



United States  
Environmental Protection  
Agency

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Chicago, IL 60604

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# **2007 Beach Sanitary Survey Great Lakes Pilot Project**

## APPENDIX A:

### Potential Sources of Pollution Reported

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	Storm sewer outfall pipes	Storm Drains	Potential of CSO/ SSO	Pipes (e.g. from aged sewer lines, etc.)	Dischg from industrial outfall	Dischg from WWTP	Storm water runoff from parking area/ impervious surface	Dischg/ drainage from beach	Septic systems	Seeps	RV park or camping area	Inputs from Creek, River, Stream, Channel, Ravine, Tributaries	Agricultural Waste	AFO/ CAFO/ Animal pastures	Rotting animals	Animal fecal material (wildlife, dog manure)	Waterfowl/ Birds (Ducks, Geese)	Gull feces/ gull population	Pigeon colonies	Bather Load	Adjacent drainage pond	Sediments	Sand	Cladophora/ Algae	Poor beach maintenance	Boats/ Marinal Harbor	Golf course	Rainfall	High waves	Turbidity	Recent storms	Current	On-shore winds			
1 Lakewalk, MN, LS	X		X			X	X																					X	X	X					Storm water runoff from the steep terrain of downtown Duluth and Sanitary Sewer Overflows (SSOs) are the primary sources of bacteria for the beach. A holding tank is scheduled to be installed to contain rainwater until Wastewater Treatment Plant (WWTP) can handle extra rainwater. The beach had 5 days under an advisory w/ 3 of the 5 days associated with a significant rain event, one of which had overflow from the sanitary system which popped manhole covers after a 2.4" rain event in the watershed. Without rain or very large waves, the beach generally has very low bacteria counts.	
2 New Duluth, NN, LS	X					X					X				X						X	X				X									Suspect primary source is waterfowl population that are typically in the harbor from ice out in spring through early fall. There are many nesting pairs of geese and ducks that reproduce prolifically. The harbor is also a resting and refueling stop for the migrating geese; thus, increasing the population in fall. Study found that <i>E. coli</i> counts in all samples increased during summer and early fall. Advisories may cover multiple days-sometimes months. Correlation analysis is performed with data collected during the survey. There is no correlation between weather-related factors and bacteria sample results. Bacteria counts do not increase w/rain events, wave events or turbidity levels. There is no correlation between wildlife counts and bacteria sample results, which was evident even though DNA finger-printing suggests otherwise. What is perplexing is that there are 4 beaches along harbor side of Park Point, all of which have large waterfowl populations, but only 3 are under advisory for most of the late summer and early fall. If waterfowl is main contributing factor, why isn't the 4	
3 Barker's Island, WI, LS	X						X	X						X	X	X	X					X		X	X		X							No sanitary facilities at beach. Moderate presence of gulls and geese. Algae is present in nearshore water a low percentage of beach season (1-20%). It's hard to pinpoint exact sources of contamination, but with information gathered for surveys, we can start to eliminate what we previously thought were potential sources of contamination at each beach. Bacteria concentrations appear to correlate with rainfall, although 2007 was a year of extreme drought in this area and rain data was limited.		

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4 Brule River #1, WI, LS								X	X			X				X	X	X										X							No sanitary facilities at beach. Low presence of geese, gulls, and dogs. Septic systems are possibly contributing to <i>E. coli</i> in beach water and Brule River. Nearby agricultural activities can contribute to <i>E. coli</i> in Brule River, which drains directly to beach area. Brule River moves sand and causes significant erosion and movement of beach material. Bacteria concentrations appear to correlate with rainfall, but there are too few data points due to drought conditions in 2007.
5 Brule River #2, WI, LS								X	X			X	X			X	X	X										X							Same as above.
6 Brule River #3, WI, LS							X								X													X							Same as above. In addition, hundreds of dead crickets on beach poses a moderate level of concern as source of pollution.
7 Thompson, WI, LS	X					X	X	X		X					X	X	X							X	X	X									No sanitary facilities at beach. Beach sand is a significant source of <i>E. coli</i> . Found debris and litter on beach very frequently and did not see beach being cleaned all summer. Rain events and beach closures on 8/21/07 and 8/27/07; elevated <i>E. coli</i> levels corresponded with elevated <i>E. coli</i> levels coming from stormwater pipe. Algae cited as being present in the nearshore water in low percent of beach season (1-20%), and on the beach in moderate percent of season (21-50%).
8 Kreher, WI, LS	X					X	X	X							X	X	X							X		X									Bacteria concentrations appear to correlate w/rainfall, air and water temperature, cloud cover, wind speed and direction. There were also correlations between bather density and <i>E. coli</i> levels. Pet waste found on and near beach. On 8/21/07, there were extremely high levels of <i>E. coli</i> ; beach was closed after a rainfall and the outfall pipe near the beach exceeded 2419 <i>E. coli</i> MPN/100 mL. Algae cited as being present on beach in low percent of beach season (1-20%).
9 Maslowski, WI, LS							X	X	X			X			X	X	X					X	X												Beach sand was a moderate source of pollution. Elevated bacteria levels roughly correlated with rainfall, however, the relatively small amount of rainfall in 2007 made these relationships suspect. Algae present on beach in low percentage of beach season (1-20%).
10 Upper Lake Pk, WI, LM	X											X															X								Elevated <i>E. coli</i> levels and total Phosphorous impacting beachwater correlated with rain-generated stormwater from Valley Creek and Sauk Creek watersheds. Specific sources for <i>E. coli</i> and P primarily from urban Valley Creek watershed and secondarily from agricultural Sauk Creek watershed. Little or no correlation between <i>E. coli</i> levels and bather density or number of gulls. Little algae noted. Turbidity correlates with <i>E. coli</i> concentration.

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11 North Beach, WI, LM	X					X	X		X						X		X						X	X		X		X	X	X					Little or no correlation between <i>E. coli</i> levels and bather density or number of gulls. Little or no algae noted. <i>E. coli</i> positively correlated to rainfall, turbidity and wave height. There are 7 permitted discharge points to Lake Michigan and 4 to Root River in Racine. There have been only 5 discharge events since 4/99.						
12 Zoo Beach, WI, LM	X			X		X	X		X						X								X	X		X		X	X	X			X		Near shore currents varied from north the south which means beach could be influenced by stormwater outfalls north and south of beach. Saw evidence of south outfall at English Street influencing water quality w/ south winds. The period of heavy rain in August was responsible for the majority of advisories. Low to moderate amounts of <i>Cladophora</i> noted in 2007. The last major algal bloom was in 2002.						
13 Bender, WI LM			X				X					X			X	X	X						X	X					X	X					Possible sources include subsurface outfalls, seven bridges creek, Oak Creek, beach sands, runoff sites north of beach, WWTP bypasses to Lake Michigan, bathhouses, and shower facilities. Man-made rock boundary creates north-facing cup shaped beach and nearly enclosed south-facing boat launch and marina area. Bounding structure may have a negative effect on water quality. Beach is primarily comprised of coarse to fine sand which is relatively well-sorted. Previous research at other beaches has demonstrated that finer sands tend to be more correlated w/elevated <i>E. coli</i> levels, especially in areas which are continually wetted. Excessive detached <i>Cladophora</i> was sporadic throughout the season.						

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14 Grant Park, WI, LM	X			X	X	X	X		X		X				X		X						X		X			X	X						There are several stormwater outfalls near and around the beach. Some have high <i>E. coli</i> counts, but further investigation is needed. There was a large population of gulls that were consistently on the beach. Regarding seeps, there are 2 areas where trickles of water are discharging out of a steep, bluff face with no apparent source which makes them appear to be groundwater seepage (although further investigation may reveal old infrastructure whose terminal ends have been sheered off due to erosion and are undetectable). This water of unknown origin and occasional very elevated fecal indicator bacteria counts often drain into Lake Michigan. Aging bath house facilities in Grant Park may be a concern, but further investigation is needed. Several drains and pipes have been identified around the beach. Crushed pipes on bluff are main concern. Oak Creek and 7 bridges may contribute to beach pollution depending on lake currents. Grant Park Beach would be an excellent candidate for a non-point source pollution study, as these sources appear to represent a greater relative contribution than either of the tributaries. <i>Cladophora</i> algae blooms were present throughout the beach season. Major blooms consistently present north of beach.
15 Neshotah, WI, LM	X							X	X						X	X	X						X						X						High gull counts. Low to moderate coverage of <i>Cladophora</i> all summer. Turbidity correlates with <i>E. coli</i> concentration.
16 Two Rivers/Point Beach, WI, LM								X	X	X		X			X	X	X						X					X	X				X		Low presence of geese; moderate presence of gulls. Low to moderate coverage of <i>Cladophora</i> all summer. Wind direction, turbidity, and wave height correlate with <i>E. coli</i> . Higher <i>E. coli</i> concentrations obtained from Molash Creek and Silver Creek than beach water.
17 Whitefish Dunes, WI, LM								X							X	X	X						X												Large populations of gulls at this beach. No sanitary facilities. Large stranding of <i>Cladophora</i> ; although algae cited as being present in near shore water and beach in low percentage of beach season (1-20%).
18 Sunset Park, WI, LM	X					X	X	X							X	X	X			X		X	X										X		No sanitary facilities. Due to the number of beach closings, Sunset Park has been added to the 303d list. Recent research has been conducted here for a couple of years to determine source of <i>E. coli</i> in swimming waters. Several pollution sources found including beach sand, runoff from park area, bird populations, and an adjacent drainage pond. Wind speed and direction and air temperature correlate with <i>E. coli</i> . Algae cited as being present in near shore water and beach in low percentage of beach season (1-20%).
19 Deland Park, WI, LM	X						X								X		X						X					X				X	X		Water from outfall often had elevated <i>E. coli</i> concentrations (higher than beach). Longshore current moving north was correlated with <i>E. coli</i> concentration. Low to moderate amounts of <i>Cladophora</i> observed all summer.

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20 General King, WI, LM	X						X									X									X					X					X	Sources unknown at this point. Low bird numbers. Outfall <i>E. coli</i> has been low, although beach <i>E. coli</i> was rarely elevated over course of beach season. Low to moderate amounts of <i>Cladophora</i> observed all summer.		
21 Kohler North, WI, LM							X	X	X					X			X		X						X					X	X						Low to moderate amounts of <i>Cladophora</i> observed all summer.	
22 Rosewood, IL, LM				X									X			X													X								A total of 173 pipe structures were mapped, 44 of which were from sanitary sewer sources; the remainder were stormwater or drainage sources. At time of survey, there was little to no flow in the tributaries (only one pipe had measurable flow).	
23 Jackson Pk (63rd), IL, LM	X			X			X		X								X	X					X	X	X		X		X	X							Results of survey suggest that elevated <i>E. coli</i> concentrations at 63rd Street Beach are caused by non-point source rainwater runoff. The 63rd Street pocket is influenced by a potentially significant bacterial load because of the large land area of rainwater runoff sources. The pocket has a relatively shallow water depth, and a shallow beach and bottom slope, and it has a configuration that may trap water and inhibit entry and mixing of cleaner lake water. Presence of gulls and other birds may contribute to the bacterial load, especially after rainfall and potentially after high wave events.	
24 Tunnel Park, MI, LM												X					X								X				X						X		Four factors were identified which appear to correlate strongly with impaired water quality. Later time of season, precipitation, cloudy weather, and northerly currents seem to indicate a greater probability of higher counts of <i>E. coli</i> . <i>E. coli</i> levels were elevated August 7 and 8, when beach sanitary survey tool was used. The only likely factor associated with this event was the presence of a large bloom of algae. The Ottawa County Health Department (OCHD) theorizes that this algae bloom created an artificial support environment for the proliferation of bacteria. This theory is supported by research which has shown that algae can provide a useful structure for bacterial growth and some level of protection from the bactericidal qualities of ultraviolet light. The decrease in the <i>E. coli</i> count on August 9 coincided with shifting currents which carried the algae away.	
25 Grand Haven City, MI, LM												X					X												X				X	X	X		Four factors were identified which appear to correlate strongly with impaired water quality. Later time of season, precipitation, cloudy weather, and northerly currents seem to indicate a greater probability of higher counts of <i>E. coli</i> .	
26 Grand Haven State Park, MI, LM												X					X												X				X	X	X		Four factors were identified which appear to correlate strongly with impaired water quality. Later time of season, precipitation, cloudy weather, and northerly currents seem to indicate a greater probability of higher counts of <i>E. coli</i> . Grand Haven City Beach and Grand Haven State Park are adjacent to each other and their water quality data are similar.	

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27 Rosy Mound Recreation Area, MI, LM											X						X										X				X	X	X	Four factors were identified which appear to correlate strongly with impaired water quality. Later time of season, precipitation, cloudy weather, and northerly currents seem to indicate a greater probability of higher counts of <i>E. coli</i> .	
28 Onekama, MI, LM											X																			X		X	Further research is needed to identify what, if any, impact weather has on the water quality of this beach.		
29 Sundling Park, MI, LM			X			X			X		X				X		X																	There are several suspected sources of low concern (waterfowl, bather load and septic systems) that require more investigation to determine how Magoon Creek and the Manistee River may impact Sundling and Magoon Creek beaches. The Manistee WWTP is located near the mouth of the Manistee River and has a Combined Sewer Overflow (CSO) system that discharges treated or partially-treated sewage to surface waters when carrying capacity is exceeded. To further assess how the CSOs impact local beaches, more intensive dry and wet weather sampling is required. An industrial discharge pipe located near the beaches was recently extended and had improvements made to minimize the discoloration due to the tannins.	
30 Magoon Creek, MI, LM			X			X			X		X				X		X																	Same as above.	
31 Traverse City State Park Beach	X						X				X				X	X														X			X	<i>E. coli</i> levels at Mitchell Creek were below water quality standards but were high. A large population of ducks is known to congregate on the Creek near its outlet to the Bay.	
32 East Bay Park Beach	X	X						X							X	X	X									X				X				One large storm drain empties into Grand Traverse (GT) Bay at this park and another drains parking area. Another storm drain at south end of park drains the immediate parking area. Beach is extremely shallow for long way out into East GT Bay. The water is warm with ducks, geese and gulls congregating in the area. Survey noted there was no wind or waves, yet water was turbid. Increased turbidity of water was caused by stormwater flow off a drain.	
33 Bryant Park Beach	X	X					X									X	X											X		X				X	Stormwater outfalls are of high concern at this park. Two large storm drains empty into GT Bay at park - one <i>directly</i> into swimming area. During heavy rains, this storm drain has exceeded its capacity resulting in water flooding out of dislodged covers.

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34 Norwood Park, MI, LM																X												X						X	Elevated <i>E. coli</i> levels in previous years may have been associated with rain events and strong on-shore winds. Weather conditions throughout the bathing beach season appear to have a significant influence on the occurrence, frequency and quantity of bacteria in the surface water environment. However, the 2007 data does not demonstrate a direct correlation between temporal weather conditions and occurrence of elevated levels of bacteria, but there were fewer rain events during the summer of 2007 in comparison to previous years. No obvious sources of pollution were identified due in part to the relatively dry summer conditions. Evaluation of land use patterns show that the watershed is 23% forested, 19% wetland, 24% agricultural, 31% residential, 3% industrial, and 21% commercial.
35 Cross Village, MI, LM								X																			X							X	Same as above, except that evaluation of land use patterns show that the watershed is 32% forested, 20% wetland, 37% agricultural, 14% residential, 1% industrial, and 22% commercial.
36 Wilderness St. Pk, MI, LM															X		X	X									X							X	Same as above.
37 Mackinaw City, MI, LM	X	X														X	X										X							X	Presence of waterfowl has been identified as a source of contamination. Additional efforts can be used to emphasize the importance of not feeding the birds and monitoring the population of birds. Numerous storm drain outfalls have been identified and are thought to impact this beach during rain events.
38 Henes Park, MI, LM																X	X																		A seasonal bird population was identified as a source of contamination. This is the most probable cause of the high <i>E. coli</i> levels in the beach water. A park employee reported that the geese come to the park each year during molting season. The Michigan DNR traps and tag the geese because there is such a high population during this time of year. Looking back at past years, Henes Park has always had closures around last week of July/early Aug which correlates to the reported molting season. Land use does not appear to correlate with bacteria sample results. The Utopia and Turtle Creek Inlet was investigated as another source. Sampling showed that upstream properties served by on-site sewage treatment/disposal systems were not a contributing source of contamination.
39 Sugar Island, MI, St. Mary's River						X		X														X					X								Sault Ste Marie Ontario East End Sewage Treatment Plant previously operated as a primary treatment facility, releasing partially treated sewage into the St. Mary's River. Significant improvements have been implemented and water quality has improved.

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40 Starlite, MI, LH		X														X	X											X					X	X	It has been observed that heavy rainfall within 24 hours of sampling will often result in higher bacteria counts. However, this is not always the case and more investigative work needs to be done. Identified sources include a storm drain at the south end of the beach and on-shore winds that tend to limit water circulation.
41 Dyer Rd., MI, LH							X				X																	X							Postings appeared to follow rain events in previous years but the summer of 2007 was relatively dry. No sources were identified, but future investigations would include the impact that rainfall and run-off have on this beach because it is located at the end of a road.
42 Singing Bridge, MI, LH		X				X					X	X			X																				East Branch of Au Gres River was created and named "Whitney Drain" to drain agricultural areas. The Whitney Drain has agricultural, man-made, and other inputs. Drain ultimately flows to Lake Huron via this beach.
43 Twining Rd., MI, LH						X		X																				X							Postings appeared to follow rain events in previous years but the summer of 2007 was relatively dry. No sources were identified, but future investigations would include the impact that rainfall and run-off have on this beach because it is located at the end of a road.
44 Whites Beach, MI, LH						X		X																				X							Postings appeared to follow rain events in previous years but the summer of 2007 was relatively dry. This beach is located at the end of a road in a small, residential neighborhood. No sources were identified, but future investigations would include the impact that rainfall and run-off have on this beach because it is located at the end of a road. Future investigations would also include septic system inspections.
45 South Linwood, MI, LH											X													X											River and storm water influences need to be investigated further. Data from 2007 indicate that CSOs are not sources of contamination. Determinations were difficult due to weather conditions in summer of 2007 which were relatively dry in comparison to previous summers.
46 Brissette Beach, MI, LH											X																								Same as above.
47 Bay City, MI, LH			X			X		X			X	X												X											Same as above. Source tracking data from MichiganState University showed that contamination was from human and bovine sources.
48 Wenona Beach, MI, LH											X													X											River and storm water influences need to be investigated further. Data from 2007 indicate that CSOs are not sources of contamination. Determinations were difficult due to weather conditions in summer of 2007 were relatively dry in comparison to previous summers.
49 Pier Pk, MI, Lake St. Clair		X				X										X	X											X					X		Geography of the beach is part of a small bay that under certain conditions, can have minimal water circulation. Data from 2007 indicate that CSOs are not sources of contamination. There are possible stormwater influences at this beach that need further investigation.

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50 Presque Isle Beach 2, PA, LE											X				X	X	X							X					X	X					Have not identified precise sources. We know tributaries west of Presque Isle are transporting contamination which likely moves to beaches by rapid, lateral transport of water in surf zone. There's evidence contamination is sequestered in pockets of stagnant water rich in <i>Cladophora</i> behind the breakwaters adjacent to Beach 2. This beach has a more shore-normal circulation pattern so material brought into the cell may have longer residence time than it would without breakwaters and groins. <i>Cladophora</i> accumulates in thick mats. Material has to wait until it can be re-exported offshore between breakwaters likely due to pronounced wave refraction and diffraction caused by breakwater-groin combination which forces debris to accumulate in the beach's central bay. During advisories, water turbid w/ disbursed <i>Cladophora</i> has appearance of dilute "lettuce soup." The percent contribution of Bacteriodes content in the beach water provides strong support that human dependent pollution is greater on this beach, most likely being transported from tributaries to the west of the park.
51 Presque Isle Beach 10 (Budny) PA, LE											X					X	X																		Beach 10 always has more birds on breakwaters than Beach 2. Very effective at flushing itself with both sides of cell showing the same current direction. Material or bacteria-rich water gets flushed down the coast relatively fast.
52 Evans Town, NY, LE	X								X		X																X	X						X	Sampling showed high <i>E. coli</i> levels (2,700 - >10,000 CFU /100 mL) in rain event-generated flows from adjacent streams and several nearby storm sewer outlets on shoreline. On one stream, the sanitary survey identified a network of beaver dams that were unexpected. It is assumed that the beaver dams catch and concentrate fecal matter from both the beavers and other sources upstream of the dams and discharge the concentrated bacterial contamination during rain events. The beaver dams provide treatment and reduce the level of contamination by allowing the contamination to settle out in the large impoundments behind the dam. The water flowing over the beaver dam spillway is not the flow that just entered. The flow out entered previously which allowed time for a significant amount of contamination to settle out. Problem is that the contributions from the beaver and other sources cannot be differentiated with the <i>E. coli</i> testing used for this project. No septic system problems have been identified as direct contributors of bacterial contamination to the beaches or streams. This does not rule them out as possible sources of bacterial contamination from storm sewers.

APPENDIX A: Potential Sources of Pollution Reported

Beach, State, Great Lake	Potential Sources of Pollution																												Potential Cause of Exceedance							Comments
	Storm sewer outfall pipes	Storm Drains	Potential of CSO/ SSO	Pipes (e.g. from aged sewer lines, etc.)	Dischg from industrial outfall	Dischg from WWTP	Storm water runoff from parking area	Storm water runoff from beach	Dischg/ drainage from wetlands	Septic systems	Seeps	RV park or camping area	Inputs from Creek, River, Stream, Channel, Ravine, Tributaries	Agricultural Waste	AFO/ CAFO/ Animal pastures	Rotting animals	Animal fecal material (wildlife, dog manure)	Waterfowl/ Birds (Ducks, Geese)	Gull feces/ gull population	Pigeon colonies	Bather Load	Adjacent drainage pond	Sediments	Sand	Cladophora/ Algae	Poor beach maintenance	Boats/ Marina/ Harbor	Golf course	Rainfall	High waves	Turbidity	Recent storms	Current	On-shore winds		
53 Lake Erie, NY, LE	X								X			X																	X	X					X	Same as above.
54 Fair Haven, NY, LO	X		X			X			X			X	X	X		X	X	X					X		X		X		X	X						Primary concern: SPDES sites and waterfowl. Moderate concern: unsewered residential areas, agricultural runoff, stormwater outfalls and Zapala Onion Farm (complaints re: decomposing onions floating down Sterling Creek). Citizens' watchdog group to conduct weekly water quality monitoring of Sterling Creek in 2008.
55 Selkirk Shores, NY, LO			X					X				X	X	X		X	X	X							X			X				X				Primary pollution sources: algae, birds and Grindstone Creek (agriculture & wildlife).
56 Sandy Island, NY, LO			X			X			X					X		X																				Excellent water quality at this beach. It is anticipated that the large quantities of wetlands in the watershed are acting as filters keeping any pollution from agricultural areas from reaching the beach.
57 Bayfield Main Beach, CN, LH	X					X						X					X	X							X		X					X				
58 Bayfield South Beach, CN, LH						X						X					X	X							X		X					X				
59 Goderich Main Beach, CN, LH						X						X					X	X							X		X					X				
60 Goderich St. Christopher's Beach, CN, LH						X						X					X	X							X		X					X				
61 Goderich Cove Beach, CN, LH						X						X					X	X							X		X					X				

## APPENDIX B:

### Recommended Remediation Measures

APPENDIX B: Recommended Remediation Measures

Recommended Remediation Measures / Beach Improvement Actions / Costs																														Impact remediation measures would have on beaches	Comments
Beach, State, Great Lake	Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wires, oil eggs, lasers)	Reduce/divert filter runoff (e.g. to vegetated area)	Install swales or rain gardens/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of previous surface	Stormwater infrastructure improvements	Control of outfalls and stormwater runoff	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Groundboom	Install Smart Sponges (eat E. coli)	Remove tile to improve circulation	Better beach maintenance	Removal of fecal material at beaches	Removal of algae or other aquatic plants	Beach Raking	Beach grooming	Public education/Adopt-a-Beach/Behavior Change	Ban on Phosphorus-based fertilizers	Sanitary surveys and/or Source Tracking	Costs	Plans to implement remediation measures?						
1 Lakewalk, MN, LS						X	X	X																	X	We will continue to work with City of Duluth and the Western Lake Superior Sanitary District (WLSSD) to lessen the effects of large rain events on this beach. Beach affected by Sanitary Sewer Overflows (SSOs) but scheduled to have holding tanks installed by 2013 to contain stormwater until Wastewater Treatment Plant (WWTP) can handle extra volume.	The public pushed to have faster remediation of the SSO issue within Duluth. Under the Plan of Action for the Administrative Order (AO), 3 holding tanks will be installed. These actions will reduce the number of SSOs in the Duluth area and amount of untreated sewage reaching Lake Superior.	Since implementation of the beach program, SSOs have become a big concern of the public, which pushed to have faster remediation. Duluth and WLSSD have a 12 year Plan of Action per the 2004 EPA AO to eliminate SSOs. Additional infiltration and inflow (I/I) source reduction through implementation of the service lateral repair program will begin in 2014 and continue through 2015. We have had discussions with Duluth Public Works (DPW) to test and survey the storm sewer lines that discharge directly to this beach. Beach program staff will work with the DPW staff to continue source tracking of bacteria in the stormwater system.			

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		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire mesh, etc.)	Reduce/divert/ filter runoff (e.g., no vegetated area; install swales or rain gardens)/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Smart Sponges	Remove litter to improve circulation	Better beach maintenance	Removal of illegal material at beaches	Beach Raking	Beach grooming	Public Education/Adopt-a-Beach/Behavior Change	Sanitary surveys and/or Source Tracking								
2	New Duluth, MN, LS																							X		Not at that point yet.		The New Duluth Boat Club (NDBC) beach advisories are a concern to the instructors and students that use the site for aquatic recreation classes. Stormwater and sanitary sewers have already been investigated at the NDBC facility. We will continue discussions with City of Duluth and WLSSD about possibility that treated effluent may be source of some of the advisories. Because it's not a heavily used beach, not likely typical waterfowl removal methods will be used. Beach is included in the 2006 MN 303(d) Total Maximum Daily Load (TMDL) list affecting aquatic recreation for the lower harbor. Listing scheduled to begin in 2012 and completed by 2021. The MN beach program staff will continue to work with ongoing research projects in the area related to bacteria in the sediments, on the periphyton, and rapid test methods. Program staff will also be involved in the TMDL development and implementation.
3	Barker's Island, WI, LS							X						X				X								Feasibility has to be discussed in areas where surveys were performed once study and analysis is complete.	Would decrease <i>E. coli</i> levels and decrease advisories/closures.	Some counties, such as Door, have used municipal funds and coastal zone management grants to improve water quality at their beaches.
4	Brule River #1, WI, LS							X						X	X			X								Not yet.	Same as above.	
5	Brule River #2, WI, LS							X						X	X			X								Not yet, but season ended less than 1 month ago.	Same as above.	
6	Brule River #3, WI, LS							X						X	X			X								Same as above.	Same as above.	
7	Thompson, WI, LS			X				X						X	X			X								Same as above.	Same as above.	
8	Kreher, WI, LS			X				X						X	X			X								Same as above.	Same as above.	
9	Maslowski, WI, LS																	X								Same as above.	Same as above.	

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Beach, State, Great Lake		Recommended Remediation Measures / Beach Improvement Actions / Costs																							Costs	Plans to implement remediation measures?	Impact remediation measures would have on beaches	Comments
		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire, etc. to kill eggs, larvae)	Reduce/divert/ filter runoff (e.g., to vegetated area)	Install swales or rain gardens/ SW BMPs	Planting of native grass/ native vegetation	Reverse orientation of each	Removal of previous surface	Stormwater infrastructure improvements	Control of outfalls and stormwater runoff	Improvements to monitoring of WWTP	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Groundboom	Remove/treat to improve circulation	Better beach maintenance	Removal of calcium material at beaches	Beach Raking	Beach grooming	Public Education/Adopt-a-Beach/Behavior Change	Ban on Phosphorus-based fertilizers	Sanitary surveys and/or Source Tracking					
10	Upper Lake Pk, WI, LM				X			X	X				X							X			X	\$30,000 estimate for complete survey of Valley Creek watershed.	If financial assistance is made available and partners agree.	Education and outreach activities are necessary first steps in a jurisdiction without a stormwater management program. Follow up sanitary surveys establish pre conditions that lead to actual infrastructure construction. In the long run, the overall impact on the beach will be positive.	A complete sanitary survey of the Valley Creek watershed is recommended to identify possible sources of contamination. Once specific sources are identified, appropriate remediation measures can be reviewed and evaluated.	
11	North Beach, WI, LM	X		X	X			X	X							X	X	X	X	X				Underground primary treatment system: \$750,000; native wetland plants: \$500 (planting time donated); \$1500 per sign; beach grooming: \$0 (method of grooming was revised).	Already implemented several measures. Recreational water quality advisories reached a record high in 2000 (66% of season) but have improved due to improved beach management, remediation, and public education. 2007 was the first year to post consecutive years with less than 5 advisories. No single measure significantly reduced advisories, but in combination have worked well. The Mayor of Racine recently banned the sale of phosphorus fertilizers.	Estimate that additional measures would reduce water quality advisory days by one or two days per year. Note that remediation measures previously implemented resulted in a reduction of postings from 2/3 of the season to less than five.	Beach grooming/grading done to improve drainage and promote drying of sands after rain events. When snow fencing is removed each spring, sand is leveled to create a slope towards water's edge. Swales are removed which could retain water on the shore, and a sufficient berm crest is maintained to prevent extensive on-shore encroachment of waves. A primary underground treatment system and wetland area (infiltration/evaporation basins with native wetland plants) has been installed to treat stormwater and these stormwater management practices remain beneficial. Bank stabilization improvements and buffers have been installed along the bike path. It is important to remain vigilant even at beaches which are well-managed because conditions can change from year to year. It is also valuable at this beach to continually assess water stormwater quality as a means to monitor stormwater infrastructure.	

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Beach, State, Great Lake	Recommended Remediation Measures / Beach Improvement Actions / Costs																					Costs	Plans to implement remediation measures?	Impact remediation measures would have on beaches	Comments	
	Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire mesh, oil eggs, lasers)	Reduce/divert/filter runoff (e.g., to vegetated area)	Install swales or rain gardens/ SW BMPs	Planting of native grass/ native vegetation	Reverse orientation of beach	Removal of debris	Stormwater infrastructure improvements	Control of outfalls and stormwater runoff	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Groundboom	Install Smart Sponges	Remove filter to improve circulation	Better beach maintenance	Removal of illegal material at beaches	Beach Raking	Beach grooming	Public Education/ Adopt-a-Beach/ Behavior Change (encourage clean up, no feeding wildlife)	Ban on Phosphorus-based fertilizers					Sanitary Sweeps and/or Source Tracking
12 Zoo Beach, WI, LM	X		X	X			X	X							X		X		X	X	X		Same as above.	Already implemented several measures. Recreational water quality advisories reached a record high in 2000 (42% of season) but have improved due to better beach management, public education and remediation. Combination of tactics worked to address both wet and dry weather concerns.	Same as above.	Beach grooming practices have been altered to reduce <i>E. coli</i> content in beach sands making less available for transport to Lake Michigan. Bluff has been stabilized, removing hard-packed earth, scrub trees, and invasive species replaced with native plants. Bike path has slight incline towards bluff (versus beach) to reduce run-off. Beach sands are leveled after winter and all swales removed. Stormwater from outfall closest to beach now passes through wetland area before entering lake.
13 Bender, WI LM		X			X							X		X		X					X			Will recommend remediation options to the Oak Creek Health Department at conclusion of study.	Could significantly decrease the number of water quality advisories/beach closures.	For algae removal, could explore use of a barrier approach in conjunction with chemical treatment. Will explore possibility of reversing orientation of beach ( <i>i.e.</i> , marina to beach side and beach to marina side).
14 Grant Park, WI, LM		X	X				X			X				X		X					X	X		We will recommend options to the South Milwaukee Health Department at conclusion of study.	Same as above.	Algae could potentially be linked to high phosphorus levels.
15 Neshotah, WI, LM		X												X	X	X		X	X					Not yet, but season ended less than 1 month ago.	Would decrease <i>E. coli</i> levels and decrease advisories/closures.	Need to determine source of <i>E. coli</i> from outfalls (DNA fingerprinting is underway).
16 Point Beach, WI, LM																								No steps to remediate sources have been taken as no specific sources have been identified.	Same as above.	Same as above.
17 Whitefish Dunes, WI, LM														X	X	X		X						Same as above.	Would decrease detectable <i>E. coli</i> levels and number of advisories/closures.	

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Recommended Remediation Measures / Beach Improvement Actions / Costs																											
Beach, State, Great Lake	Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire mesh, oil eggs, lasers)	Reduced/divert/filter runoff (e.g., oil vegetated area)	Planting of dune grass/native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Improvements to monitoring of WWTP	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Gunderboom	Install Smart Sponges (eat E. coli) at SW outfalls	Better beach maintenance	Removal of fecal material at beaches	Removal of algae or other aquatic plants	Beach Raking	Beach grooming	Public Education/Adopt-a-Beach/Behavior Change	Ban on Phosphorus-based fertilizers	Sanitary surveys and/or Source Tracking	Costs	Plans to implement remediation measures?	Impact remediation measures would have on beaches	Comments	
18 Sunset Park, WI, LM			X	X	X																			Redesign is modular in nature and could be done in phases at a cost of approximately \$98,000 - \$250,000. Much depends on the options selected and involvement of community groups in the activity.	Conceptual designs have been prepared for the redesign of this beach and final engineered drawings are being prepared. Meetings have been held with Wisconsin regulatory agencies and permitting for the project does not appear to be a problem.	Redesigned beach would not only provide for cleaner, healthier water, but a better, more natural, and aesthetically pleasing beach area for all beach users.	Conceptual redesign plans include a natural and sustainable approach to the beach to improve water quality: beach nourishment, native plantings to discourage waterfowl, planting trees to discourage geese congregation, changing angle of the beach to maximize interaction with long shore currents, planting of dune grass in small dunes in upper beach, and increasing natural runoff and stormwater infiltration prior to it reaching the beach area, and addressing subsurface movement of E. coli contaminated water from the drainage pond to the beach.
19 Deland Park, WI, LM																X								Same as above.	Same as above.		
20 General King, WI, LM																X										Beach contamination sources unknown at this point. Low bird numbers. Outfall E. coli has been low, although beach E. coli was rarely elevated over course of beach season.	
21 Kohler Andrae State Park North Beach, WI, LM																										No beach contamination sources identified at this time. Conducted sand sampling and spatial sampling of beach water (depth and length of beach).	

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		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wires, etc. to scare birds)	Reduce/divert/ filter runoff (e.g., to vegetated area)	install swales or rain gardens/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Improvements to monitoring of WWTP	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Gunderboom	Install Smart Sponges (eat E. coli) at SW outfalls	Better beach maintenance	Removal of fecal material at beaches	Removal of algae or other aquatic plants	Beach Raking	Beach grooming	Public Education/ Adopt-a-Beach/ Behavior Change (encourage clean up, no feeding wildlife)	Ban on Phosphorus-based fertilizers	Sanitary Surveys and/or Source Tracking																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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29 Sundling Park, MI, LM	X	X														X				X		X	Approximately \$2 million spent on design improvements and an extension of a discharge pipe to minimize discoloration due to tannins. An unknown amount is needed to eliminate overflow events from the Manistee WWTP.	The Long-Term Control Plan (LTCP) (sewer separation project) being implemented is included in the permit which requires elimination of overflows from River St./Jones St. outfall (#014) by 12/31/2011, and elimination of overflows from the remaining 3 outfalls by 12/31/2016. Sundling is near Magoon and both are near an effluent discharge. Recently, the effluent discharge pipe was extended from 1,000 ft in 40 feet of water to 2 miles in 80 feet of water. Residents complained about dark colored discharge at the beach and tourists would leave when told it was from an industrial discharge.		Further studies are required to determine how water from Magoon Creek impacts Sundling and Magoon Creek beaches. Suspected sources of low concern (waterfowl, bather load and septic systems) require more intense investigation to determine what possible impact they may have on the beach water quality. The Manistee WWTP has a CSO system that discharges untreated or partially-treated sewage to surface waters when carrying capacity is exceeded. To further assess how the CSOs impact local beaches, more intensive dry and wet weather sampling is required.		
30 Magoon Creek, MI, LM	X	X														X			X		X	Same as above.	Same as above.		Same as above.			
31 Traverse City State Park Beach	X		X										X						X		X	Public Education: \$70,000-\$100,000; Sanitary Survey: \$65,000-\$85,000; Stormwater Improvements: \$5 million to \$8 million. Recent demonstration projects by Traverse City ranged from \$50,000 to \$80,000 each. With approximately 100 stormwater outfalls in Traverse City, an estimated investment of \$5 million to \$8 million is needed to implement water quality improvement projects.	Yes. But first need to know cause of contamination.	Yes, on sources that we can address. But where source is from strong onshore winds kicking up E. coli in sediment, remediation measures would not have much impact on beaches.	E. coli has become a "hot button" Issue in this area and has received a great deal of attention. Citizens are calling upon community leaders to take action. Tourism income is a key source of economy and we realize that without clean water and clean beaches, tourists might go elsewhere.			

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	Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire mesh, egg traps)	Reduce/divert/filter runoff (e.g., no vegetated area; install swales or rain gardens)/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Improvements to monitoring of WWTP	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Gunderboom	Install Smart Sponges (eat E. coli)	Better beach maintenance	Removal of fecal material at beaches	Removal of algae or other aquatic plants	Beach Raking	Beach grooming	Public education/ Adopt-a-Beach/ Behavior Change (encourage clean up, no feeding wildlife)					Sanitary Surveys and/or Source Tracking
32 East Bay Park Beach	X		X										X						X		X	Same as above.	Same as above.	Same as above.	A key question is: Does the <i>E. coli</i> that lives in the beach sediments and occurs in high numbers during strong onshore winds, indicate the presence of other pathogens harmful to humans, or is it just non-harmful <i>E. coli</i> ? The answer to this question would allow agencies to better determine the efficiency of issuing advisories for beaches that exhibit high <i>E. coli</i> levels during strong onshore winds.
33 Bryant Park Beach	X		X										X						X		X	Same as above.	Same as above.	Same as above.	For example, there is a storm drain outfall at Bryant Park that discharges high amounts of <i>E. coli</i> into the water during rain events; however, we don't know where the <i>E. coli</i> is coming from. It could be waterfowl or dog feces in residential neighborhoods washing into the storm drain, it could be illicit sewer connections, or a dead animal decomposing in the drain - or a mixture of all these sources.
34 Norwood Park, MI, LM																					Unknown	Continue monitoring and possibly sanitary survey work as funding allows for a few consecutive years to gain better understanding of changes in water quality.			
35 Cross Village, MI, LM		X												X	X	X	X				Unknown	Same as above.		No steps to remediation were identified during 2007 beach season, but measures listed have been shown to be effective methods of reducing <i>E. coli</i> at several area beaches.	
36 Wilderness St. Pk, MI, LM		X												X		X					\$8-12,000	Other methods have been proposed to discourage waterfowl congregation on beaches.			

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	Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire, egg, oil eggs, lasers)	Reduce/divert/filter runoff (e.g., to vegetated area; install swales or rain gardens)/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Improvements to monitoring of WWTP	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Cunderboom	Install Smart Sponges (eat E. coli)	Remove litter to improve circulation	Better beach maintenance	Removal of illegal material at beaches	Removal of illegal log or other aquatic plants	Beach raking	Beach grooming	Public education/Adopt-a-Beach/Behavior Change (encourage clean up, no feeding wildlife)	Ban on Phosphorus-based fertilizers	Sanitary Surveys and/or Source Tracking				
																								Costs	Plans to implement remediation measures?		
37 Mackinaw City, MI, LM	X																						X	Unknown	Continue monitoring and possibly sanitary survey work as funding allows for a few consecutive years to gain better understanding of changes in water quality.		Further study needed to address stormwater outfalls, waterfowl presence, weather impacts, and physical characteristics (porous rock, fractured limestone). Future plans should include wet weather monitoring, heavy wave action monitoring, and implementation of anti-waterfowl feeding policy.
38 Henes Park, MI, LM		X																						Unknown	Recommendations can be made to the City of Menominee about how to control the bird populations. The city is currently attempting to control bird populations at local parks through the use of dog shaped cutouts. If it works, same principle could be applied to Henes Park Beach.	Minimal. The depth of water in the swimming area is no deeper than 18". The beach area is protected from the predominant wind directions which limits the natural water turnover at the beach.	Reducing the beach water contamination at Henes Park may prove to be very difficult. The beach is on the North side of a peninsula which protects it from the southerly winds. Therefore, the water is not turned over as frequently as other area Great Lakes beaches. Controlling bird populations would be one way to possibly reduce the contamination. It may be difficult due to the natural nesting areas for gulls and geese.
39 Sugar Island, MI, St. Mary's River		X	X											X			X							Several thousand (\$76 Million Canadian has been spent on plant upgrades)	Yes	Moderate	Municipal sewage treatment plant upgraded 8/06 to secondary treatment.
40 Starlite, MI, LH	X*																					X	Unknown	Continue monitoring and possibly sanitary survey work as funding allows for a few consecutive years to gain better understanding of changes in water quality.		* The number of waterfowl on the beach has decreased from previous years as a result of a city ordinance prohibiting the feeding of waterfowl.	

APPENDIX B: Recommended Remediation Measures

Recommended Remediation Measures / Beach Improvement Actions / Costs																									Impact remediation measures would have on beaches	Comments
Beach, State, Great Lake	Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire mesh, illegal eggs, lasers)	Reduce/divert/filter runoff (e.g., to vegetated area)	Install swales or rain gardens/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Cunderboom	Install Smart Sponges	Remove tile to improve circulation	Better beach maintenance	Removal of illegal material at beaches	Beach Raking	Beach grooming	Public Education/ Adopt-a-Beach/ Behavior Change (encourage clean up, no feeding wildlife)	Costs	Plans to implement remediation measures?				
41 Dyer Rd., MI, LH																					X	Continue monitoring and possibly sanitary survey work as funding allows for a few consecutive years to gain better understanding of changes in water quality.		An intensive study would need to be undertaken with multiple samples and surveys taken per day. More accurate survey tools need to be used in order to fully capture the physical parameters of the beach. Adjacent campground is another concern. Health dept. officials indicated that campground had previously conducted a sanitary survey but no further elaborations were detailed. To better understand influences campground may have on Dyer Road Beach, a complete and updated survey should occur.		
42 Singing Bridge, MI, LH			X								X										X	\$17,000	Same as above.		Remediation measures may include planting trees along the ravine, reseeding the banks of the creek, and a grade stabilization structure. Relocating cattle away from ravine could be costly. Additional measures could include installing a fence, constructing a retaining wall, and installing eve troughs on farm buildings.	
43 Twining Rd., MI, LH																					X	Unknown	Same as above.		No remediation steps have been taken at this time, but data will be compiled with previous and future data to make comparison and eventually develop a predictive model. An intensive study would need to be undertaken with multiple samples and surveys taken per day. More accurate survey tools need to be used in order to fully capture the physical parameters of the beach.	

APPENDIX B: Recommended Remediation Measures

Beach, State, Great Lake		Recommended Remediation Measures / Beach Improvement Actions / Costs																									Impact remediation measures would have on beaches	Comments
		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wires, etc.)	Reduce/divert/ filter runoff (e.g. oil, tires, etc.)	Planting of dune grass/ native vegetation	Reverse orientation of native vegetation	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Cunderboom	Install Smart Sponges (eat E. coli)	Better beach maintenance	Removal of illegal material at beaches	Beach Raking	Beach grooming	Public Education / Outreach	Ban on Phosphorus-based fertilizers	Sanitary surveys and/or Source Tracking	Costs	Plans to implement remediation measures?					
44 Whites Beach, MI, LH										X												X	Unknown	Same as above.		No remediation steps have been taken at this time but the data will be compiled with previous and future data to make comparisons and eventually develop a predictive model. Should offer money for loans for septic tank upgrades or sewer installation. Small community so measures could be cost prohibitive.		
45 South Linwood, MI, LH																						X	Unknown	Same as above.		No steps for remediation initiated, but amount of interest in muck issues on Saginaw Bay shorelines and bacterial contamination of local rivers have allowed local county government to initiate several projects with remediation in mind such as Kawkawlin River restoration project. While not entirely in Kawkawlin watershed, Brissette shares many of the same geographic areas within the watershed that remediation efforts that take place may have a positive effect on water quality.		
46 Brissette Beach, MI, LH																						X	Unknown	Same as above.		Same as above.		
47 Bay City, MI, LH															X		X					X	Unknown	Same as above.		Bay Co. plans to initiate several projects with remediation in mind (e.g., the Kawkawlin River restoration project. While beach not in watershed, it's less than one mile to mouth of river).		

APPENDIX B: Recommended Remediation Measures

Beach, State, Great Lake		Recommended Remediation Measures / Beach Improvement Actions / Costs																										Impact remediation measures would have on beaches	Comments	
		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wires, etc. if eggs, lasers)	Reduce/divert filter runoff (e.g. to vegetated area)	Install swales or rain gardens/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of roofs	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Gunderboom	Install Smart Sponges (eat E. coli) at SW outfalls	Better beach maintenance	Removal of fecal material at beaches	Removal of algae or other aquatic plants	Beach Raking	Beach grooming	Public Education (encourage clean up, no feeding wildlife)	Ban on Phosphorus-based fertilizers	Sanitary Surveys and/or Source Tracking	Costs	Plans to implement remediation measures?					
48 Wenona Beach, MI, LH																									X	X	Unknown	Same as above.		The amount of interest due to muck issues on Saginaw Bay shorelines and bacterial contamination of local rivers have allowed the local county government to initiate several projects with remediation in mind such as the Kawkawlin River restoration project. Also, the Bay County Board of Commissioners recently passed a ban on Phosphorus-based fertilizers to assist in combating the amount and prevalence of algae in surface water areas.
49 Pier Pk, MI, Lake St. Clair																										X	Unknown	Same as above.		Future investigations will include the impact of rainfall and stormwater.

APPENDIX B: Recommended Remediation Measures

Beach, State, Great Lake		Recommended Remediation Measures / Beach Improvement Actions / Costs																				Impact remediation measures would have on beaches	Comments						
		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wires, no illegal eggs, lasers)	Reduce/divert filter runoff (e.g., to vegetated area)	Install swales or rain gardens/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Improvements of monitoring of WWTP	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Gunderboom	Install Smart Sponges (eat E. coli)	Remove illegal material at beaches	Better beach maintenance	Removal of illegal material at beaches	Beach Raking	Beach grooming			Public Education/ Adopt-a-Beach/ Behavior Change (encourage clean up, no feeding, wildlife)	Sanitary Sweeps and/or Source Tracking				
																						Costs	Plans to implement remediation measures?						
50 Beach 2, PA, LE										X	X								X	X						A rough estimate using sulfur dioxide gas as the dechlorination agent would cost roughly \$25,000-\$50,000. The cost of adding any type of treatment would be dependent on variables such as equipment, the ability to use existing buildings, size of the treatment system and the design flow of the system. Depending on which technology and how easily it can be added to the existing system the cost for treatment would fluctuate more or less than this estimate.	Recommendations will be made to the E. coli Task Force, a consortium of state and local government agencies and university researchers developing strategies to further investigate and remediate bacterial contamination in Pennsylvania's Lake Erie watershed. A priority is the identification of sources of bacterial contamination and a recommendation for more in-depth studies of existing and new discharges will be made. Grant funding has been awarded from Pennsylvania's Department of Conservation and Natural Resources and the Coastal Zone Program to continue evaluating beach water and testing beach grooming techniques. Improvements to existing infrastructure and connecting septic system users to treatment facilities would require a large amount of funding. Discussions should be initiated with the municipalities regarding potential upgrades.	Remedial measures to keep the bacterial contamination from entering the tributaries by either source removal or treatment would have a significant impact on the number of bacteria in the beach waters. It is difficult to quantify the percentage reduction in the number of bacteria before specific loadings to the tributaries are determined. Further reductions should also be seen with the removal of Cladophora from the water and beaches as it is hypothesized that the Cladophora acts as a sink and source of bacteria to the water and sand. Grooming the sand to prevent bacterial growth should also reduce the amount of bacteria entering the water from the beach.	The general sources (e.g., western tributaries) but not the specific sources (e.g., discharge pipe) of E. coli are known. Next step is to evaluate permitted discharges in the tributaries and look for non-permitted discharges that could be contributing to the E. coli loadings. This could include an assessment of existing permit limits under NPDES and identification of failing septic systems and illegal discharges. Remedial measures may include connecting septic system users to existing treatment systems, correcting failing systems, and removal of illegal discharges. Also, consider a focused initiative to reduce the bacterial discharge limits for new and existing permits. Existing WWTP located with Trout Run, Walnut Creek and Elk Creek watersheds should be encouraged to add super chlorination and then dechlorination prior to discharge to treatment system to further reduce bacterial loadings. Remedial measures could also be adopted to address beach sand and Cladophora, both of which are believed to serve as a reservoir for bacteria. Grooming techniques could prevent bacteria in the sand. Work is also needed to determine methods for Cladophora removal from both the sand and the water.
51 Beach 10 (Budny) Pennsylvania, LE									X	X								X	X						Same as above.	Same as above.	Same as above.	Same as above.	

APPENDIX B: Recommended Remediation Measures

Beach, State, Great Lake		Recommended Remediation Measures / Beach Improvement Actions / Costs																				Costs	Plans to implement remediation measures?	Impact remediation measures would have on beaches	Comments		
		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wires, oil eggs, lasers)	Reduce/divert/ filter runoff (e.g. to vegetated areas)	Install swales or rain gardens/ SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of each stormwater outfall	Removal of impervious surface	Control of outfalls and stormwater runoff	Improvements to infrastructure	Septic system upgrades	Eliminate source of sewage	Agriculture BMPs	Install Gunderboom	Remove/replace/improve filtration	Better beach maintenance	Removal of fecal material at beaches	Removal of algae or other aquatic plants	Beach Raking	Beach grooming	Public Education/ Outreach/ Adopt-a-Beach/ Behavior Change (encourage clean up, no feeding wildlife)					Sanitary surveys and/or Source Tracking	
52 Evans Town, NY, LE																							X		Storm sewers w/high <i>E. coli</i> levels will be identified. The Erie County Health Department will request that investigation be done on voluntary basis by the municipality responsible for the storm sewer.	Significant. Any reduction in bacterial contamination from streams and storm sewers should be significant in improving water quality at beaches and reduce the number of water quality exceedances.	There was very little rain this summer which severely limited sampling opportunities to identify bacterial contamination point sources. Follow-up investigations are necessary to identify the sources of bacterial contamination to the storm sewers. A lack of heavy rains makes it doubtful that sampling requirements for enforcement of New York State Department of Environmental Conservation (NYSDEC) Surface Water Discharge regulations. Many storm sewers that have been identified as potential problems are yet to be sampled.
53 Lake Erie, NY, LE																							X		Same as above.	Same as above.	Same as above.
54 Fair Haven, NY, LO			X				X					X				X								Gull harrassment: \$2500 - \$10,000 (please see comments).	Canada geese control measures may be used in 2008. An inspection of State Pollutant Discharge Elimination System (SPDES) will be initiated before swimming season and deficiencies will be corrected.	If geese kept are off beaches, it could have a very large impact on improving water quality results, especially at the East Swim area, which had large numbers of exceedances in 2007 and the most activity by geese.	Budget: \$5,000 to buy a trained Border Collie or \$2500 to lease one for a summer season. Plus the cost of food and care for the dog, a kayak for chasing the geese in the water, and travel. Egg addling/oiling would involve travel expenses for the team for 2 weeks (\$1,000 - \$5,000). Any SPDES discharge sites within the park that test positive for bacteria must be brought into compliance.
55 Selkirk Shores, NY, LO			X									X		X		X								Algae control: \$30,000 per beach for Gunderboom installation. Gull harrassment minimal cost.	Plan to experiment w/Gunderboom at 1-3 Great Lakes beaches depending upon funding. Park staff will clean gull droppings from beach and jetties. Harassment techniques will be considered if water quality standards are consistently exceeded and gull droppings are thought to be a primary source.	Gunderboom system could improve swimming conditions and water quality at this site and could dramatically reduce algae in swimming area.	Wire or fishing lines over an area have been shown to work well to deter gulls; however, the jetty is heavily used for fishing and wires may get in the way. Other gull harassment techniques may be explored such as use of lasers at night.

APPENDIX B: Recommended Remediation Measures

Beach, State, Great Lake		Recommended Remediation Measures / Beach Improvement Actions / Costs																							Costs	Plans to implement remediation measures?	Impact remediation measures would have on beaches	Comments		
		Ordinance prohibiting feeding of waterfowl	Gull management (dogs, wire, etc., or egg, larvae)	Reduce/divert/ filter runoff (e.g., to vegetated area)	install swales or rain gardens	SW BMPs	Planting of dune grass/ native vegetation	Reverse orientation of beach	Removal of impervious surface	Storm water infrastructure improvements	Control of outfalls and stormwater runoff	Improvements to monitoring of WWTP	Septic system upgrades	Eliminate source of seeps	Agriculture BMPs	Install Groundboom	Install Smart Sponges (eat E. coli)	Better beach maintenance	Removal of fecal material at beaches	Removal of algae or other aquatic plants	Beach Raking	Beach grooming	Public education/ Adopt-a-Beach/ Behavior Change	Ban on phosphorus-based fertilizers					Sanitary surveys and/or Source Tracking	
56 Sandy Island, NY, LO																											No remediation efforts have been identified as the beach has excellent water quality.			
57 Bayfield Main Beach, CN, LH		X	X														X	X	X									Need to meet with municipal and conservation authority partners to explore further.		
58 Bayfield South Beach, CN, LH		X	X														X	X	X									Same as above.		
59 Goderich Main Beach, CN, LH		X	X														X	X	X									Same as above.		
60 Goderich St. Christopher's Beach, CN, LH		X	X														X	X	X									Same as above.		
61 Goderich Cove Beach, CN, LH		X	X														X	X	X									Same as above.		

## APPENDIX C:

### Use of Forecast Predictive Models, Source Tracking Methods, and qPCR

APPENDIX C: Use of Forecast Predictive Models, Source Tracking Methods, and Real-time Quantitative Polymerase Chain Reaction (qPCR)

Beach, State, Great Lake

Use model?	SwimCast	Virtual Beach	Precipitation	Pre-emptive	Forecast/USGS	Visual	Intend to continue use of model?	Microbial Source Tracking (MST)?	qPCR? <i>asterisk = would be willing if funding available</i>	Note change in beach conditions that may have affected # of postings?	Comments
1 Lakewalk, MN, LS	N									Spring and summer of 2007 was marked by a significant drought which intensified in July and August. Drought conditions brought record low water levels in Lake Superior. Then, Aug 18-20, 2007, a series of thunderstorms dropped extremely heavy rain on much of southern Minnesota. September and October were very wet.	No models developed because of small amount of data available. At this point, not sure that 3.5 months worth of data during a drought will be enough data to develop forecasting models for either beach. May develop a model for Lakewalk. Turbidity and precipitation appear to be the best factors to be used in developing a predictive model for this beach once more data is gathered.
2 New Duluth, MN, LS	N							Modified rep-PCR (HFERP) DNA fingerprinting work completed during 2004 and 2005 by University of Minnesota-Duluth.	ongoing	The Duluth area has been in a drought for the 2006 and 2007 monitoring seasons w/only 3 significant rain events during 2007 monitoring season. Drought conditions brought record low water levels in Lake Superior. The low water levels were very noticeable in the Duluth-Superior Harbor and the harbor side beaches. Then during Aug 18-20, 2007, a series of storms dropped extremely heavy rain on much of southern Minnesota. September and October were very wet. 2007 was the best year for the beach as far as number of days under advisory.	No models developed. There are 5 years of <i>E. coli</i> , water and air temperature, wind speed and direction, wave height and observational data available, but only 1 season of turbidity and conductivity data to use. With the addition of more data in coming years, a model may be developed. Preliminary look at the data does not point to any good correlations with any of the data gathered. Regarding qPCR, current ongoing research is to examine short-term changes in the abundance of fecal bacteria from waterfowl and humans at these beaches using hybridization and qPCR methods.
3 Barker's Island, WI, LS	Y	X					If this program continues the model will be utilized in 2008.		N	Severe drought and limited rainfall events in 2007.	Would be willing to do qPCR analyses if funding was available.
4 Brule River #1, WI, LS	Y	X					Same as above.		N	Severe drought conditions along Lake Superior. Water quality data not collected in previous years.	Same as above.
5 Brule River #2, WI, LS	Y	X					Same as above.		N	Severe drought and limited rainfall events in 2007.	Same as above.
6 Brule River #3, WI, LS	Y	X					Same as above.		N	Same as above.	Same as above.
7 Thompson, WI, LS	Y	X					Same as above.		N	Similar to the past several years of data. Less rainfall.	Same as above.
8 Kreher, WI, LS	Y	X					Same as above.		N	Similar.	Same as above.
9 Maslowski, WI, LS	Y	X					Same as above.	Genetic analysis of <i>E. coli</i> isolates from the beach and comparisons to known libraries of <i>E. coli</i> isolates.	N	Similar.	For lower Lake Michigan, it was a dry summer up until August when an unusual amount of rain for about a week affected this region of the state.
10 Upper Lake Pk, WI, LM	Y		X				Yes. A model is in development that utilizes 24 hour rainfall, 48 hr. rainfall, beachwater turbidity, and creek flow rate based on data collected during the 2007 beach season. Validation will occur during 2008 and subsequent beach seasons.	N	N	This year there were relatively light concentrations of algae on the beach and in the water. During 2007 all the advisories were rain-related. In comparison, 2006 was a low rainfall year and a majority of the advisories were algae-related. A major rain event in August 2007 closed the beach for six days and drove up the number of advisories.	Continued funding is needed for model development. Additional funding is needed to do source tracking to determine the sources of <i>E. coli</i> , especially when coming from a creek or pipe in order to stop its influx into the system.
11 North Beach, WI, LM	Y	X					A single year of data will not yield a strong model so the 3 previous years' data was also input into the model. Because few water quality advisories in past 3 or 4 years, the model may not predict <i>E. coli</i> elevations accurately. To test this hypothesis, Racine Health Department intends to look at historic data (1998-2001) to determine if model has a better predictive rate at beaches w/frequent advisories.	<i>E. coli</i> isolates were processed for MST. Water samples collected and processed for human-specific <i>Bacteriodes</i> testing.	Y	There was an unusual amount of rain (9.1") for a 2 week period in August, 2007.	Beaches with limited advisories are not conducive to predictive modeling. Regarding qPCR, some testing has been completed but testing will continue through October, 2007, and then again in the spring of 2008.

APPENDIX C: Use of Forecast Predictive Models, Source Tracking Methods, and Real-time Quantitative Polymerase Chain Reaction (qPCR)

Beach, State, Great Lake	Use model?								Intend to continue use of model?	Microbial Source Tracking (MST)?	qPCR? <i>asterisk = would be willing if funding available</i>	Note change in beach conditions that may have affected # of postings?	Comments
		SwimCast	Virtual Beach	Precipitation	Pre-emptive	Forecast/USGS	Visual						
12 Zoo Beach, WI, LM	Y		X						Same as above.	Same as above.	Y	August 2007 was second wettest month on record (since 1896) and had largest single 24-hour rainfall amount ever recorded (4.1").	Same as above.
13 Bender, WI LM	Y		X	X					Oak Creek/South Milwaukee municipalities currently use a precipitation model, closing the beach if precipitation is equal to or exceeds one inch within a 24-hour period. This season, the <i>E. coli</i> levels correlate negatively w/rainfall at traditional monitoring station (-0.09). It is our intent to construct a database using Virtual Beach to see if they can get improved accuracy.	<i>E. coli</i> isolates were collected for MST. Water samples were collected for <i>Bacterioides</i> (human specific) source tracking and submitted to University of Wisconsin-Milwaukee Great Lakes Water Institute.	N*	Beach monitoring was increased from two days per week to five in 2007. This may explain some of the additional advisory events. It is unknown how ambient conditions may have affected water quality in previous years as data is limited. Note that there was significant dredging on the opposing harbor side during late May until about mid-June, 2007.	Additional funding is necessary to increase confidence in identifying contamination sources and also to make the data set sufficient for predictive modeling to be valid. A single year of funding is a good start and will benefit the community in preliminary identification of pollution sources, but additional data is necessary to appropriately target remediation efforts. A beach with a previously thin data set may require multiple years of investigation via sanitary surveys to identify trends and develop the most effective beach management plan.
14 Grant Park, WI, LM	Y		X	X					Same as above. In addition, a rainfall model is currently used. We have constructed a database/model using Virtual Beach but need additional data for significant relationships to occur.	Same as above.	N	Same as above (except that no dredging occurred at Grant Park.)	Same as above. In addition, the beach is closed if rainfall within 24 hours exceeds 1 inch. The rainfall method for predicting poor water quality was correct for 3 water quality advisories in 2007. There were two type 1 errors and 14 type 2 errors in the 2007 beach season when using this rainfall model. From the comparisons done using Virtual Beach, a water quality correlation was determined for algae levels and clarity. Increased levels of algae and poor clarity correlated with elevated levels of <i>E. coli</i> . <i>E. coli</i> counts also correlate to gulls about 20-30% of the time at 2 of the sampling sites and wave height 32% of the time at 2 sites. There is no correlation to bather load or rainfall.
15 Neshotah, WI, LM	Y		X						If this program continues, the model would be tested in 2008.	MST		Decrease in rainfall during summer 2007. In addition, resampling of beaches occurred immediately after advisory was posted. Beach could be opened in a more timely fashion than previous summers.	Need to determine source of <i>E. coli</i> from outfalls. DNA fingerprinting is underway.
16 Point Beach, WI, LM	Y		X						Same as above.	MST	N*	Same as above.	* Would be willing to do qPCR analyses if funding was available.
17 Whitefish Dunes, WI, LM	Y		X						Same as above.		N*	Decrease in rainfall during summer 2007.	Same as above. In addition, predictive modeling software correlates wind speed, log water temperature and square root (wind speed/ long shore current speed) with <i>E. coli</i> .
18 Sunset Park, WI, LM	Y		X						Same as above.	Genetic source tracking, antibiotic sensitivity testing, and molecular study.	N*	Same as above. Fewer advisories and closures than last year.	Recent research has been conducted here to determine source of <i>E. coli</i> . These data sets/projects include spatial sampling for <i>E. coli</i> surrounding the beach area, <i>E. coli</i> in beach sand determinations, genetic source tracking of beach <i>E. coli</i> , antibiotic sensitivity testing of <i>E. coli</i> found at the beach, a study on the impacts of rain on beach water quality, and a molecular study of the migration of <i>E. coli</i> from the nearby drainage basin to the beach.
19 Deland Park, WI, LM	Y		X						Same as above.	MST	N*	Same as above. Fewer closures than in recent years.	Same as above.
20 General King, WI, LM	Y		X						Same as above.		N*	Same as above.	Same as above.
21 Kohler North, WI, LM	Y		X						Same as above.		N*	Same as above.	Same as above.
22 Rosewood, IL, LM	Y	X							Yes.				Over the season, 24 of the 141 samples (17%) exceeded water quality standards. Ten of the 24 (42%) were collected in the afternoon, which shows the need to be able to predict <i>E. coli</i> concentration on an hourly basis as <i>E. coli</i> levels change throughout the day.

APPENDIX C: Use of Forecast Predictive Models, Source Tracking Methods, and Real-time Quantitative Polymerase Chain Reaction (qPCR)

Beach, State, Great Lake	Use model?								Intend to continue use of model?	Microbial Source Tracking (MST)?	qPCR? <i>asterisk = would be willing if funding available</i>	Note change in beach conditions that may have affected # of postings?	Comments
		SwimCast	Virtual Beach	Precipitation	Pre-emptive	ForecastUSGS	Visual						
23 Jackson Pk (63rd), IL, LM	N								Forecast model was not developed, but simple single variable regression was useful for diagnostic purposes. A model was developed for this beach in 2004 from data collected by U.S. Geological Survey (USGS) in 2000 from a local weather station. Publication asserts that onshore wind vector (4 hr mean), rainfall (24 hour total), average lake stage (4 hr mean), insolation (4 hr. mean), water temperature (4 hr mean) and interative term involving onshore wind vector, rainfall, and turbidity could predict the beach advisory threshold for E. coli 88% of the time. It is not apparent whether this model could be implemented on a regular basis without a weather station and appropriately trained staff.		N/A	Information not analyzed at this time.	Using meteorology data from the nearest weather stations, precipitation is positively correlated with elevated bacteria concentration events at this beach. Ninety-four percent (94%) (15 of 16) of elevated concentration ( <i>E. coli</i> >1000 cfu/100 ml) events (swim bans) were preceded by measurable rain in the previous 72 hours. Fifty-two percent (52%) (16 of 31) of elevated concentration ( <i>E. coli</i> 235-999 cfu/100 ml) events (swim advisories) were preceded by measurable rain in the previous 72 hours. Overall, 48-hr precipitation showed the strongest quantitative correlation with elevated bacterial concentration. Conversely, every precipitation event with accumulation >1 inch was followed by a swim ban or advisory within 72 hours or less. Higher water temperature at the time of sampling was quantitatively correlated with elevated bacteria concentration.
24 Tunnel Park, MI, LM	N								In 2005/2006, worked with National Oceanic and Atmospheric Administration (NOAA) to look at how contaminants moved from Grand river to Lake Michigan.		N	The 2007 swim season was relatively dry this year (less than 3" of rain recorded during July and August), but saw no effect on the beach.	Beginning to develop a model looking at rainfall and onshore winds.
25 Grand Haven City, MI, LM	N								Same as above.		N	Same as above.	Same as above.
26 Grand Haven State Park, MI, LM	N								Same as above.		N	Same as above.	Same as above.
27 Rosy Mound, MI, LM	N								Same as above.		N	Same as above.	Same as above.
28 Onekama, MI, LM	N								N		N	Same as above.	Forecast modeling is in its infancy for the entire state. It appears that when wind and rain occur on the day before or during sampling, the <i>E. coli</i> counts rise.
29 Sundling Park, MI, LM	N								N		N	Same as above.	Same as above.
30 Magoon Creek, MI, LM	N										N	Same as above.	Same as above.
31 Traverse City State Park Beach	N								N		N	Very dry summer with few rain events and few opportunities to sample beaches during adverse conditions. Rain events that occurred were on weekends when lab was closed.	Strong onshore winds tend to lead to increased turbidity measurements, which also correlate to high <i>E. coli</i> levels, particularly at Traverse City State Park Beach. We have known about the correlation between strong onshore winds and elevated <i>E. coli</i> readings; our obstacle is how to educate the public about this correlation.
32 East Bay Park Beach	N								N		N	Same as above.	If we have a dry period followed by a heavy rain, we know that our beaches with storm water outfalls located at them (Bryant and East Bay) may have high <i>E. coli</i> levels.
33 Bryant Park Beach	N								N		N	Same as above.	More money is needed for entities to do source tracking to determine the sources of <i>E. coli</i> , especially when coming from a stream or pipe in order to stop its influx into the system.

APPENDIX C: Use of Forecast Predictive Models, Source Tracking Methods, and Real-time Quantitative Polymerase Chain Reaction (qPCR)

Beach, State, Great Lake	Use model?								Intend to continue use of model?	Microbial Source Tracking (MST)?	qPCR? <i>asterisk = would be willing if funding available</i>	Note change in beach conditions that may have affected # of postings?	Comments
		SwimCast	Virtual Beach	Precipitation	Pre-emptive	Forecast/USGS	Visual						
34 Norwood Park, MI, LM	N									N	N	2007 experienced an extended period of temperatures that were warmer than usual and a severe lack of precipitation. The Palmer Drought Severity Index utilized by the National Weather Service identified the region as a severe drought area throughout the summer. The lack of precipitation likely limited the transport mechanisms necessary to mobilize bacteria from sources remote from the beach areas.	
35 Cross Village, MI, LM	N									N	N	Same as above.	
36 Wilderness St. Pk, MI, LM	N									N	N	Same as above.	
37 Mackinaw City, MI, LM	N									N	N	The 2007 swim season was relatively dry this year (less than 3" of rain recorded during July and August), but saw no effect on the beach. We issued no advisories or closings for this beach as none were warranted.	There were no significant rainfall events during this season that allowed these outfalls to be directly sampled.
38 Henes Park, MI, LM	N								Additional information on weather in relation to bacteria sample results would be helpful to further evaluate the weather as a factor.	N	N	The closure of Henes Park this year lasted longer than during past years. Water level was very low in the beach area, and with predominantly southern winds, the water rarely turned over.	
39 Sugar Island, MI, St. Mary's River	Y			X					The forecast model will be used in addition to regular monitoring.	N	N	Decrease in rain events, hotter air and water temperatures, lower <i>E. coli</i> levels, fewer advisories, new municipal sewage treatment facility on line with secondary treatment.	Results showed minimal success due to lack of rain events.
40 Starlite, MI, LH	N									N		The 2007 swim season was relatively dry this year (less than 3" of rain recorded during July and August), but saw no effect on the beach. We issued no advisories or closings for this beach as none were warranted.	
41 Dyer Rd., MI, LH	N									N	N	Very dry summer with few rain events or opportunities to sample beaches during adverse conditions. Rain events that occurred were on weekends when lab was closed. Due to the lack of rainfall during the 2007 swim season, runoff to the beach was difficult to monitor.	Certain logistical challenges need to be corrected before a predictive model can be developed. An intensive study will need to be undertaken with multiple samples and surveys taken per day. Data will be compiled with previous and future data to make comparisons and eventually develop a predictive model.
42 Singing Bridge, MI, LH	N									N	N	Same as above.	This beach is affected by the Whitney Drain. More investigation is needed on effects of the drain on this beach.
43 Twining Rd., MI, LH	N									N	N	Same as above.	Same as above.
44 Whites Beach, MI, LH	N									N	N	Same as above.	Additional sanitary survey work is recommended in the immediate vicinity of this beach.
45 South Linwood, MI, LH	N								Having an accurate predictive model would be both useful and valuable.	N	N	This beach has had extensive history with algae and muck issues, primarily in 2006. However, in 2007, this beach did not suffer the extent of accumulation of <i>Cladophora</i> as did the Bay City State Recreation Area.	It is hoped that data collected would be used to develop models in the future based upon weather and associated conditions.
46 Brissette Beach, MI, LH	Y			X					Same as above.	N	N		Sampling taken directly after substantial rain events did indicate that there was a positive correlation between rainfall and elevated levels of <i>E. coli</i> . It is hoped that data collected would be used to develop models in the future based upon weather and associated conditions.

APPENDIX C: Use of Forecast Predictive Models, Source Tracking Methods, and Real-time Quantitative Polymerase Chain Reaction (qPCR)

Beach, State, Great Lake	Use model?	SwimCast	Virtual Beach	Precipitation	Pre-emptive	Forecast/USGS	Intend to continue use of model?	Microbial Source Tracking (MST)?	qPCR? <i>asterisk = would be willing if funding available</i>	Note change in beach conditions that may have affected # of postings?	Comments
47 Bay City, MI, LH	N						Same as above.	DNA and genetic marking. Data showed human and bovine sources.	N		It is hoped that data collected would be used to develop models in the future based upon weather and associated conditions.
48 Wenona Beach, MI, LH	N						Same as above.	N	N		Same as above.
49 Pier Pk, MI, Lake St. Clair			X					N	N	The 2007 swim season was relatively dry this year (less than 3" of rain recorded during July and August), but saw no effect on the beach.	Sampling taken directly after substantial rain events did indicate that there was a positive correlation between rainfall and elevated levels of <i>E. coli</i> . Combined Sewer Overflow (CSO) data indicates that overflows did not contribute to <i>E. coli</i> levels at the beach. It is hoped that data collected would be used to develop models in the future based upon weather and associated conditions.
50 Beach 2, PA, LE	N						We are in the validation stage of developing a forecasting model, but we do use some explanatory parameters like wind, direction, wave height, and previous night rainfall amount to make preemptive closures at the western-most beaches. Survey information, real time identification of bacteria sources, characterization of transport and better understanding of the hydrodynamics will be used to develop model.	Real time qPCR has been very useful in the identification of <i>Bacteriodes</i> and thus in the realization that there is a significant amount of contamination of human origin. There have been difficulties in correlating the real time qPCR data with standard plate counts. qPCR analysis included <i>E. coli</i> , Shigatoxin, and <i>Bacteriodes</i> .	Y	There was some variability with rain events, algae and temperatures when comparing last season with this season. Without doing a complete analysis of the entire 2007 data set, it is impossible to determine whether these events had any effect statistically on the number of beach advisories/closures. Prior to 2007, an advisory was issued when <i>E. coli</i> levels reached 235 cfu/100 ml. In 2007, beaches were posted with an advisory if <i>E. coli</i> counts exceeded 235 cfu/100 ml and swimming restricted when the levels exceeded 1000 cfu/100 ml. In 2006, beaches closed 17 times. In 2007, there were only 2 beaches with restricted swimming, but the difference in the number of postings was due to weather and the new beach advisory/closure system.	A composite of information from 3 studies describe the movement of contamination from the tributaries west of Presque Isle to the beaches. The first study sampled water from 18 to 21 sites in the lake and near the mouth of 3 major tributaries on 3 occasions. During dry weather, there were no instances of water contamination, however, during wet weather, the sites near the mouths of the tributaries showed significant contamination. The second study looked at nearshore transport of water. Because of the rate of movement of water in the nearshore, the likely source of contamination is constrained to have been located anywhere within 19 miles of the park ( <i>i.e.</i> , the western tributaries). The third study identified the types of contamination ( <i>E. coli</i> and <i>Bacteriodes</i> ) using real time qPCR and standard plating techniques in Presque Isle beach samples of water and sand (and <i>Cladophora</i> ). Results indicate a high percentage of bacterial pollution from human sources is present on days where overall levels of bacterial pollution are high, compared to days when overall levels of bacterial pollution are problem with bacterial pollution of Presque Isle beaches is due to increa appears that bacterial contamination originates along the course of at le
51 Beach 10 (Budny) PA, LE	N						Same as above.	Same as above.	Y	Same as above.	

APPENDIX C: Use of Forecast Predictive Models, Source Tracking Methods, and Real-time Quantitative Polymerase Chain Reaction (qPCR)

Beach, State, Great Lake	Use model?								Intend to continue use of model?	Microbial Source Tracking (MST)?	qPCR? <i>asterisk = would be willing if funding available</i>	Note change in beach conditions that may have affected # of postings?	Comments
		SwimCast	Virtual Beach	Precipitation	Pre-emptive	Forecast/USGS	Visual						
52 Evans Town, NY, LE					X						N		Since 1998, Erie County Health Department has had a pre-emptive beach closing policy triggered by any rain event of 1/2" or more during a 24 hour period at a regulated beach or in watershed of a stream impacting the public beach. There were 4 rain events in 2007 at both beaches and exceedances associated with rain events were predicted correctly by the pre-emptive beach closing policy.
53 Lake Erie, NY, LE					X						N		Same as above.
54 Fair Haven, NY, LO						X			Working with USGS on an improved forecast model. Preemptive closure protocol has been used to close this beach based on 1.2 inches of rain, but doesn't appear that there is a simple correlation between rain and exceedances. The closure protocol is very conservative and results in closures on days with good water quality.	Sediment & water samples sent to USGS for analysis in winter. Water samples from East Swim area submitted to New York State Department of Health Wadsworth Lab. Using qPCR, we detected <i>E. coli</i> and bacterial DNA belonging to the genus <i>Bacteriodes</i> ; but did not detect human-specific <i>Bacteriodes</i> DNA.		The summer of 2007 was very dry, especially in comparison to 2006 which was a very rainy season. This dry summer resulted in fewer exceedances and closures of beaches and sections of beaches this year as compared to 2006. We may need to repeat more intensive monitoring during a wetter summer.	USGS installed monitoring equipment to measure weather, current, and wave height conditions at the beach which they plan to correlate with our bacterial data. We hope to have a forecast model in place to use in 2008. Regarding the use of qPCR, findings suggest that fecal contamination is coming from some other organisms.
55 Selkirk Shores, NY, LO	N									No, but source tracking studies may be useful in the future to determine if gulls are a major pollution source at this beach.		Same as above.	Forecast model not needed since exceedances are associated with algae mats and postings can be based on pre-emptive decisions linked to the presence of algae mats.
56 Sandy Island, NY, LO	N									Same as above.		The summer of 2007 was very dry, especially in comparison to 2006 which was a very rainy season. However, the lack of rain did not affect this beach because it is not influenced by rainfall. It did not have any exceedances or closures from 2005-2007.	Forecast model not needed since beach has excellent water quality.
57 Bayfield Main Beach, CN, LH	Y						X		Yes. It's a "visual" model - if water samplers can see their feet the forecast is that it is safe to swim.	N	N	Yes, a decrease in rain events, increase in algae (earlier and later in season), and hotter temperatures. However, we did not get the severe thunderstorms that usually bring heavy rainfall events that flush the land and cause the beaches to be posted as unsafe for up to 2 days.	The beach water quality was excellent this year, so it was not a good year to analyze where the "off the land" discharges were coming from. The area has been under a "Level 2" low water advisory most of the summer. Stream flows range anywhere from 15 to 45 percent of the lowest average summer monthly flow in watercourses in the watershed, with many of the headwater streams completely dry. August precipitation amounts were close to normal; however, stream flow remained low in August until mid-September due to abnormally dry conditions in June & July. Most of the water that fell in August was consumed by the very dry soils and vegetation resulting in almost no runoff into local watercourses, the watershed only received 47% of the normal 3 month precipitation period ending in August.
58 Bayfield South Beach, CN, LH	Y						X		Same as above.	N	N		Same as above.
59 Goderich Main Beach, CN, LH	Y						X		Same as above.	N	N		Same as above.
60 Goderich Cove Beach, CN, LO	Y						X		Same as above.	N	N		Same as above.

APPENDIX C: Use of Forecast Predictive Models, Source Tracking Methods, and Real-time Quantitative Polymerase Chain Reaction (qPCR)

Beach, State, Great Lake

61 Goderich Cove Beach, CN, LH

Use model?	SwimCast	Virtual Beach	Precipitation	Pre-emptive	Forecast/USGS	Visual	Intend to continue use of model?	Microbial Source Tracking (MST)?	qPCR? <i>asterisk = would be willing if funding available</i>	Note change in beach conditions that may have affected # of postings?	Comments
Y					X		Same as above.	N	N		Same as above.

## APPENDIX D:

### Suggested Improvements to Sanitary Survey

# APPENDIX D: Suggested Improvements to Sanitary Survey

Beach, State, Great Lake	Recommend to other beach mgrs?	Suggested Improvements to Sanitary Survey Tool and Database	Comments
1 Lakewalk, MN, LS	Y	We used our own field sheets for gathering info while sampling which are more of a spreadsheet format because we have staff sampling 11-18 sites in one day and find it easier to collect the information all on one sheet. Water current was too difficult and time-consuming to collect routinely.	We recommend that the beach monitoring staff collect sanitary survey data when out collecting bacteria samples. Since the beginning of the beach program, we have found that the other data collected is helpful in determining what is affecting the bacteria counts at a beach, especially when there is not an obvious source.
2 New Duluth, MN, LS	Y	Same as above.	Routine sanitary survey data collected while monitoring beaches for bacteria is very enlightening when looking for bacteria sources at problem beaches and for unexpected high bacteria counts at clean beaches. Minnesota has been using a modified version of the sanitary survey since we began monitoring in 2003. We felt it was necessary to gather as much information as possible to provide insight into the sources of bacteria at the beaches because each beach is so different. Beach monitoring staff should be encouraged to gather as much information as possible each and every time they make a trip to the beach.
3 Barker's Island, WI, LS		Include easy to use Standard Operating Procedures (SOPs) for evaluations of <i>E. coli</i> (e.g., sand, spatial, runoff). Give the health departments tools to do these additional tests using not just traditional <i>E. coli</i> testing, but collection techniques from 'suspected sources' that may not be traditional surface water.	
4 Brule River #1, WI, LS		Same as above.	
5 Brule River #2, WI, LS		Same as above.	
6 Brule River #3, WI, LS		Same as above.	
7 Thompson, WI, LS		Same as above.	
8 Kreher, WI, LS		Same as above.	
9 Maslowski, WI, LS		Same as above.	
10 Upper Lake Pk, WI, LM	Y	We recommend developing training DVDs for both field and lab staff. We also recommend drafting site specific data sheets as not all sampling sites are beaches. We re-wrote the daily data sheets to mirror our project and field needs. We took measurements in commonly used units so as to communicate with the general public. Trash considerations should be separated into human generated and natural trash types. Recommend evaluation of longshore current (direction only). Appears much lake data can only be accurately monitored via buoy or sonde which was not available in our area. Sanitary Survey funding does not cover this cost.	We envision sanitary surveys as being both one time exploratory tools as well as a measure of continuing performance progress.
11 North Beach, WI, LM		Provide more explanation to surveyors why some of the data is important to collect (e.g., high water mark). We may know that beaches with negligible slope may suffer poor water quality due to wave encroachment over fecal-contaminated beach sands, but individuals completing the survey may not understand the connection. The SOPs should include sections on where one might find certain data (e.g., impervious surface area) and stress the need for cooperation with other municipal departments such as city planning, public works, parks, WWTP, etc. Completing the annual survey could be overwhelming without "where to go" guidance. This could also include external references such as Google Earth. It may be beneficial to suggest that surveyors include photographs which may prove beneficial for future investigations (i.e., aerial plumbing from creeks and streams, run-off, mysterious pipes, etc.) A narrative section should be added to the sanitary surveys so beach managers can include additional information.	
12 Zoo Beach, WI, LM		Same as above.	
13 Bender, WI LM		Same as above.	
14 Grant Park, WI, LM		Same as above.	Further investigation is needed.
15 Neshotah, WI, LM		Same as above.	
16 Point Beach, WI, LM		Same as above.	
17 Whitefish Dunes, WI, LM		Include easy to use SOPs for evaluations of <i>E. coli</i> (e.g., sand, spatial, runoff). Give the health departments tools to do these additional tests using not just traditional <i>E. coli</i> testing, but collection techniques from 'suspected sources' that may not be traditional surface water.	
18 Sunset Park, WI, LM		Same as above.	
19 Deland Park, WI, LM		Same as above.	
20 General King, WI, LM		Same as above.	
21 Kohler North, WI, LM		Same as above.	
22 Rosewood, IL, LM		Additional bacteria and WQ sampling should be conducted in the tributaries, particularly during or immediately after a rain event.	

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23 Jackson Pk (63rd), IL, LM	Y	The questions are almost all useful in evaluating factors that influence the water quality. However, the format of the actual surveys could be revised to make them more user-friendly. It should be noted that they may be carried into the field to be filled out by hand and later completed in electronically. The tables would be easier to use if there were mostly just rows instead of rows and columns. There is a bit of redundancy in the questions that could be reduced (bounding structures are requested twice, for example). Some questions have categories that are ambiguous (Section 8, question about presence of wildlife and domestic animals asks for degree of presence low, med, high -what does that mean? Section 11 asks for level of concern H, M, L, or NA also unclear). Multiple questions ask for measurements, some requesting answers in British units, some in metric units. This should be more consistent.	
24 Tunnel Park, MI, LM	Y	The Beach Sanitary Survey Tool (BSST) needs a greater degree of standardized data collection. Without scientific instruments to measure some of the variables, it becomes possible to introduce a greater degree of error into the tool. Three Ottawa County Health Department employees used the BSST over the course of the 2007 summer and it seems possible that they could have used slightly different techniques to collect their data. Secondly, the BSST should also provide a standardized method of data analysis. It may become difficult to compare findings with other agencies since different analytical techniques were used. The final recommendation is to encourage beach managers and public health officials to use the BSST over several swim seasons to improve the statistical significance of the results.	
25 Grand Haven City, MI, LM	Y	Same as above.	
26 Grnd Hav State Pk, MI, LM			
27 Rosy Mound, MI, LM	Y	Same as above.	
28 Onekama, MI, LM			
29 Sundling Park, MI, LM			
30 Magoon Creek, MI, LM			
31 Traverse City State Park Beach	Y	More funding and longer time frame needed to do more testing.	We now have a good handle on what sources of contamination are affecting our beaches. What is now needed is to determine exactly what combination of factors produce high <i>E. coli</i> levels ( <i>e.g.</i> , why did one rain event or strong onshore winds affect one beach but not the other?) It is probably a suite of factors that affect our beaches and conducting the sanitary survey was the first step to effectively document all types of conditions at our beaches and their corresponding <i>E. coli</i> values.
32 East Bay Park Beach	Y	Same as above.	
33 Bryant Park Beach	Y	Same as above.	
34 Norwood Park, MI, LM			
35 Cross Village, MI, LM	Y	The tools used in the survey project will be used in future sampling programs and applied to some of our other beaches.	Data gathered in this project will be included in a larger dataset consisting of historical data and future data to look at trends and associations between a variety of environmental factors and surface water quality.
36 Wilderness St. Pk, MI, LM			
37 Mackinaw City, MI, LM			
38 Henes Park, MI, LM	Y	Should have a section for information on people interviewed and results of interviews. Entering data into database was not as simple as it could have been. Computer database does not mirror the paper format provided and asks for additional information not recorded on paper version.	Having opportunity to spend more time evaluating possible sources of contamination allowed us to get more information of what is actually occurring at the beach. We were able to interview lifeguards, park employees and DNR staff.
39 Sugar Island, MI, St. Mary's River	Y	More training.	
40 Starlite, MI, LH			
41 Dyer Rd., MI, LH		An intensive study needs to be undertaken with multiple samples and surveys taken per day. More accurate survey tools need to be used in order to fully capture the physical parameters of the beach.	
42 Singing Bridge, MI, LH		Same as above.	
43 Twining Rd., MI, LH		Same as above.	
44 Whites Beach, MI, LH		Same as above.	

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Beach, State, Great Lake	Recommend to other beach mgrs?	Suggested Improvements to Sanitary Survey Tool and Database	Comments
45 South Linwood, MI, LH		Trying to obtain info on turbidity using a Secchi Disc in chest-deep water with waves is cumbersome, potentially dangerous and difficult to obtain accurate information. It was frequently difficult to collect the survey information and water samples, review the information collected the previous day, calculate single-event and 30 day geometric mean averages, update the MDEQ web page and keep the staff informed. Following data elements not useful in addressing impacts from pollution sources: bather load, beach cleaning, description of sanitary facilities, and description of other facilities. Guidance materials were useful. It is beneficial to review what others are doing, review common trends, and read about new developments. A training session would be useful along with information regarding what others are doing, as well as the discussions of rapid testing and predictive modeling. The most important information to improve water quality is the identification and elimination of sources of pollution.	The data collected during the survey is representative of observable data collected during dry weather conditions. This information will serve as a useful baseline for comparison with data collected in future surveys under different weather conditions. Having funds for water quality monitoring and data collection 4 days/wk allowed Bay County Health Department to obtain accurate information on water quality during dry weather conditions, and being at each sampling station 3 days per week improved public awareness of monitoring program.
46 Brissette Beach, MI, LH		Same as above.	Same as above.
47 Bay City, MI, LH		Same as above.	Same as above. In addition, sampling conducted during the sanitary survey provided no conclusive correlation that any of these hypothetical sources contribute to bacterial contamination of the beach. More analysis of the data is needed and further analysis of the data may show that rain and associated conditions (e.g., wave height, wind) may also contribute to elevated levels of bacteria.
48 Wenona Beach, MI, LH		Same as above.	Same as above.
49 Pier Pk, MI, Lake St. Clair			
50 Beach 2, PA, LE	Y	The surveys are a useful tool, but we suggest that the database provided by EPA for keeping track of the routine, annual, and 5-year surveys have more reporting capabilities. Currently, the only reporting option that the database has is the number of entries in the database.	
51 Beach 10 (Budny) PA, LE	Y	Same as above.	
52 Evans Town, NY, LE	Y (with reservations)		This is a complex issue. The questions relate to several factors: responsible organizations for different surveys, level and sophistication of seasonal staff, availability of measuring equipment, availability of secondary data, commitment of resources, size of beach, and authority to require cooperation by conducting surveys. For these reasons, our suggestions will require further analysis and consideration on our part.
53 Lake Erie, NY, LE			Same as above.
54 Fair Haven, NY, LO	Y	The sanitary survey forms need to exactly match the online database. It would have been more efficient and would have improved the quantitative and qualitative aspects of the data. Some of the data collected by the sampling staff was not applicable to any of the data fields in the online database so data was put into "Comments" field. The data entry into the online database was generally easy to use; however, if there was an error in data entry, the error message did not specify which field was in fault, so staff did not know which field to correct. After the error message was displayed, the whole online form was cleared, leaving staff no choice but to re-enter the data without knowing what the original mistake was. Many of the data fields were very appropriate on the survey; however, it is important to keep in mind that each beach is unique. It is impossible to create one form that is applicable to all beaches. Our Agency has one generic field report form; however, we tailor this form to specific beaches so that we can collect the best data possible. It is important to have the flexibility to add data fields based on known potential pollution sources for a beach (e.g., if a beach is affected by algae, form should include several algae-specific questions). Also, we sample at multiple stations at some beaches, and have designed distinct forms for those facilities so that staff do not have to rewrite certain data fields (e.g., weather), but have space to write information on factors that differ among the stations. Beach managers must be allowed to modify EPA's final form to make it more user-friendly to individual beaches. Finally, it is important to be as specific as possible on these forms. Park staff responsible for beach monitoring may change, and some may not have an environmental background. Thus, it is important for questions on the field sheet to be very specific; if they are not, we've found that we do not collect quality data (or the data that we initially intended to collect).	
55 Selkirk Shores, NY, LO	Y	Same as above.	
56 Sandy Island, NY, LO	Y	Same as above.	
57 Bayfield Main Beach, CN, LH	Y		
58 Bayfield South Beach, CN, LH	Y		
59 Goderich Main Beach, CN, LH	Y		
60 Goderich St. Christopher's Beach, CN, LH	Y		

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61 Goderich Cove Beach, CN, LH	Y		