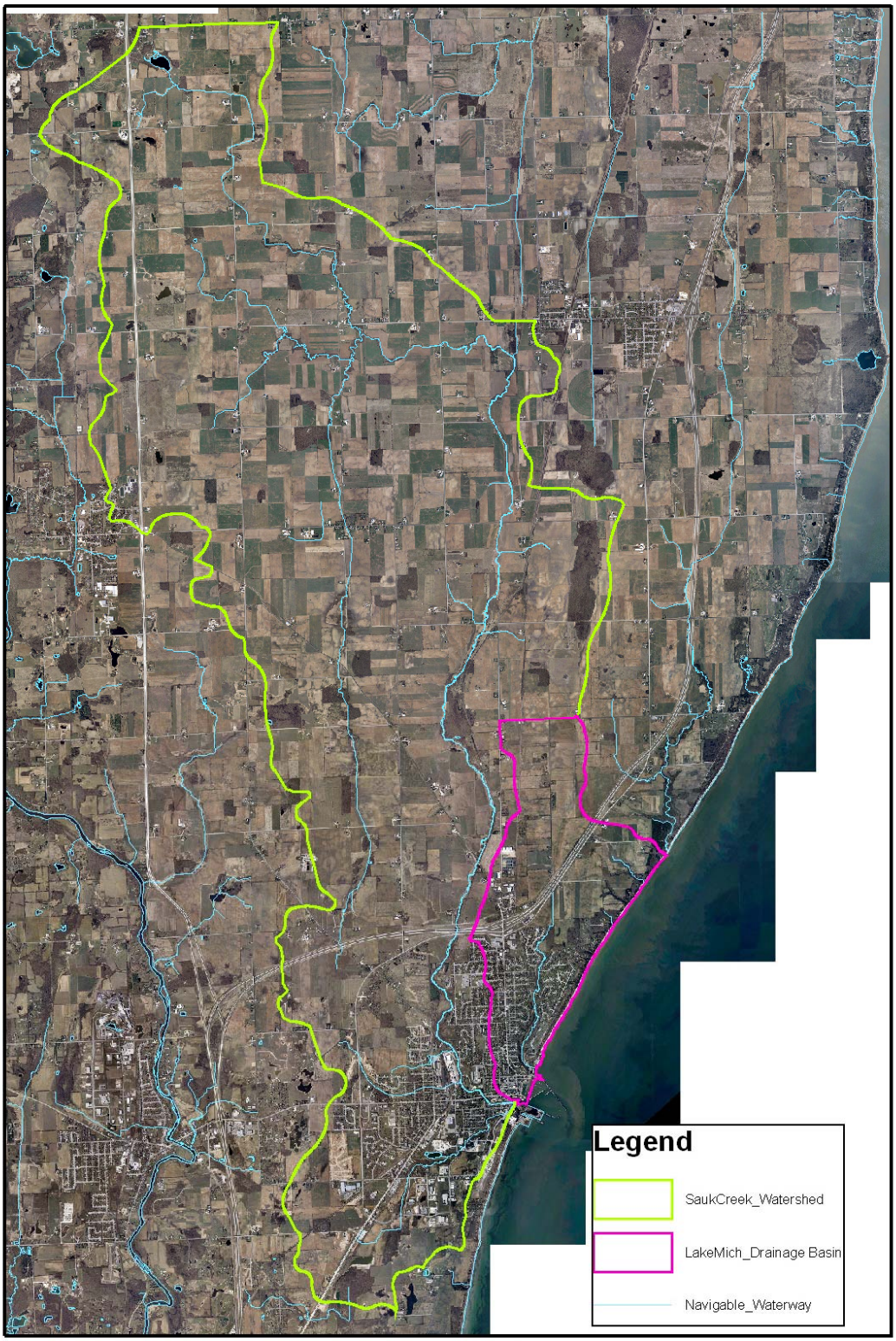
Field Analysis	
Parameter	**Method Used**
E.coli & Turbidity	**Beach sites:** Samples were taken approx 35 yards offshore at a depth of 2ft. **Other locations:** Sample bottles were dipped into water using a pole.
Total Phosphorus and Ammonia Nitrogen	A 1L bottle was rinsed 3 times with sample water, and then poured into the bottle with H_2SO_4.
pH & Temperature	Water was brought from source in a bucket rinsed 3 times with sample water; pH electrode and thermometer were then placed in the water.
Wave Measurement	Wave stick was used for under 3ft; over 3ft wave height was estimated.
Longshore Current	2”x2” Wooden blocks were thrown in the water, and the time was noted it took to flow between a known distance.

Appendix I

Shown below are sampling site locations for the 2007 sanitary survey.



Appendix II



Sauk Creek & Lake Michigan SubBasin
Watershed Map

N

0 0.5 1 2
Miles

Appendix III

N

Sauk Creek & Lake Michigan SubBasin
Watershed Map

0 0.15 0.3 0.6
Miles

Appendix IV

The table below is a correlation matrix of parameters that were measured during the sanitary survey project.

0.01 -- 0.20 Very Weak

0.20 -- 0.40 Weak

0.40 -- 0.60 Moderate

0.60 -- 0.80 Moderately Strong

0.80 -- 1.00 Strong

	24hr rain	48hr rain	E.coli ULP	E.coli Valley Creek	Valley Creek Flow	Turbidity ULP	Turbidity Valley Creek	Wave Height	Wave Direction	Longshore Current Direction	Wind Direction	pH ULP	Total P ULP	Total P Valley Creek	Ammonia Nitrogen ULP	Water Temperature ULP
24hr rain	1.00	N/A	0.57	0.44	0.67	0.68	0.61	0.57	-0.17	-0.11	-0.18	-0.22	0.39	0.58	0.10	0.11
48hr rain		1.00	0.75	0.42	0.79	0.81	0.68	0.51	-0.20	0.02	-0.21	-0.24	0.58	0.71	0.06	0.16
E.coli ULP			1.00	0.33	0.72	0.79	0.59	0.49	-0.13	0.16	-0.26	-0.29	0.61	0.58	0.11	0.24
E.coli Valley Creek				1.00	0.38	0.34	0.34	0.28	-0.13	0.08	0.04	-0.08	0.26	0.35	-0.07	0.17
Valley Creek Flow					1.00	0.90	0.57	0.26	-0.10	-0.14	-0.08	-0.38	0.72	0.61	0.25	0.25
Turbidity ULP						1.00	0.63	0.51	-0.11	-0.07	-0.17	-0.27	0.73	0.63	-0.14	0.22
Turbidity Valley Creek							1.00	0.52	-0.15	-0.12	-0.08	-0.12	0.49	0.79	0.03	0.19
Wave Height								1.00	-0.11	0.02	-0.24	-0.10	0.46	0.50	0.02	0.17
Wave Direction									1.00	0.11	-0.28	-0.12	-0.07	-0.21	0.04	-0.24
Longshore Current Direction										1.00	-0.30	0.02	-0.01	0.08	-0.15	0.06
Wind Direction											1.00	0.13	-0.24	-0.14	-0.11	0.15
pH ULP												1.00	-0.31	-0.10	-0.29	0.45
Total P ULP													1.00	0.45	0.25	0.15
Total P Valley Creek														1.00	0.08	0.30
Ammonia Nitrogen ULP															1.00	0.02
Water Temperature ULP																1.00