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South Shore Beach Relocation Study

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South Shore Beach Relocation Study

Prepared for

Milwaukee County
Department of Parks, Recreation and Culture (Parks)
Department of Administrative Service, Architecture, Engineering, and Environmental Services Section (AE&ES)

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1.0 INTRODUCTION

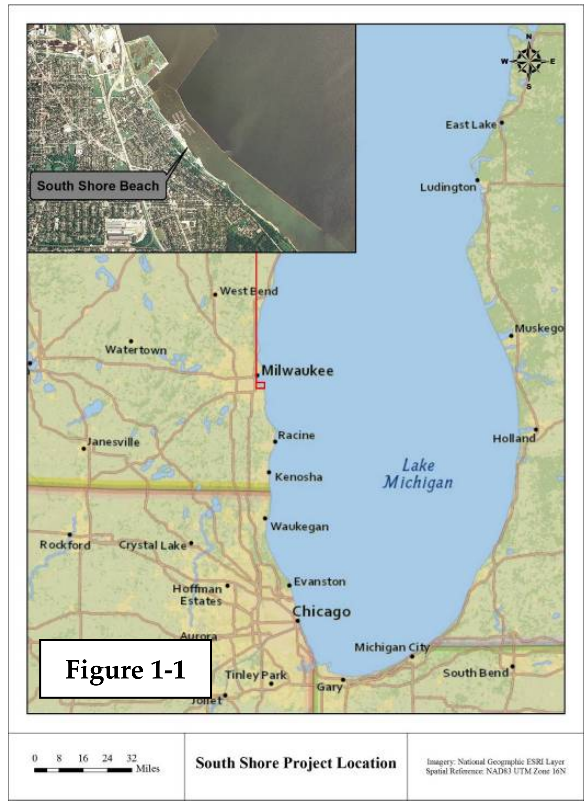


Figure 1-1

South Shore Beach is a recreational beach located in Milwaukee County, on the west side of Lake Michigan as shown in Figure 1-1 and Figure 2-1. The beach is located at the northern end of South Shore Park, adjacent to the County's boat launch ramp, South Shore Yacht Club, and swing mooring field (refer to Figure 1-3).

South Shore Beach experiences periodic closures due to water quality issues. During the 2011 swimming season, there were 34 beach closure or advisory days (NRDC, 2012). Per Wisconsin Regulations, an *E.Coli* sample with 236 - 999 cfu/100 ml leads to an advisory, a sample greater than 1,000 cfu/100 ml results in a closure (NRDC, 2012).

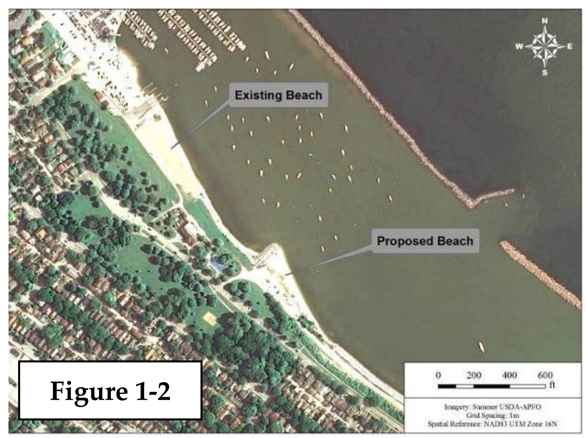


Figure 1-2

Milwaukee County (2012) and previously completed studies have identified the following sources of water quality issues at South Shore Beach:

- Birds, particularly gulls and geese;
- Runoff from adjacent parking lot;
- Boat launch ramp;
- Swing mooring field; and
- Stormwater outfalls.

The above sources in conjunction with poor water circulation at South Shore Beach contribute to beach closures. Milwaukee County wishes to examine the feasibility of rectifying the water quality issues by relocating the beach further south where there may be potential for additional wave energy through the offshore breakwater entrance to improve water circulation. The proposed beach location is shown in Figure 1-2.

W.F. Baird & Associates Ltd. (Baird) was retained by Milwaukee County to evaluate the feasibility of relocating the beach. The study objective is to understand whether the water quality at the proposed beach location will be better than that at the existing beach through the use of a hydrodynamic model analyzing circulation velocities.

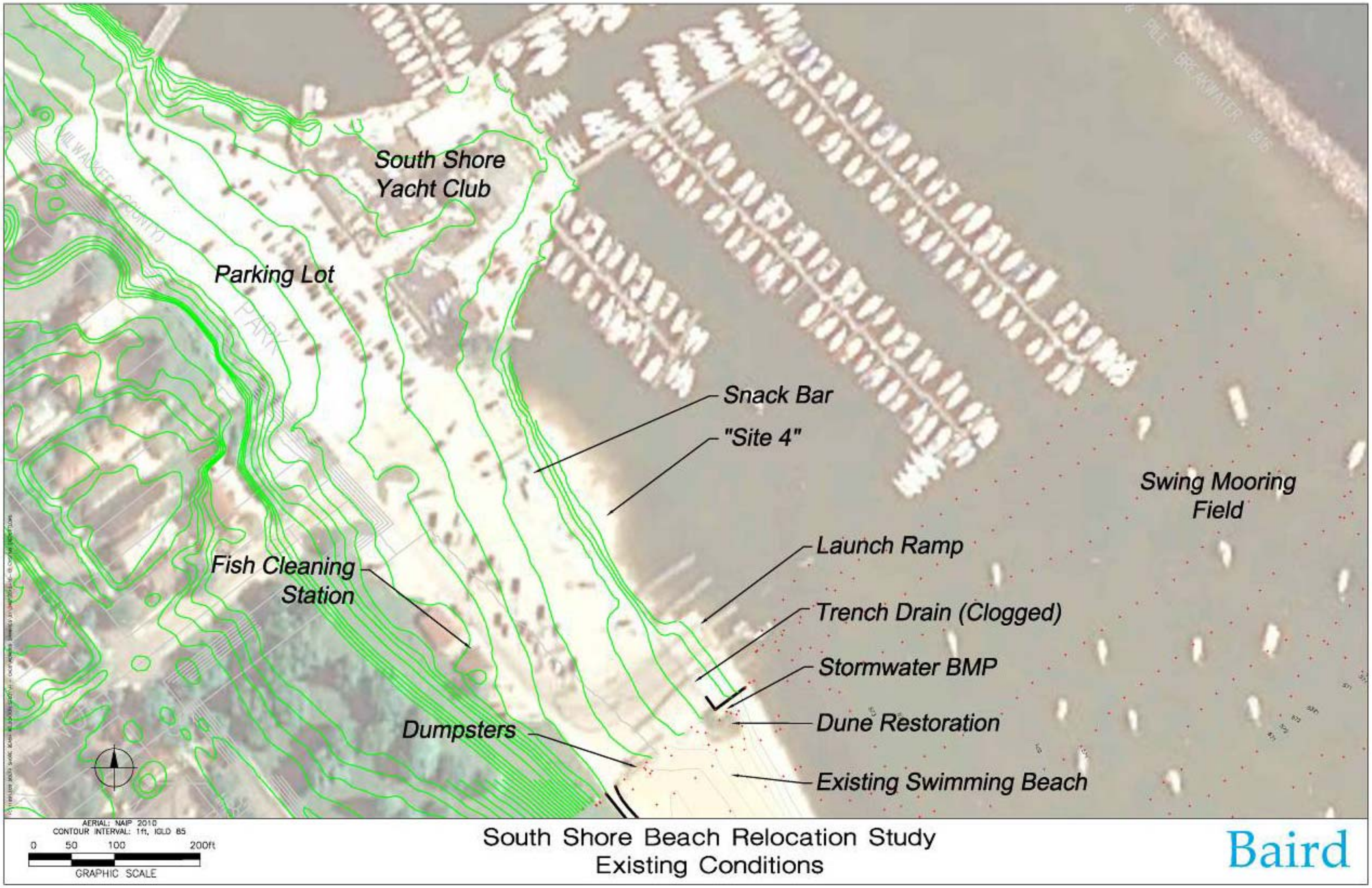


Figure 1-3 Location Map

2.0 SUMMARY OF ENVIRONMENTAL CONDITIONS

The following data sets were used to define the existing environmental conditions near South Shore Beach including; water levels, winds, currents, and waves:

- Measured water level data (National Oceanic and Atmospheric Administration (NOAA) Milwaukee station 9087057);
- Measured wind data (NOAA Milwaukee meteorological station);
- Offshore modeled current and wave data (GLERL, 2012); and
- Nearshore measured current data (EPA, 2012).

A map showing the locations of the data utilized in this study are shown in Figure 2-1. Additional details and analysis pertaining to each data set are provided in the following sub-sections.

Figure 2-1 Map Showing Locations of Data used in Study

2.1 Water Levels

Water levels on Lake Michigan vary in response to long-term and seasonal climatic fluctuations (precipitation and evaporation) over the Great Lakes drainage basin, and over the short-term as a result of individual weather systems (storm surge). Long-term monthly mean lake levels were obtained from the USACE Detroit District. The historic data record extends from 1918 to 2011, and is summarized in Figure 2-2.

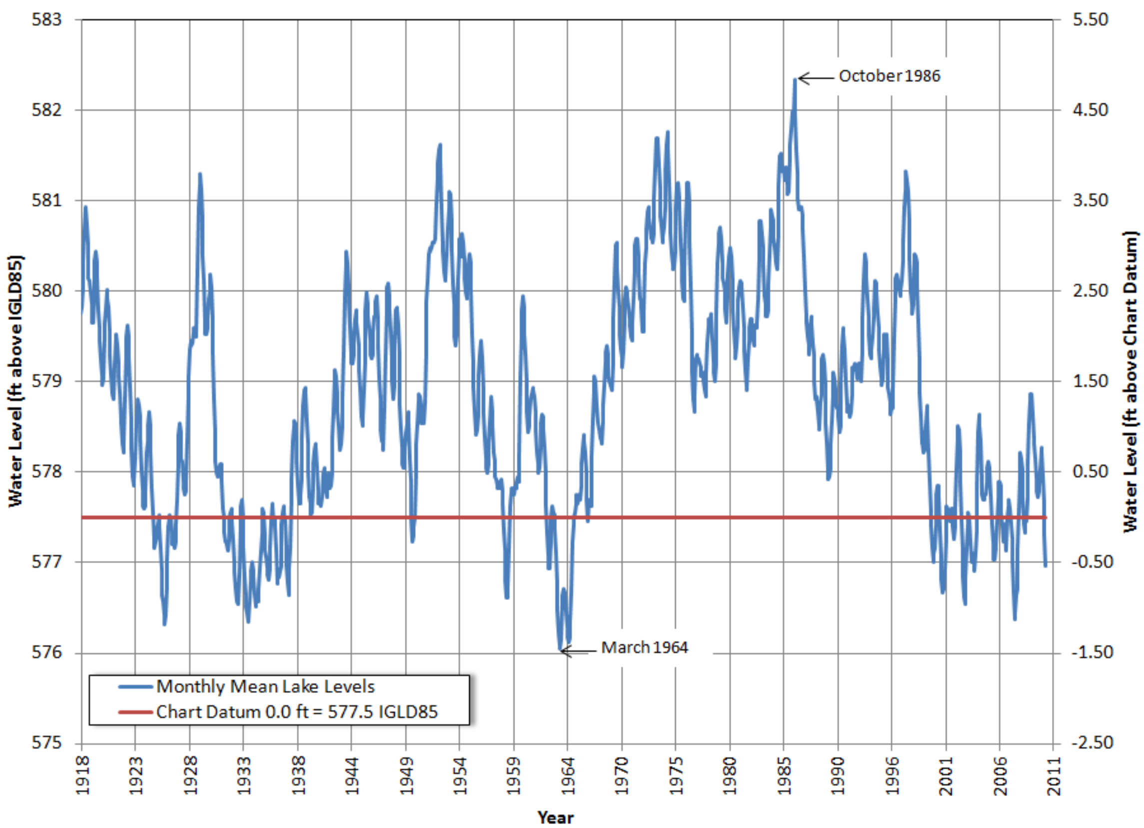


Figure 2-2 Monthly Average Lake Level (1970 to June 2011)

Since 1918, the average monthly lake level on Lake Michigan has varied from a high of 582.35 ft IGLD 1985 (+4.9 ft CD) in October 1986 to a low of 576.0 ft IGLD 1985 (-1.5 ft CD) in March 1964. The long-term annual average level is 578.9 ft IGLD 1985 (+1.4 ft CD).

The closest water level gauge to the project site is Milwaukee (NOAA Station ID: 9087057), located just south of the ferry terminal as shown in Figure 2-1. This gauge has been collecting hourly data since 1970. The monthly mean lake level, calculated from the Milwaukee gauge data is shown in Figure 2-3, the seasonal variation on Lake Michigan is typically in the order of one foot, with the annual high occurring in the summer (June-July) and the annual low occurring in the winter (January - February).

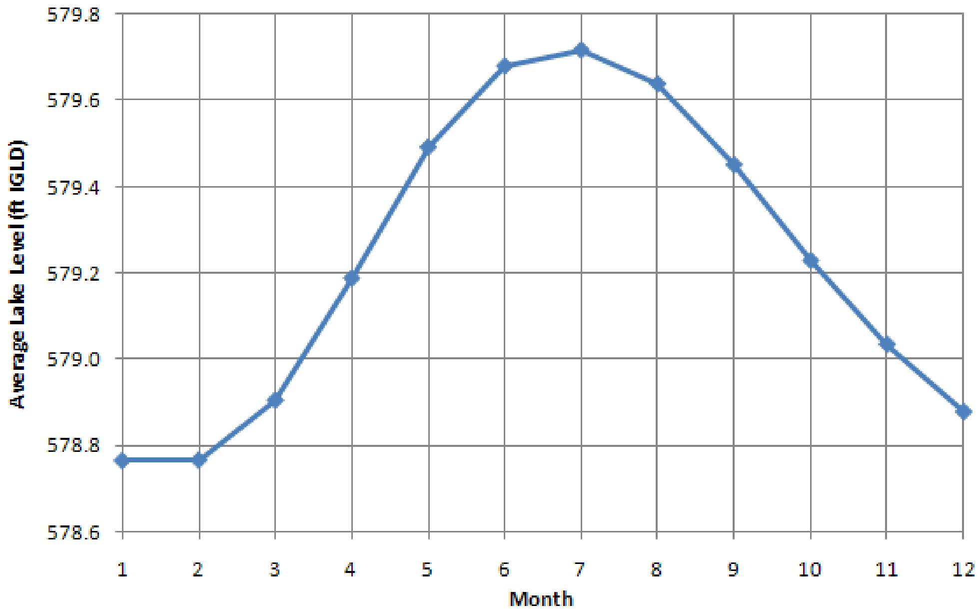


Figure 2-3 Monthly Average Lake Level at NOAA Milwaukee Station 9087057, 1970 to June 2011 (NOAA, 2012 b)

During the summer when the beach is heavily used, the average water level is 579.68 ft IGLD (+2.18 ft CD). The highest water level occurs during July, and the lowest occurs during August, as tabulated in Table 2-1. Note that chart datum (low water datum), 0.0 ft CD (0.0 ft LWD) is 577.5 ft IGLD85.

Table 2-1 Average Monthly Water Levels during Summer Months

	Average Water Level	
Month	**ft IGLD**	**ft CD**
June	579.68	+2.18
July	579.72	+2.22
August	579.64	+2.14
Summer	**579.68**	**+2.18**

2.2 Winds

Over water wind data was obtained from the Milwaukee meteorological station (NOAA, 2012 a) from 2000 to 2011. This station is operated by the Great Lakes Environmental Research Laboratory (GLERL), refer to Figure 2-1 for location. The anemometer is located 40 ft above the site elevation (577 ft above Mean Sea Level).

A wind rose including all seasons is provided in Figure 2-4; it demonstrates that the dominant winds are from the WNW and NW. The strongest winds are from the NE, which relative to South Shore Beach is coming from offshore.

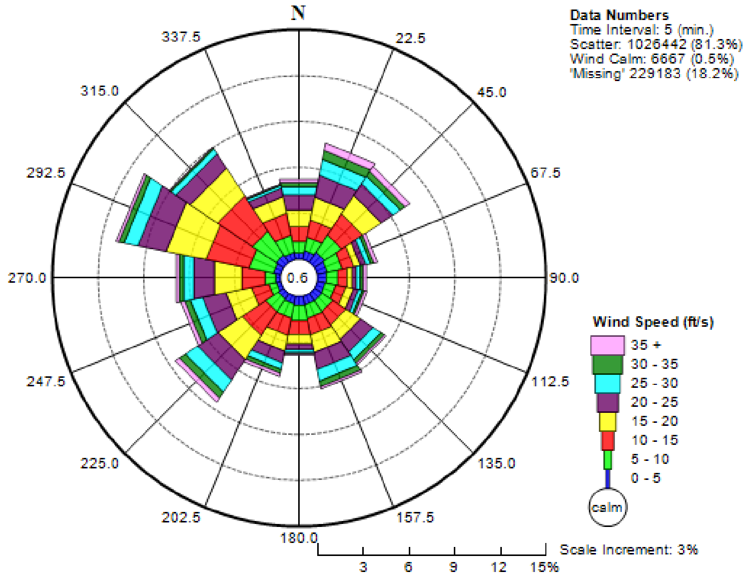


Figure 2-4 All Season Wind Rose (Direction wind is from)

A wind rose including only data from the summer, when the beach is being used, is provided in Figure 2-5. The dominant winds during the summer are from the NNE and NE. The strongest winds during the summer are from the SW, which relative to South Shore Beach is coming from overland.

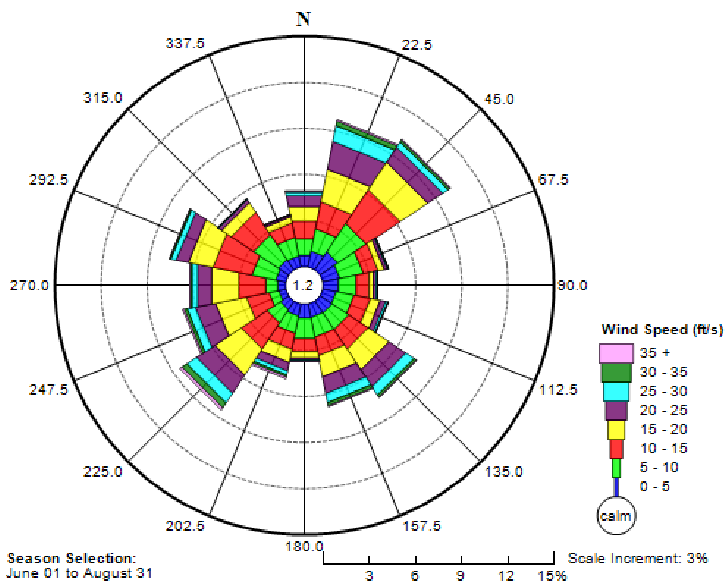


Figure 2-5 Summer Wind Rose (Direction wind is from)

Comparing the summer wind rose to the all season shows that wind speeds are lower during the summer. Winds are less than 2 ft/s about 5% of the time during the summer months.

2.3 Currents

Great Lakes Environmental Research Laboratory (GLERL) of NOAA conducted extensive research into current patterns in Lake Michigan. These studies have included field measurement programs (Miller, 1997), the synthesis of existing datasets (Liu, 1997; Beletsky et al., 1999), and comprehensive numerical modeling of the lake hydrodynamics (eg. Schwab and Beletsky, 1998; Beletsky and Schwab, 2001; Beletsky et al., 2003).

Long-term (annual) numerical simulations of the hydrodynamics (currents, water levels and temperature structure) have also been conducted by GLERL researchers in support of various projects. This modeling utilized the well-known Princeton Ocean Model (POM) that represents the physics of three-dimensional flow and thermal structure in the lake. The current version of the model has a horizontal grid resolution of 6560 ft (2 km) and 20 vertical layers. The vertical layers are more closely spaced in the upper 98 ft (30 m) of the water column in order to better represent the seasonal thermocline. Horizontal diffusion is simulated by means of a Smagorinsky eddy parameterization. Considerable effort has gone into appropriate representation of the surface wind fields and surface heat flux that drive the model (for further details refer to Beletsky and Schwab, 2001).

The numerical model has undergone a comprehensive validation program through comparison with long-term measurements of currents and water temperatures. Some of the key findings of the numerical modeling program relevant to South Shore Beach include:

- Currents in the southern part of Lake Michigan flow in a counter-clockwise direction in both summer and winter. This induces a general southward flow offshore of the project site.

- The strongest currents occur during the winter months when temperature gradients are minimal and the wind speeds are largest.

- The lake currents are primarily driven by wind. The contribution of density-driven currents is not large, and occurs primarily in the summer months in deep water.

Data from the GLERL numerical model in the vicinity of the project site were provided by NOAA in support of this project. Specifically, water level, current, wind speed and direction, and water temperature data were provided from 2007 to 2012 for one grid point approximately four miles offshore of the project site (Lat 43.010086°, Long -87.791290°) in a water depth of 80 ft as shown in Figure 2-1.

The data is presented in current roses for all seasons (Figure 2-6) and the summer season (Figure 2-7). The shoreline orientation is from about 135 to 315 degrees and the offshore currents generally travel alongshore in both directions (N and S relative to the shoreline orientation). Figure 2-6, demonstrates that when looking at all seasons combined, the dominant currents are along the

NNW-SSE axis, which is shore parallel. This shore parallel dominant current direction is generally consistent with the dominant wind direction presented in Figure 2-4. During the summer, the current speeds are generally lower, with the highest current speeds from the SSE and S (refer to Figure 2-7).

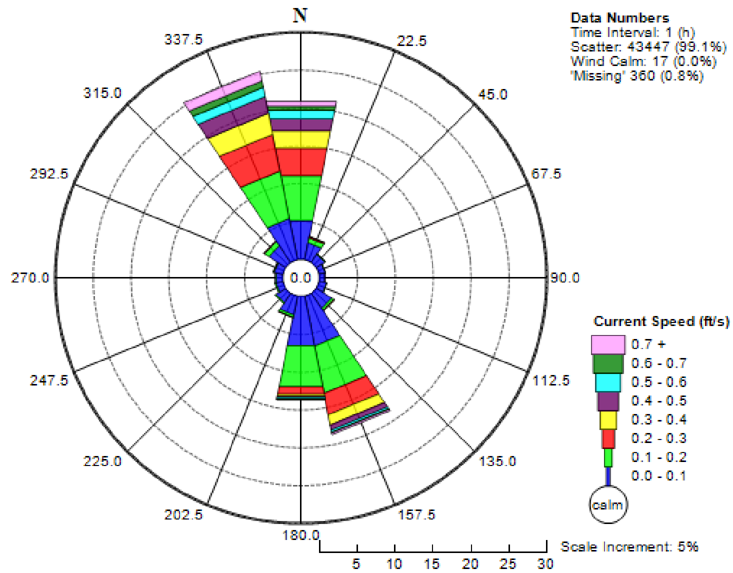


Figure 2-6 All Season Depth Average Current Rose (Direction from)

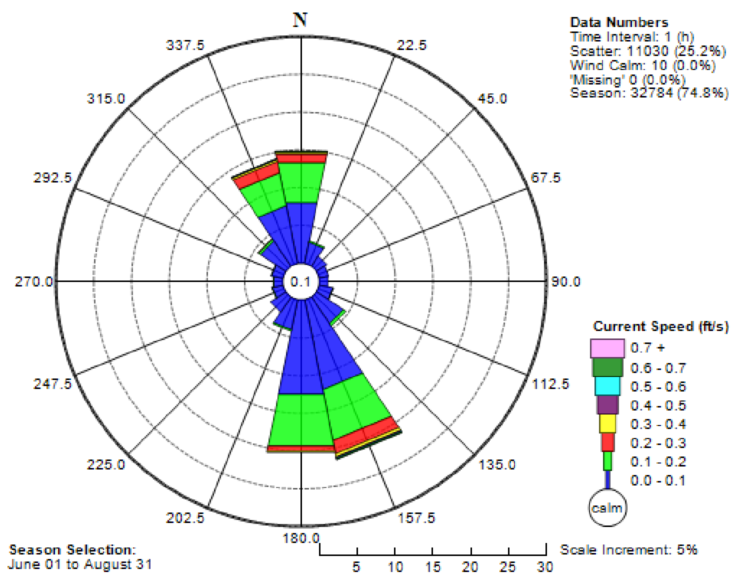


Figure 2-7 Summer Depth Averaged Current Rose (Direction from)

The Environmental Protection Agency (EPA) installed an Acoustic Doppler Current Profiler (ADCP), inshore of the breakwater, near South Shore beach. The ADCP was installed just offshore of the South Shore Yacht Club dock in about 8 ft of water as shown in Figure 2-8, and collected data from July to October 2008.

Figure 2-8 ADCP Location

Although the ADCP was only in place for four months in the summer/autumn of 2008, the data provides an indication of the nearshore currents near South Shore Beach. These data could also be used in future stages of the study to calibrate the hydrodynamic model, discussed in Section 7.0.

The ADCP data are summarized in the current rose shown in Figure 2-9. From this figure, it can be observed that the dominant current directions are from SE, which is shore parallel towards the north (relative to the shoreline orientation). The dominant direction of the nearshore current data is consistent with the summer offshore currents presented in Figure 2-7. The winds during this time period were predominantly from the NE (refer to Figure 7-1), which tends to generate currents from the SE behind the breakwater at South Shore beach; this is consistent with the ADCP data.

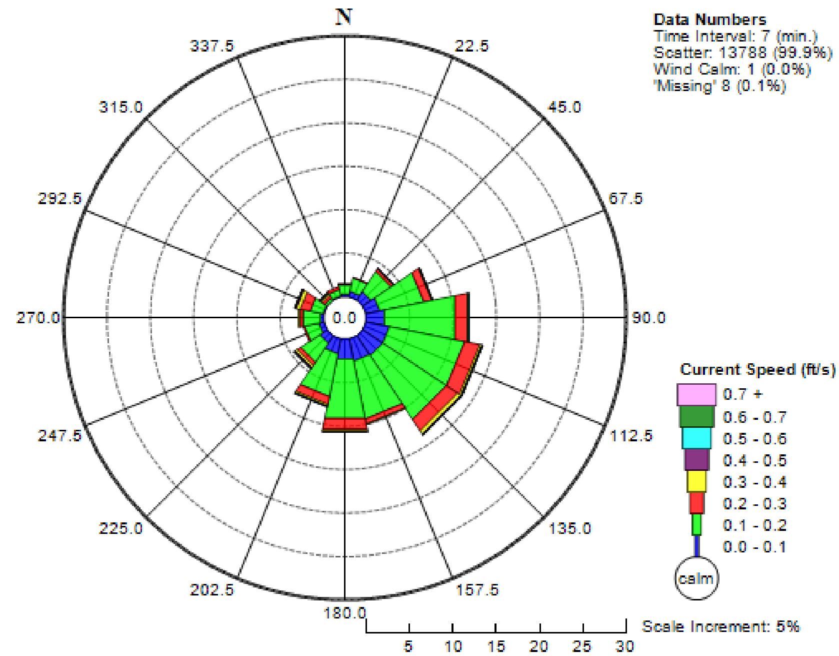


Figure 2-9 Depth Averaged Current Rose from ADCP from July – October 2008 (Direction from)

The ADCP data also provide an indication of nearshore current speeds; it was determined that on average the current speeds were low, with only 0.16 ft/s and the maximum speed was 0.7 ft/s. This information was assumed to be representative of depth averaged current speeds and based on this assumption was used to loosely check the results from the numerical model presented in Section 6.0.

It is interesting to observe that these nearshore currents are smaller and are more variable in direction than the offshore currents presented in Figure 2-6 and Figure 2-7. The variability in direction, may be due to either a combination of eddies that are formed in the nearshore (discussed in further detail in Section 6.0), turbulence caused by boat wakes, or other noise captured by the ADCP.

2.4 Waves

Waves are a significant factor when considering coastal processes, including longshore and cross-shore sediment transport, and the design of coastal structures. Increased wave energy can move sediment, attack coastal structures and generally have an impact on the entire shoreline. Waves are created by wind stresses across a stretch of water known as a fetch and increased wind speeds create larger waves. Waves are also heavily influenced by the water depth. In shallower water waves undergo phenomena known as wave refraction and wave shoaling/breaking, both of which reduce the energy of the wave.

There are no wave measurements offshore of the project site. As a result, modeled data from GLERL's Nowcast 2-dimensional model (http://data.glos.us/glcfs/) were used to assess the wave climate near the project site. Wave data were available from 2006 to 2011 at the grid point approximately four miles offshore of the project site (Lat 43.010086°, Long -87.791290°) in a water depth of 80 ft. The wave rose in Figure 2-10, shows that the majority of the waves are travelling from the northeast (offshore). However, during the summer (refer to Figure 2-11), there is also a large component of waves coming from the southeast.

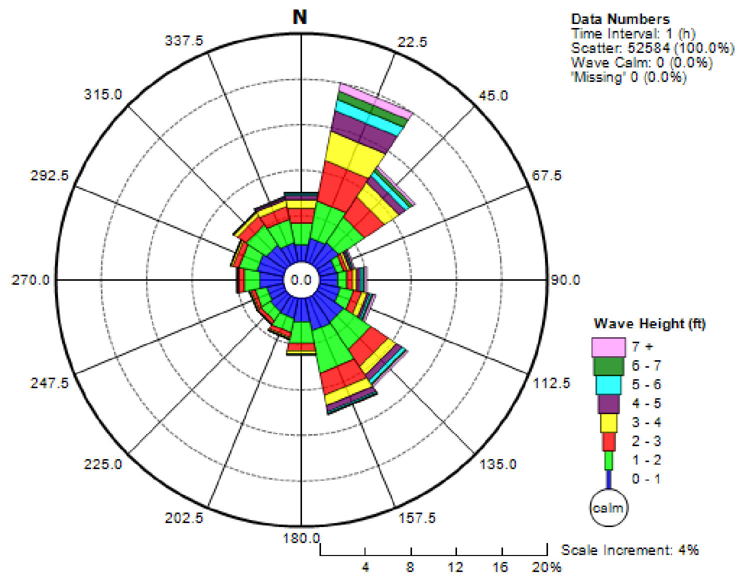


Figure 2-10 All Seasons Deep Water Wave Rose from GLERL (2006 to 2011) (Direction from)

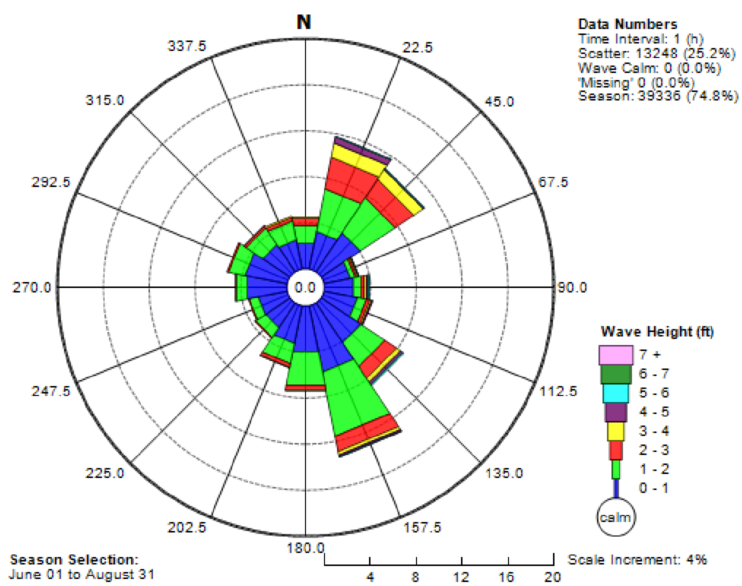


Figure 2-11 Summer Deep Water Wave Rose from GLERL (2006 to 2011) (Direction from)

It is important to note that the wave data presented are for deep water waves. Wave height and direction changes as waves move inshore, due to refraction and shoaling. The design of a stable recreational swimming beach introduces the concept of depth limited waves. As waves enter shallow water, they break and energy is dissipated. While wave energy is significant offshore, Figure 2-12 illustrates the reduction of wave energy in the nearshore environment as prepared by Baird for previous studies at South Shore Park.

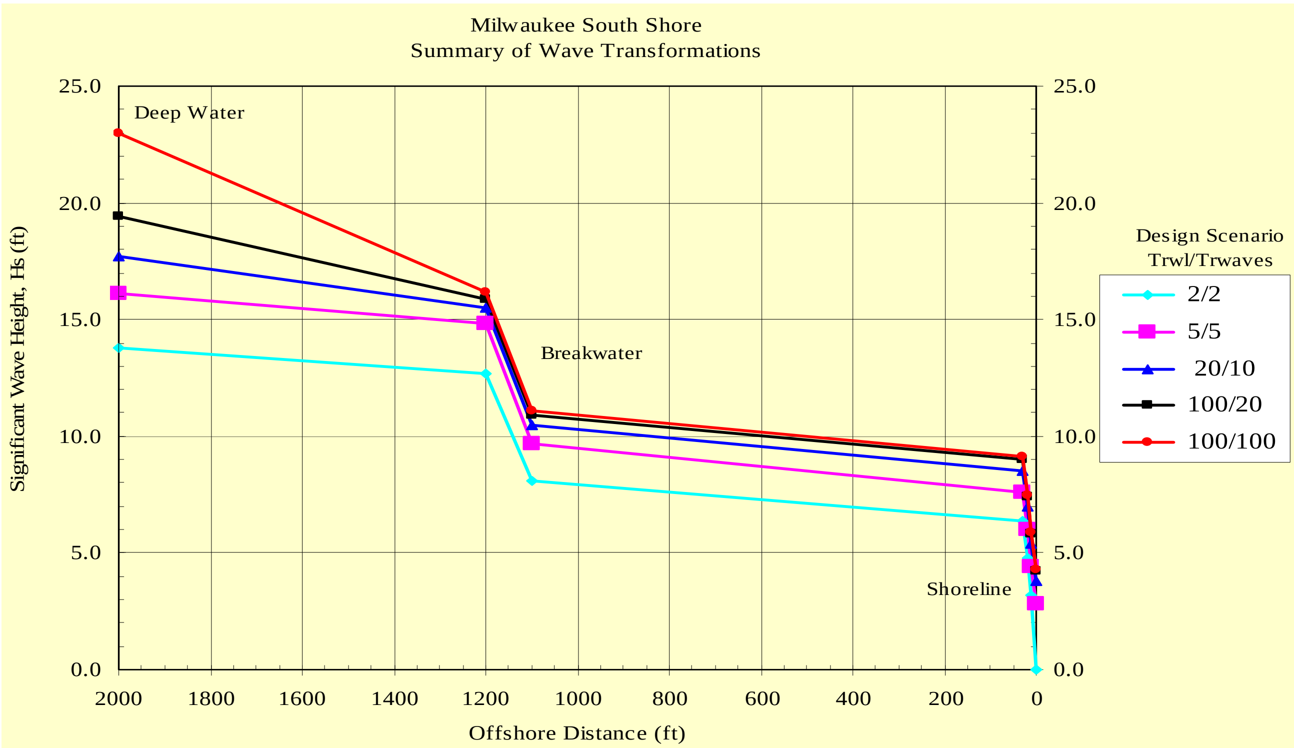


Figure 2-12 Wave Transmission (Baird, 2005)

3.0 EXISTING PHYSICAL CONDITIONS

A field program that included topographic survey, bathymetry survey and surface geotechnical sampling were undertaken for the study. Details pertaining to the data collection programs and analysis are provided in this section, and full size graphics are included in Appendix C.

3.1 Topographic Survey

Himalayan Consultants completed a topographic survey on August 1-2, 2012 of the existing beach and the proposed beach location. Survey cross-sections were completed 100 ft on center within these areas.

Himalayan Consultants and Baird representatives coordinated with Milwaukee County, the City of Milwaukee and the City of St. Francis to locate outfalls in the area of the proposed beach relocation. No outfalls were located within the area of the proposed beach.

3.2 Hydrographic Survey

Himalayan Consultants conducted a hydrographic survey on August 1-2, 2012 of the breakwater entrance channel and nearshore area adjacent to the proposed beach location. Survey data were collected with GPS and echo sounding equipment along cross-sections 100 ft on center. The topographic and hydrographic survey data are shown in Figure 3-1 and Appendix C. These survey points were combined with existing Milwaukee County data and previously collected Baird data, which included as-built surveys from the revetment construction and nearshore environment adjacent to the proposed beach (Luhr Brothers, 2007).

3.3 Geotechnical Program

Grain-size and geotechnical analyses (ASTM D-421) were performed on the ten sediment samples collected at the existing beach in 2012, the proposed beach location and the sandbar adjacent to the boat launch ramps; known as Site 4 (refer to Figure 1-3). The sample locations are shown in Figure 3-2 and the results of the analyses are summarized in Table 3-1. The laboratory results are included in Appendix A. Note that these results are coherent with data collected previously by Milwaukee County adjacent to the outer breakwater within the marina. In particular, the grain size at Site 4 is very similar to that of M-1 (refer to Appendix B for additional details).

Table 3-1 Geotechnical Parameters

Geotechnical Design Parameters South Shore Beach Relocation Study Milwaukee County					
Sample ID*	Depth (ft)	Soil/Sediment Description	USCS Classification	Approximate Moist Unit Weight (γ) pounds/cubic foot	Approximate Internal Angle of Friction (Ø) degrees
Existing Beach Area					
S-1A	0-1	Well graded gravel with sand	GW	130	35
S-1B*	0-1	Well graded sand with gravel	SW	120	32
S-1C*	0-1	Well graded gravel with sand	GW	130	35
S-2A	0-1	Well graded sand with gravel	SW	120	32
S-2B*	0-1	Well graded sand with gravel	SW	120	32
S-2C*	0-1	Well graded sand with gravel		120	32
Proposed Beach Area					
S-3A	0-1	Well graded gravel with sand	GW	130	35
S-3B*	0-1	Well graded sand with gravel	SW	120	32
S-3C*	0-1	Well graded gravel with sand	GW	130	35
Beach Area north of Boat Launch					
S-4	0-1	Poorly graded sand	SP	118	30

* = Subtract unit weight of water, γ_w (62.4 lbs/ft^3) from Υ to obtain submerged or effective unit weight, γ'

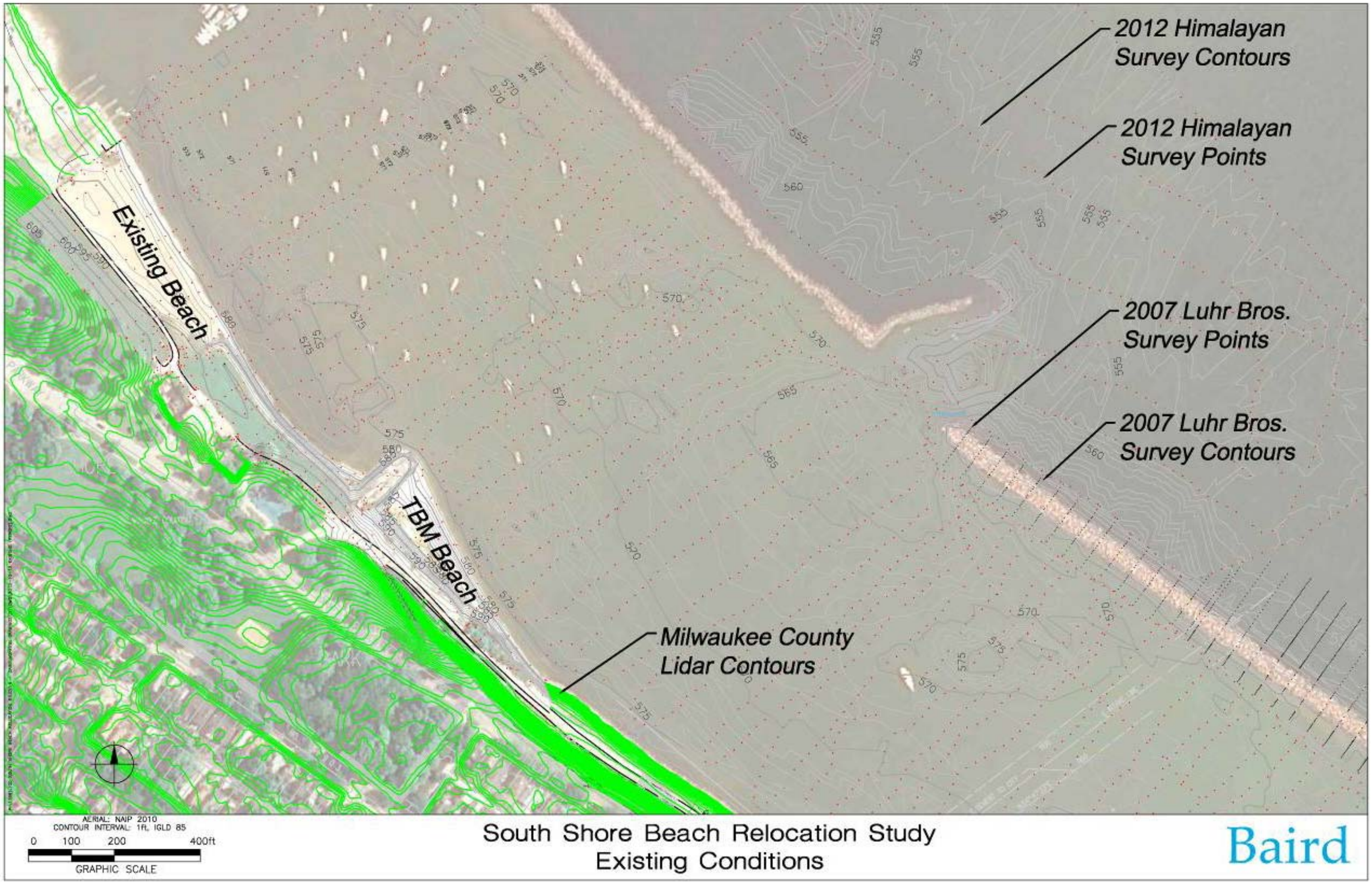


Figure 3-1 Existing Conditions Survey

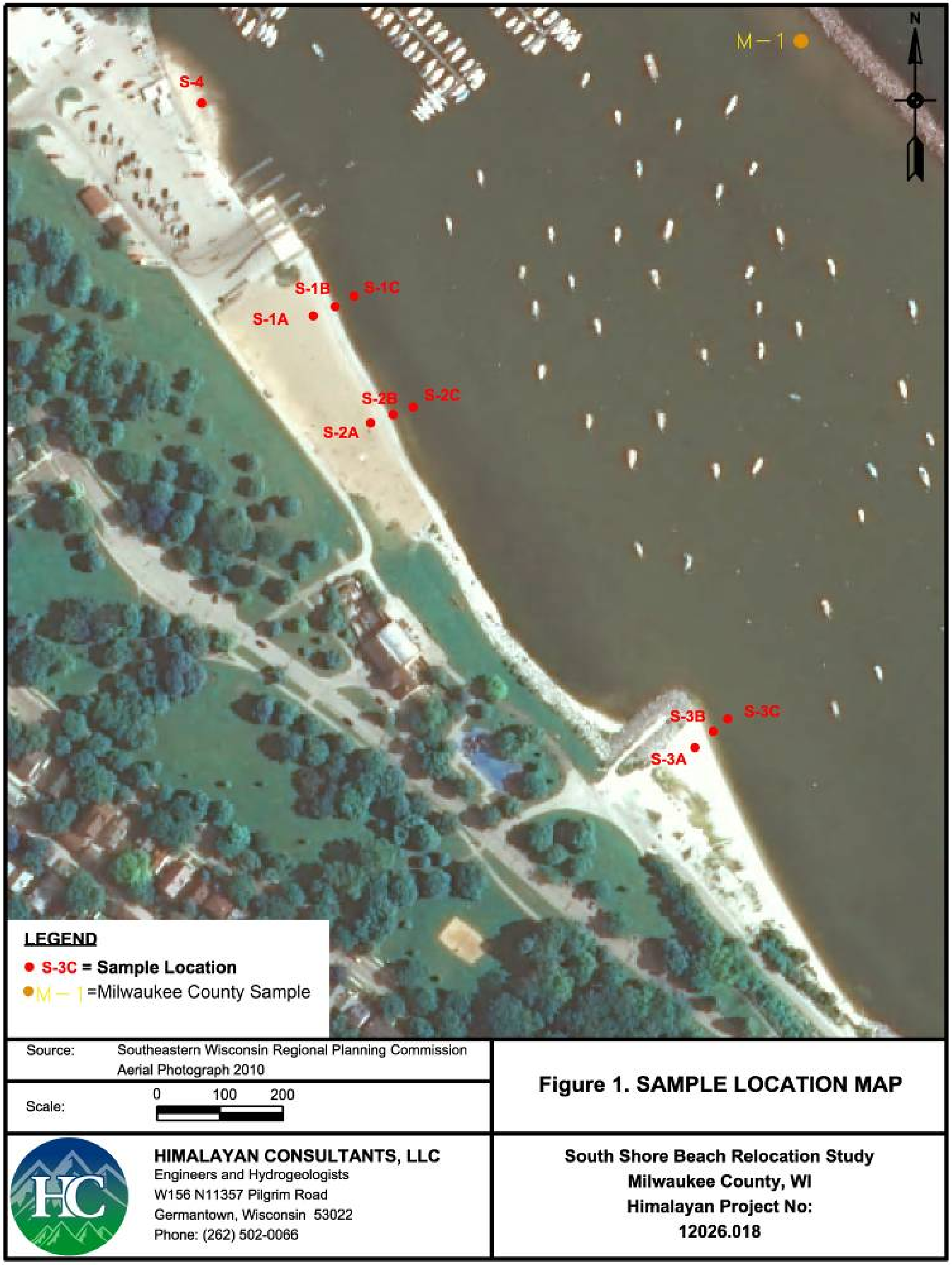


Figure 3-2 Sediment Sample Locations

4.0 WATER QUALITY

The water quality at South Shore Beach was assessed through a literature review of previous studies. Based on the literature review and discussions with Milwaukee County staff, sources of contaminants affecting South Shore Beach were identified. Specifically, contamination by *E. coli* leading to beach closure was the measure of water quality for this study. These efforts were used in conjunction with hydrodynamic modeling of the physical characteristics of the existing and proposed beach locations to assess the differences between the two sites.

4.1 Literature Review

With an effort to leverage previous research by others, Baird conducted a literature search and review of previous studies on water quality issues at South Shore Beach. The bulk of the pertinent literature was produced by Dr. Sandra McClellan at the University of Wisconsin- Milwaukee School of Freshwater Science. A brief summary of the most applicable papers are provided in this section.

4.1.1 Evidence for Localized Bacterial Loading as the Cause of Chronic Beach Closings in a Freshwater Marina (McLellan and Salmore, 2003)

Water quality advisories were issued for South Shore Beach 43%, 55%, and 37% of the 75 day swimming seasons in 1999, 2000, and 2001, respectively. This study determined that the source of contamination was localized, and primarily avian in origin.

Water quality samples (refer to Figure 4-1) were taken throughout the beach and marina area, and throughout the outer harbor periodically during the summer of 2002. *E. coli* levels were highest at Site 4 (refer to Figure 1-3), which is close to South Shore Beach and is an area where waterfowl consistently reside. The *E. coli* levels at Site 4 were greater than the beach-closure threshold (235 cfu/100 ml) 88% of the days sampled, and reached levels as high as 27,000 cfu/100 ml. The *E.* coli concentrations at Sites 1-3 were significantly lower than Site 4, but still exceeded the threshold in 58% of the sample days. The study findings concluded that the higher *E. coli* levels at Site 4 indicate that the water quality is adversely affected by the waterfowl populations.

The study also noted that *E. coli* levels were much higher within the first 10 m from the shoreline. The *E. coli* counts at 10 m away from the shoreline were similar to the *E. coli* levels 150 m from the shoreline. This indicates that the source of the contamination is from the shoreline. The *E. coli* levels at the breakwall inlet were expected to be highly contaminated, as they are close to the Milwaukee Harbor. However, the concentration of *E. coli* at the inlet was found to be significantly less than the levels found in the swimming area. The *E. coli* levels found at the stormwater outfall were below the threshold for all samples, except the one day that there was a Combined Sewer Overflow (CSO) event.

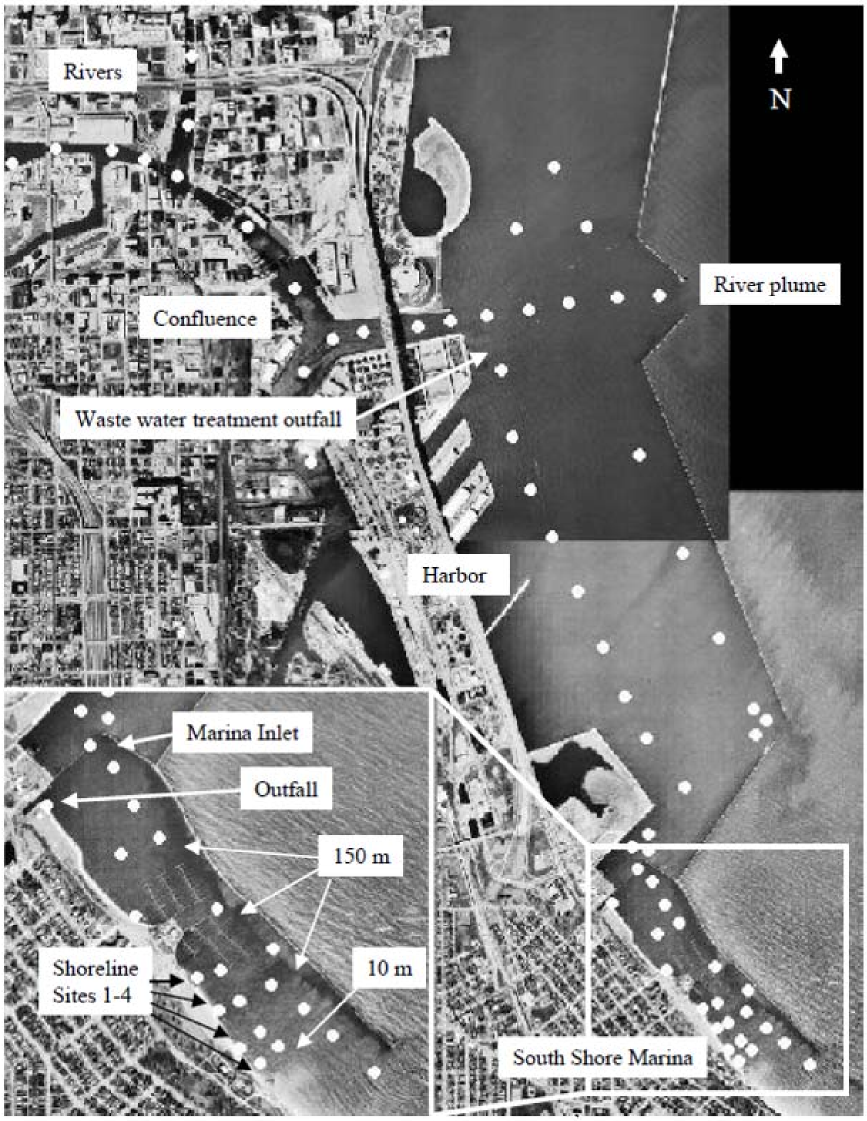


Figure 4-1 Sampling Locations (McLellan and Salmore, 2003)

4.1.2 Identification and Quantification of Bacterial Pollution at Milwaukee County Beaches (McLellan and Jensen, 2005)

Water quality samples were collected and analyzed during the summer of 2005 at and around South Shore, Bradley, and McKinley beaches to quantify and identify sources of contamination by testing for *E. coli* and *Bacteroides*. Overall, the *E. coli* counts were consistently higher after a precipitation event indicating transport via stormwater runoff. South Shore Beach had the highest level of contamination as 77% of its 68 samples measured over 235 CFU/100 ml. Also, *E. coli* concentrations increased six-fold, the highest increase of the three beaches, after a precipitation event. Water samples from South Shore and Bradford parking lots were collected and measured between 100 and 39,300 *E. coli* counts per 100 ml. Finally, *E. coli* levels were consistently higher in beach sand near the water line and nearshore berm than in dry middle and landside locations.

A total of 34 beach water samples were analyzed for *Bacteroides* and human specific *Bacteroides*. 33 of the 34 samples tested positive for *Bacteroides*, but none of the samples tested positive for human specific *Bacteroids*. Therefore, it can be deduced that much of the contamination is not from human sewage, which is logical considering there were no CSO events in the summer of 2005.

4.1.3 Influence of Nearshore Water Dynamics and Pollution Sources on Beach Monitoring Outcomes at Two Adjacent Lake Michigan Beaches (Scopel, Harris and McLellan, 2006)

Water quality sampling (216 samples) between May and September 2003 at the existing South Shore beach location and at the proposed beach site (150 m south) noted stark differences in *E. coli* counts. The existing beach had much higher levels than the proposed beach, and the number of days the levels exceeded standards was much higher for the existing beach (12 verses four out of the 39 sampling days, or 30% versus 10%). The primary cause of contamination was determined to be pollutants from the adjacent shoreline rather than CSO or river discharges. In fact, *E. coli* at South Shore Beach did not exceed 235 cfu/100 ml following a CSO event. While *E. coli* levels increased with precipitation, the rise in levels significantly increased at the existing beach location.

A fluorescein dye study demonstrated that wind could move the water out of the beach areas, but only during strong wind conditions. During calm wind conditions, the longshore current was determined to be the principle dispersion factor at the current beach. The study determined that at the proposed location, the dye moved twice as fast during calm wind conditions as it did at the existing beach. During high wind conditions, the current direction was very different at the proposed location. At the current beach, the dye moved away from the shore; however, at the proposed location, the dye continued to move along the shore, only at a faster rate. Despite the differing current dynamics, the residence times for 90% replacement of the dye were similar for both sites under the NNW wind conditions. The primary mechanism for *E. coli* dispersion appeared to be surface currents, while mixing was a minor factor.

4.1.4 Distribution and Fate of Escherichia coli in Lake Michigan Following Contamination with Urban Stormwater and Combined Sewer Overflows (McLellan, et. al., 2007)

This study concluded that *E. coli* levels were notably higher during CSO and storm sewer overflow events. Unfortunately, it is difficult to determine if the pollution originated from the CSO events, or from the large volume of urban stormwater that was released directly into the receiving waters. It was also observed that the bacterial pollution traveled in a noticeable plume and *E. coli* levels within that plume were between 30 and 100 times higher than the samples taken at least 50 m outside of the plume. However, the study recognized that numerous environmental factors also influence the levels and distribution of the bacteria; such as: temperature, ultraviolet exposure, water circulation patterns, etc.

The study noted that while the health of the rivers, estuary, and lake is important, a chief concern with CSO events is the health and safety of the local beaches. *E. coli* levels dramatically decreased outside the breakwall. Beaches at least one kilometer from the harbor were not affected by overflow events. On the other hand, South Shore Beach was greatly impacted by CSO events as it is located within the breakwall.

4.1.5 Beach Closings: Science versus Public Perception (Jensen and McLellan, 2005)

This study scrutinized Milwaukee's media coverage of local beach closings on Lake Michigan. The purpose was to understand the relationship, or lack thereof, between the public's perception and the actual health risks. The public's perception of the risk often plays a larger role in resource management; therefore, it is important that the public is well informed.

Unfortunately, environmental issues can be a problematic topic for media as they are typically met with political and economic contention. Many studies have been conducted on beach closings on urban beaches on the Great Lakes. The paper indicated that most of the studies have found that stormwater runoff and waterfowl populations are the main contributors to high *E. coli* levels. However, in most cases the media will blame the beach closures on sewage overflows, rather than the actual causes.

In Milwaukee, the impression that sewage overflows are the cause of beach closures is not just limited to the popular media, but the Natural Resources Defense Council (NRDC) also reported that water quality advisories were largely attributed to sewage pollution. The study noted that this finding is very doubtful considering a number of scientific studies have identified waterfowl populations and stormwater runoff as the leading cause of high *E. coli* counts. Forty-eight different newspaper articles were reviewed during this study, of which 19 reported that sewage pollution was the primary source of bacterial contamination, despite the numerous studies proving otherwise. Moreover, 24 of the articles cast doubt on scientific evidence that stormwater runoff or waterfowl populations were a cause of the pollution. Conversely, past studies have repeatedly shown that elevated *E. coli* levels at Lake Michigan beaches can be attributed to rainfall events, shorebird populations, and runoff. Elevated levels at South Shore Beach are primarily in the nearshore waters.

4.1.6 A Review of Best Management Practices Benefiting Great Lakes Recreational Waters: Current Success Stories and Future Innovations (Koski and Kinzelman, 2010)

Six of the leading management practices that can improve local water quality were identified in this study:

- Stormwater and urban runoff;
- Combined sewer overflow/septic waste reduction;
- In place techniques;
- Wildlife impacts on water quality;
- Beach sediments; and

- Source control policies, agricultural Best Management Practices (BMPs), and Public Education.

A combination of BMPs and a multi-faceted plan to improve water quality is important in long-term improvements. Many of the BMPs in this study could be incorporated into a relocated South Shore Beach, or applied to improve water quality at the existing swimming beach.

4.1.7 Testing the Waters (Natural Resources Defense Council Annual Report, 2012)

Water sampling data is collected and compiled by the Natural Resources Defense Council (NRDC) on a yearly basis. This nationwide analysis of beach water quality included monitoring results from 123,886 samples at 3,325 beaches. South Shore Beach is highlighted as one of 19 "repeat offenders" with more than 25% of its samples exceeding EPA standards for the last five years.

Nationwide trends are interesting to compare to site-specific research by Dr. McLellan and others. Of note are reasons that officials closed beaches or issued Advisories, as shown in Figure 4-2. While nearly 70% of closures are due to actual monitoring data, approximately 30% are due to precautionary, or preemptive events that would affect both the existing South Shore Beach and the proposed beach location equally.

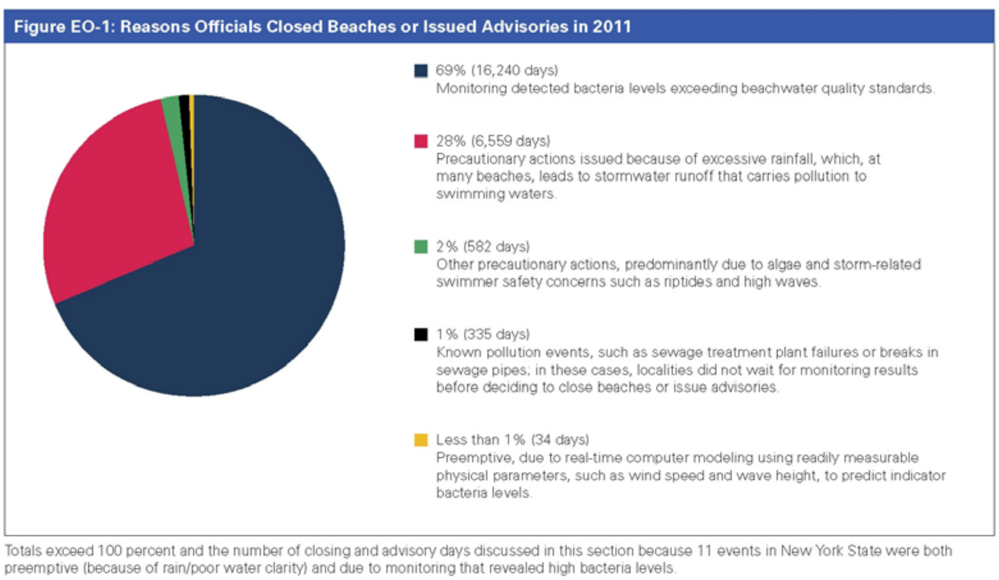
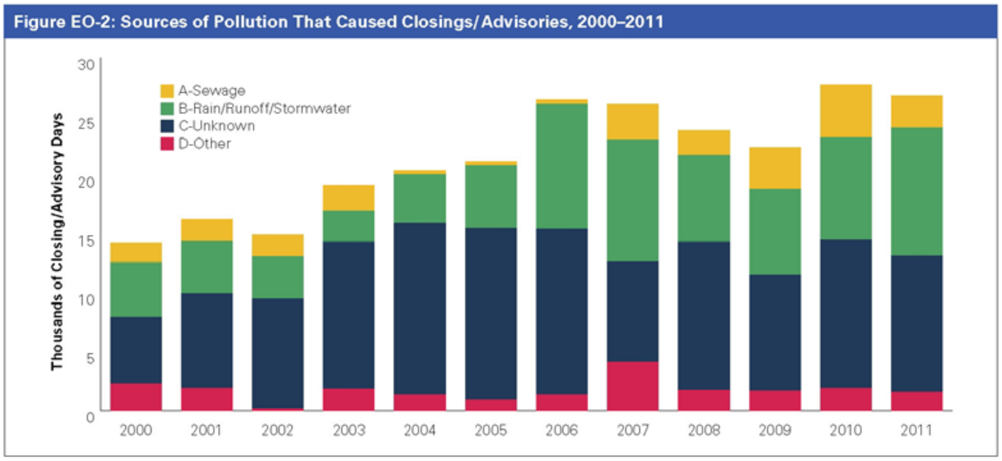


Figure 4-2 U.S. Beach Closure Cause (NRDC, 2012)

The nationwide data on sources of contamination leading to closures or advisories as shown in Figure 4-3 indicates a large amount of site-specific variability. Almost one half of beach closures are due to an unknown source or sources of pollution. South Shore Beach is well positioned to address water quality issues because pollution sources have already been identified.



Total days shown are greater than annual totals because more than one pollution source may have contributed to each closing/advisory.
Key: (A) Sewage spills and overflows. (B) Polluted runoff, stormwater, or preemptive due to rain. (C) Unknown. (D) Other reasons (including closings/advisories with no source information provided).

Figure 4-3 U.S. Beach Pollution Source by Year (NRDC, 2012)

4.2 Contaminant Sources

A review of previous studies suggests that the water quality/beach closure issues at the existing South Shore Beach are primarily due to localized sources; however, the following all lead to the increased likelihood of elevated *E. coli* in water quality sampling at the beach:

- Avian;
- Humans;
- Runoff from the parking lot; and
- Contaminated sediment.

Each of the above sources is discussed in detail in the following sections.

4.2.1 Avian

Bird populations are significant at South Shore Park. Ducks, geese, doves, and gulls are prevalent on the swimming beach, grassy park areas, the parking lot, the outer breakwater, and especially the sandbar adjacent to the boat launch (Site 4 on Figure 1-3). Bird feces are major sources of water quality contamination. *E. coli* concentration in geese feces is typically 10,000 per gram (MMSD, 2002). Gull feces can have concentrations as high as 340,000,000 *E. coli* per gram. Hence, 100 geese equal the loading from one gull (MMSD, 2002). Management techniques should focus on all problematic or excessive bird populations, but especially on gulls.

4.2.2 Humans

Human uses also contribute to the likelihood of water quality contamination. Outfalls (stormwater and combined sewer) at Russell Avenue contribute harmful bacteria to the nearshore environment. Milwaukee County issues a four day beach closure following any CSO event, though

Dr. McLellan's research (2005) has indicated that fecal coliforms may be present from the stormwater outfall even without a CSO release. St. Francis also maintains combined sewer outfalls south of the site, and the City of Milwaukee operates a 126" storm sewer outfall at Morgan Avenue as shown in Figure 4-4.

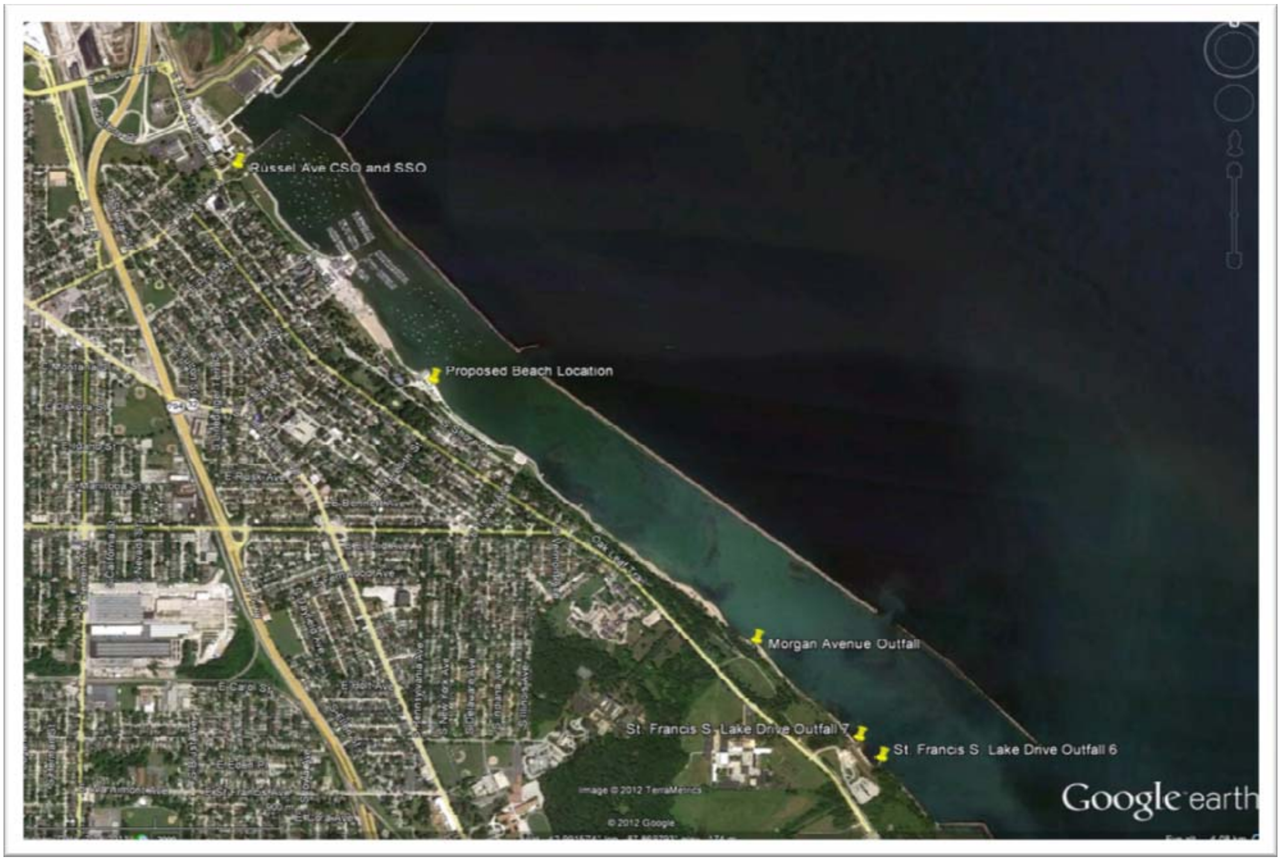


Figure 4-4 Outfall Locations

Conversations with bilge service providers have suggested that users of the swing mooring field adjacent to the swimming beach routinely empty contaminated water into the harbor. The frequency or quantity of this source of contamination is extremely difficult to quantify, but stronger enforcement and/or incentives to properly dispose of grey and black water from boaters could improve water quality at the beach.

There is evidence that human activities within the Yacht Club, parking lot, and park also contribute to contamination. Litter and dog feces are sources of pollution. Litter can be especially prevalent near the snack bar and fish cleaning station. Dumpsters onsite also overflow periodically. Furthermore, human litter attracts gull populations.

4.2.3 Parking lot Runoff

Stormwater runoff from the South Shore parking lot has been shown to contain greater than 100,000 cfu/100 ml *E. coli* with only 0.1 inches of precipitation (McLellan, 2002). Contamination from human and avian sources accumulates on the nearly four acres of impervious parking area, which largely drains south and east towards the existing swimming beach. The parking lot functions as a collection point for avian and human sources of *E. coli* at South Shore which efficiently funnels contaminated runoff directly towards the beach and nearshore waters of the harbor.

4.2.4 Sediment

Previous research had indicated the likelihood of resident bacteria populations in beach sand and sediments. *E. coli* is susceptible to UV radiation, and can largely dissipate when exposed to sunlight. When sand and nearshore sediments are exposed to high concentrations of bacteria there is evidence that self sustaining populations can survive, for at least one to six weeks (Kinzelmen 2010). In fact, even the partial replacement of contaminated sand may result in the contamination of replacement sand (Whitman, 2003). Dr. McLellan's research has also shown especially high concentrations of *E. coli* in shallow, nearshore waters at South Shore Beach (McLellan and Salmore, 2003).

4.3 Data Gaps and Recommendations for Next Steps

The literature review identified that it is difficult to determine the relative impacts of each source of contamination. For example, McLellan, et. al., 2007 found that *E. coli* counts were notably higher during CSO/SSO events at South Shore Beach but could not verify where the pollution originated. Human signature *E. coli* has been present during storm events that do not include a CSO event, indicating possible cross leakage between sanitary and storm sewers. The extensive sampling programs that have been completed to date could be complimented by continued water quality sampling and the development of a water quality model that could be used to assess the relative impacts of the various sources of contaminates. Key tasks to assist this type of study could include:

- Quantifying CSO/SSO storm water flows and concentration;
- Water fowl survey program in conjunction with *E. coli* sampling;
- Additional collection of current data;
- The identification of any additional point source discharges, which may act as a potential source of contamination at South Shore Beach; and
- Development of water quality model including all point sources.

A water quality model could then be used to gain information regarding the origin of contamination at South Shore Beach and residence times. This could provide the necessary information to prioritize efforts to reducing the number of beach closures during the summer at South Shore Beach.

5.0 DESIGN ALTERNATIVES

Design alternatives were developed based on design criteria and represent a variety of sizes, layouts and costs. Details pertaining to the design criteria and design alternatives are provided in the following subsections.

5.1 Design Criteria

5.1.1 Water Level and wave conditions

Design water level and wave conditions have been defined based on the results of detailed analyses previously undertaken to support the design of improvements to McKinley Marina (Baird, 1994). The 100-year water level (+6.1-ft CD) and 20-year wave condition (Hso = 19.4 ft, Tp = 11s) was used in the preliminary design of shore protection structures, in accordance with the design criteria used by the U.S. Army Corps of Engineers (USACE) for their design of the offshore breakwater rehabilitation/improvements (Baird, 1994). It is noted that these estimates do not include any allowance for wave energy associated with diffraction through gaps in the offshore breakwater and overtopping; this should be considered during future design phases.

It is important to note that these data are outdated; while it is sufficient for this feasibility level study, revised design conditions will have to be prepared for future phases of design. Other recent USACE projects on Lake Michigan, such as large scale reconstruction of shore protection structures in Chicago, have been designed for the 20-year water level and 10-year storm or the 10-year water level and 20-year storm.

5.1.2 Beach Crest

The beach crest elevation is determined based on water levels, surge, waves and sediment grain size. Based on an analysis of the existing physical conditions, and previous Baird engineering studies, the crest of a stable beach is assumed to be approximately +585.0 (+7.5 CD) for planning purposes. It is assumed that suitable beach fill will be placed to this elevation, and will remain in place through annual storm events. As with any project, a level of risk must be addressed in final design, and it is likely that severe storms (i.e. 100 yr storms) may displace sand from the beach over a period of time, and beach maintenance and/or nourishment may be required.

5.1.3 Coastal Structures

Wave height also dictates stone size for stable coastal structures. For the purpose of this feasibility level planning project, Baird has used coastal calculations and stone sizes based on previously completed and constructed structures at South Shore Park (2005). Engineering calculations were based on data analysis presented in Section 2.0.

5.1.4 Stable Shoreline Orientation

The most reliable method to predict stable shoreline orientations along a given stretch of shoreline is to observe beach azimuths at nearby fillet beaches, and historical averages of the shoreline being studied. Shorelines for the proposed beach location, which is comprised of tunnel boring material (TBM) were analyzed based on available aerial imagery. The stable shoreline orientation for the beach was calculated to be approximately 116 degrees, with a shore-perpendicular azimuth equal to an average of approximately 26 degrees. This angle also corresponds with aerial imagery showing diffraction of waves through the breakwater entrance. This shore azimuths was used as a likely beach planform shape for the proposed alternatives.

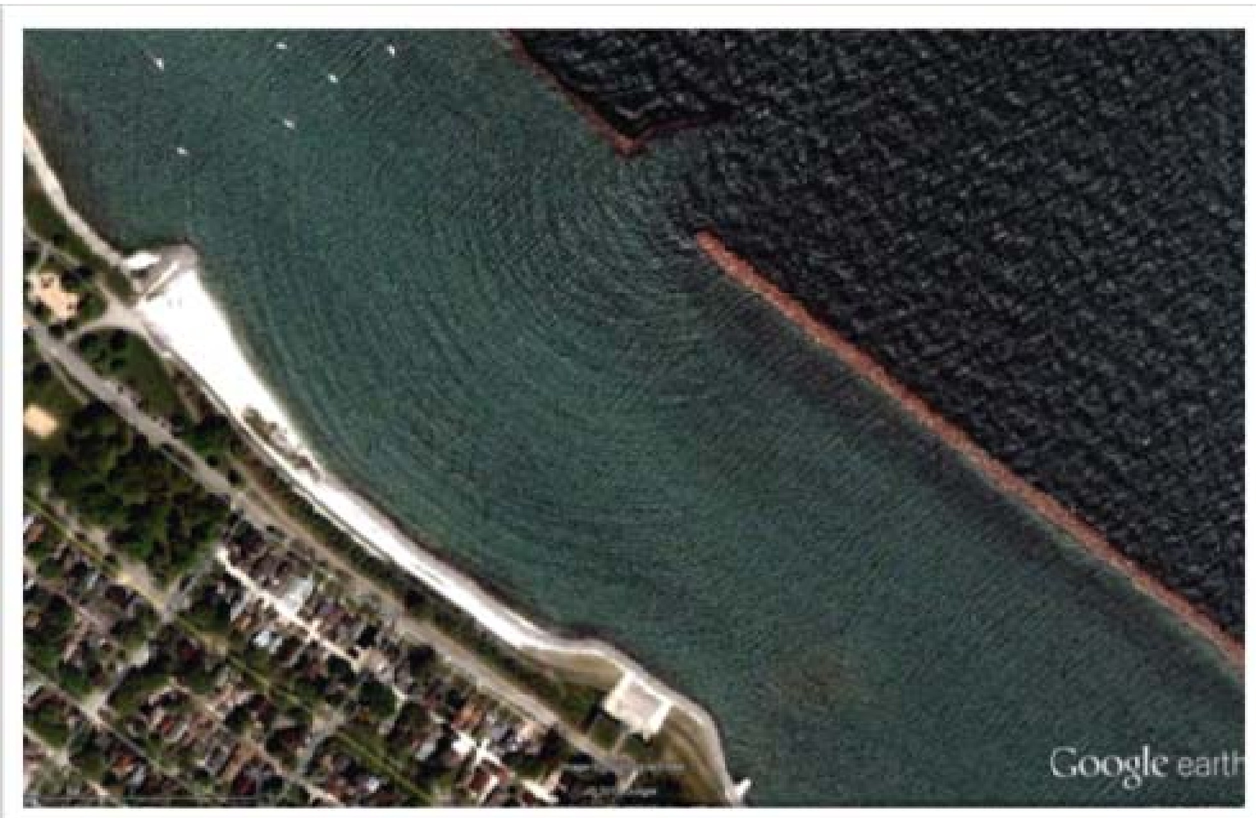


Figure 5-1 Diffraction at Breakwater Entrance

5.1.5 Influence of Grain Size

Beach slope is a function of grain size; the larger the grain size, the steeper the beach can sit thereby reducing the total material required. In addition, larger grain sized material is more stable, and may be required where a beach is exposed to larger waves. The slope of a stable beach is independent of the internal angle of friction of dry sand. Five different median grain sizes and their general stable beach slopes are listed below.

- 200 μm (very fine sand): >1:20 slope

- 500 µm (medium sand): 1:20 slope
- 840 µm (torpedo sand): 1:15 slope
- 1000 µm (coarse sand): 1:12 slope
- 3000 µm (bird's eye sand): 1:10 slope

Baird has assumed a 1:20 slope for planning purposes of the initial alternatives. The 500-600 µm (~#30-#40 sieve size) is similar to the sand found at the existing South Shore Beach (see Appendix A). Coarser sand could be specified in future design projects to provide a steeper beach. The implications of this decision are discussed in Section 5.3. It is recommended that numerical modeling with COSMOS (or a similar cross-shore sediment transport model) be used to design the beach in future stages. Physical models are also a powerful tool for understanding beach stability in a complex environment such as South Shore. COSMOS estimates the change in the beach profile based on given wave and water level conditions for various beach slopes and grain sizes; an example of COSMOS model output is shown below:

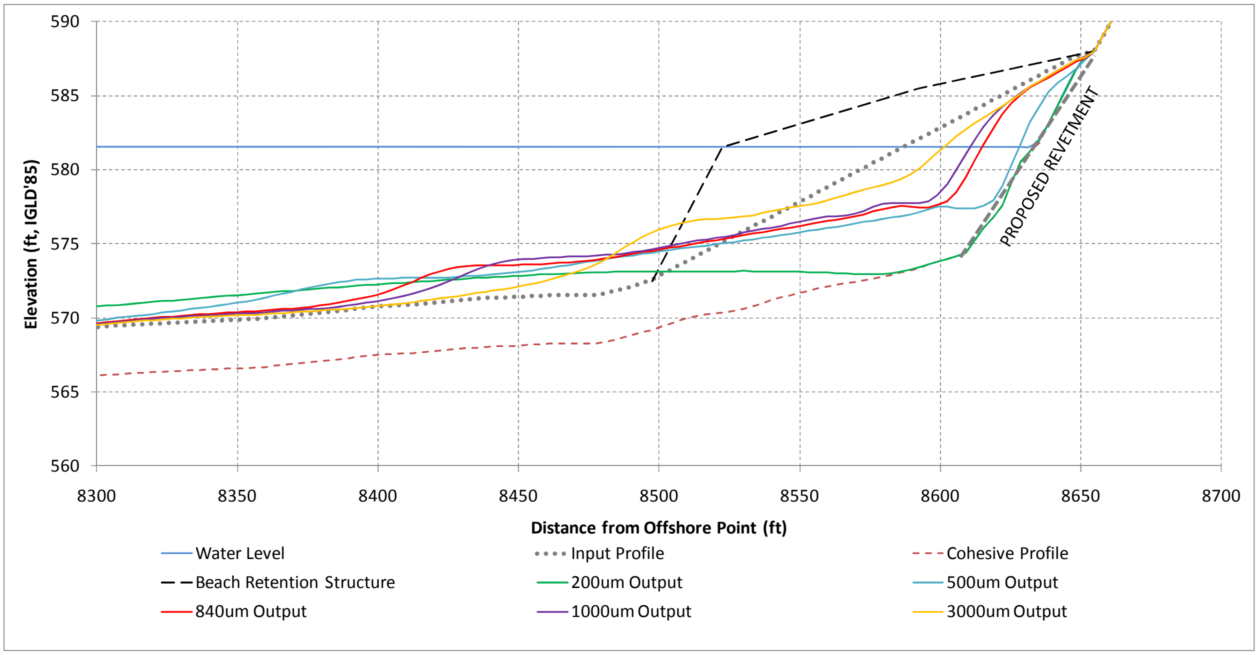


Figure 5-2 COSMOS Output

5.2 Relocation Opportunities and Constraints

Relocating South Shore Beach represents a significant opportunity to change the character of the park and possibly provide a swimming beach with fewer advisories and closures than the existing beach. Several opportunities and constraints are listed below:

5.2.1 Beach Relocation Opportunities:

- Proposed beach located adjacent to breakwater opening, where there may be improved circulation.
- Proposed beach located further from existing parking lot (runoff).
- Proposed beach located further from yacht club activities.
- Proposed beach located further from boat launch.
- Fewer swing mooring sites adjacent to proposed beach.
- Opportunity to restore eroding bluff and expand revetment adjacent to proposed beach.

5.2.2 Constraints Affecting Beach Relocation:

- Small, incremental increases in circulation velocity and frequency compared to existing beach.
- Increased distance between proposed beach and parking lot.
- Large elevation difference between bike path and proposed beach.
- Potential for avian presence and contamination at proposed beach.
- Beach cleaning, management, and maintenance required to maintain possible water quality improvements.

5.3 Design Alternatives

Baird has prepared four initial alternative layouts for a relocated beach. These alternatives were presented for comparison purposes and represent a variety of sizes, layouts and costs. Their relative merits are discussed in the following sub-sections. Full size graphics are available in Appendix C.

5.3.1 Alternative A

Alternative A (Figure 5-3) involves replacing the existing TBM beach at the proposed location with a sand swimming beach. Existing TBM would be excavated and removed, and beach sand would be replaced to a depth of three feet. Based on the stable shoreline orientation and the assumed stable beach slope of 1:20, the furthest lakeward extent (toe) of the beach is at the toe of the existing stone groyne.

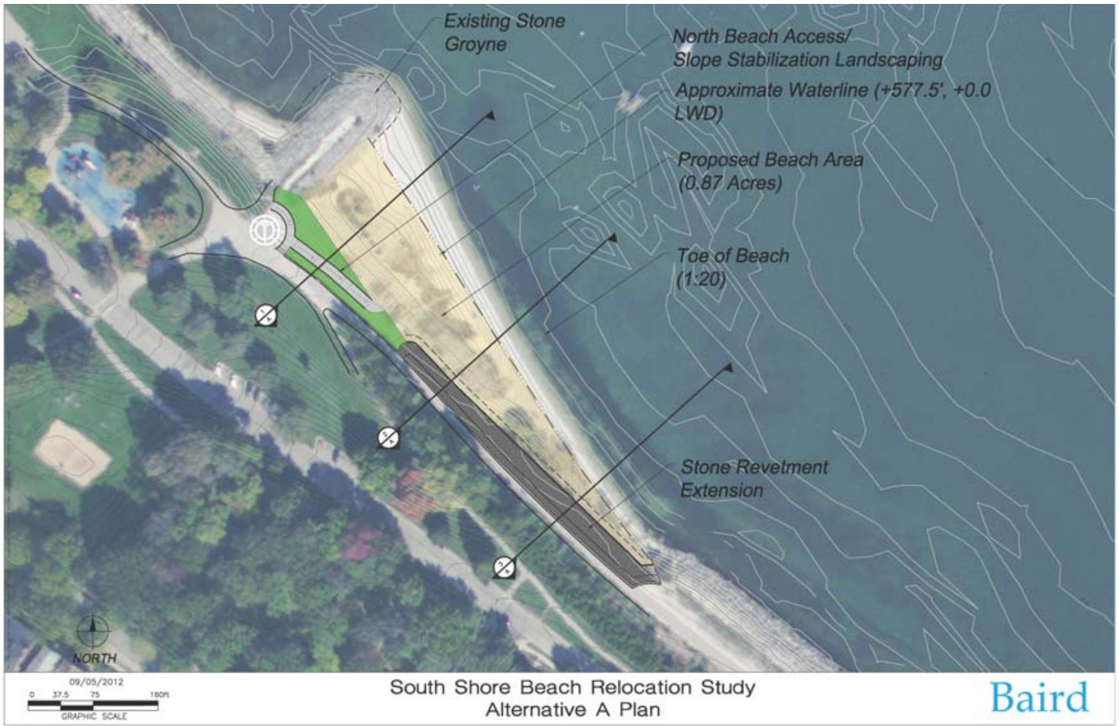


Figure 5-3 Alternative A Plan

Assuming a water level of 0.0 Chart Datum/Low Water Datum (LWD), the usable beach area for Alternative A will be approximately 0.9 acres. For comparison, the existing South Shore swimming beach is approximately 1.5 acres.

As the existing bike path is roughly 14 feet above the water line, a ramp or stair structure will be required to provide access to the beach. This area would also likely include slope stabilization or decorative landscaping. A conceptual view of an access structure is shown in below:

Figure 5-4 Conceptual Access Structure

As the stable beach orientation leads to a narrower beach south of the existing groyne, it is suggested that the existing stone revetment is extended approximately 400 feet northward. This is necessary to stabilize the eroding bluff and provide protection for the bike path. Conceptual cross sections of Alternative A are shown below:

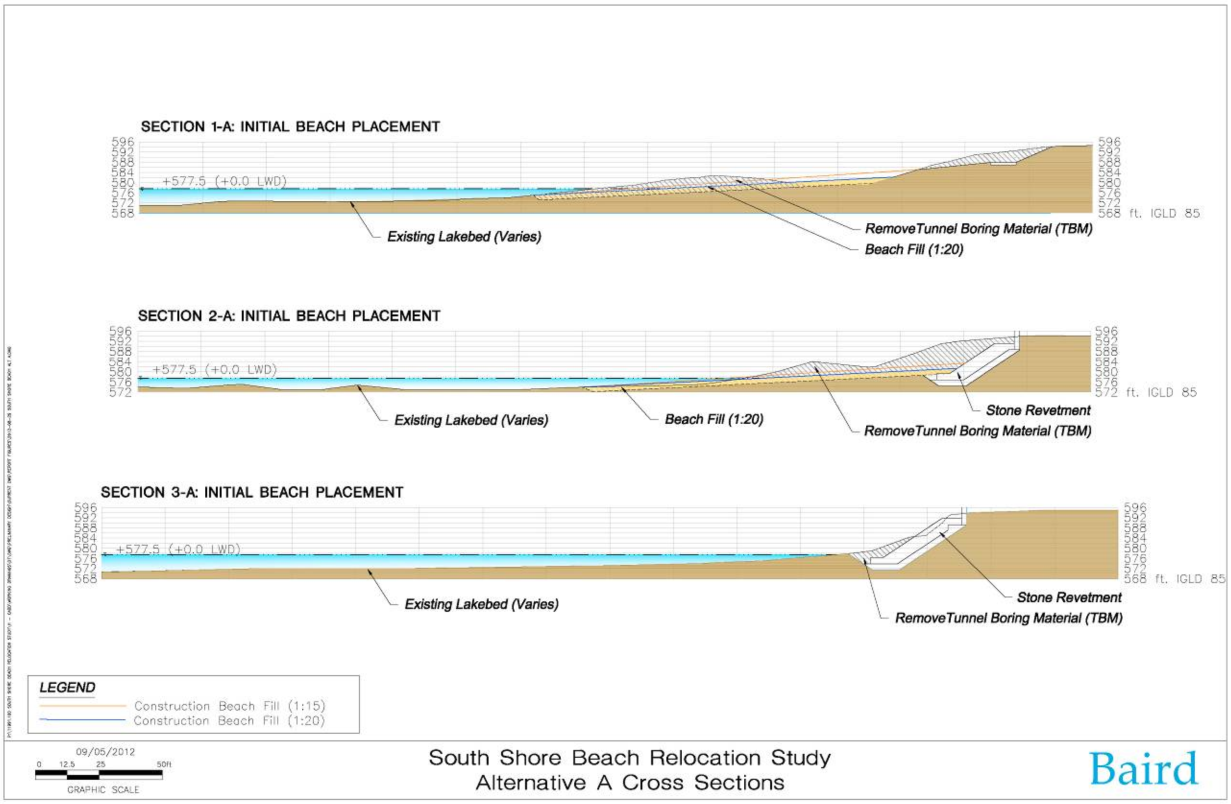


Figure 5-5 Alternative A Cross Sections

5.3.2 Alternative B

Alternative B provides a usable beach area that is similar in size to the existing South Shore Beach. To maintain the stable shoreline orientation, and contain beach sand in deeper water, the existing stone groyne is extended lakeward and a second beach retention structure will be required at the south end of the beach. Both stone structures could include public access. The stone structures could provide an appealing sense of enclosure for the beach, though the stone required to withstand wave energy and high water levels could be viewed as undesirable to some beach users. Alternative B is shown below:

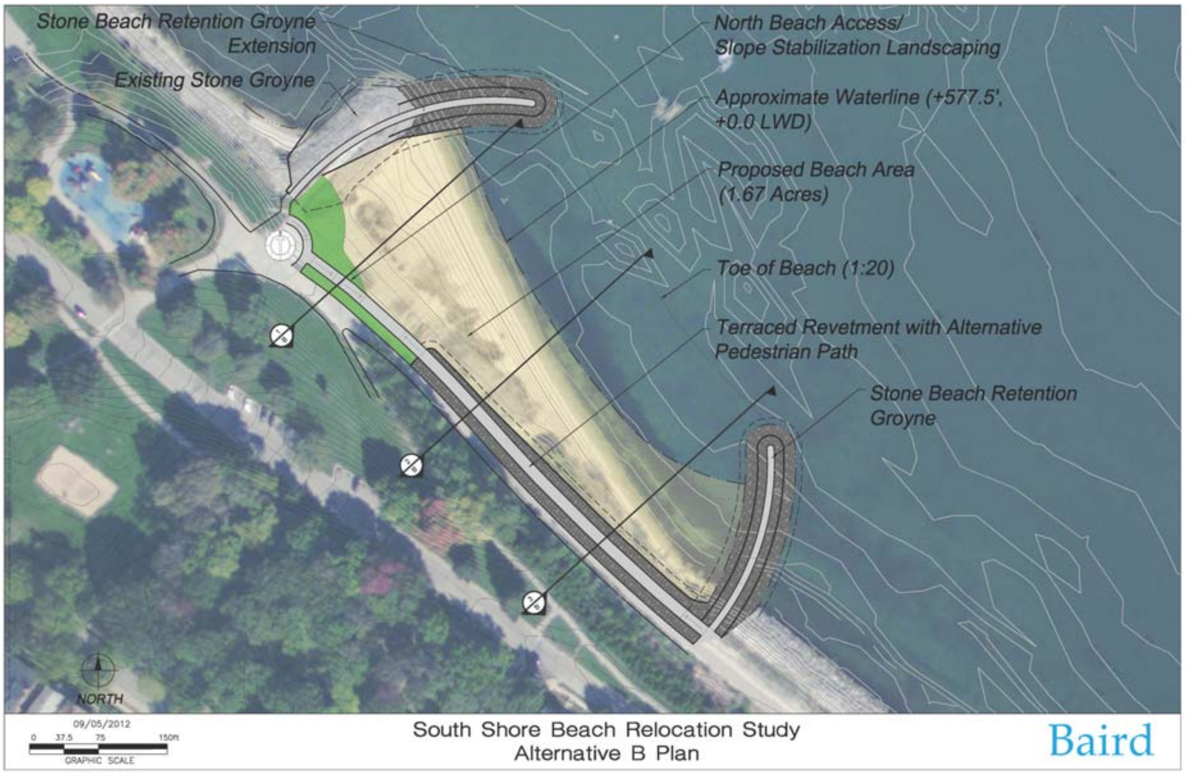


Figure 5-6 Alternative B Plan

While the south beach retention structure and resulting sand beach would protect the existing bluff at the south end of the beach, a terraced revetment and path has been proposed. Through traditional retaining walls or slope stabilization measures, the bluff would be re-graded down to a sloped pedestrian path. The lakeward side of the path would be armored for protection from storms during periods of high water. Conceptual sketches and cross sections are shown below:

Figure 5-7 Conceptual Alternative B From Bike Path

Figure 5-8 Conceptual Alternative B From North Groyne

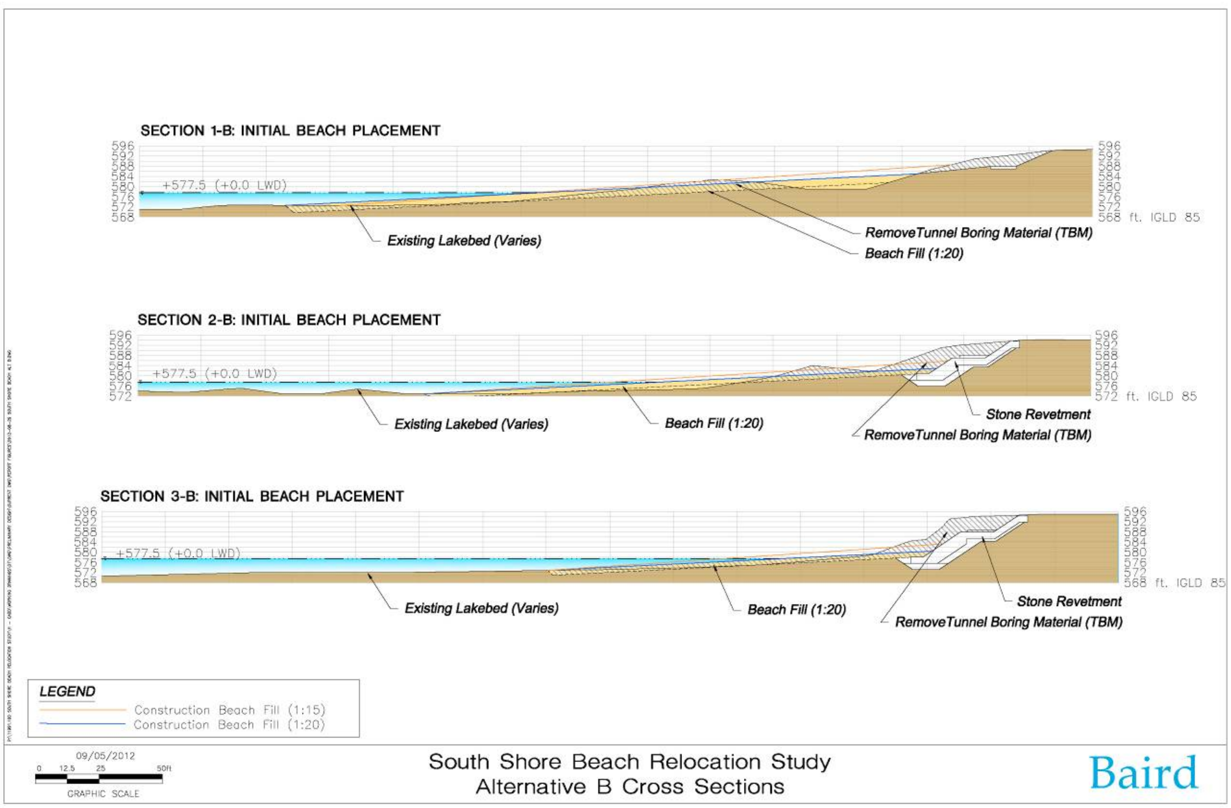


Figure 5-9 Alternative B Cross Sections

5.3.3 Alternative C

Alternative C utilizes a steel sheet pile (SSP) cell at the end of the existing stone revetment to provide a stable swimming beach. The SSP cell extension to the existing revetment will help contain the swimming beach and create a point of interest for park visitors, and could serve as a public overlook/fishing pier. An additional stone groyne with a possible public access path will be placed at the south end to contain the beach cell. The south groyne is perpendicular to shore to enhance views outward and maximize efficiency. Alternative C is shown below:

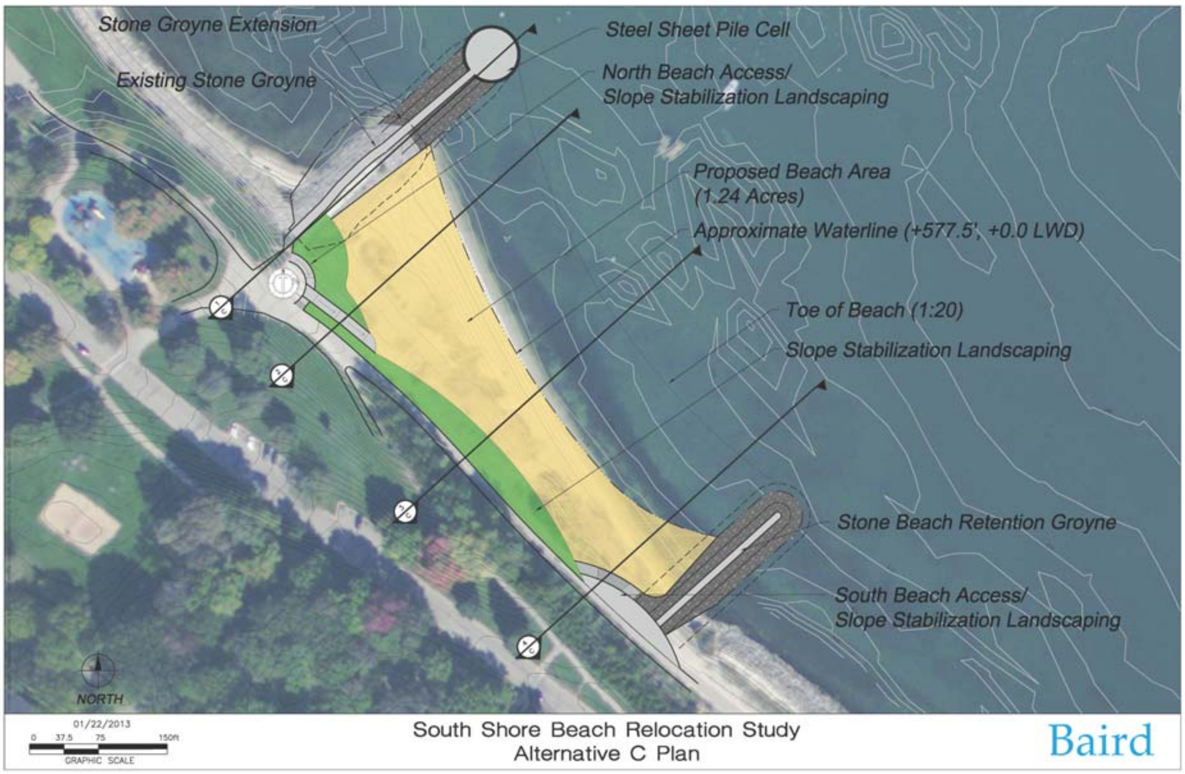


Figure 5-10 Alternative C Plan

A secondary beach access structure is proposed adjacent to the south beach retention groyne to mitigate bluff erosion. Passive/vegetative slope stabilization is proposed behind the swimming beach. Conceptual sketches and cross sections are shown below:

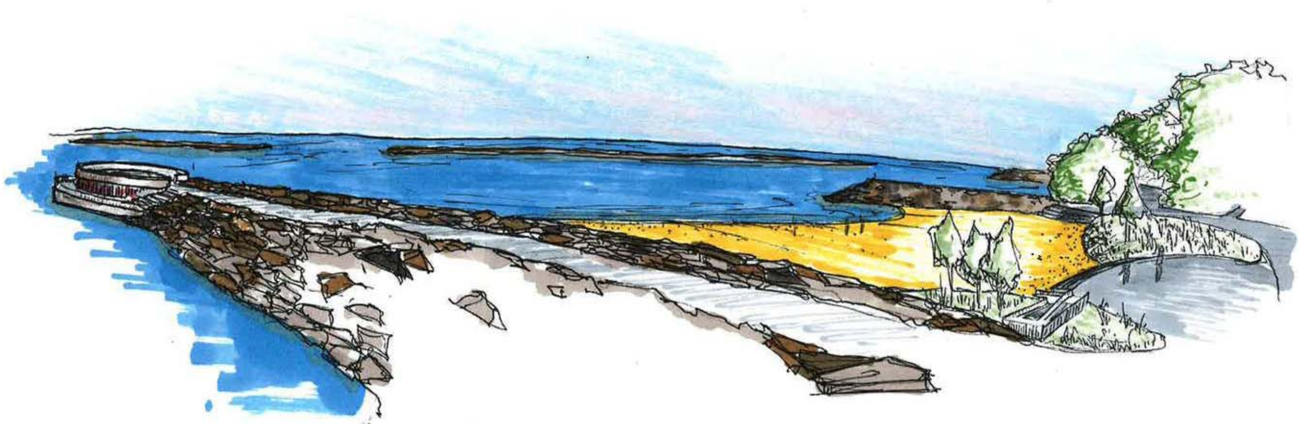


Figure 5-11 Conceptual Alternative C

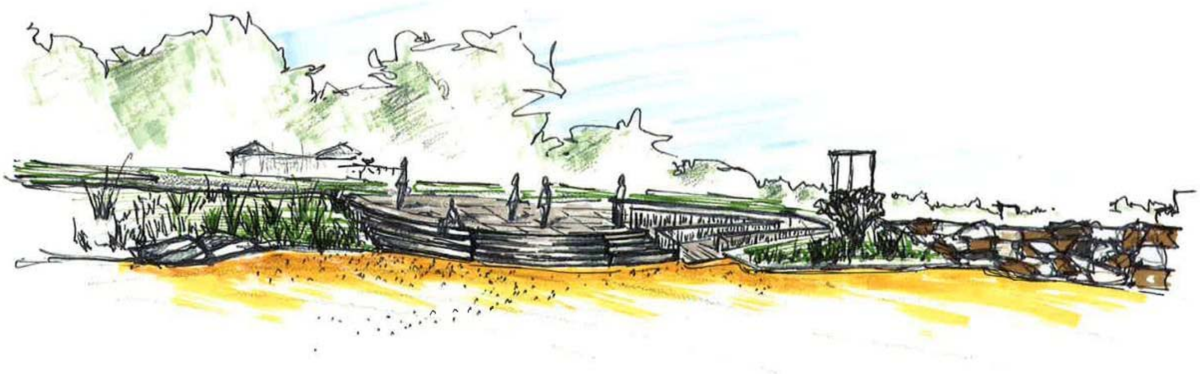


Figure 5-12 Conceptual Access Structure

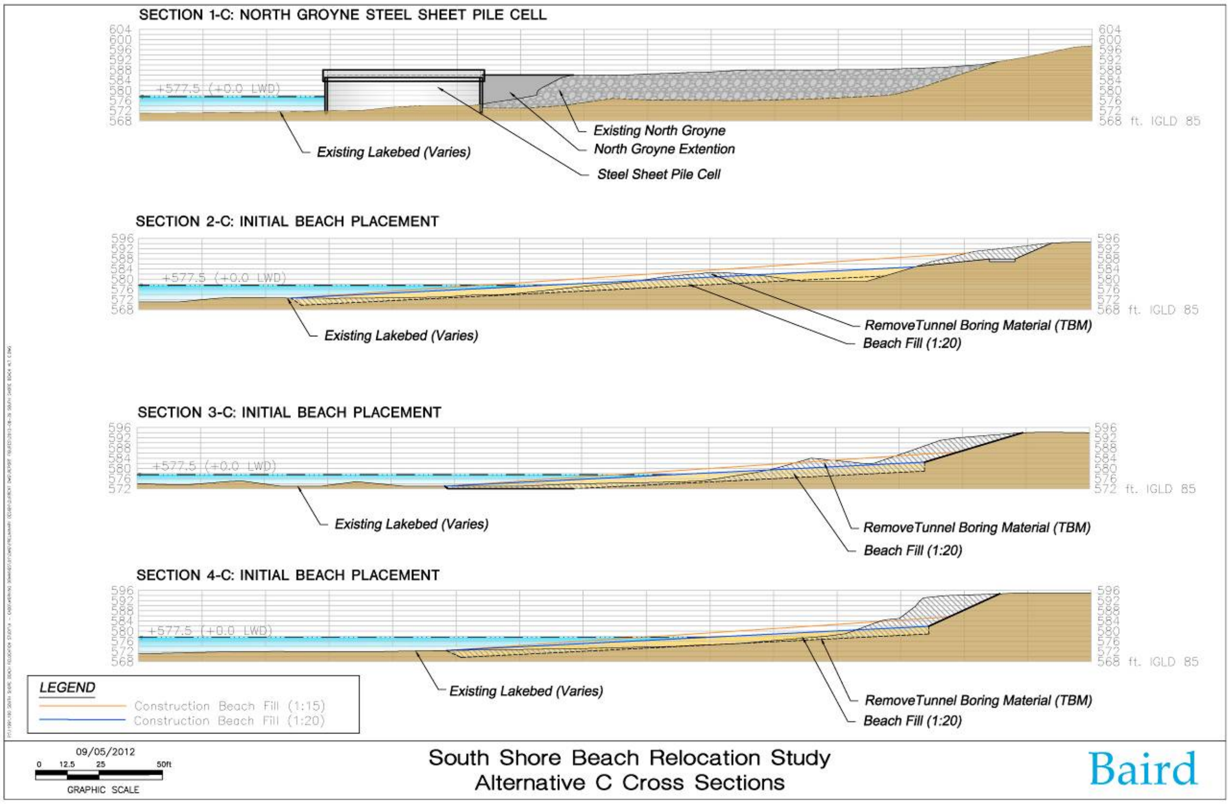


Figure 5-13 Alternative C Cross Sections

5.3.4 Alternative D

Alternative D utilizes four offshore stone breakwaters to create a series of curved beach cells. The existing stone groyne will not be altered; however, an additional stone groyne may be needed to contain the southern end of the beach. The offshore breakwaters provide a larger, more usable beach than the previous alternatives (approximately 4.4 acres). Offshore breakwater heights could be optimized in future engineering studies to contain sand to limit impact to the visual character of the beach. Alternative D is shown below:

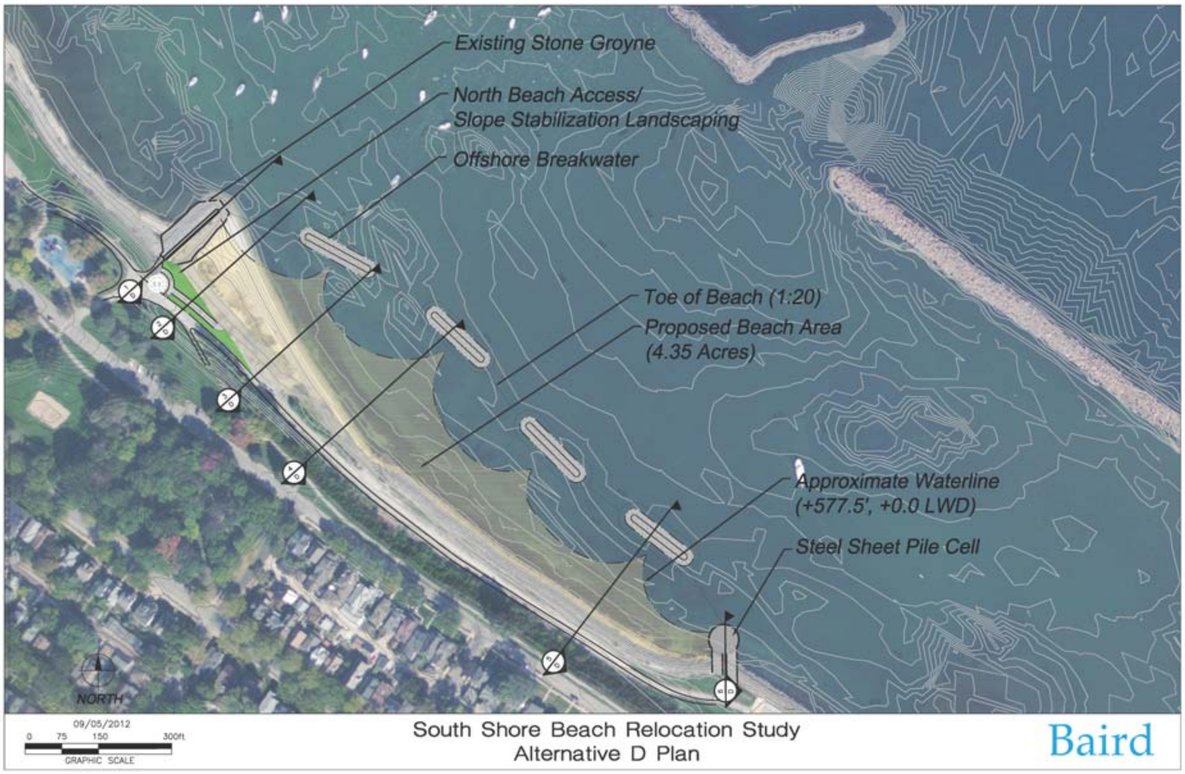


Figure 5-14 Alternative D Plan

Figure 5-15 Conceptual Alternative D

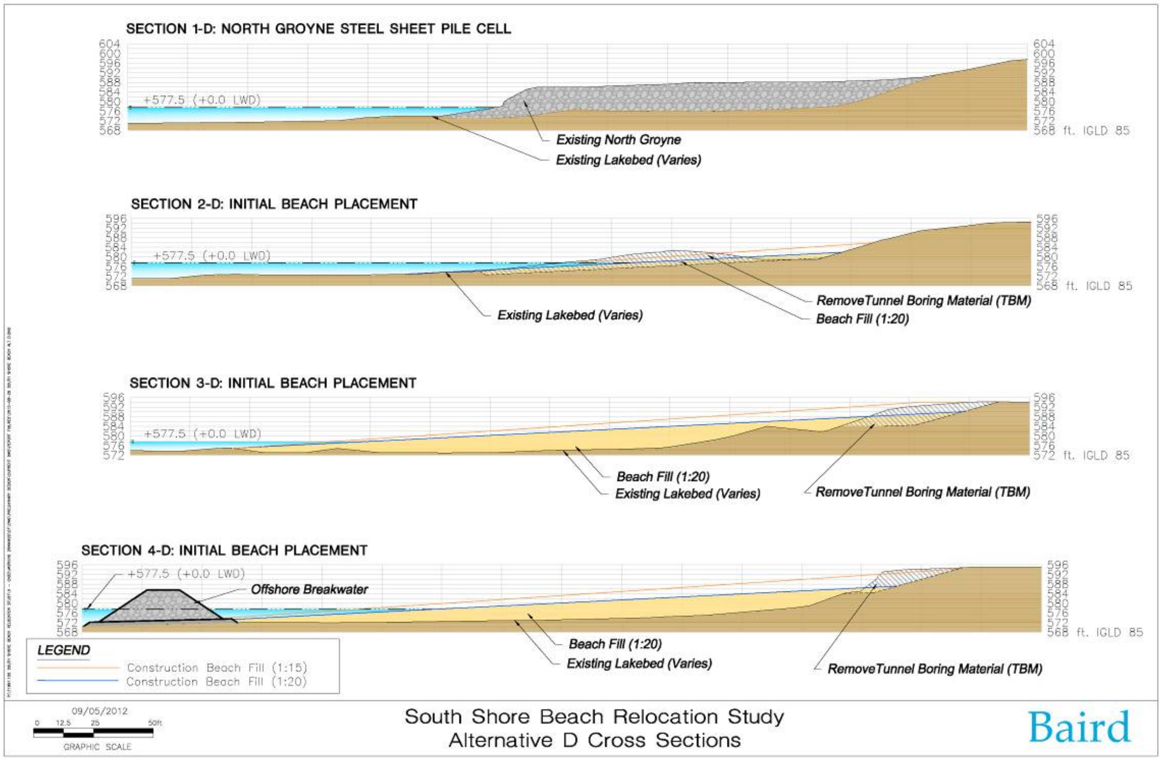


Figure 5-16 Alternative D Cross Sections

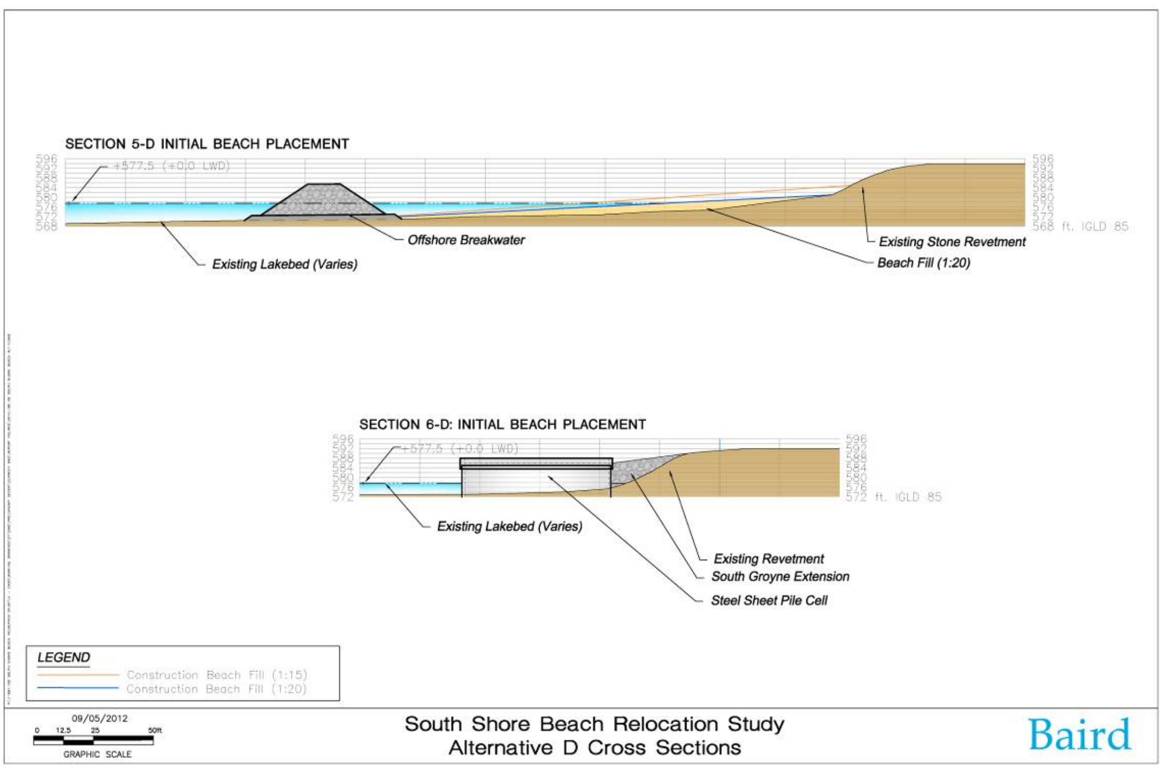


Figure 5-17 Alternatives D Cross Sections

5.3.5 Sustainability

Future engineering designs for a relocated South Shore Beach should consider Sustainable Site Considerations including opportunities for Leadership in Environmental and Energy Design (LEED) standards to be incorporated wherever possible in future park development. While significant opportunities exist for LEED design principals to be incorporated into possible architecture projects, opportunities for site design may be less obvious. Appendix E includes a LEED score card. Possible credits for New Construction and Major Renovations at South Shore Park are listed below:

- Construction activity pollution prevention
- Site selection
- Alternative transportation: public transportation access
- Alternative transportation: bicycle storage and changing rooms
- Alternative transportation: parking capacity
- Site development: protect or restore habitat
- Site development: maximize open space
- Stormwater design: quantity control
- Stormwater design: quality control
- Heat island effect: nonroof
- Light pollution reduction
- Storage and collection of recyclables
- Construction waste management
- Materials reuse
- Recycled content
- Regional materials
- Rapidly renewable materials
- Certified wood
- Innovation in design

Sustainability and environmental responsibility should be factored into the final decision of whether or not to relocate South Shore Beach. Relocating the beach could be construed as simply avoiding water quality problems, rather than rectifying the pollutant sources at the existing beach. While an additional buffer from the primary sources of contamination at the site (the parking lot) could improve water quality at a proposed beach, it would require a significant amount of materials and site disruption. It would be more sustainable and environmentally responsible to mitigate and manage bacterial sources on-site, leading to improved overall water quality in the area, with limited material inputs.

5.4 Itemized Statements of Comparative Cost

Itemized statements of probable cost have been prepared for each of the four alternatives, and are included in Appendix D. Unit costs were prepared based on previous and current experience on similar projects on the Great Lakes. The following table highlights the anticipated cost of each of the four alternatives, including a 25% contingency:

Table 5-1 Comparison of Design Alternatives

Alternatives	Capital Cost	Beach Area
No Action	$0	1.5 Acres
Alternative A	$1,600,000	0.9 Acres
Alternative B	$4,500,000	1.7 Acres
Alternative C	$4,200,000	1.2 Acres
Alternative D	$5,600,000	4.4 Acres

5.5 Preferred Alternative

Based on discussions with stakeholders, it was determined that Alternative C would be considered the Preferred Alternative. Alternative C provides a fair amount of usable beach area at the second least expensive anticipated cost. The addition of a steel sheet pile cell will provide a significant amenity for park users. Figure 5-18 illustrates Alternative C within the context of the nearshore environment. Note that several swing mooring slips would likely be affected by the alternative. It is not anticipated that the groyne extensions would limit navigation within the breakwater.

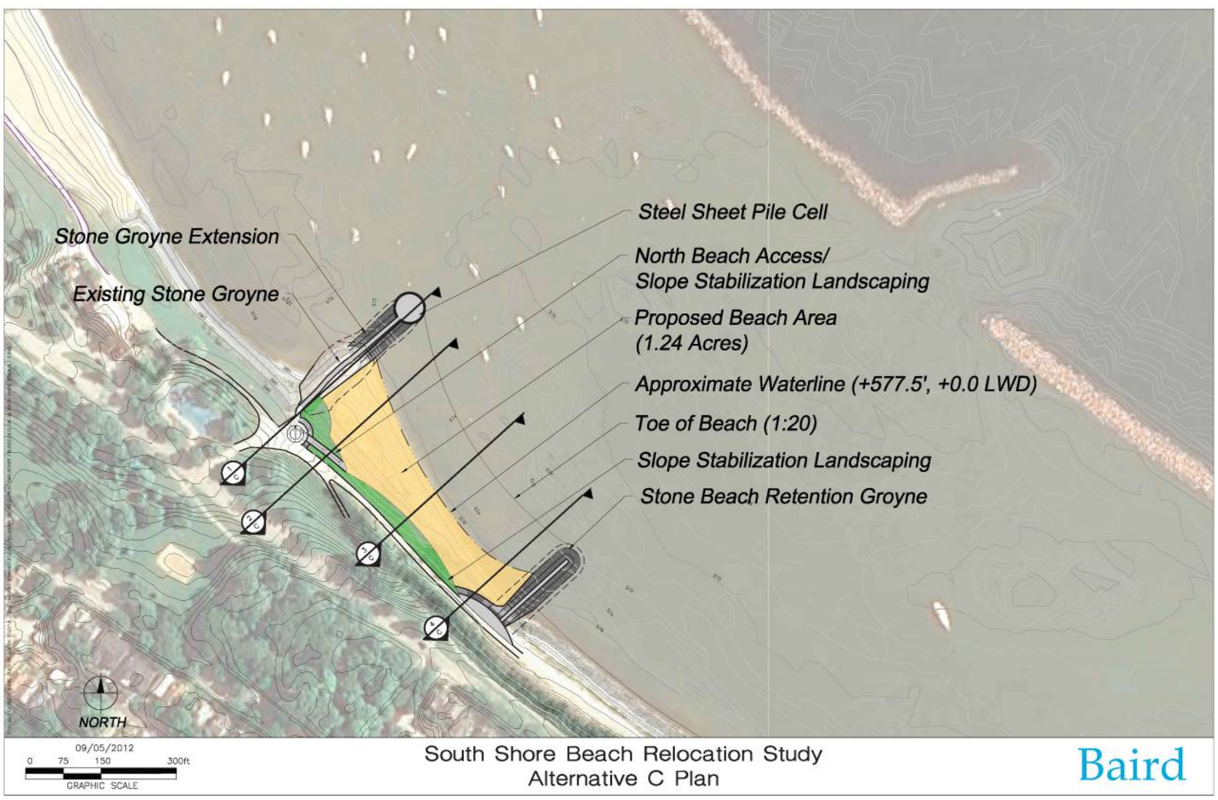


Figure 5-18 Alternatives C Context

Alternative C was also chosen as the Preferred Alternative for hydrodynamic modeling as it is likely to represent better water quality potential than Alternative B or D. The large stone structures proposed in these alternatives are necessary to contain beach sand, and provide a stable site that will withstand storm events. However, the curved groynes in Alternative B may limit turnover of water, capturing debris such as cladophora and zebra mussels that would require additional maintenance to remove. The offshore breakwaters proposed in Alternative D provide shelter for the beach which allows for a large, stable planform; but may limit circulation velocities voiding any increases on circulation and water quality that the proposed beach location may provide. Section 9.2 of this report describes 63rd Street Beach in Chicago. Figure 5-19 below shows results of *E. coli* modeling published by Ge Et. El (2012) that show areas of increased concentration where hydrodynamics have been limited by coastal structures. Alternative C represents a balance of coastal structures needed to contain a stable beach, without providing major barriers to circulation.

Nearshore hydrodynamics for E. coli *contamination*

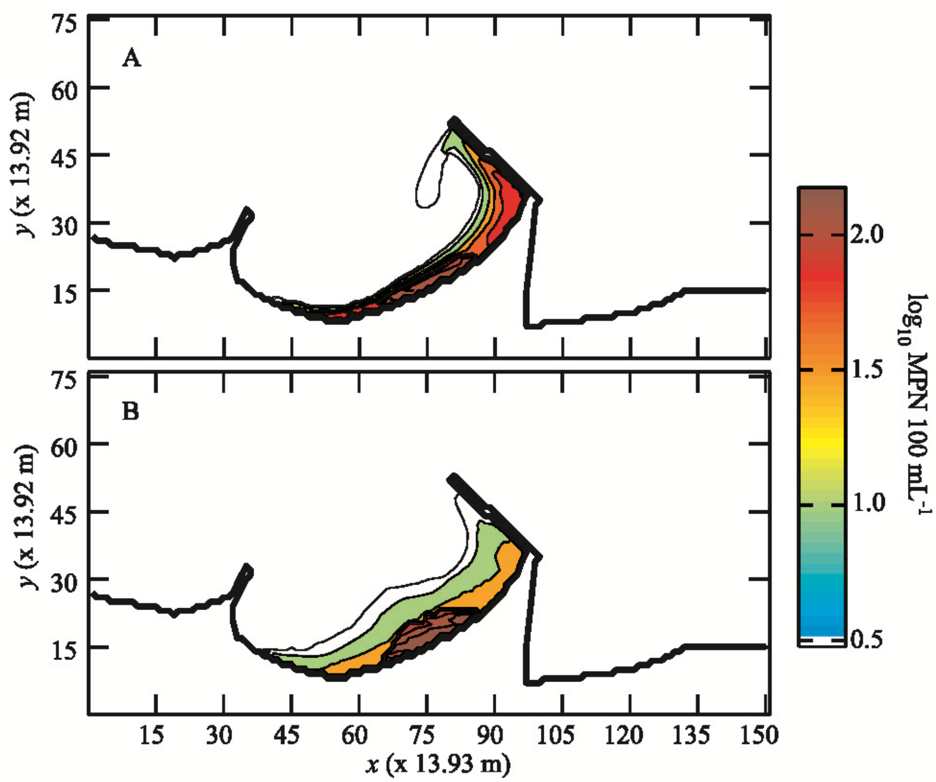


Fig. 11. Distributions of *E. coli* concentration at the eighth hour after a resuspension event in the embayment (case II). Initial *E. coli* concentration was given at 200 and 100 MPN 100 mL^{-1} in waters less than 1.22 m deep and 1.83 m deep, respectively, in the embayment and zero elsewhere. (A) Suspended culturable *E. coli* concentration; (B) settled culturable *E. coli* concentration.

Figure 5-19 Nearshore Hydrodynamics. Ge Et El, 63rd Street Beach, Chicago

6.0 NUMERICAL MODELING

Numerical modeling was undertaken by Baird to assess the relative difference in circulation and potential water quality conditions at the existing and proposed beach locations. A two-dimensional model ((MIKE21) was selected to simulate the hydrodynamics in the vicinity of the project site. MIKE21 is a state of the art model for simulating free surface flow where stratification can be neglected. Stratification in the study area in summer is unlikely due to shallow water depths. It is a robust modeling system that allows for seamless coupling to other modules and has powerful processing and visualization capabilities.

It is important to note that model calibration and verification was not part of the current project scope. It is recommended that the model be calibrated prior to future phases of design. The hydrodynamic model that has been developed can be further developed to include water quality modeling. Although this was not part of the current scope of work, a water quality model would be beneficial to assess the relative impact of all the sources of contaminant on South Shore Beach and residence times. This will provide the necessary information to prioritize efforts to reduce the number of summer beach closures at South Shore Beach.

6.1 Model Setup

This section provides an overview of the model setup and the data used as input to the model.

6.1.1 Computational Domain

The model domain extends three miles offshore, five miles to the south and three miles to the north of South Shore Beach. An advantage to using MIKE21 is the flexible mesh application, which accommodates variable mesh sizes within the model domain. This allows for the mesh to be refined near the project site and more coarse in deeper water. The mesh size ranged from 33 feet (10 m) near the project site to 1640 feet (500 m) offshore in the deeper water.

The bathymetry data was compiled from the following data sets including:

- 1948 03L11099 Survey;
- 2007 Luhr Bros., Inc. Survey;
- 2008 USACE LiDAR Survey; and
- 2012 Himalayan Consultants Survey.

Figure 6-1 shows the extent of coverage from the different datasets. Where there was overlap in the datasets, the more recent bathymetry data were used. The bathymetry data were converted to a common coordinate system, North American Datum 1983 Universal Transverse Mercator 16 North (NAD83 UTM 16 N) and all depths were converted to North American Vertical Datum 1988

(NAVD 88) in meters. The final digital elevation model (DEM) was made by interpolating the bathymetry data to the mesh, as shown in Figure 6-2.

6.1.2 Model Boundaries and Forcing

The hydrodynamic model was forced with wind data over the entire domain and waves at the offshore boundary. The wind data used was described in Section 2.2 from the Milwaukee meterological station. The wave data was extracted from the GLERL model as previously discussed in Section 2.4.

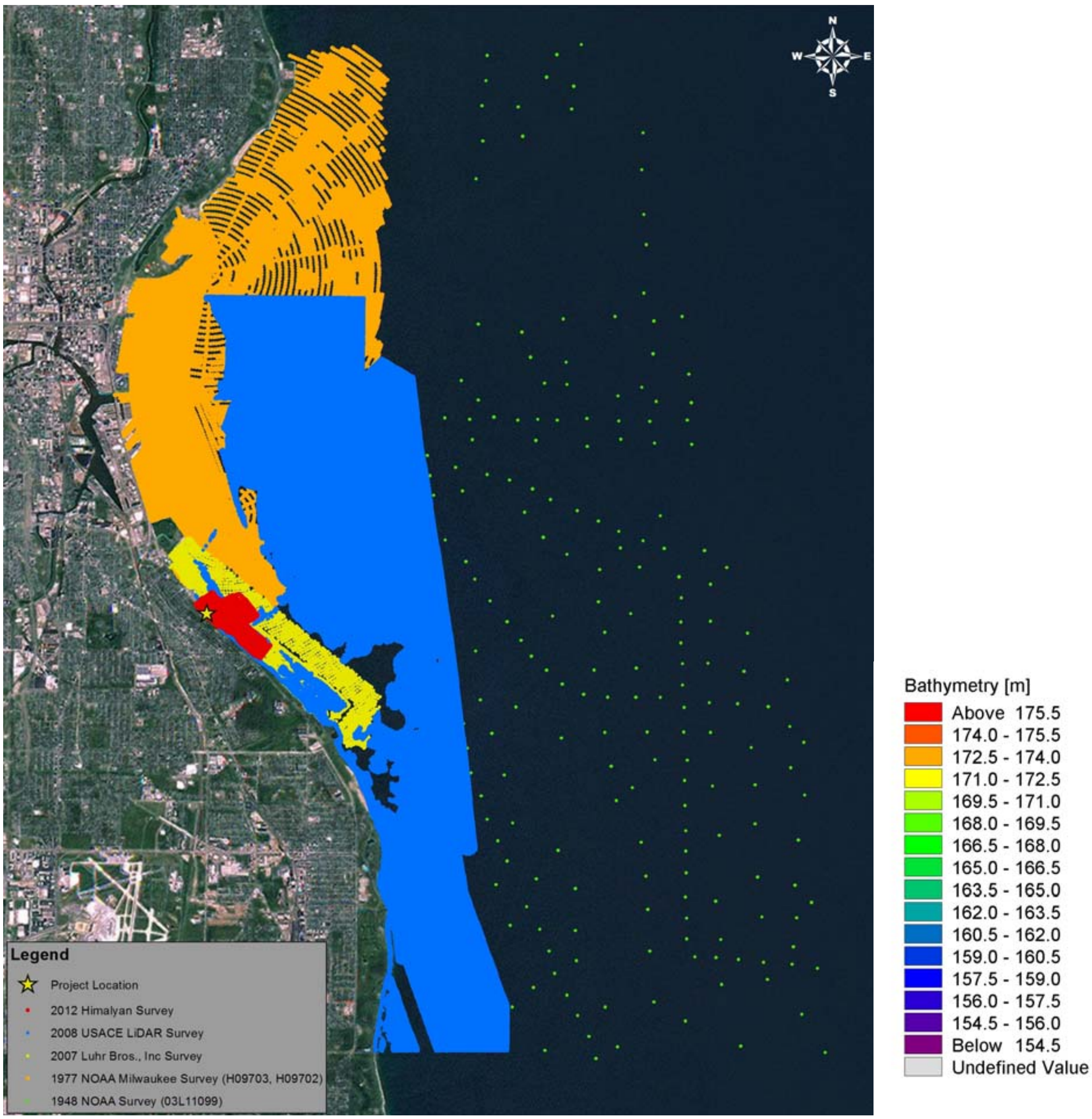


Figure 6-1 Bathymetry Data Compilation

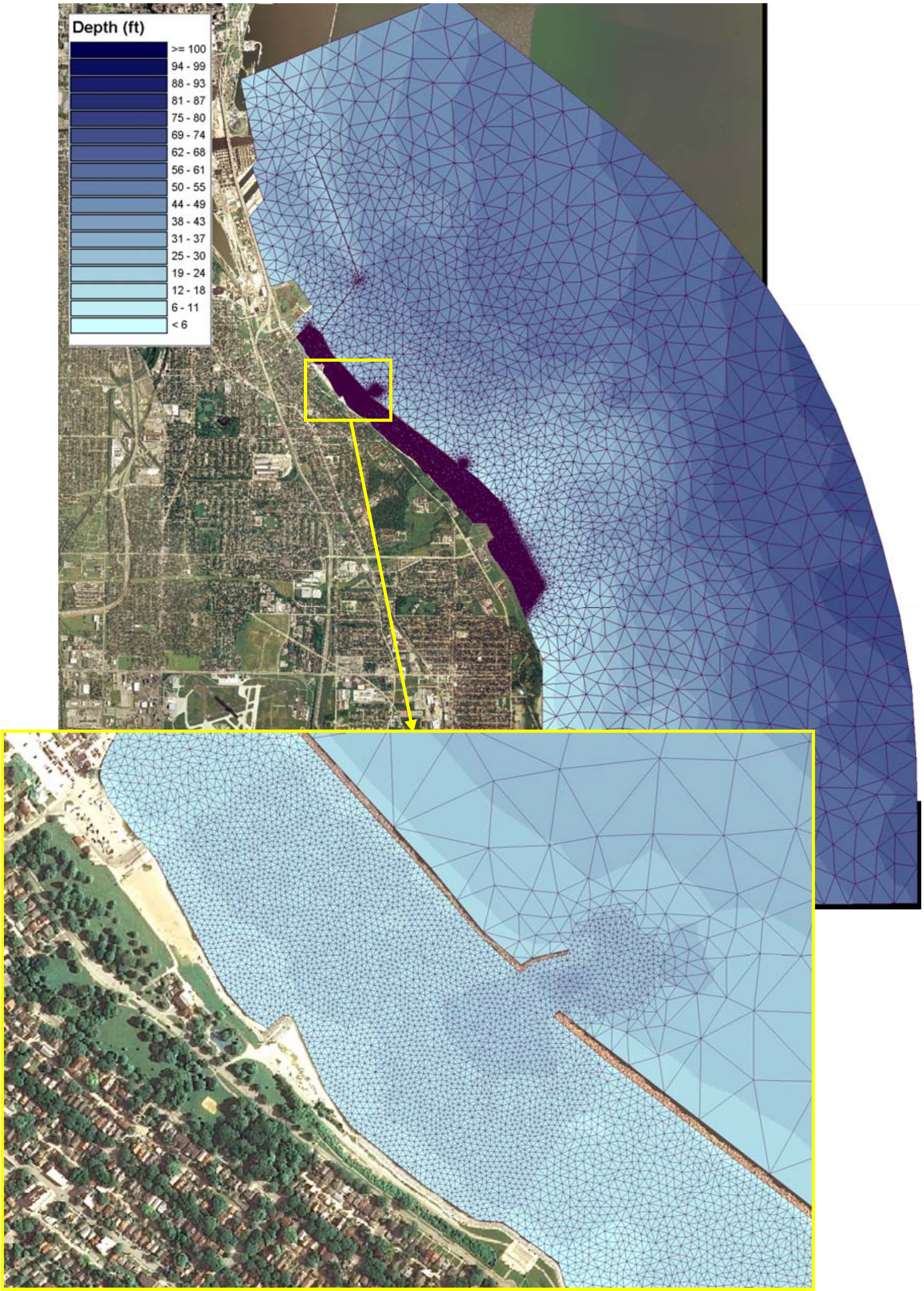


Figure 6-2 Model Mesh

6.2 Model Simulations

To assess the hydrodynamics during the summer period, four different steady state scenarios were modeled using MIKE21. The purpose of the steady state simulations was to assess the difference in the nearshore currents at both beach locations during different wind conditions including:

- Winds alongshore towards the south (winds from NW)
- Winds from offshore (winds from NE)
- Winds alongshore towards the north (winds from SE)
- Winds from overland (winds from SW)

The wind and waves used to force the model were average summer conditions corresponding to each direction considered as shown below in Table 6-1. All steady state simulations were modeled using the average summer water level of 579.68 ft IGLD (+2.18 ft CD) as was previously presented in Section 2.1.

Table 6-1 Model Simulation Input Conditions

		Average Offshore Wave Conditions	
Simulation	Wind Speed (ft/s)	Wave Height (ft)	Wave Period (s)
NW Winds	17.1	1.0	2.4
NE Winds	19.1	2.0	3.4
SE Winds	16.6	1.6	3.1
SW Winds	18.6	1.3	2.5

6.3 Model Results of Existing Conditions

The circulation patterns at both beach locations are quite complex due to:

1. The offshore breakwaters, which run parallel to the beach; and
2. The breakwater opening, located across from the proposed beach location.

It is important to note that MIKE21 does not have the ability to accurately simulate complex diffraction pattern of the waves through the breakwater entrance. Instead a phase-decoupled refraction-diffraction approximated is used. A more complex boussinesq type model that can resolve the diffraction pattern through the breakwater in more detail may be required for additional studies to support future design phases.

Through the examination of steady state simulations with winds blowing consistently from one direction, quantitative comparisons can be made between the two beach locations. The results are presented in Table 6-2 and in Figure 6-3 to Figure 6-6. Note that the average current speeds were calculated based on all predicted currents at the respective beaches to a depth of about 6 ft.

Table 6-2 Comparison of Currents at Beach Locations

Wind Conditions Causing Currents From:	Probability of Occurrence during Summer Months	Average Current Speed at Existing Beach	Average Current Speed at Proposed Beach
NE	15%	0.10 ft/s	0.17 ft/s
NW	40%	0.14 ft/s	0.16 ft/s
SE	10%	0.16 ft/s	0.17 ft/s
SW	35%	0.07 ft/s	0.08 ft/s
	Weighted Average	**0.11 ft/s**	**0.13 ft/s**

Figure 6-3 Steady State Current Speeds when Summer Average Winds Are From the NE

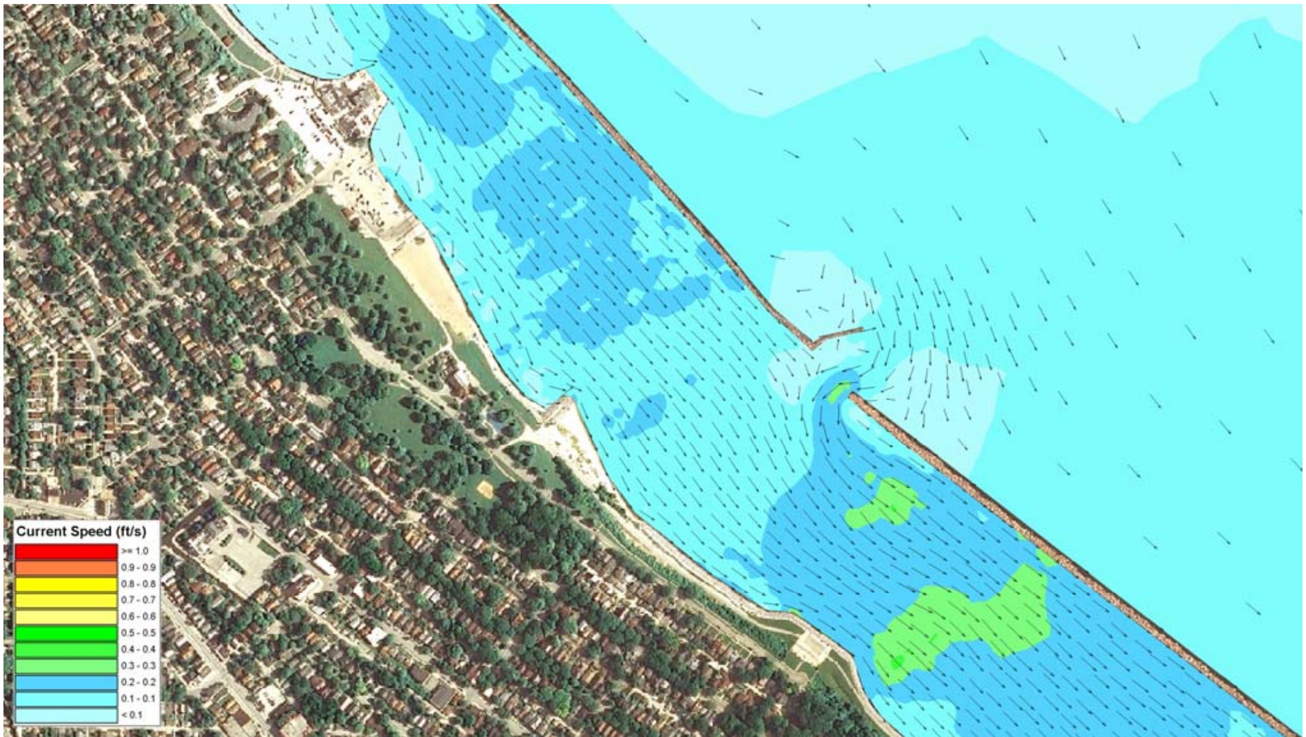


Figure 6-4 Steady State Current Speeds when Summer Average Winds Are From the NW

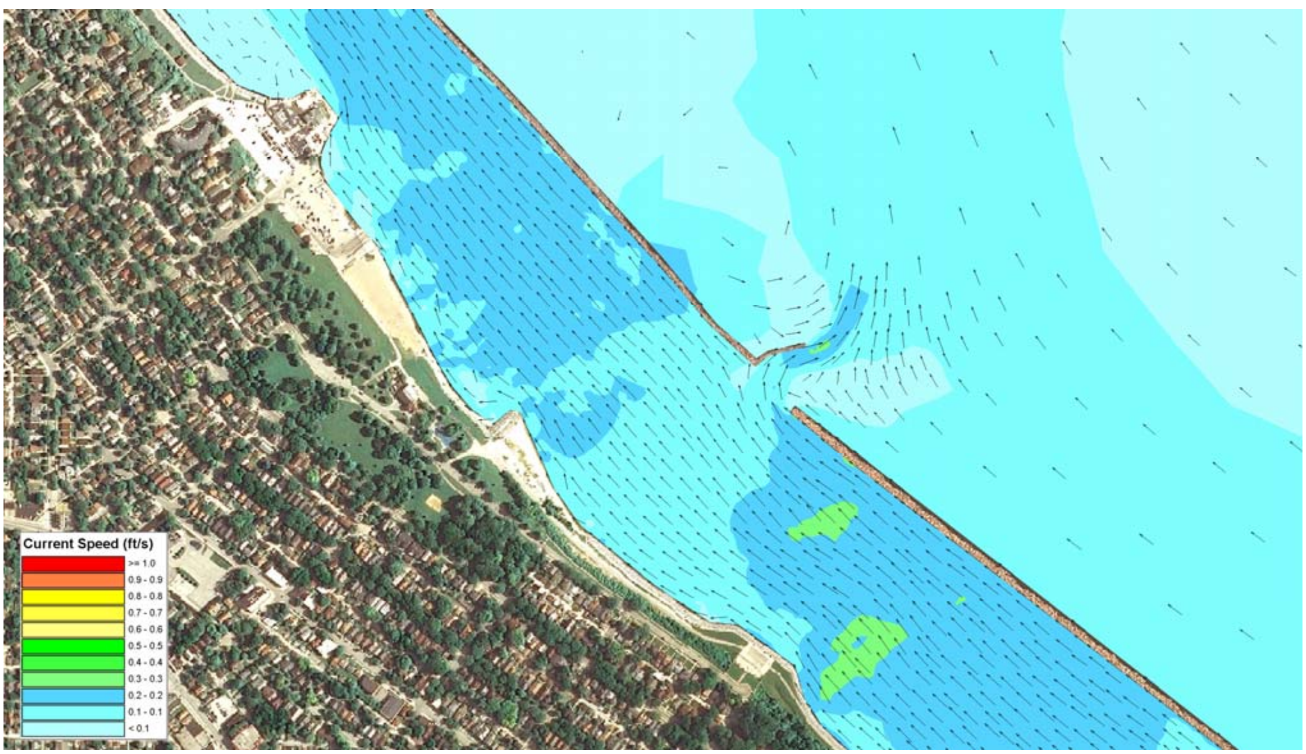


Figure 6-5 Steady State Current Speeds when Summer Average Winds Are From the SE

Figure 6-6 Steady State Current Speeds when Summer Average Winds Are From SW

A notable observation is the direction of the currents in the lee of the breakwater during different wind conditions. When winds are from the NE, SE, and SW, currents are towards the NW at both the beach locations. Based on wind data from 2005 to 2011, this occurs about 60% of the time during the summer months. This dominant northerly current direction is supported by the direction of longshore sediment transport which can be observed through the natural beach orientation at both South Shore Beach and the proposed beach location.

It is interesting to observe that when winds are from the SW (from overland), the currents tend to go in opposite directions after flows enter through the breakwater entrance. Currents to the north of the breakwater gap travel towards the NW and currents to the south of the breakwater gap travel towards the SE. The results also show the dominant current direction going offshore through the breakwater entrance when winds are from NE and SE. This circulation pattern is caused by the presence of the offshore breakwaters causing water in the lee of the breakwater to accumulate and then travels offshore through the breakwater entrance where the water level is lower.

Based on the results from the four steady state model runs, the following conclusions can be drawn:

- In general, current speeds generated at the beach under average wind speeds are very low for all wind directions.

- Winds from the NE, SE and SW generate currents towards the NW at both beach locations. Therefore, the dominant current direction behind the offshore breakwaters during the summer is towards the NW (60% of the time).
- NW/SE winds generate relatively consistent pattern of shore parallel currents inside the breakwater and along the beach face. Negligible exchange would occur through the gap under these wind conditions.
- SW winds generated the smallest currents at the beach. In addition, these current speeds may actually be less due to the sheltering effects of landside topographical features which are not accounted for in the model.
- Current speeds at the proposed beach location are only marginally larger on average.

The modeling results show that hydrodynamically, the benefits of moving the beach are not significant. This finding is consistent with Scopel, Harris and McLellan (2006), who found that the during a dye study the residence time for 90% replacement of dye were similar for both beach locations.

It is important to note that the observations presented here apply only to the typical summer season when lake conditions in the vicinity of South Shore Beach are relatively calm. During other seasons, offshore conditions may generate flow through the breakwater gap with higher velocities than the currents in the lee of the breakwater, which may result in additional instances of increased circulation at the proposed beach compared to the existing beach. This will be important to consider for future design phases because the beach and any structures will have to be designed to withstand conditions for all seasons, not just the relatively benign summer conditions.

6.4 Model Results of Alternative Scenario

The preferred alternative presented in Section 5.5 (Alternative C) was simulated in MIKE21 for the steady state scenarios in Table 6-1. Through the examination of steady state simulations with winds blowing consistently from one direction, quantitative comparisons can be made between the two beach locations. The results are presented in Table 6-3 and in Figure 6-7 to Figure 6-10. Note that the average current speeds were calculated based on all predicted currents at the respective beaches to a depth of about 6 ft.

Table 6-3 Comparison of Currents at Proposed Beach Locations

Wind Conditions Causing Currents From:	Probability of Occurrence during Summer Months	Average Current Speed at Proposed Location with TBM Beach	Average Current Speed at Proposed Beach with Alternative C
NE	15%	0.17 ft/s	0.18 ft/s
NW	40%	0.16 ft/s	0.11 ft/s
SE	10%	0.17 ft/s	0.13 ft/s
SW	35%	0.08 ft/s	0.07 ft/s
	Weighted Average	**0.13 ft/s**	**0.11 ft/s**

Figure 6-7 Steady State Current Speeds when Summer Average Winds Are From the NE

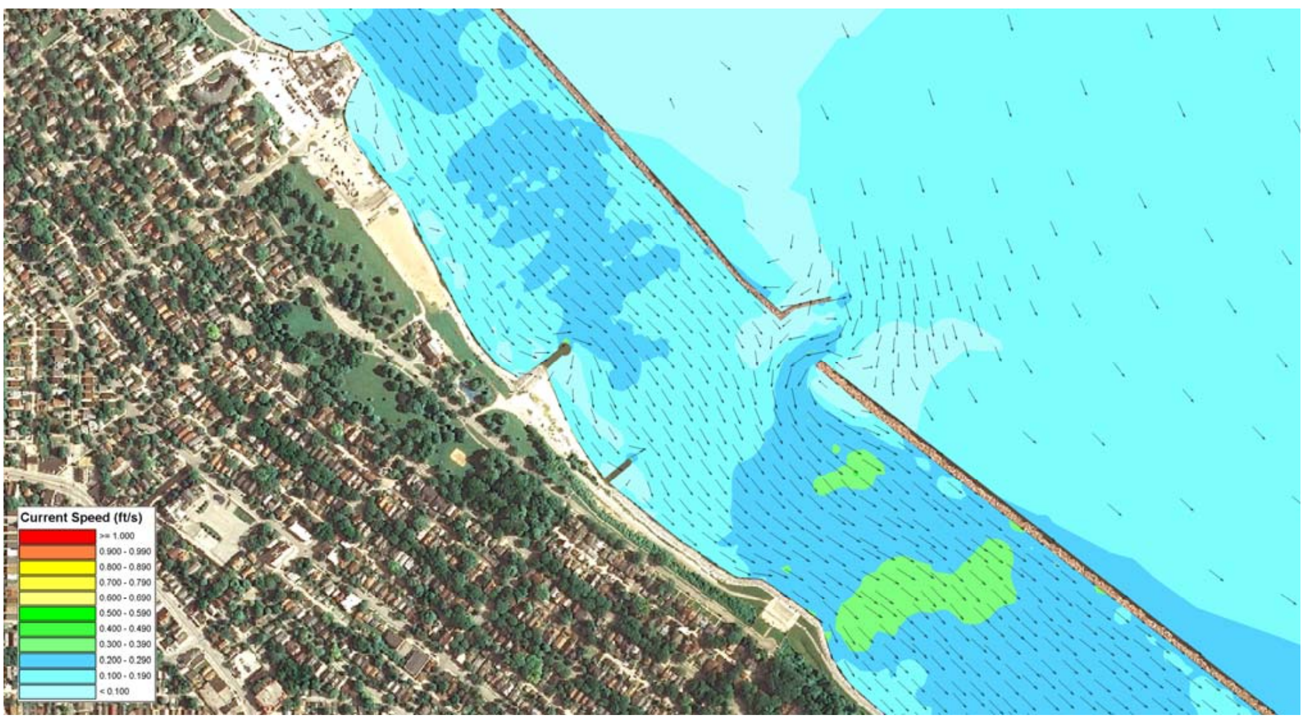


Figure 6-8 Steady State Current Speeds when Summer Average Winds Are From the NW

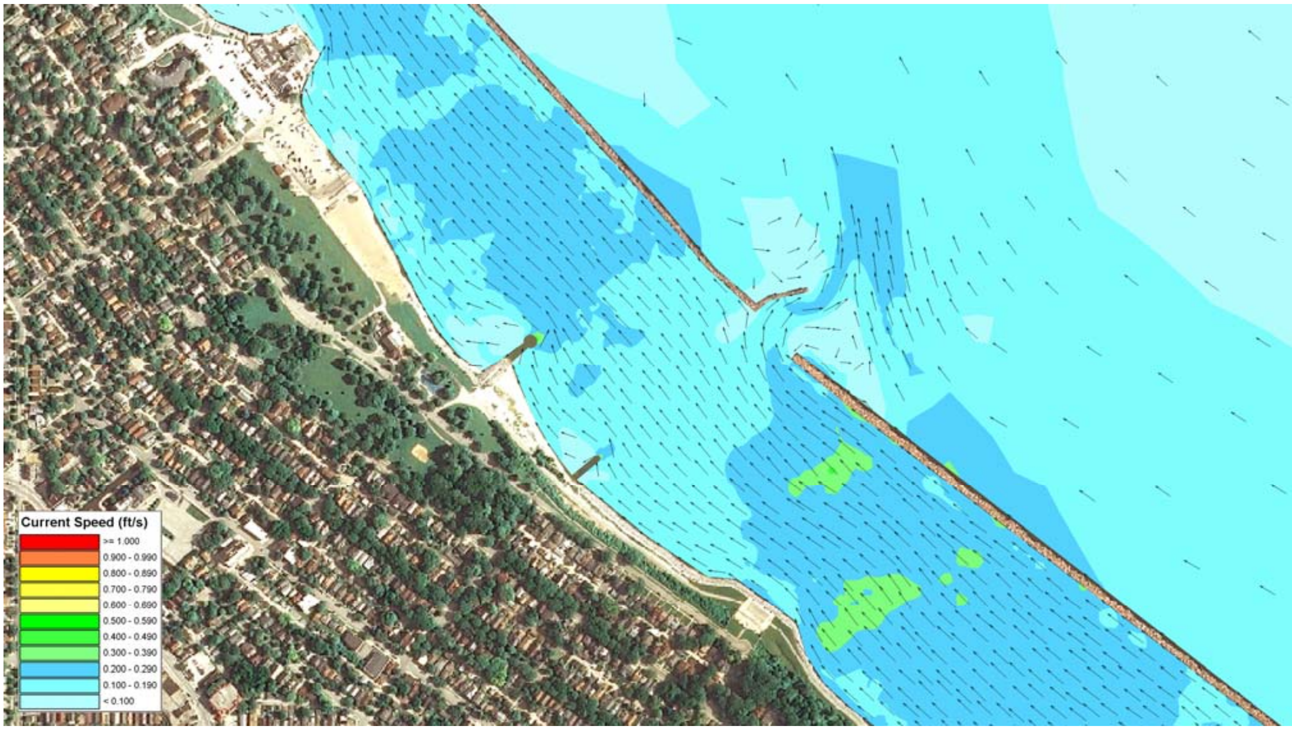


Figure 6-9 Steady State Current Speeds when Summer Average Winds Are From the SE

Figure 6-10 Steady State Current Speeds when Summer Average Winds Are From SW

Based on the results from the four steady state model runs, the following conclusions can be drawn:

- In general, current speeds generated at the beach under average wind speeds are very low for all wind directions.

- NW/SE winds generate relatively consistent pattern of shore parallel currents inside the breakwater and along the beach face. Negligible exchange would occur through the gap under these wind conditions.

- SW winds generated the smallest currents at the beach. In addition, these current speeds may actually be less due to the sheltering effects of landside topographical features which are not accounted for in the model.

- Currents generated under winds from the NE are faster with Alternative C than they are at the proposed beach under existing condition. However, under all other wind directions, currents speeds at the proposed beach are smaller. This is due to the cross-shore structures acting as a physical barrier to the longshore currents, which reduces circulation in the vicinity of the proposed beach.

Hydrodynamically, the benefits of moving the beach and constructing Alternative C are not significant. Although cross-shore structures are required to contain the beach sediment, minimizing the length of the structures will improve circulation at the proposed beach, and will result in smaller usable beach areas.

7.0 POTENTIAL EFFECT ON THE BEACH FROM LOCAL OUTFALLS

To assess the potential effects on the beach from local outfalls during the summer period, a month long simulation with variable winds (with wind magnitude and direction changing with time) was modeled using MIKE21. The month chosen was from 17 July to 17 August 2008, which covers the period when the ADCP was deployed off the South Shore Yacht Club. During this period, the largest winds were from the NNE as shown in Figure 7-1. This is consistent with the NNE dominant direction of the currents measured using the ADCP as discussed in Section 2.3.

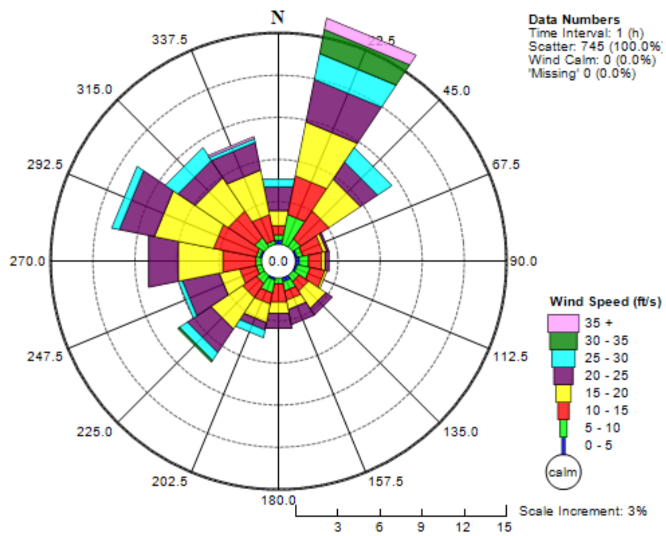


Figure 7-1 Wind Rose from 17 July to 17 August 2008 (Direction from)

Particle tracking was used to assess potential differences in travel time from the CSOs to the beach locations. Baird's in-house particle tracking model was used to highlight the circulation patterns in different areas. The hydrodynamics from the month long variable MIKE21 simulation were used to drive the particle movement. Current advection and local acceleration due to unsteady hydrodynamics were considered in the model. Turbulent mixing and dispersion were also considered by applying the random walk theory. Particles were released at the approximate locations of the Russell Avenue CSO, Morgan Avenue SSO and St. Francis CSO. It is important to note that decay was not considered and as a result, the model results are conservative.

When the winds are from the northwest, the model predicted that it would take approximately five hours for the flow from Russell Avenue CSO to reach the existing beach and an additional two hours for particles to reach the proposed beach location.

When the winds are from the southeast, the model predicted that it would take approximately ten hours for the flow from Morgan Avenue and 14 hours for the flow from St. Francis to reach the proposed beach location. If the winds persisted, the model predicted that it would take approximately two more hours to reach the existing beach location.

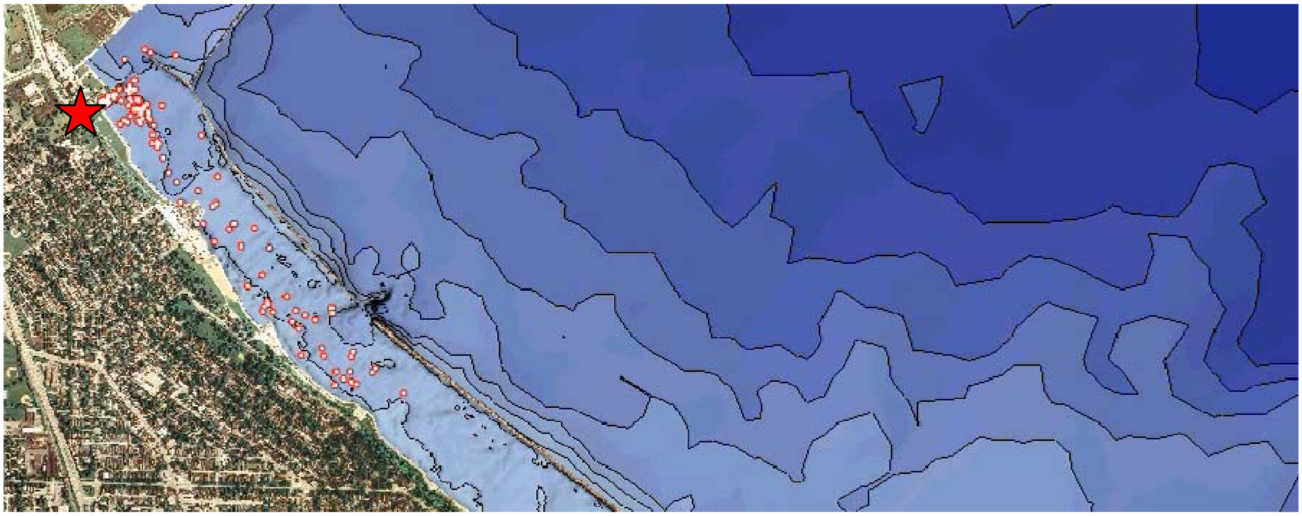


Figure 7-2 Snap Shot of Particles Release at Russell Avenue CSO

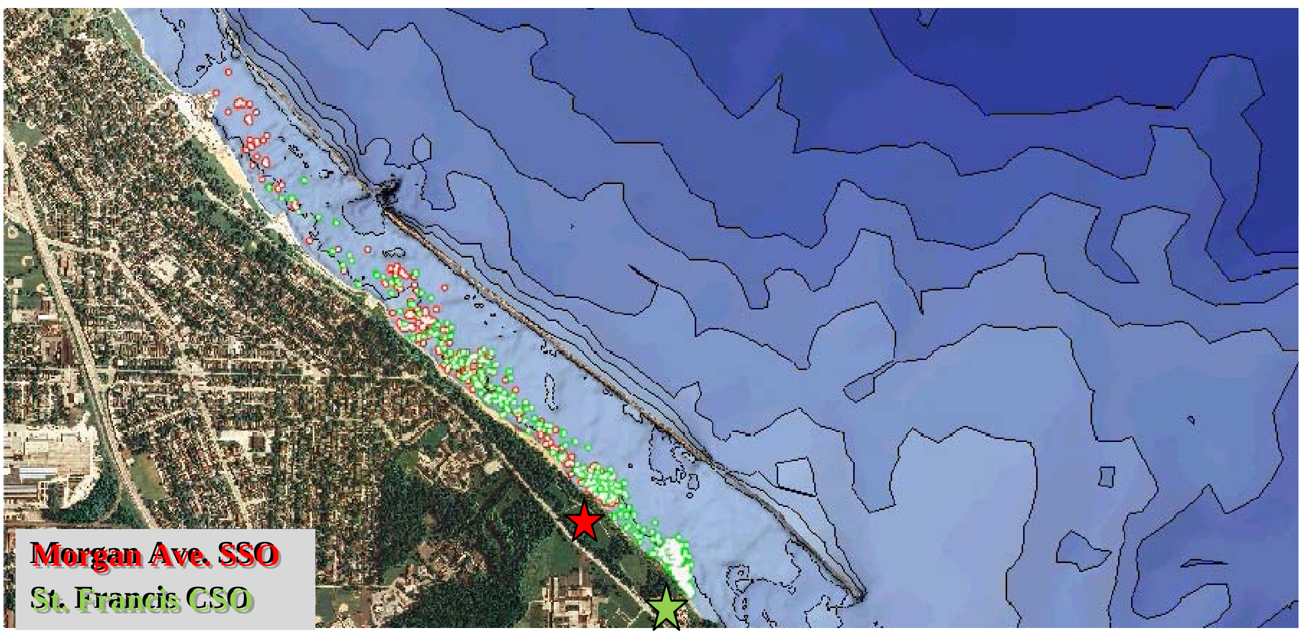


Figure 7-3 Snap Shot of Particles Release at Morgan Avenue Storm Sewer and St. Francis CSO

In summary, the model results show that flow from Russell Ave. CSO, Morgan Ave. SSO, and St. Francis CSO can potentially affect the beach during wet weather events. Findings from past studies in the literature review such as McLellan and Jensen, 2005 and McLellan, et. al., 2007 reported higher *E. coli* counts at South Shore Beach after wet weather events. Although, both studies recognized that the origin of the pollution could not be identified from the water quality sampling results. They hydrodynamic model could be expanded to include water quality and used to assess the relative impacts of each CSO and SSO on both beach locations.

8.0 REGULATORY INPUT

The regulatory process is often a critical path element in waterfront engineering projects. In order to streamline the design process, and identify regulatory concerns, representatives from agencies including: US Army Corps of Engineers (USACE), US Coast Guard (USCG), Department of Natural Resources (DNR) were invited to the project kickoff meeting and preliminary presentation of modeling and alternatives. Limited comments received from representatives in attendance are summarized below:

USACE:

- Any activity regarding fill, dredging, or structure modification below the ordinary high water mark needs to be compliant with USACE regulations.
- Study should include an option of not moving the beach ("no action alternative").
- Study should include an option of addressing water quality issues with BMPs.
- Potential for an EA/EIS if proposed relocation becomes extensive.
- If lakebed impact is greater than 10,000 square feet potential mitigation options would likely be examined. Possible mitigation areas include the existing beach and "Site 4" (refer to Figure 1-3).
- Any potential negative impacts should be considered.
- There is a ship wreck offshore near the site that may require an archeological resources survey (SHPO).

USCG:

- Coast Guard representatives were not present at initial meetings.
- It is anticipated that proposed beach improvements would not interfere with navigation in the nearshore areas.

DNR:

- Potential for parking lot retrofit to prevent runoff, including rain gardens or engineering solutions to improve water quality more efficiently than relocating the beach.
- It may be more effective to manage existing infrastructure and the sources of contamination rather than building a new beach.
- Improvements should be made to water quality at the beach such that it could eventually be removed from the Wisconsin 303(d) impaired waters list.

These comments are incorporated into the conceptual beach relocation alternatives, and will be noted in future design efforts. Future design efforts will require additional coordination, and possibly the procurement of permits from USACE, USCG, and DNR.

9.0 PUBLIC INFORMATION MEETING

A public information meeting was held on March 20, 2013 to present the project methodology and results. The meeting was well attended by local residents, stakeholders, County staff, and elected officials. Meeting Minutes are provided in Appendix F. Public questions beyond specific inquiries about the project generally fell into the following categories:

- **Project Schedule:** Attendees asked about the time frame and budget for future work at South Shore Park. It was noted that no plans are in place for immediate action, and public input will be considered for future project work.

- **Existing Conditions:** Several questions focused on the existing site, such as the purpose and origin of the stone groyne, TBM beach, and existing swimming beach. It was noted that removal of the groyne and alterations to the outer breakwater were not considered in this study. It was noted that water level fluctuations on short and long term basis have been included in coastal designs. Modeling efforts were based on historic conditions.

- **Water Quality:** Clarification was requested regarding the difference between water quality sampling data, and hydrodynamic modeling results. It was noted that current water quality sampling data at the proposed beach location does indicate less *E. coli*, but this does not guarantee that this will remain true if a recreational beach was constructed. Beach slope, water depth, avian presence, and substrate would all change immensely if a new beach were to be constructed. The results of the hydrodynamic model indicated that any improvements in circulation velocities at the proposed beach location compared to the existing location would be eliminated by the construction of stone structures to contain a new beach.

- **Parking Lot:** Clarification was requested about the contribution of *E. coli* from the parking lot compared to "Site 4". It was noted that concentration of *E. coli* is staggering from both. In dry years, Site 4 may have a large affect on water quality, but in wet years, the runoff from the parking lot is a larger contributor to contamination. It was noted that when the parking lot is due to be resurfaced, it likely makes sense to incorporate stormwater management BMPs to capture and treat runoff.

- **Beach Management:** Significant concern exists about beach management activities, especially public education. It was noted that community groups will work to educate beach users, and train citizens on constructive methods to encourage positive behavior at the beach. County officials suggested that increased enforcement and beach cleaning may be possible. Fireworks and special events were noted as an additional concern.

10.0 BEACH MANAGEMENT PRACTICES

Research and the investigation of similar beaches highlight the importance of proactive management activities for beach health. Management techniques include beach tilling to expose *E. coli* to UV radiation, education, cleanliness/rubbish disposal, enforcement, stormwater management, bird management, etc. Regardless of the decision to relocate South Shore Beach or continue to utilize the existing beach, a comprehensive beach management plan should be enacted to improve and maintain beach water quality. An example of the successful implementation of beach management practices is 63rd street Beach in Chicago, which is described in Section 10.1. A summary of various beach management practices is provided in Section 10.2.

10.1 Beach Management Practices Used to Improve 63rd Street Beach in Chicago

On Lake Michigan, water quality impairment is not a problem unique to South Shore Beach on Lake Michigan. Numerous beaches experience advisories and closures, though South Shore is a noted offender of water quality standards (NRDC, 2012). Baird has identified 63rd Street Beach in Chicago as a precedent project. This beach had considerable water quality problems. Through proactive and diligent management techniques, the number of advisories and closures has been significantly reduced at 63rd Street Beach.

The City of Chicago, USGS, and Chicago Parks District developed a comprehensive plan to understand the excessive *E. coli* occurrences at 63rd Street Beach through the identification of sources, a determination of effectiveness of mitigation measures, an efficient testing and analysis protocol and a forecast model to alert residents of beach closures (Whitman, 2001). It soon became evident that the factors influencing *E. coli* concentrations were complex. Through daily sampling, hourly sampling, exposure to sunlight, groundwater testing, DNA analysis, and modeling, existing conditions were documented (Whitman, 2001). Many of the conclusions from this study are similar to those published by Dr. McLellan, and are relevant to South Shore Beach. For example, *E. coli* concentrations were consistently lower with increasing water depths, were higher in morning than afternoon, were higher in sand samples than water samples, and were highest in areas with the highest gull densities. Hourly sampling and UV tests validated the theory that sunlight reduces *E. coli* concentrations. DNA fingerprinting indicated that *E. coli* and Enterococci at the beach were at least partially from resident gulls. Furthermore, *E. coli* at the beach likely becomes trapped due to a large breakwater and southward sediment transport, as seen in Figure 10-1 (Whitman, 2001).

Figure 10-1 63rd Street Beach, Chicago

Further studies in 2003 correlated gull activity with *E. coli* density, and studied self sustaining *E. coli* colonization in nearshore and foreshore sand (Whitman, 2003). The Parks District attempted to partially remove and replace contaminated sand, but within two weeks *E. coli* concentrations had returned to the original levels. Whitman also suggested that improper beach tilling (simply aerates, remoistens, and turns sand) may actually lead to an increase in *E. coli* concentrations. Ge et. al., 2012, also concluded that hydrodynamics and circulation affect beach water quality at 63rd Street Beach.

Nearshore hydrodynamics for E. coli *contamination*

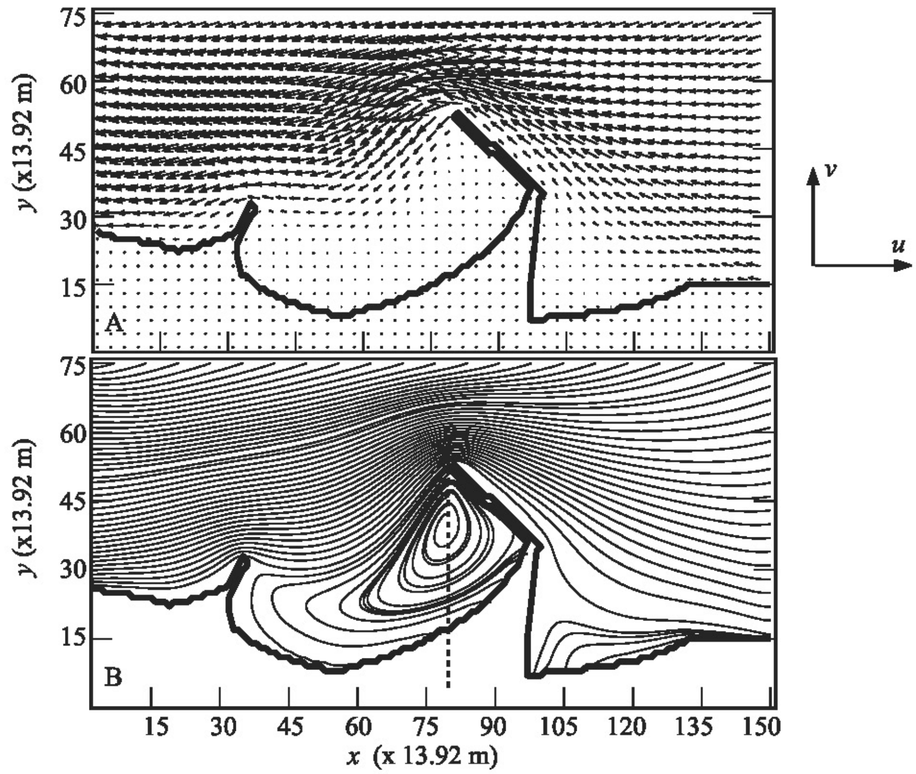


Fig. 4. Current pattern around the study beach driven by an upcoast longshore current entering the computational domain through the offshore (top) boundary with $u = -0.15$ m s^{-1} and $v = -0.05$ m s^{-1} and through the downcoast (right) boundary with $u = -0.15$ m s^{-1} and v decreasing linearly toward shore from -0.05 to 0 m s^{-1} and exiting at the upcoast (left) boundary with a uniform u determined by mass balance in the computational domain and a linearly decreasing v from -0.05 to 0 m s^{-1} toward shore. (A) Current velocity vectors; (B) streamlines. For clarity, streamlines inside the embayment start at selected points along the dotted vertical line.

Figure 10-2 Circulation Velocities. Ge Et El, 63rd Street Beach, Chicago

It is important to note for the current South Shore Beach Relocation Study that Ge et. al., 2012, discussed the need for computer modeling and design to balance the desire to maintain a stable beach while significantly increasing circulation to maintain water quality. For example, overly conservative coastal structures to contain beach sand in challenging coastal conditions would likely result in lower water quality due to decreased circulation velocities.

Chicago received Great Lakes Restoration Initiative grant funding and implemented a variety of management measures at 63rd Street Beach. Dune restoration reduced and filtered runoff, reduced erosion, managed invasive species, enhanced ecological habitat, provided educational and passive recreation opportunities, improved site aesthetics, and reduced gull presence (Yerkamov, 2009).

The city also purchased three beach tillers (small, medium, and large) and implemented a daily grooming program to till and expose nearshore sand to UV radiation (Chicago Parks District, 2009).

Approximately one hour is required to till the beach each day, and reductions in *E.coli* have been achieved.

Intensive management of gulls has also improved water quality through oiling of eggs, dogs, and vegetation (Hartmann et. el, 2009, 2013). Conflicting reports exist on the effectiveness of canine harassment, though it is clear that it causes at least a temporary improvement in gull counts, though at a significant cost (Barry, 2012).

10.2 Beach Management Techniques

Active and consistent management procedures are necessary for beach health. The following beach management techniques apply to the relocated beach, but are equally valid for the existing beach. With a few simple techniques, it is likely that water quality can be improved at South Shore Beach.

10.2.1 Educate Beach Users and Local Residents

Through signage, community education sessions, and properly located garbage cans, park users can manage the park and beach areas in ways that will limit the likelihood of contamination. Humans facilitate bird populations by feeding or providing materials that provide odors which attract birds. Prominent, positively phrased signage should be posted to discourage the feeding of birds. Education sessions can be held to explain the severity of the problem and solutions involving simple changes in behavior. Closed trash cans can be implemented to reduce odors. Properly placed trash cans will reduce the amount of litter at the park. In addition, frequent enforcement patrolling could be considered.

10.2.2 Reduce Bird Presence

The number of birds could be reduced by eliminating the bird roosting area (Site 4 on Figure 1-3) or making it less appealing to birds. Bird deterrent measures can take a variety of forms including streamers, overhead netting, or vegetation. Overhead netting from monofilament can effectively discourage birds while impacting human uses and views very little. If wetland type vegetation can be established in the roosting area, it will become inaccessible to birds. This would have the secondary benefit of filtering any runoff flowing through the area.

Dogs (specially trained) can be deployed to successfully discourage birds on beach areas and throughout the park. This technique has been successfully deployed at 63rd Street in Chicago, resulting in a 98% reduction of gull counts, and a 30% reduction in *E. coli* (Barry, 2012).

If nests are present, eggs can be covered with food-grade corn oil to prevent reproduction. It is unclear if nests are present at South Shore, though colonies have been noted anecdotally elsewhere in Milwaukee including above the Post Office and on Summerfest Island.

Other management techniques to be investigated in future projects include noise makers, encouraging predatory bird populations, and the creation of dune habitat. Research has shown that increased vegetation limits attractiveness and access for birds. This technique could be implemented at Site 4.

10.2.3 Maintain a Clean Beach

Beach sand should be cleaned daily during the swimming season. Removal of bird, animal, and human waste is essential to water quality and discouraging the presence of additional pests. Beach sand tillage provides a more appealing surface for beach users, and can expose contaminated sediment to UV radiation, reducing *E. coli* concentrations. The City of Chicago has experienced significant reductions in beach closures due in part to a consistent beach tillage program. The tilling takes approximately one hour per day, and equipment (three sizes) was purchased in 2012 for $105,000 (CPD, 2012).

10.2.4 Manage Stormwater Runoff

As the South Shore parking lot has been demonstrated to be a major source of contaminated runoff, investment in reducing, treating, or redirecting stormwater would likely result in significant improvements in water quality. A small rain garden and trench drain has been installed near the boat launch ramp, but it is poorly maintained and likely not functional.

Possible management techniques include permeable pavement, a regular pavement cleaning (street sweeping) program, regrading the parking lot to drain into bioswales or buffer strips, filtration or treatment before runoff enters the lake, the introduction of trees or vegetation, and regular trash collection at the snack bar and fish cleaning station. Stormwater management systems could be designed to manage both water quality and water quantity.

10.3 Beach Management Alternative

Baird prepared a conceptual graphic of an enhanced recreational swimming beach at South Shore Park as shown in Figure 10-3. The north end of the beach could be reconfigured to accommodate a large stormwater treatment buffer without impacting parking capacity for the boat launch. If desired, the recreational beach could be expanded to the south. This would allow the beach to be centered on the Bath House. The revetment north of the existing stone groyne could be salvaged and reused for a small stone groyne to provide separation between the beach and boat launch area while containing the beach. A wetland could possibly be established adjacent to the boat launch.

It is important to note that this Alternative will likely not provide any improvements in circulation velocities compared to the existing beach. However, extensive buffers adjacent to the parking lot and bike path will provide filtration and could discourage birds from using the beach. Total construction cost would likely be on the order of $1,000,000 to $1,500,000.

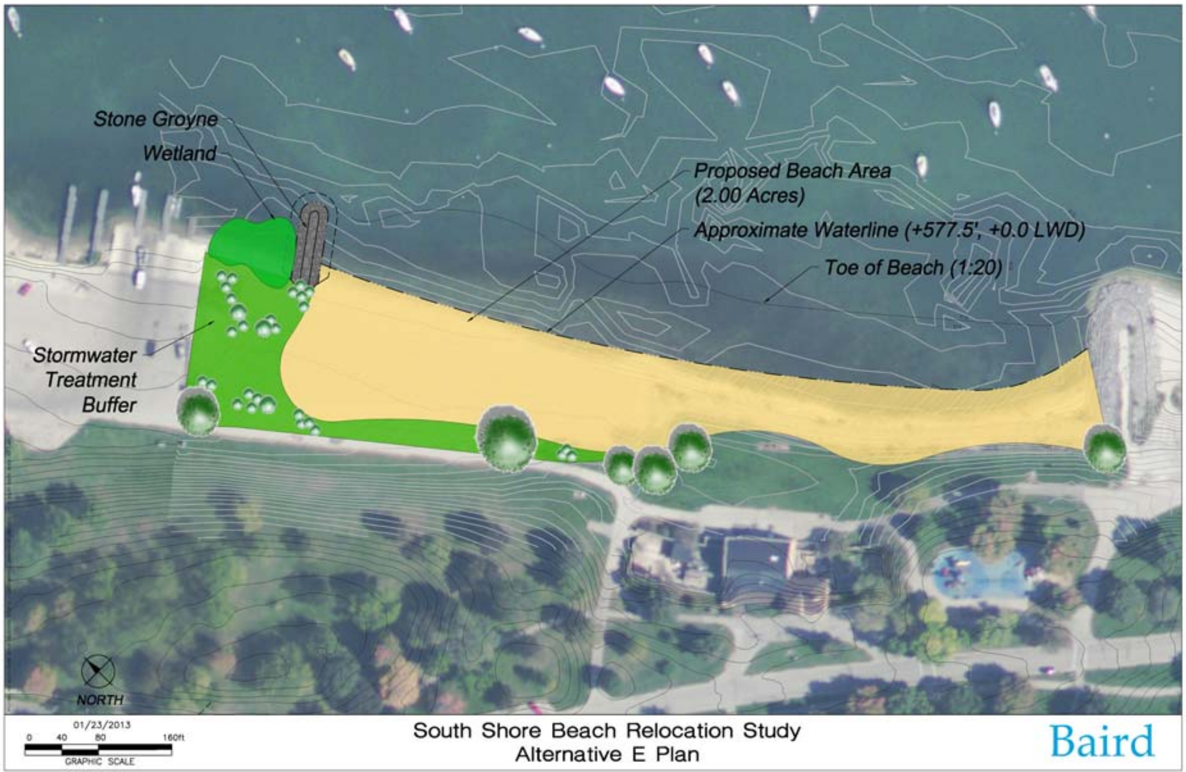


Figure 10-3 Alternative E – Reconfiguration of Existing Beach

11.0 CONCLUSION

The purpose of the South Shore Beach Relocation Study was to evaluate the feasibility of relocating South Shore Beach to the proposed beach location. The study objective was to understand whether the water quality at the proposed beach will be improved compared to the existing beach. Part of the study involved conducting a literature review of past studies and preparing a two-dimensional hydrodynamic numerical model.

Through the literature review, it was identified that the main sources of contaminants include avian, human, parking lot runoff and sediment. Scopel, Harris, and McLellan, 2006, collected and conducted extensive analysis of water quality data collected at both beach locations from May to September 2003. This study concluded that the existing beach had much higher levels of *E. coli* than the proposed beach with 12 out of 39 samples exceeding water quality standards compared to four out of 39 at the proposed beach location (Scopel, Harris, and McLellan, 2006). It is speculated that this is mainly due to the proposed beach location being further from the sources identified as contributing to the water quality issues at South Shore Beach. It is difficult to quantify future water quality at the proposed beach location, because new sources may be introduced if it becomes a swimming beach:

- The bird population may increase as beach sand and humans facilitate bird population growth through food waste;
- Parking lot runoff - if a parking lot is included in the design; and
- Humans.

It is difficult to determine the relative impacts of each source of contamination. For example, McLellan, et. al., 2007 found that *E. coli* counts were notably higher during CSO/SSO events at South Shore Beach but could not verify where the pollution originated. The extensive sampling programs that have been completed to date could be complimented by continued water quality sampling and the development of a water quality model that could be used to assess the relative impacts of the various sources of contaminates. A water quality model could then be used to gain information regarding the origin of contamination at South Shore Beach and residence times. This will provide the necessary information to prioritize efforts to reducing the number of beach closures during the summers at South Shore Beach.

Four different design alternatives for a recreational beach at the proposed beach location were presented for comparison purposes (refer to Table 11-1). These alternatives represent a variety of sizes, layouts and costs. Alternative C was selected as the preferred alternative for functional and water quality benefits over the other Alternatives.

Table 11-1 Comparison of Design Alternatives

Alternatives	Brief Description	Capital Cost	Beach Area
No Action	Swimming beach remains at existing South Shore Beach.	$0	1.5 Acres
Alternative A	Replace existing TBM material with beach sand.	$1,600,000	0.9 Acres
Alternative B	Increased beach area by extending existing rock groyne lakeward and constructing a second beach retention structure at the south end of the beach.	$4,500,000	1.7 Acres
Alternative C	Increased beach area by extending the existing rock groyne with a steel sheet pile (SSP) and constructing a second beach retention structure at the south end of the beach.	$4,200,000	1.2 Acres
Alternative D	Increased beach area by placing four offshore breakwaters to create a series of curved beach cells. The existing groyne will not be altered; however, an additional stone revetment may be needed to contain the southern end of the beach.	$5,600,000	1.4 Acres

Numerical modeling was undertaken to assess the relative difference in circulation and potential water quality conditions at the existing and proposed beach site locations. The two-dimensional model MIKE21 was selected to simulate the hydrodynamics in the vicinity of the project site. The model was run for typical summer conditions; and the following conclusions were made:

- In general, current speeds generated at the beach under average wind speeds are very low for all wind directions.
- Winds from the NE, SE and SW generate currents towards the NW at both beach locations. Therefore, the dominant current direction behind the offshore breakwaters during the summer is towards the NW (60% of the time).
- NW/SE winds generate relatively consistent pattern of shore parallel currents inside the breakwater and along the beach face. Negligible exchange would occur through the gap under these wind conditions.
- SW winds generated the smallest currents at the beach. In addition, these current speeds may actually be less due to the sheltering effects of landside topographical features which are not accounted for in the model.
- Current speeds at the proposed beach location are only marginally larger on average.

The modeling results show that hydrodynamically the benefits of moving the beach are not significant. This finding is consistent with Scopel, Harris and McLellan (2006), who found that the during a dye study the residence time for 90% replacement of dye were similar for both beach locations.

The preferred design alternative, Alternative C was simulated in MIKE21. Through the examination of steady state simulations with winds blowing consistently from one direction, quantitative comparisons were made between the two beach locations. In summary, currents generated under winds from the NE are faster with Alternative C than they are at the proposed beach under existing condition. However, under all other wind directions, current speeds at the proposed beach were smaller. This is due to the cross-shore structures acting as a physical barrier to the longshore currents, which reduces circulation in the vicinity of the proposed beach. Therefore, hydrodynamically, the benefits of moving the beach and constructing Alternative C are not significant. Although cross-shore structures are required to contain the beach sediment, minimizing the length of the structures will improve circulation at the proposed beach.

To assess the potential effects on the beach from local outfalls during the summer period, a month long simulation with variable winds (with wind magnitude and direction changing with time) was modeled using MIKE21. In summary, the model results show that flow from Russell Ave. CSO, Morgan Ave. Storm Sewer, and St. Francis CSO can potentially affect the beach during wet weather events. Findings from past studies in the literature review such as McLellan and Jensen, 2005 and McLellan, et. al., 2007 reported higher *E. coli* counts at South Shore Beach after wet weather events. Although, both studies recognized that the origin of the pollution could not be identified from the water quality sampling results. The hydrodynamic model could be expanded to include water quality and used to assess the relative impacts of each CSO and SSO on both beach locations.

Research and the investigation of similar beaches such as 63rd Street Beach in Chicago, highlights the importance of proactive management activities for beach health. Management techniques include beach tilling to expose *E. coli* to UV radiation, education, cleanliness/rubbish disposal, enforcement, stormwater management, bird management, etc. could all contribute to improved water quality at South Shore Beach.

11.1 Recommendations

When making the decision to relocate South Shore Beach, it is important to carefully weigh the cost of relocating the beach with:

1. The possible reductions in beach closures at the proposed beach location. The Milwaukee County Health Department issues beach closure notices based on set thresholds of rainfall events (>1”/24 hrs) and CSO discharge events. These rules would be in effect at the proposed beach location. In addition, moving the beach would provide a spatial buffer from the primary source of contaminates, but without proper and aggressive management techniques, it is likely that birds would follow human activities to the new beach and continue to be a source of contamination. Therefore a proactive and comprehensive beach management plan will be required to limit and control bacterial inputs.

2. The cost of implementing beach management techniques to improve water quality at the existing beach. Examples of various beach management techniques that could be applied to the existing beach location include:

- Educate beach users and local residents through signage, community education sessions, and properly located garbage cans, park users can manage the park and beach areas in ways that will limit the likelihood of contamination.

- Reduce bird presence by eliminating the bird roosting area (Site 4 on Figure 1-3) or making it less appealing to birds. Bird deterrent measures can take a variety of forms including streamers, overhead netting, vegetation or dogs.

- Maintain a clean beach through daily removal of bird, animal, and human waste during the swimming season. Beach sand tillage provides a more appealing surface for beach users, and can expose contaminated sediment to UV radiation, reducing *E. coli* concentrations.

- Manage stormwater runoff from the parking lot by reducing, treating, or redirecting stormwater from South Shore Beach. Possible management techniques include permeable pavement, a regular pavement cleaning (street sweeping) program, regrading the parking lot to drain into bioswales or buffer strips, filtration or treatment before runoff enters the lake, the introduction of trees or vegetation, and regular trash collection at the snack bar and fish cleaning station.

Although preparing detailed cost estimates of the above was beyond the current scope of work, it is anticipated that a number of beach management techniques could be applied at South Shore Beach for a fraction of the cost necessary to develop a new beach at the proposed beach location.

The extensive sampling programs completed to date and hydrodynamic model developed as part of this study could be complimented by continued water quality sampling and the development of a water quality model. The hydrodynamic model could be leveraged and used as a basis for the water quality model in MIKE21. A water quality model would help assess the relative impacts of the various sources of contaminates and gain information regarding the origin of contamination at South Shore Beach. Key tasks to assist this type of study could include:

- Quantifying CSO/storm sewer flows and concentration;
- Water fowl survey program in conjunction with *E. coli* sampling;
- Additional collection of current data;
- The identification of any additional point source discharges, which may act as a potential source of contamination at South Shore Beach;
- Development of water quality model including all point sources.

This will provide the necessary information to prioritize efforts to reducing the number of beach closures during the summers at South Shore Beach.

11.2 Parking Lot Redesign

Based on the results of the hydrodynamic modeling and the anticipated costs of relocating South Shore Beach, Baird has prepared a conceptual figure illustrating possible concepts for the redesign of the parking lot, as shown in Figure 11-1.

It is recommended that future improvements at South Shore Park focus on aggressively managing stormwater runoff and avian presence at the park. Redesigning the parking lot and establishing vegetation on "Site 4" would accomplish both of these goals.

Addressing Site 4 through the establishment of native grasses, wetland, or possible dredging could provide an immediate reduction in the source of *E. coli* at South Shore Beach. This project could be accomplished on a limited budget and could involve community groups.

Total cost of parking lot improvements (including the north area not shown below) is dependent on future design efforts. For planning purposes, these efforts could cost between $1,000,000 and $3,000,000. This corresponds to approximately $5 to $17 per square foot. For comparison, traditional asphalt may be approximately $1 per square foot and interlocking porous concrete paver blocks may be approximately $12 per square foot (Rochester, 2013). The redesigned parking lot will offer improvements in longevity, opportunities for public education, and likely long term improvements to water quality at South Shore Beach.

Figure 11-1 Parking Lot Redesign Concepts

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APPENDIX A

HIMALAYAN GEOTECHNICAL REPORT

September 17, 2012

Ben Yahr, RLA
W.F. Baird & Associates, Ltd
2981 Yarmouth Greenway Drive
Madison, Wisconsin 53711

Subject: Geotechnical Analysis
South Shore Beach Relocation Study
Milwaukee County, Wisconsin

Dear Mr. Yahr:

Himalayan Consultants, LLC (Himalayan) has completed sampling and testing for grain size analysis (ASTM Procedure D-421) of the beach materials collected at the above referenced site. The sampling and testing of the beach materials was conducted as part of the study performed by W.F. Baird & Associates, Ltd (Baird) in assisting Milwaukee County to investigate the feasibility of relocating the existing swimming beach at South Shore Park in Milwaukee.

The following is a brief letter report describing sampling activities, testing results, and geotechnical design parameters (internal angle of friction and unit weight):

1.0 FIELD ACTIVITIES

On August 2 and 8, 2012, Himalayan performed sampling of the beach materials at the site. Ten samples were collected from the existing swimming beach, proposed beach containing Tunnel Boring Materials (TBM), and boat launch areas as directed by Baird,. Six Samples (S-1A, S-2B, S-3C, and S-1B, S-2B, S-3C) were collected from the existing beach location, three samples (S-3A, S-3B, S-3C) were collected from the proposed beach location, and one sample (S-4) was collected from the beach area approximately 150 feet north of the existing boat launch. Samples from the existing and proposed beach areas were collected at the on-shore, at the water line, and at off-shore locations (2 feet below water surface within the breakwater area). Refer to Figure 1 in Appendix A for sample locations.

The beach material samples were obtained using a Universal Core Sampler from Forestry Suppliers. The Universal Core Sampler consists of a manually advanced 2-foot long 2.6-inch

diameter, clear polycarbonate sample tube. Upon sample retrieval, a one-way check valve seated inside the core head creates a partial vacuum within the sample tube in order to retain the material and/or water within the tube.

The core sampler at each core location was manually advanced to approximately 1 foot into the sand or sediment surfaces with a 5-pound sledge hammer. A 2.54-inch diameter plastic disk was placed on the top of the sample and a one-inch diameter aluminum rod was used to extrude each sample out of the sample tube. The samples were placed in one-gallon sized sealable plastic bags. Prepared samples were then submitted with chain-of-custody procedures to Professional Services Industries Inc, (PSI) for grain size analysis (ASTM D-421).

Himalayan examined the sand and sediment samples collected from each sample location for soil type, texture, and other characteristics using visual-manual procedures. Sand and sediment classifications were based on Himalayan's visual observations of the samples and results of the grain size analyses and were performed according to the Unified Soil Classification System (USCS), in general accordance with ASTM Procedure D-2487. Refer to Appendix B for the grain size analysis reports.

2.0 GEOTECHNICAL DESIGN PARAMETERS

Table 1 presents the geotechnical design parameters (internal angle of friction and unit weight) of the sand and sediment samples along with each sample ID, sample depth, and a summary of soil descriptions/classifications noted for each sample:

Table 1. Geotechnical Design Parameters South Shore Beach Relocation Study Milwaukee County					
Sample ID	**Depth (ft)**	**Soil/Sediment Description**	**USCS Classification**	**Approximate Moist Unit Weight (γ) lbs/ft^3**	**Approximate Internal Angle of Friction (□) degrees**
Existing Beach Area					
S-1A	0-1	Well graded gravel with sand	GW	130	35
S-1B*	0-1	Well graded sand with gravel	SW	120	32
S-1C*	0-1	Well graded gravel with sand	GW	130	35
S-2A	0-1	Well graded sand with gravel	SW	120	32
S-2B*	0-1	Well graded sand with gravel	SW	120	32
S-2C*	0-1	Well graded sand with gravel		120	32
Proposed (TBM) Beach Area					
S-3A	0-1	Well graded gravel with sand	GW	130	35
S-3B*	0-1	Well graded sand with gravel	SW	120	32
S-3C*	0-1	Well graded gravel with sand	GW	130	35
Beach Area North of Boat Launch					
S-4	0-1	Poorly graded sand	SP	118	30

lbs/ft^3 = pounds per cubic foot

* = Subtract unit weight of water, γ_w (62.4 lbs/ft^3) from γ to obtain submerged or effective unit weight, γ'

Note that the geotechnical design parameters provided in Table 1 for the sand and sediments samples are based on the existing data obtained from the historical testing of similar materials.

We hope the above information meets your needs at this time. We greatly appreciate the opportunity to be of service to you in this project. If you have any questions or comments, which require further clarification, please feel to contact us at (262) 502-0066.

Sincerely,

HIMALAYAN CONSULTANTS, LLC

Matthew J. Hilse
Project Hydrogeologist

Gopal K. Adhikary, P.E.
Principal/ Senior Engineer

APPENDICES

Appendix A. Figure 1. Sample Location Map
Appendix B. Grain Size Analysis Report

APPENDIX A

SAMPLE LOCATION MAP

LEGEND

● S-3C = Sand Sample Location

Source: Southeastern Wisconsin Regional Planning Commission Aerial Photograph 2010

Scale: 0 100 200

Figure 1. SAMPLE LOCATION MAP

HIMALAYAN CONSULTANTS, LLC
Engineers and Hydrogeologists
W156 N11357 Pilgrim Road
Germantown, Wisconsin 53022
Phone: (262) 502-0066

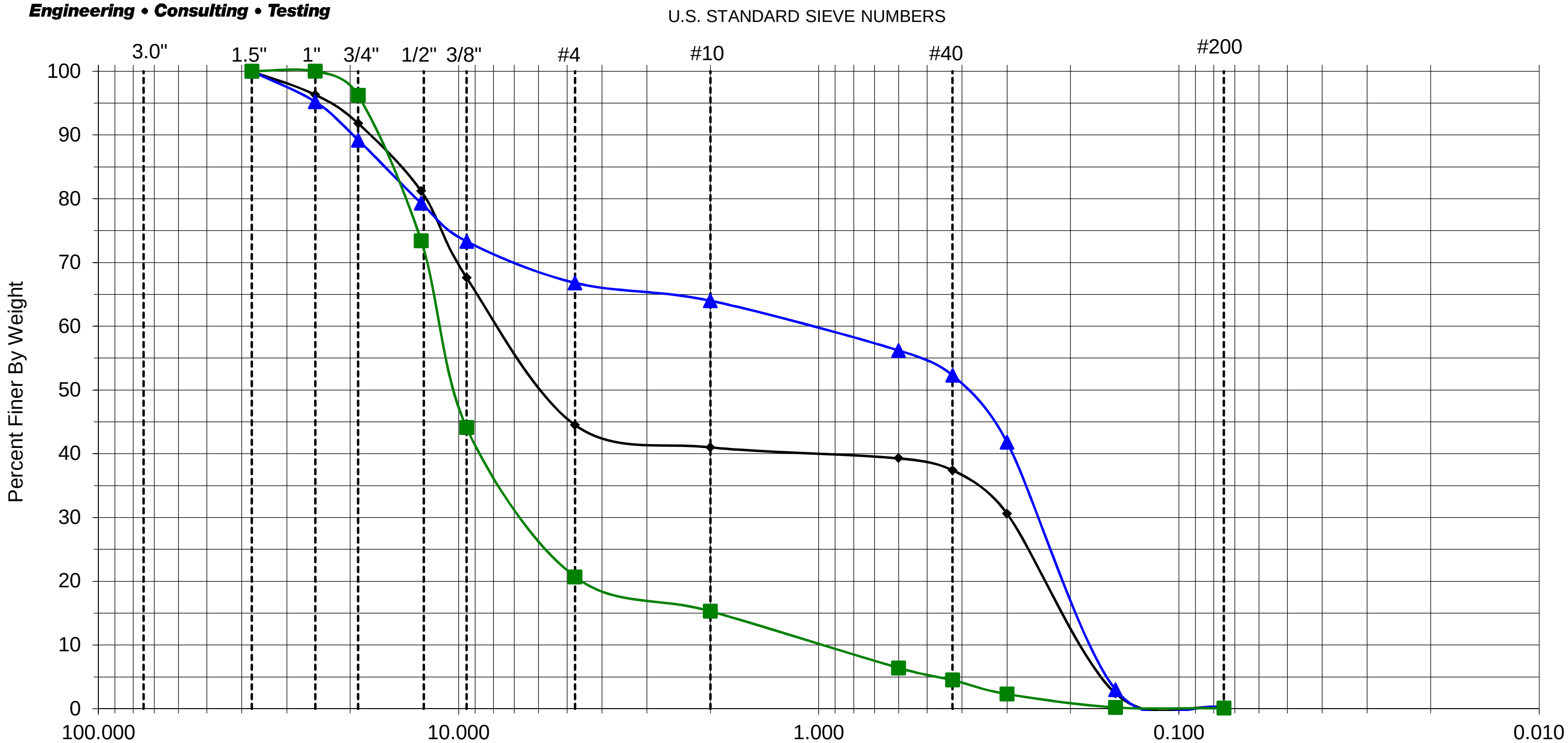
South Shore Beach Relocation Study
Milwaukee County, WI
Himalayan Project No:
12026.018

APPENDIX B

GRAIN SIZE ANALYSIS REPORT

Information To Build On
Engineering • Consulting • Testing

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



ASTM Classification

Gravel	Sand	Fines (Silt and Clay)

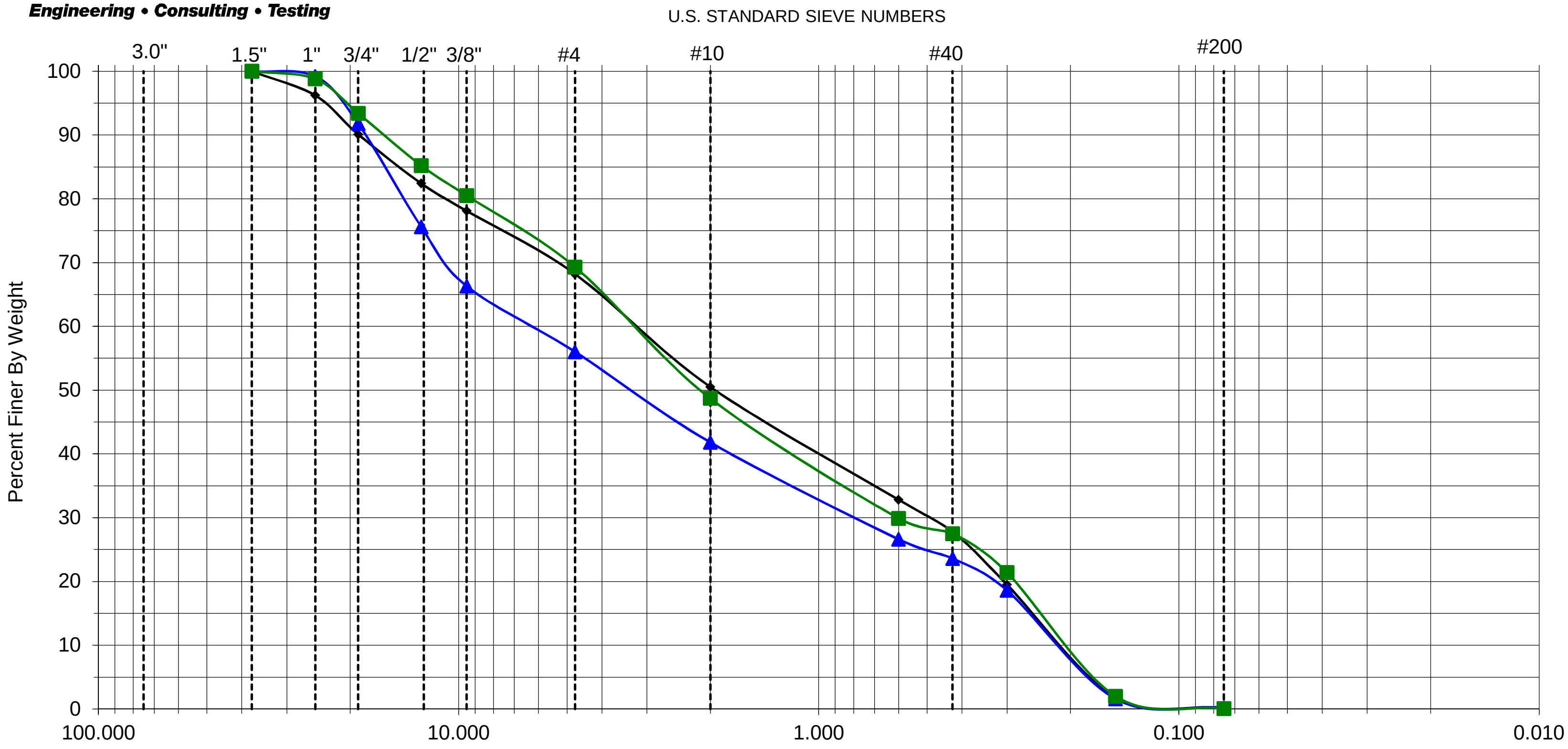
Key	Project	Sample Number	%Gravel	%Sand	%Fines
◆	South Shore Beach	S-1A	55.5	44.3	0.2
▲	South Shore Beach	S-2A	33.2	66.6	0.2
■	South Shore Beach	S-3A	79.3	20.6	0.1

Himalayan Consultants, LLC	File No.	0052598

Professional Service Industries ● W237 N2878 Woodgate Road ● Pewaukee, WI 53072 ● 262-347-0898 ● 262-347-2256 (Fax)

PSI Information To Build On
Engineering • Consulting • Testing

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



ASTM Classification

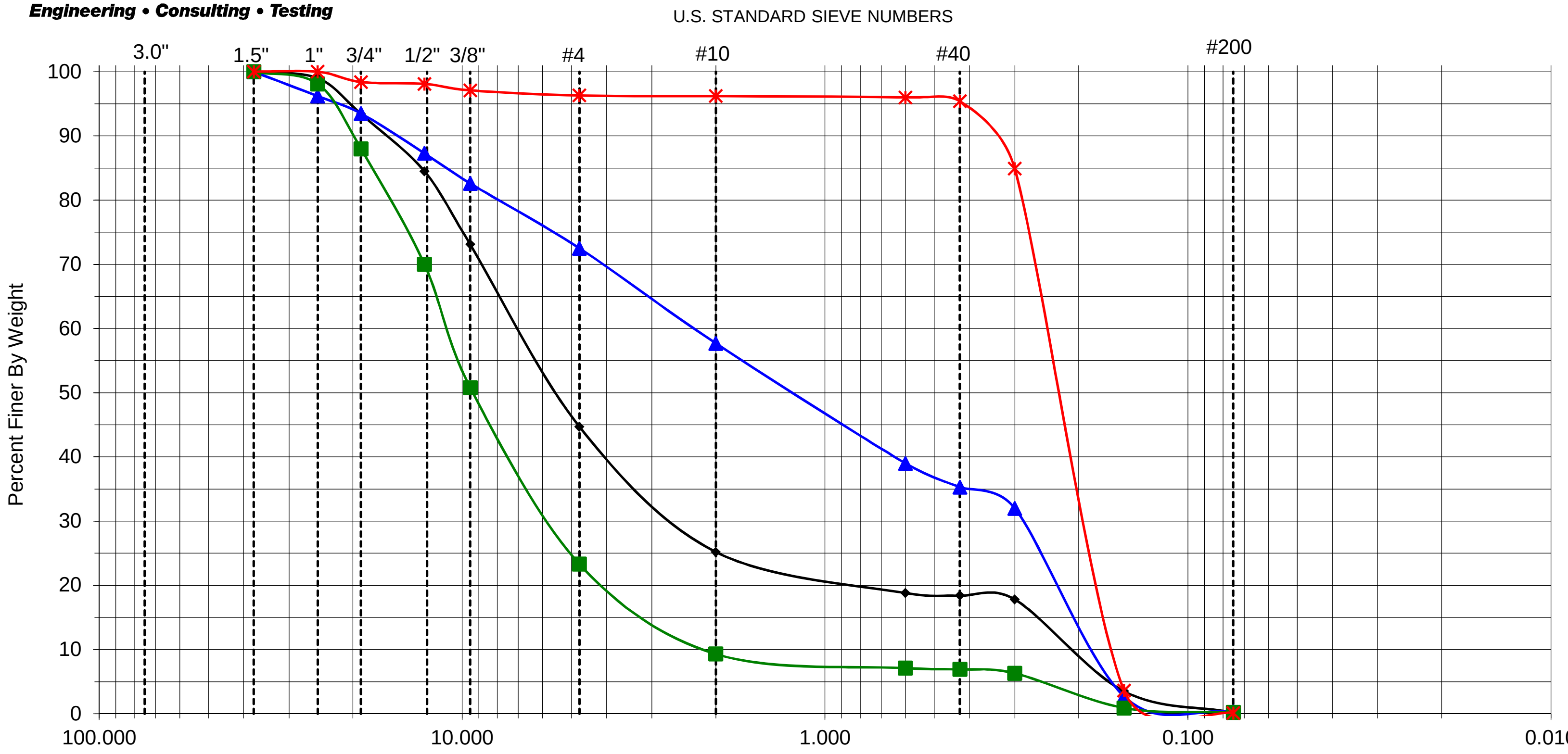
Gravel	Sand	Fines (Silt and Clay)

Key	Project	Sample Number	%Gravel	%Sand	%Fines
◆	South Shore Beach	S-1B	31.8	68.0	0.2
▲	South Shore Beach	S-2B	44.0	55.8	0.2
■	South Shore Beach	S-3B	30.7	69.3	0.1

Himalayan Consultants, LLC	File No.	0052598

Professional Service Industries ● W237 N2878 Woodgate Road ● Pewaukee, WI 53072 ● 262-347-0898 ● 262-347-2256 (Fax)

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



ASTM Classification

Gravel	Sand	Fines (Silt and Clay)

Key	Project	Sample Number	%Gravel	%Sand	%Fines
◆	South Shore Beach	S-1C	55.3	44.5	0.2
▲	South Shore Beach	S-2C	27.5	72.2	0.3
■	South Shore Beach	S-3C	76.7	23.1	0.2
✳	South Shore Beach	S-4	3.7	96.2	0.1

Himalayan Consultants, LLC File No. **0052598**

Professional Service Industries ● W237 N2878 Woodgate Road ● Pewaukee, WI 53072 ● 262-347-0898 ● 262-347-2256 (Fax)

PSI Information To Build On
Engineering • Consulting • Testing

CHAIN OF CUSTODY RECORD

PROJECT NAME	REPORT TO	INVOICE TO
South Shore Beach	Matt Hilse	Same
PROJECT NUMBER: 12021.018	PROJECT MANAGER: Matt Hilse	ADDRESS
P.O. NUMBER	ADDRESS: W156 N11357 Pilgrim Road	CITY / STATE / ZIP
REQUIRED DUE DATE (MM-DD-YY)	CITY / STATE / ZIP: Germantown, WI 53022	ATTENTION
SAMPLES TO LAB VIA	TELEPHONE 262-502-0066 FAX	TELEPHONE
NUMBER OF COOLERS/PACKAGES	REPORT DATA VIA ☐ VERBAL ☒ EMAIL* ☐ FAX ☐ U.S. MAIL	

LABORATORY SUBMITTED TO:

☐ 850 Poplar Street
Pittsburgh, PA 15220
412/922-4000

☒ OTHER Pewaukee

RELINQUISHED BY DATE / TIME	ACCEPTED BY DATE / TIME	SEAL NUMBER
Matt Hilse 8/8/12 7:15	Cindy Kittson 8/8/12 7:15	

LABORATORY USE ONLY

FIELD SERVICES Y/N $

SHIPPING Y/N $

LABORATORY USE ONLY

ANALYTICAL DUE DATE	
REPORT DUE DATE	
PSI PROJECT NAME	
PSI PROJECT NUMBER	
PSI BATCH NUMBER	

LABORATORY USE ONLY

SAMPLE CUSTODIAN	DATE / TIME

PARAMETER LIST

SAMPLE IDENTIFICATION	DATE / TIME	AIR-A BULK-B DUST-D NOB-N PAINT-P / SOIL-S VACUUM-V WASTE-X WATER-W WIPE-WP	LAB USE ONLY LAB NUMBER	NUMBER OF CONTAINERS	Grain Size ASTM D-421
S-1 A	8/2/12	Soil			X
S-1 B	↓	↓			↓
S-1 C	↓	↓			↓
S-2 A	↓	↓			↓
S-2 B	↓	↓			↓
S-2 C	↓	↓			↓
S-4	8/6/12	↓			
S-3 A	8/8/12	Soil			X
B	↓	↓			
C	↓	↓			

ADDITIONAL REMARKS

*EMAIL ADDRESS mhilse@himalayanllc.com SAMPLER'S SIGNATURE [signature]

PSI A-600-10 (7)

Your signature denotes agreement with the PSI General Conditions which are printed on the back side of this document.

APPENDIX B

MILWAUKEE COUNTY GEOTECHNICAL RESULTS

Fw: NLS Project Completed: 182179 Sediment Sampling - South Shore -- NORTHERN LAKE SERVICE, INC.
Karl.Stave
to:
byahr
09/05/2012 03:05 PM
Hide Details
From: Karl.Stave@milwcnty.com
To: byahr@baird.com,

4 Attachments

Final182179.pdf Final_tmplt_HYDROMETER.pdf Final_tmplt_PCBS.pdf COC_OA_182179.pdf

Ben,

Attached is information from the soil sample taken from the sand bar that has formed inside the breakwater near the yacht club. We took the sample to understand whether there is contamination present and provide some understanding of the material for consideration of utilizing the material to create the relocated south shore beach.

Thanks,
Karl

----- Forwarded by Karl Stave/DPW/Milwaukee County on 09/05/2012 03:03 PM -----

From: Tim Detzer/DPW/Milwaukee County
To: Karl Stave/DPW/Milwaukee County@milwco
Cc: Stevan Keith
Date: 09/05/2012 01:53 PM
Subject: Fw: NLS Project Completed: 182179 Sediment Sampling - South Shore -- NORTHERN LAKE SERVICE, INC.

Karl,

Attached are the results for the South Shore sediment sample.

For the grain size analyses, the results are shown on two different pages. On the sheet with the metals it shows the result of a sieve test; 76.3 percent passed a 75um sieve. The hydrometer test then further determines the constituents of the sample. Water and other liquids are added to the sediment and the constituents can then be determined by how the different materials settle out. In this case it was all sand.

I've left a message with the WDNR for he beach nourishment questions.

Tim Detzer, P.E.
Environmental Engineer
Milwaukee County DTPW-Environmental Services
2711 West Wells Street #213
Milwaukee, WI 53208
(414) 278-2988
Fax (414) 223-1853

Please print only if necessary.

----- Forwarded by Tim Detzer/DPW/Milwaukee County on 09/05/2012 01:47 PM -----

From: "Client Services at Northern Lake Service, Inc" <clientservices@nlslab.com>
To: <tdetzer@milwcnty.com>,
Date: 09/04/2012 04:39 PM
Subject: NLS Project Completed: 182179 Sediment Sampling - South Shore -- NORTHERN LAKE SERVICE, INC.

Attached is the final report from Northern Lake Service for completed project 182179 -- Sediment Sampling - South Shore

If you have any questions regarding this project, please contact Sara Bach (sarab@nlslab.com) at our Waukesha lab or Nicole Noel (nicolen@nlslab.com) at our Crandon lab via email or by phone at (715) 478-2777. Hard copy reports will still be mailed out.

DISCLAIMER:
The information contained in this e-mail may be confidential and is intended solely for the use of the named addressee. Access, copying or re-use of the e-mail or any information contained therein by any other person is not authorized. If you are not the intended recipient please notify us immediately by returning the e-mail to the originator.
You will need Adobe Acrobat Reader to view these files, if you dont have it please download it from their webpage...
http://www.adobe.com/products/acrobat/readstep2.html

****

SAMPLE COLLECTION AND CHAIN OF CUSTODY RECORD

Wisconsin Lab Cert. No. 721026460
WI DATCP 105-000330

NORTHERN LAKE SERVICE, INC.

Analytical Laboratory and Environmental Services

400 North Lake Avenue • Crandon, WI 54520-1298
Tel: (715) 478-2777 • Fax: (715) 478-3060

NO. 146707

CLIENT Milwaukee County	
ADDRESS 2711 W Wells St #213	
CITY Milwaukee STATE WI ZIP 53208	
PROJECT DESCRIPTION / NO. Sediment Sampling - South Shore	QUOTATION NO. 114944
DNR FID #	DNR LICENSE #
CONTACT Tim Detzer	PHONE 414-278-2988
PURCHASE ORDER NO.	FAX 414-223-1853

MATRIX:
SW = surface water
WW = waste water
GW = groundwater
DW = drinking water
TIS = tissue
AIR = air
SOIL = soil
SED = sediment
PROD = product
SL = sludge
OTHER

USE BOXES BELOW: Indicate Y or N if GW Sample is field filtered.
Indicate G or C if WW Sample is Grab or Composite.

PARAMETER

ITEM NO.	NLS LAB. NO.	SAMPLE ID	COLLECTION DATE	COLLECTION TIME	MATRIX (See above)	ANALYZE PER ORDER OF ANALYSIS	Sieve test	RCRA metals	mercury									COLLECTION REMARKS (i.e. DNR Well ID #)
1.		sed-s shore - 1	7-27-12	10:30 AM	SED		X	X	X									
2.																		
3.																		
4.																		
5.																		
6.																		
7.																		
8.																		
9.																		
10.																		

ONE SAMPLE PER LINE

COLLECTED BY (signature) Tim Detzer	CUSTODY SEAL NO. (IF ANY)	DATE/TIME 7-27-12 11:15 AM
RELINQUISHED BY (signature)	RECEIVED BY (signature) [signature]	DATE/TIME 7-27-12 1140
DISPATCHED BY (signature)	METHOD OF TRANSPORT	DATE/TIME

RECEIVED AT NLS BY (signature) [signature]	DATE/TIME 7-27-12 1245	CONDITION	TEMP.
COOLER #	REMARKS & OTHER INFORMATION do not do semivolatiles		
	WDNR FACILITY NUMBER	E-MAIL ADDRESS	

REPORT TO

INVOICE TO

PRESERVATIVE:
NP = no preservative
S = sulfuric acid
N = nitric acid
Z = zinc acetate
M = methanol
OH = sodium hydroxide
HA = hydrochloric & ascorbic acid
H = hydrochloric acid

IMPORTANT:
1. TO MEET REGULATORY REQUIREMENTS, THIS FORM **MUST** BE COMPLETED IN DETAIL AND INCLUDED IN THE COOLER CONTAINING THE SAMPLES DESCRIBED.
2. PLEASE USE ONE LINE PER SAMPLE, **NOT** PER BOTTLE.
3. RETURN THIS FORM WITH SAMPLES - CLIENT MAY KEEP PINK COPY.
4. PARTIES COLLECTING SAMPLE, LISTED AS **REPORT TO** AND LISTED AS **INVOICE TO** AGREE TO STANDARD TERMS & CONDITIONS ON REVERSE.

ANALYTICAL RESULTS: Hydrometer

Customer: Milwaukee County Dept Public Works NLS Project: 182179

Project Description: Sediment Sampling - South Shore

Project Title: Template: HYDROMETER Printed: 09/04/2012 15:59

Sample: 675346 SED-S Shore - 1 Collected: 07/27/12 Analyzed: 08/13/12 -

ANALYTE NAME	RESULT	UNITS	WWB	DIL	LOD	LOQ	Note
Percent Clay	0.00	%		1			
Percent Sand	100.00	%		1			
Percent Silt	0.00	%		1			

ANALYTICAL RESULTS: PCBs by Method EPA 8082

Customer: Milwaukee County Dept Public Works   NLS Project: 182179
Project Description: Sediment Sampling - South Shore
Project Title: Template: PCBS   Printed: 09/04/2012 15:59

Sample: 675346   SED-S Shore - 1   Collected: 07/27/12   Analyzed: 08/20/12 - 75.6%Solids

ANALYTE NAME	RESULT	UNITS DWB	DIL	LOD	LOQ	Note
PCB-1016	ND	ug/Kg	1	6.4	22	
PCB-1221	ND	ug/Kg	1	9.0	30	
PCB-1232	ND	ug/Kg	1	6.8	23	
PCB-1242	ND	ug/Kg	1	5.8	19	
PCB-1248	33	ug/Kg	1	8.5	28	
PCB-1254	ND	ug/Kg	1	6.2	21	
PCB-1260	ND	ug/Kg	1	6.4	21	
Total PCBs	33	ug/Kg	1	6.4	22	
TCMX (SURR)	28%					S

NOTES APPLICABLE TO THIS ANALYSIS:

S = This compound is a surrogate used to evaluate the quality control of a method.
CL = The extract was subjected to florisil and sulfur cleanup before analysis.

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105-330
EPA Laboratory ID No. WI00034

Client: **Milwaukee County Dept Public Works**
Attn: Tim Detzer
Environmental Svcs Div #215
2711 West Wells Street
Milwaukee, WI 53208

NLS Project: 182179
NLS Customer: 95190
Fax: 414 223 1853 Phone: 414 278 4355

Project: Sediment Sampling - South Shore

SED-S Shore - 1 NLS ID: 675346
COC: 146707:1 Matrix: MS
Collected: 07/27/12 10:30 Received: 07/31/12

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Arsenic, tot. recoverable as As by ICP	2.2	mg/Kg DWB	5	0.46	1.6	08/16/12	SW846 6010	721026460
Barium, tot. recoverable as Ba by ICP	10	mg/Kg DWB	5	0.34*	0.68*	08/16/12	SW846 6010	721026460
Cadmium, tot. recoverable as Cd by ICP	0.15	mg/Kg DWB	5	0.016	0.060	08/16/12	SW846 6010	721026460
Chromium, tot. recoverable as Cr by ICP	6.0	mg/Kg DWB	5	0.092	0.27	08/16/12	SW846 6010	721026460
Lead, tot. recoverable as Pb by ICP	6.5	mg/Kg DWB	5	0.19	0.68	08/16/12	SW846 6010	721026460
Mercury, total as Hg on solids	[0.015]	mg/Kg DWB	1	0.014	0.047	08/01/12	SW846 7470A	721026460
Selenium, tot. recoverable as Se by ICP	ND	mg/Kg DWB	5	1.1	4.0	08/16/12	SW846 6010	721026460
Silver, tot. recoverable as Ag by ICP	ND	mg/Kg DWB	5	0.038	0.12	08/16/12	SW846 6010	721026460
Solids, total on solids	75.6	%	1	0.10*		08/01/12	SM 2540-G 20ed	721026460
Metals digestion - tot. recov (solid) ICP	yes					08/14/12	SW846 3050M	721026460
Sieve test	76.3	% > 75um	1			08/13/12	ASTM D422-63	721026460
Hydrometer	see attached					08/13/12	ASTM D422-63	721026460
PCBs (solid) by SW846 8082	see attached					08/20/12	SW846 8082	721026460
Organics Extraction (Soil) for Organochlorine Pesticides/PCBs	yes					08/01/12	SW846 3546M	721026460

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution.

LOD = Limit of Detection LOQ = Limit of Quantitation ND = Not Detected (< LOD) 1000 ug/L = 1 mg/L
DWB = Dry Weight Basis NA = Not Applicable %DWB = (mg/kg DWB) / 10000
MCL = Maximum Contaminant Levels for Drinking Water Samples. Shaded results indicate >MCL.

Reviewed by:

Authorized by:
R. T. Krueger
President

APPENDIX C

CONCEPTUAL ALTERNATIVES

South Shore Beach Relocation Study
Existing Conditions

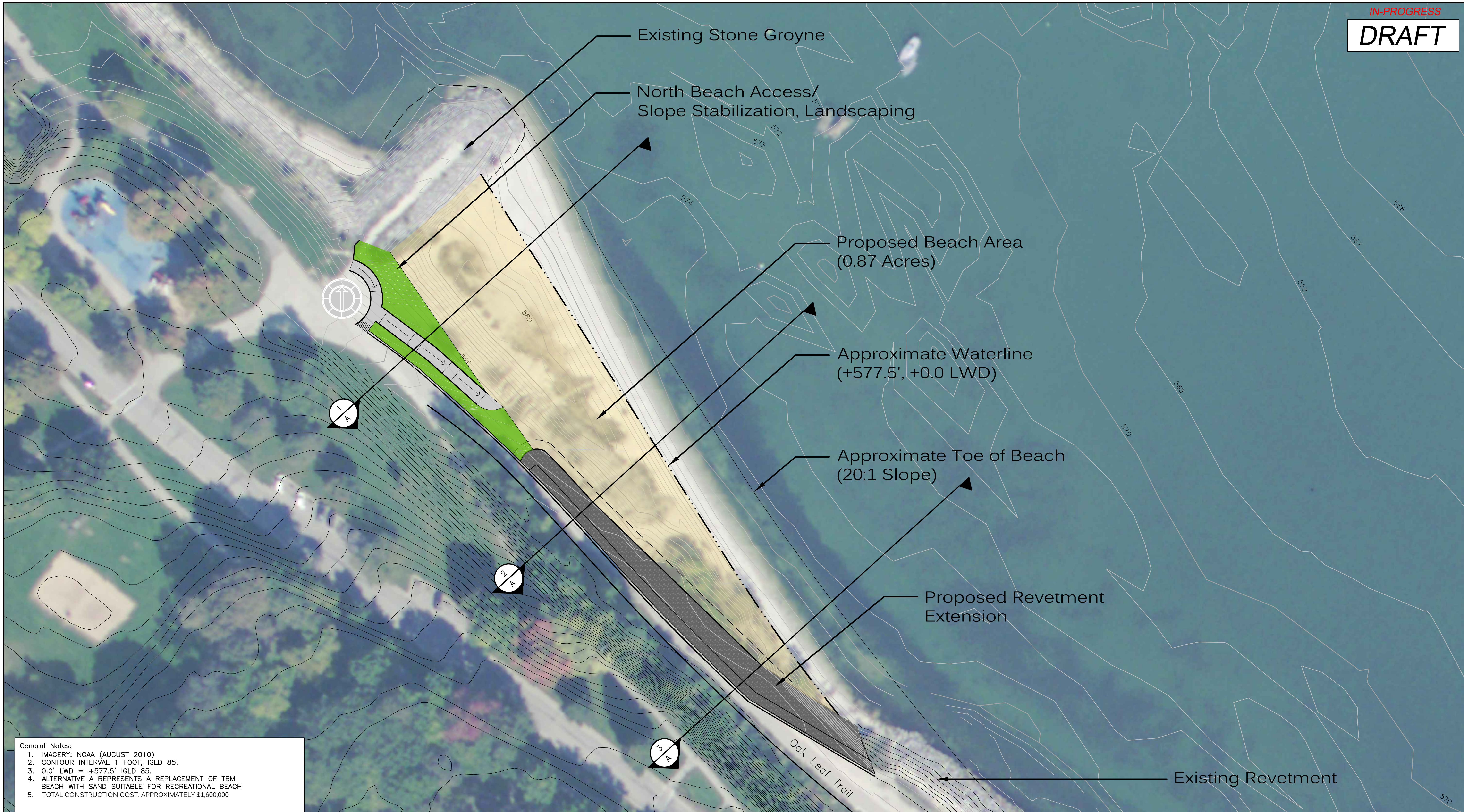
Baird

AERIAL: NAIP 2010
CONTOUR INTERVAL: 1ft, IGLD 85

0 50 100 200ft
GRAPHIC SCALE

South Shore Beach Relocation Study
Existing Conditions

Baird



General Notes:

1. IMAGERY: NOAA (AUGUST 2010)
2. CONTOUR INTERVAL 1 FOOT, IGLD 85.
3. 0.0' LWD = +577.5' IGLD 85.
4. ALTERNATIVE A REPRESENTS A REPLACEMENT OF TBM BEACH WITH SAND SUITABLE FOR RECREATIONAL BEACH
5. TOTAL CONSTRUCTION COST: APPROXIMATELY $1,600,000

NORTH

0 20 40 80ft.
GRAPHIC SCALE – FEET

SOUTH SHORE BEACH RELOCATION STUDY
Alternative A Plan

SOUTH SHORE BEACH RELOCATION STUDY

Figure Number:	Project Number:
11991-CD-01	11991.100
Description:	**Date:**
ALTERNATIVE A - LAYOUT	03/20/2012

Baird

P:\11991.100 SOUTH SHORE BEACH RELOCATION STUDY\H – CADD\WORKING DRAWINGS\01\DWG\2013-03-18 SOUTH SHORE BEACH ALT A.DWG

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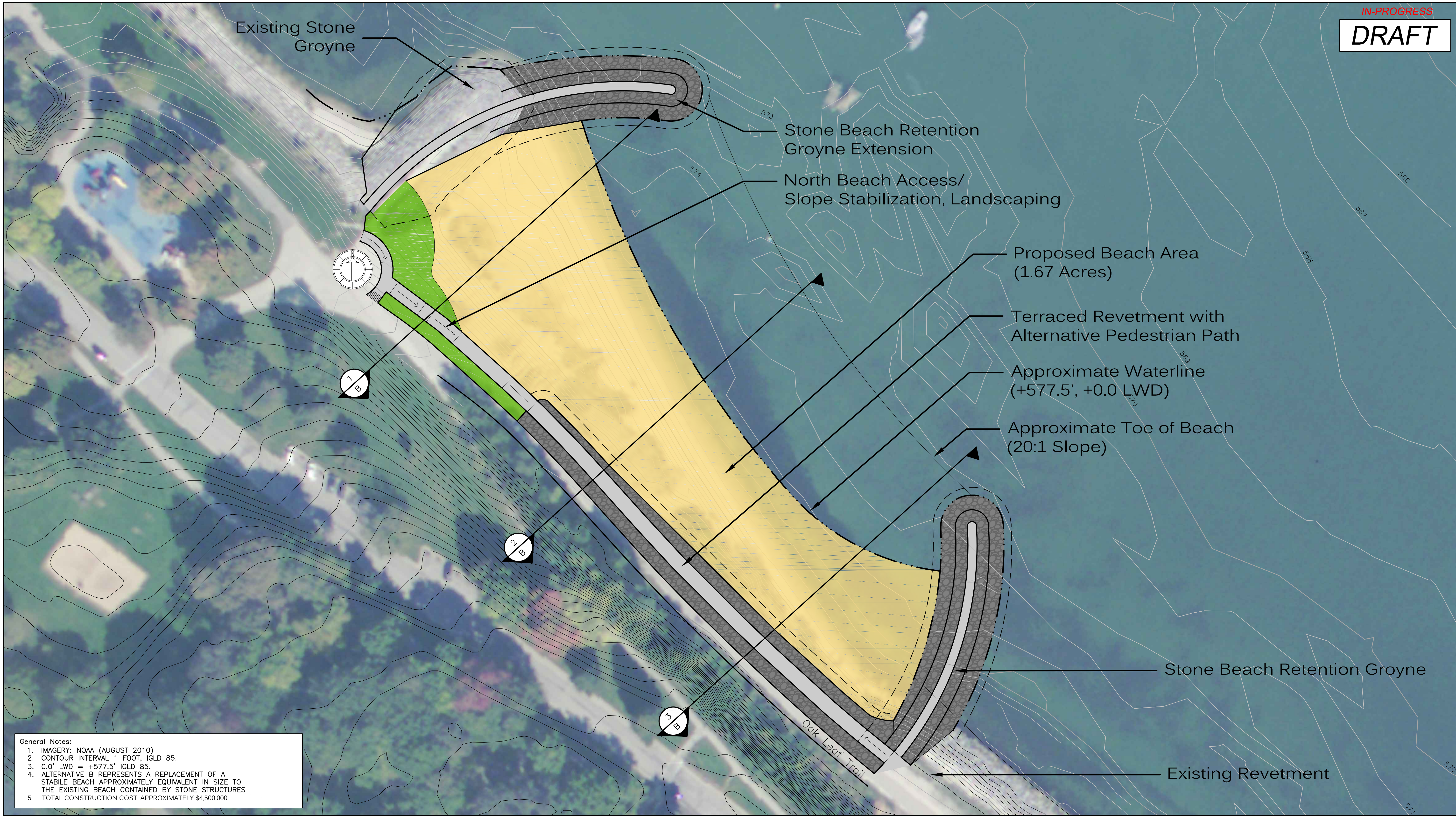

General Notes:

1. IMAGERY: NOAA (AUGUST 2010)
2. CONTOUR INTERVAL 1 FOOT, IGLD 85.
3. 0.0' LWD = +577.5' IGLD 85.
4. ALTERNATIVE B REPRESENTS A REPLACEMENT OF A STABILE BEACH APPROXIMATELY EQUIVALENT IN SIZE TO THE EXISTING BEACH CONTAINED BY STONE STRUCTURES
5. TOTAL CONSTRUCTION COST: APPROXIMATELY $4,500,000

NORTH

0 20 40 80ft.
GRAPHIC SCALE – FEET

SOUTH SHORE BEACH RELOCATION STUDY
Alternative B Plan

SOUTH SHORE BEACH RELOCATION STUDY	
Figure Number: 11991-CD-02	Project Number: 11991.100
Description: ALTERNATIVE B - LAYOUT	Date: 03/20/2012

Baird

P:\11991.100 SOUTH SHORE BEACH RELOCATION STUDY\H – CADD\WORKING DRAWINGS\01\DWG\2013-03-18 SOUTH SHORE BEACH ALT B.DWG

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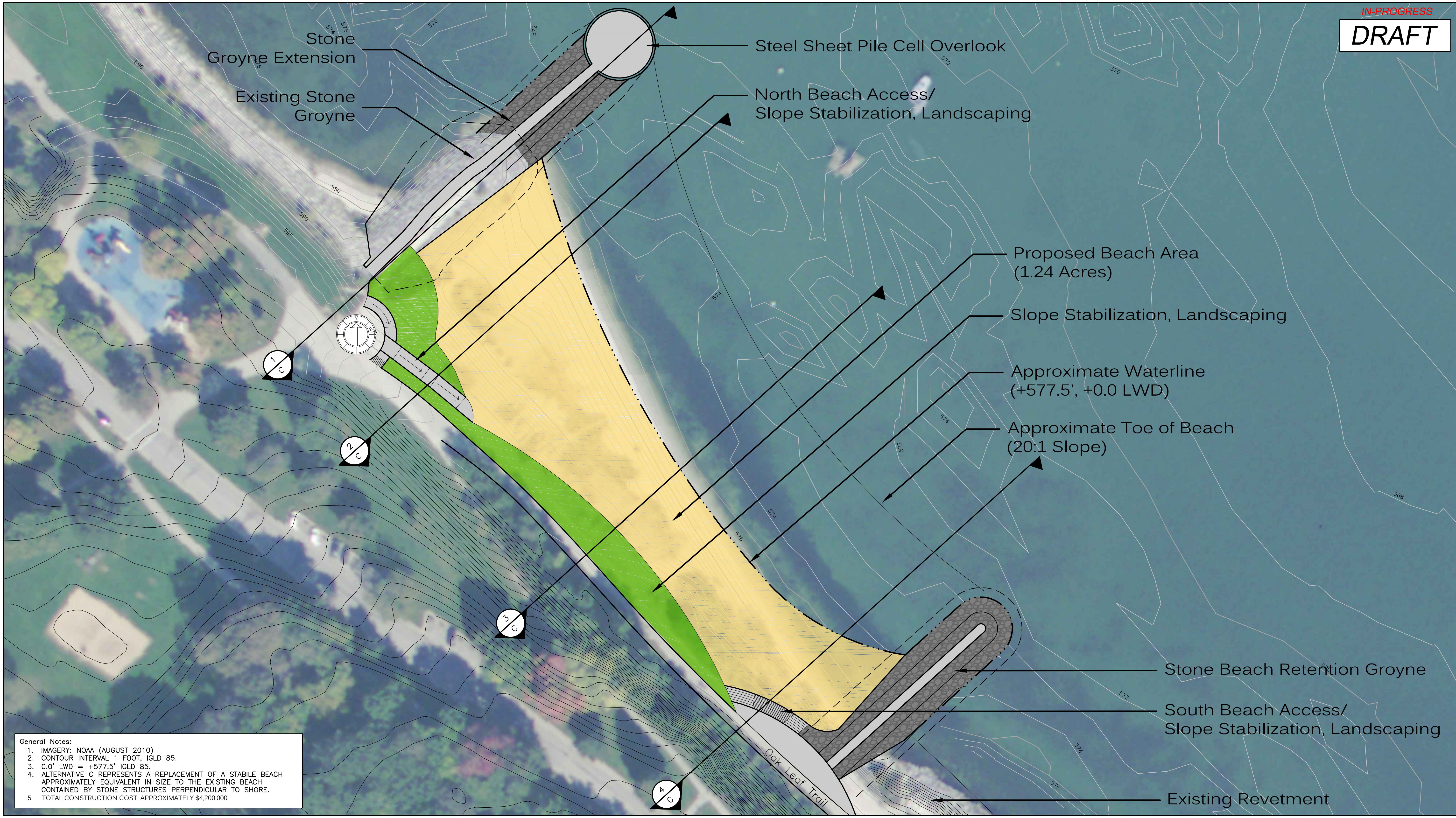


General Notes:

1. IMAGERY: NOAA (AUGUST 2010)
2. CONTOUR INTERVAL 1 FOOT, IGLD 85.
3. 0.0' LWD = +577.5' IGLD 85.
4. ALTERNATIVE C REPRESENTS A REPLACEMENT OF A STABILE BEACH APPROXIMATELY EQUIVALENT IN SIZE TO THE EXISTING BEACH CONTAINED BY STONE STRUCTURES PERPENDICULAR TO SHORE.
5. TOTAL CONSTRUCTION COST: APPROXIMATELY $4,200,000

NORTH

0 20 40 80ft.

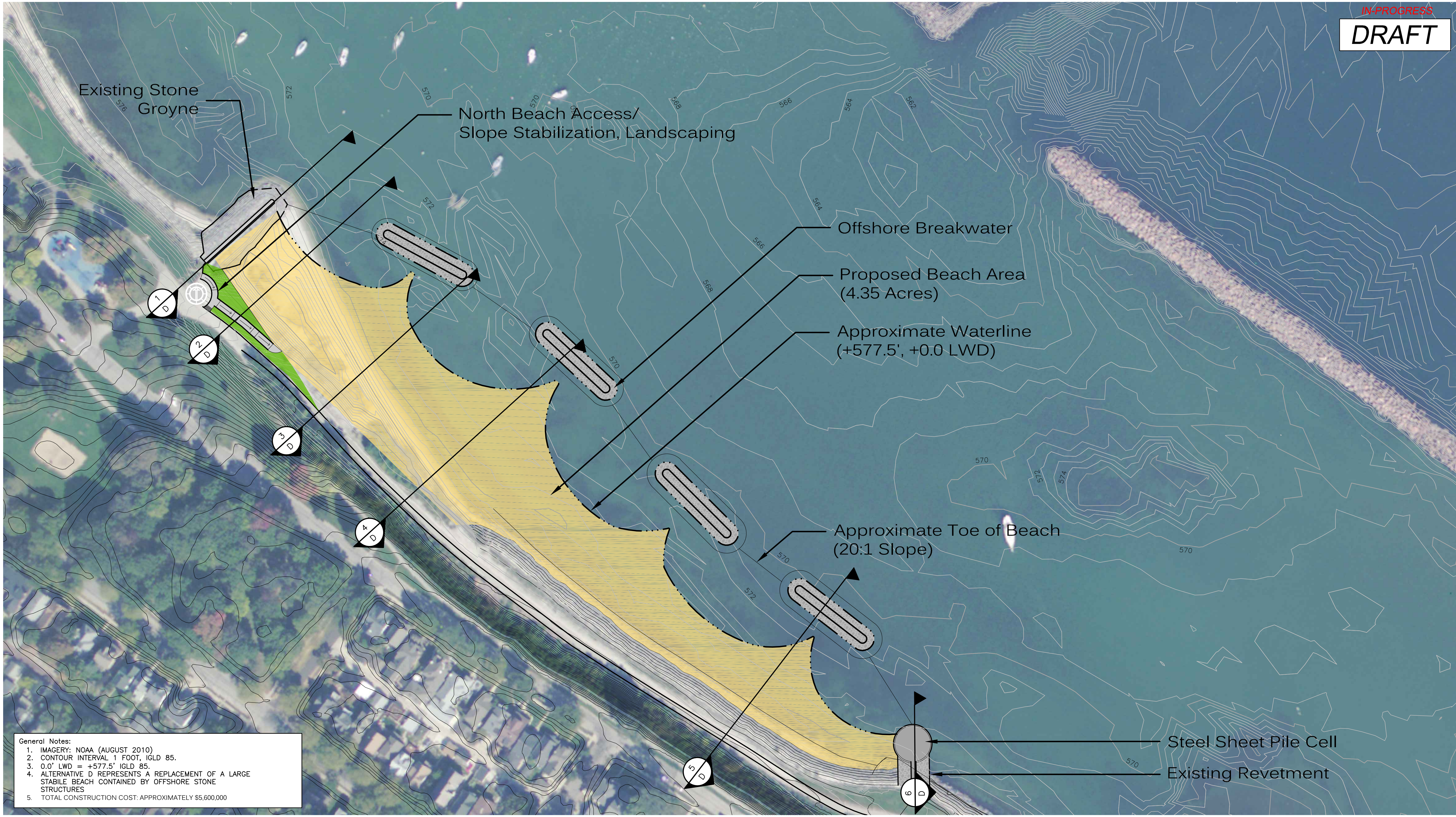
GRAPHIC SCALE – FEET

SOUTH SHORE BEACH RELOCATION STUDY
Alternative C Plan

SOUTH SHORE BEACH RELOCATION STUDY		
Figure Number: 11991-CD-03	Project Number: 11991.100	Baird
Description: ALTERNATIVE C - LAYOUT	Date: 03/20/2012	

P:\11991.100 SOUTH SHORE BEACH RELOCATION STUDY\H – CADD\WORKING DRAWINGS\01\DWG\2013-03-18 SOUTH SHORE BEACH ALT C.DWG

Date Plotted: 3/18/2013 11:05:21 AM



General Notes:

1. IMAGERY: NOAA (AUGUST 2010)
2. CONTOUR INTERVAL 1 FOOT, IGLD 85.
3. 0.0' LWD = +577.5' IGLD 85.
4. ALTERNATIVE D REPRESENTS A REPLACEMENT OF A LARGE STABILE BEACH CONTAINED BY OFFSHORE STONE STRUCTURES
5. TOTAL CONSTRUCTION COST: APPROXIMATELY $5,600,000

NORTH

0 37.5 75 150ft.
GRAPHIC SCALE – FEET

SOUTH SHORE BEACH RELOCATION STUDY
Alternative D Plan

SOUTH SHORE BEACH RELOCATION STUDY

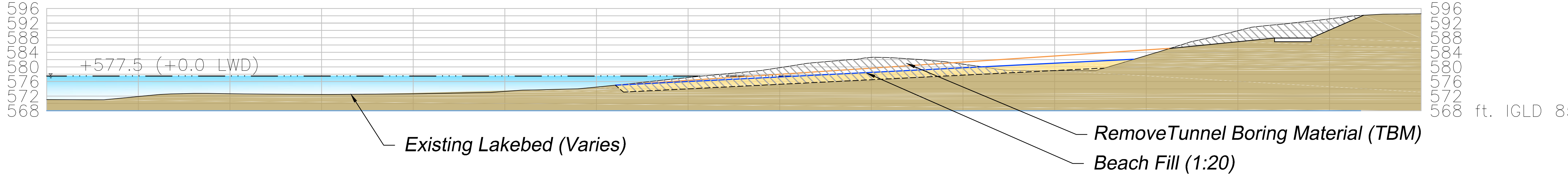
Figure Number:	Project Number:
11991-CD-04	11991.100
Description:	Date:
ALTERNATIVE D - LAYOUT	03/20/2012

Baird

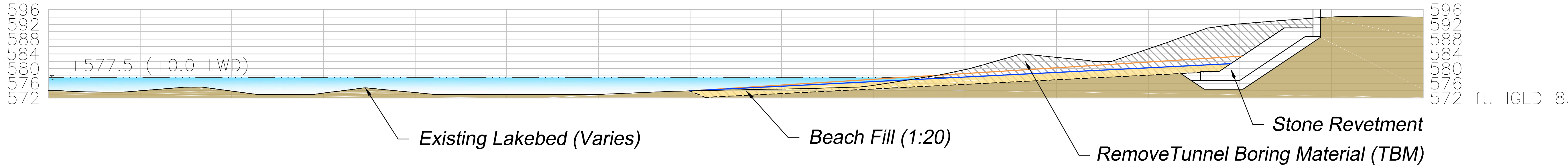
P:\11991.100 SOUTH SHORE BEACH RELOCATION STUDY\H – CADD\WORKING DRAWINGS\01\DWG\2012–08–29 SOUTH SHORE BEACH ALT D.DWG

Date Plotted: 3/18/2013 11:22:31 AM

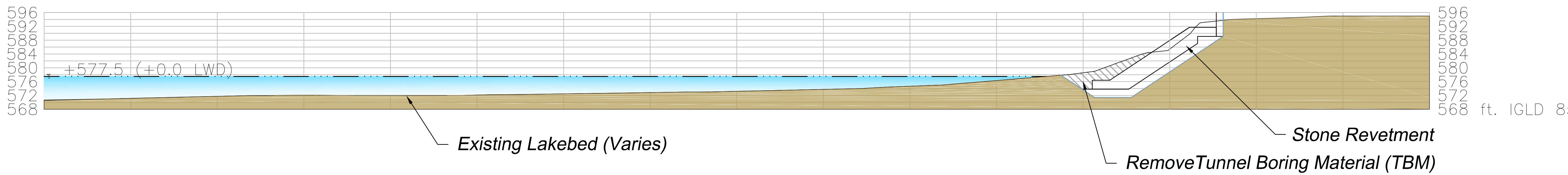
SECTION 1-A: INITIAL BEACH PLACEMENT



SECTION 2-A: INITIAL BEACH PLACEMENT



SECTION 3-A: INITIAL BEACH PLACEMENT



LEGEND

Construction Beach Fill (1:15)
Construction Beach Fill (1:20)

09/05/2012

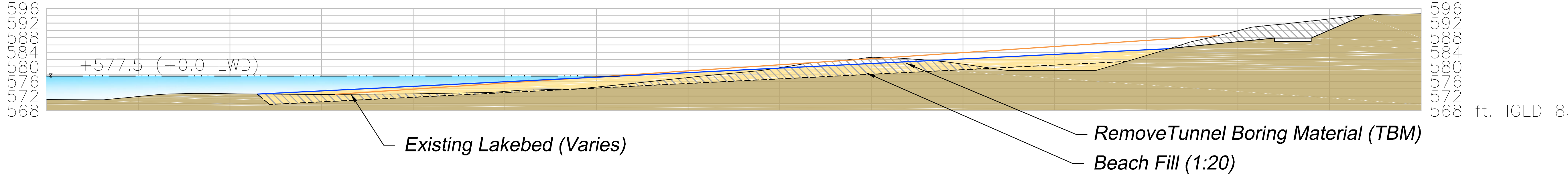
0 12.5 25 50ft

GRAPHIC SCALE

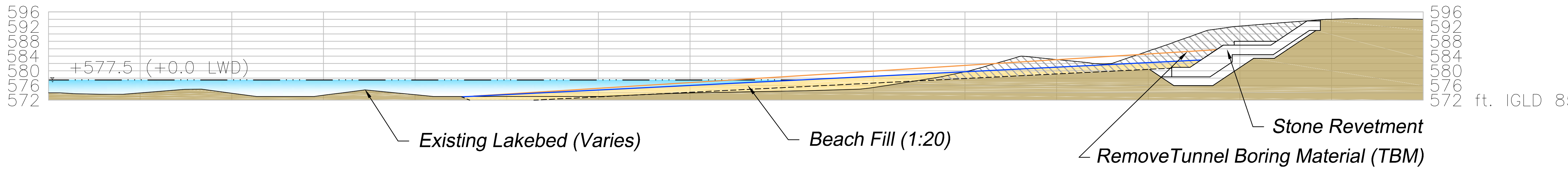
South Shore Beach Relocation Study
Alternative A Cross Sections

Baird

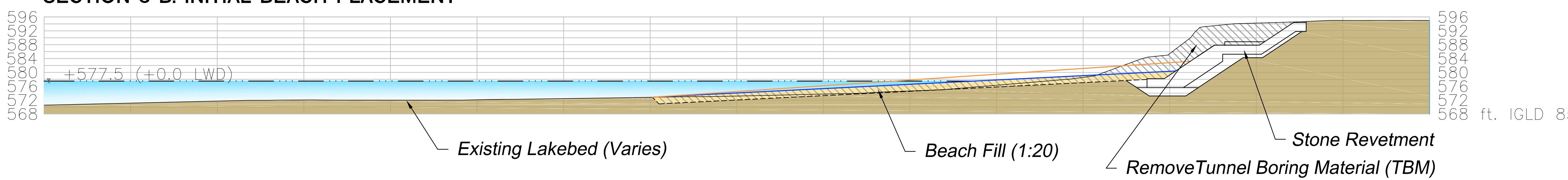
SECTION 1-B: INITIAL BEACH PLACEMENT



SECTION 2-B: INITIAL BEACH PLACEMENT



SECTION 3-B: INITIAL BEACH PLACEMENT



LEGEND

Construction Beach Fill (1:15)

Construction Beach Fill (1:20)

09/05/2012

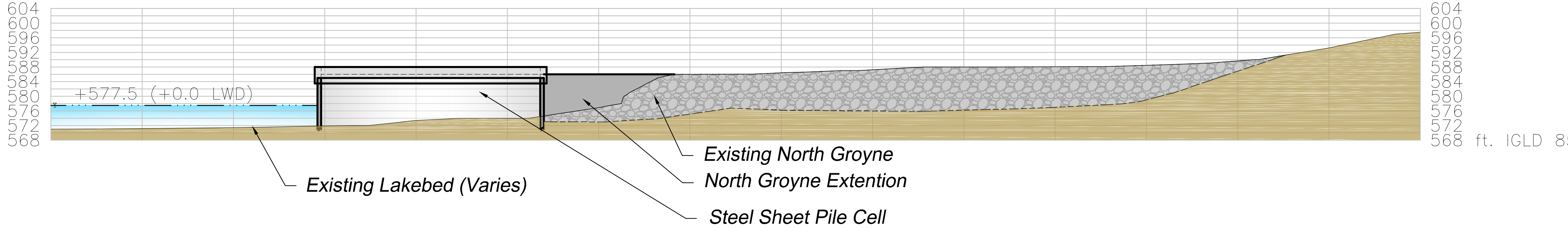
0 12.5 25 50ft

GRAPHIC SCALE

South Shore Beach Relocation Study
Alternative B Cross Sections

Baird

SECTION 1-C: NORTH GROYNE STEEL SHEET PILE CELL



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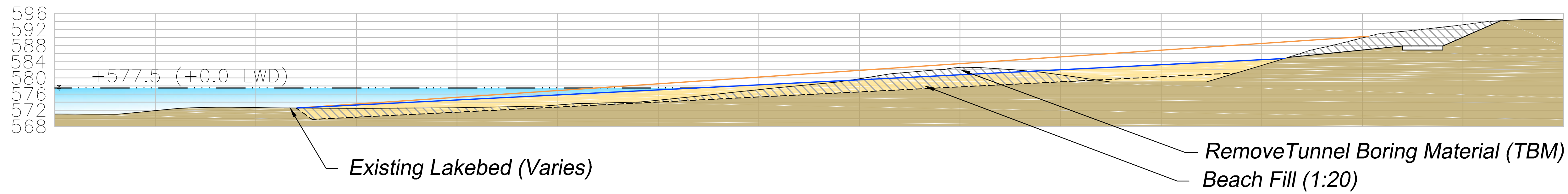
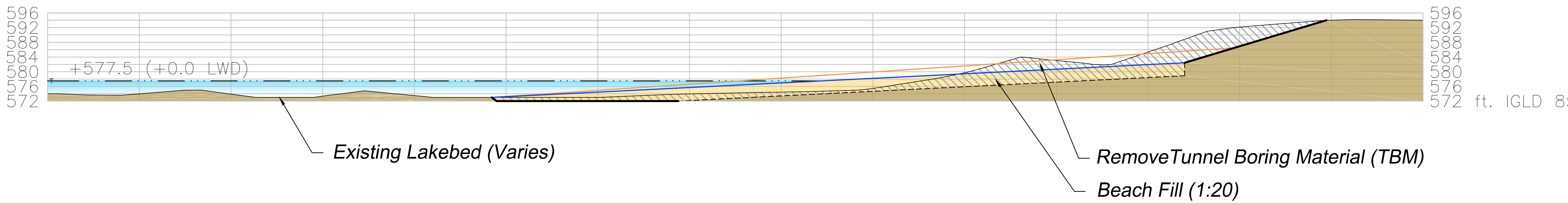
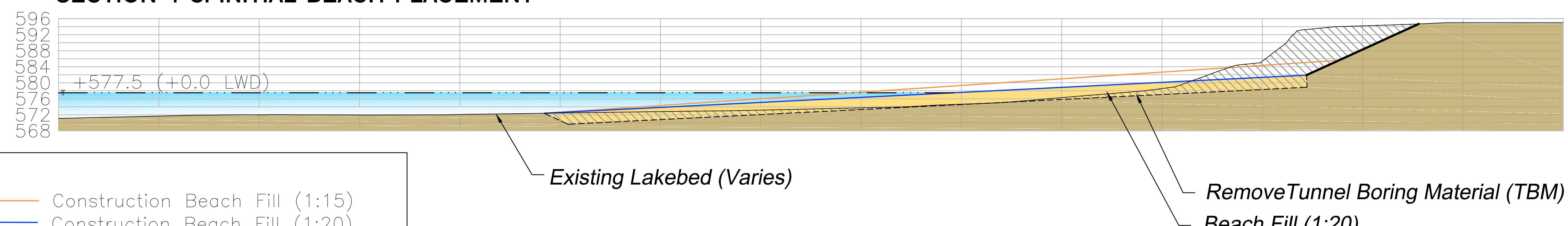


SECTION 3-C: INITIAL BEACH PLACEMENT



SECTION 4-C: INITIAL BEACH PLACEMENT



LEGEND

Construction Beach Fill (1:15)
Construction Beach Fill (1:20)

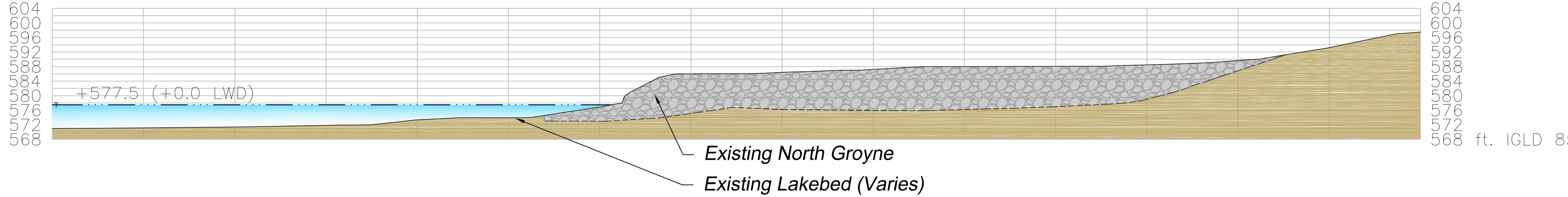
09/05/2012

0 12.5 25 50ft
GRAPHIC SCALE

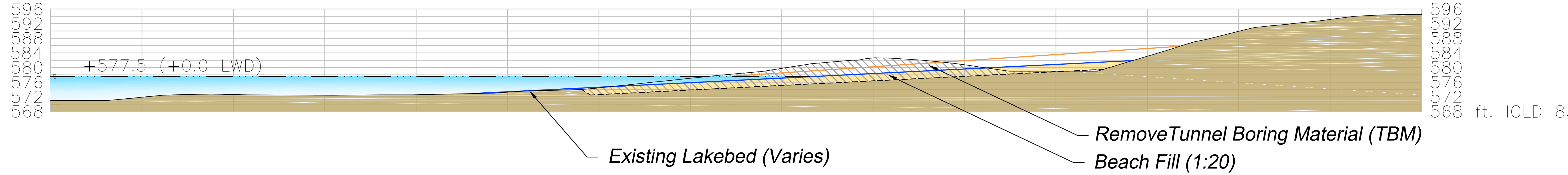
South Shore Beach Relocation Study
Alternative C Cross Sections

Baird

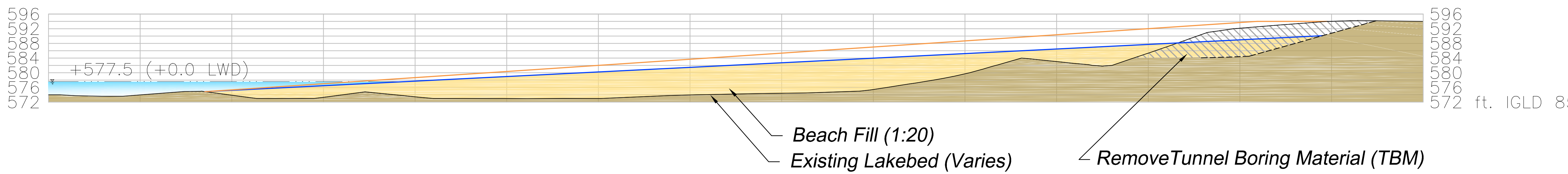
SECTION 1-D: NORTH GROYNE STEEL SHEET PILE CELL



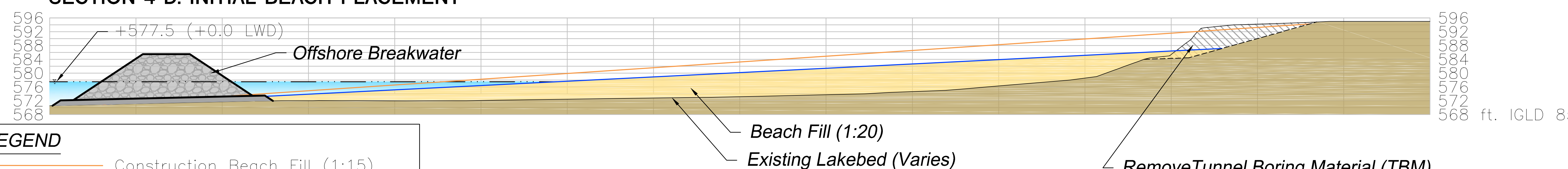
SECTION 2-D: INITIAL BEACH PLACEMENT



SECTION 3-D: INITIAL BEACH PLACEMENT



SECTION 4-D: INITIAL BEACH PLACEMENT



LEGEND

Construction Beach Fill (1:15)
Construction Beach Fill (1:20)

P:\11991.100 SOUTH SHORE BEACH RELOCATION STUDY\H - CADD\WORKING DRAWINGS\01\DWG\PRELIMINARY DESIGN\CURRENT DWG\REPORT FIGURES\2012-08-29 SOUTH SHORE BEACH ALT D.DWG

09/05/2012

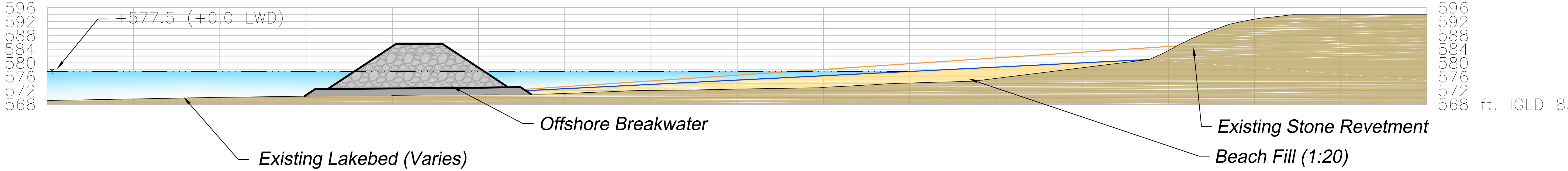
0 12.5 25 50ft

GRAPHIC SCALE

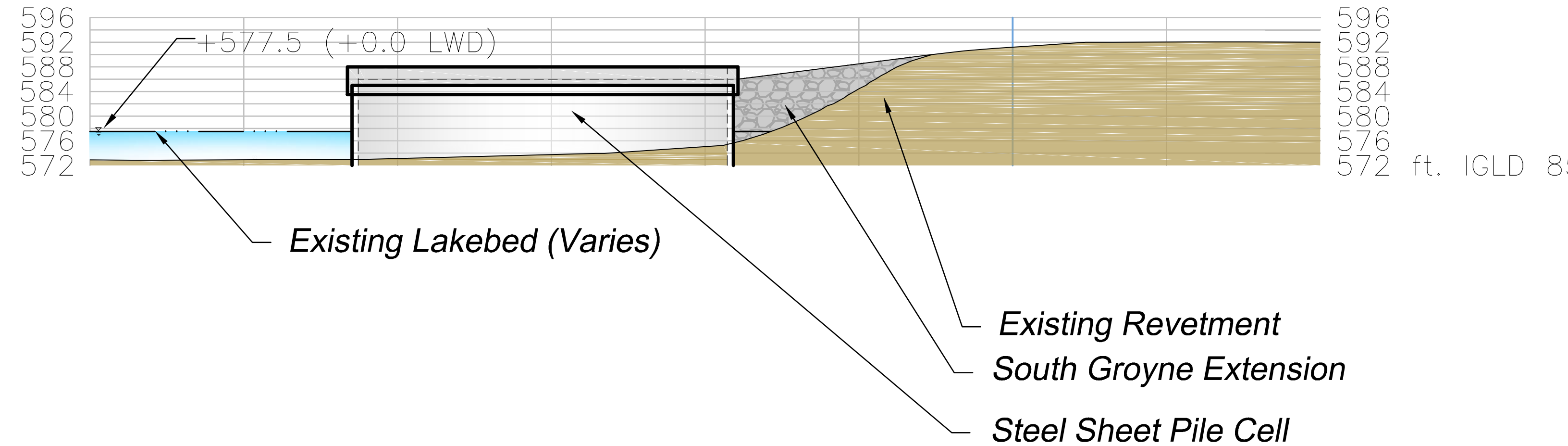
South Shore Beach Relocation Study
Alternative D Cross Sections

Baird

SECTION 5-D INITIAL BEACH PLACEMENT



SECTION 6-D: INITIAL BEACH PLACEMENT



LEGEND

Construction Beach Fill (1:15)
Construction Beach Fill (1:20)

P:\11991.100 SOUTH SHORE BEACH RELOCATION STUDY\H - CADD\WORKING DRAWINGS\01\DWG\PRELIMINARY DESIGN\CURRENT DWG\REPORT FIGURES\2012-08-29 SOUTH SHORE BEACH ALT D.DWG

09/05/2012

0 12.5 25 50ft

GRAPHIC SCALE

South Shore Beach Relocation Study
Alternative D Cross Sections

Baird

General Notes:
1. IMAGERY: NOAA (AUGUST 2010)
2. CONTOUR INTERVAL 1 FOOT, IGLD 85.
3. 0.0' LWD = +577.5' IGLD 85.
4. ALTERNATIVE E REPRESENTS AN ADDITION OF STORMWATER MANAGEMENT FEATURES/BUFFERS ADJACENT TO EXISTING PARKING LOT AND RELOCATING BEACH SLIGHTLY SOUTH ADJACENT TO PAVILION.
5. TOTAL CONSTRUCTION COST: APPROXIMATELY $1,000,000 - $1,500,000

NORTH

0 20 40 80ft.
GRAPHIC SCALE – FEET

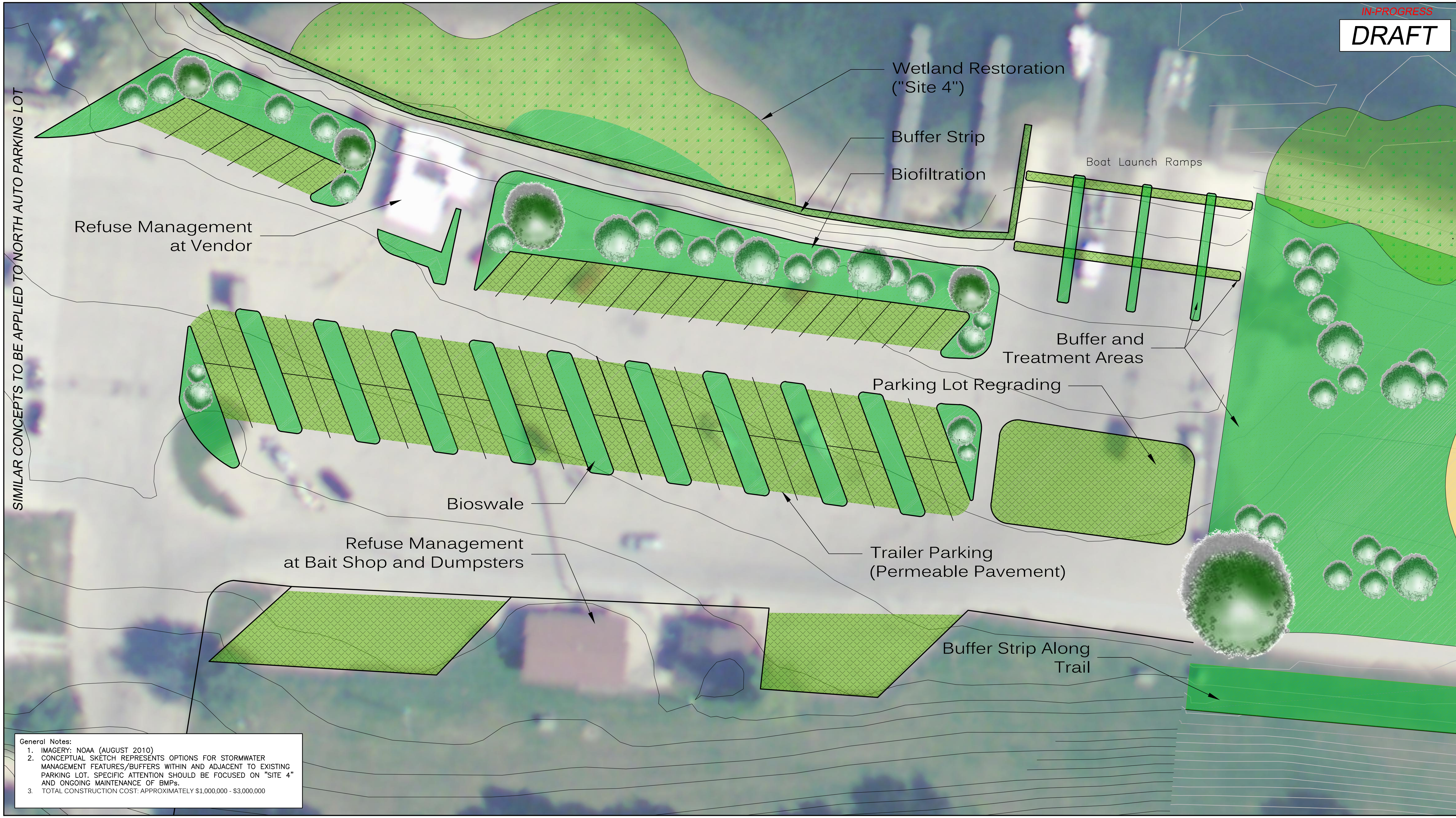
SOUTH SHORE BEACH RELOCATION STUDY
Alternative E Plan

SOUTH SHORE BEACH RELOCATION STUDY	
Figure Number: 11991-CD-05	Project Number: 11991.100
Description: ALTERNATIVE E - LAYOUT	Date: 03/20/2012

Baird

P:\11991.100 SOUTH SHORE BEACH RELOCATION STUDY\H – CADD\WORKING DRAWINGS\01\DWG\2013-03-18 SOUTH SHORE BEACH ALT E.DWG

Date Plotted: 3/18/2013 11:25:20 AM



General Notes:

1. IMAGERY: NOAA (AUGUST 2010)
2. CONCEPTUAL SKETCH REPRESENTS OPTIONS FOR STORMWATER MANAGEMENT FEATURES/BUFFERS WITHIN AND ADJACENT TO EXISTING PARKING LOT. SPECIFIC ATTENTION SHOULD BE FOCUSED ON "SITE 4" AND ONGOING MAINTENANCE OF BMPs.
3. TOTAL CONSTRUCTION COST: APPROXIMATELY $1,000,000 - $3,000,000

NORTH

0 10 20 40ft.
GRAPHIC SCALE – FEET

SOUTH SHORE BEACH RELOCATION STUDY
Parking Lot Concept

SOUTH SHORE BEACH RELOCATION STUDY	
Figure Number: 11991-CD-06	Project Number: 11991.100
Description: CONCEPTUAL PARKING LOT - LAYOUT	Date: 03/020/2012

Baird

Date Plotted: 3/18/2013 3:58:11 PM

APPENDIX D

ITEMIZED STATEMENTS OF COMPARATIVE COST

South Shore Beach Relocation Study

Baird

Itemized Statement of Probable Construction Costs

Project No 11991.100

Conceptual Design Phase

Date: 09/06/2012

Alternative A

DRAFT

Item	Unit	Quantity	Unit Cost	Extension	Sub Total
Mobilization	Allow	1	$75,000	$75,000	$75,000
Beach Fill					
Excavate and Remove Existing TBM Beach	CY	13,000	$15	$195,000	
Initial Beach Fill Placement	CY	9,000	$50	$450,000	$645,000
Land-side Beach Rubblemound Revetment (400 ft)					
Armor Stone	TON	3,500	$70	$245,000	
Filter Stone	TON	2,400	$60	$144,000	
Geotextile Fabric	SY	2,300	$4	$9,200	
Excavation	CY	4,000	$15	$60,000	$458,200
North Beach Access					
Stairs, Ramps, Slope Stabilizaton	Allow	1	$25,000	$25,000	$25,000
				Sub Total	$1,203,200
				Contingency 25%	$300,800
				Total	$1,504,000

Notes:

South Shore Beach Relocation Study

Baird

Itemized Statement of Probable Construction Costs
Conceptual Design Phase
Alternative B

Project No 11991.100
Date: 09/06/2012
DRAFT

Item	Unit	Quantity	Unit Cost	Extension	Sub Total
Mobilization	Allow	1	$175,000	$175,000	$175,000
North Rubblemound Groyne Extention					
Armor Stone	TON	3,400	$70	$238,000	
Filter Stone	TON	2,000	$60	$120,000	
Core Stone	TON	6,200	$50	$310,000	
Concrete (walls and walkway)	CY	180	$400	$72,000	
Excavation	CY	3,800	$30	$114,000	$854,000
South Rubblemound Groyne Extention					
Armor Stone	TON	4,600	$70	$322,000	
Filter Stone	TON	2,700	$60	$162,000	
Core Stone	TON	8,500	$50	$425,000	
Concrete (walls and walkway)	CY	250	$400	$100,000	
Excavation	CY	5,200	$30	$156,000	$1,165,000
Beach Fill					
Excavate and Remove Existing TBM Beach	CY	9,250	$15	$138,750	
Initial Beach Fill Placement	CY	13,800	$50	$690,000	$828,750
Beach Front Path and Shore Protection (500 ft)					
Armor Stone	TON	2,500	$60	$150,000	
Filter Stone	TON	2,400	$50	$120,000	
Geotextile Fabric	SY	2,800	$4	$11,200	
Concrete Path	CY	170	$400	$68,000	
Excavation	CY	3,000	$15	$45,000	$394,200
North Beach Access					
Stairs, Ramps, Slope Stabilizaton	Allow	1	$25,000	$25,000	$25,000
				Sub Total	**$3,441,950**
				Contingency 25%	**$860,488**
				Total	**$4,302,438**

Notes:

South Shore Beach Relocation Study

Baird

Itemized Statement of Comparative Construction Costs
Conceptual Design Phase
Alternative C

Project No 11991.100
Date: 10/12/2012
DRAFT

Item	Unit	Quantity	Unit Cost	Extension	Sub Total
Mobilization	Allow	1	$175,000	$175,000	$175,000
North Rubblemound Groyne Extention					
Armor Stone	TON	2,400	$75	$180,000	
Filter Stone	TON	1,400	$65	$91,000	
Core Stone	TON	4,500	$55	$247,500	
Concrete (walls and walkway)	CY	130	$400	$52,000	
Excavation	CY	2,700	$30	$81,000	$651,500
Steel Sheet Pile Cell					
60' Steel Sheet Pile Cell with Concrete Cap	Allow	1	$700,000	$700,000	$700,000
South Rubblemound Groyne Extention					
Armor Stone	TON	3,800	$75	$285,000	
Filter Stone	TON	2,300	$65	$149,500	
Core Stone	TON	7,100	$55	$390,500	
Concrete (walls and walkway)	CY	207	$400	$82,800	
Excavation	CY	4,300	$30	$129,000	$1,036,800
Beach Fill					
Excavate and Remove Existing TBM Beach	CY	9,900	$15	$148,500	
Initial Beach Fill Placement	CY	12,600	$50	$630,000	$778,500
South Beach Access					
Slope Stabilization	SY	1,000	$8	$8,000	
South Beach Entrance	Allow	1	$20,000	$20,000	$28,000
North Beach Access					
Stairs, Ramps, Slope Stabilizaton	Allow	1	$40,000	$40,000	$40,000
				Sub Total	$3,409,800
				Contingency 25%	$852,450
				Total	$4,262,250

South Shore Beach Relocation Study

Baird

Itemized Statement of Probable Construction Costs — **Project No 11991.100**
Conceptual Design Phase — Date: 09/06/2012
Alternative D — **DRAFT**

Item	Unit	Quantity	Unit Cost	Extension	Sub Total
Mobilization	Allow	1	$250,000	$250,000	$250,000
Offshore Breakwaters (4)					
Armor Stone	TON	3,400	$70	$238,000	
Filter Stone	TON	900	$60	$54,000	
Core Stone	TON	800	$50	$40,000	
			(each)	$332,000	$1,328,000
South Rubblemound Groyne Extention					
Armor Stone	TON	190	$70	$13,300	
Filter Stone	TON	115	$60	$6,900	
Core Stone	TON	355	$50	$17,750	
Concrete (walls and walkway)	CY	10	$400	$4,000	
Excavation	CY	215	$30	$6,450	$48,400
South Steel Sheet Pile Cell					
60' Steel Sheet Pile Cell with Concrete Cap	Allow	1	$700,000	$700,000	$700,000
Beach Fill					
Excavate and Remove Existing TBM Beach	CY	5,500	$15	$82,500	
Initial Beach Fill Placement	CY	33,300	$50	$1,665,000	$1,747,500
North Beach Access					
Stairs, Ramps, Slope Stabilizaton	Allow	1	$30,000	$30,000	$30,000
				Sub Total	$4,103,900
				Contingency 25%	$1,025,975
				Total	$5,129,875

Notes:

South Shore Beach Relocation Study

Baird

Itemized Statement of Comparative Construction Costs
Conceptual Design Phase
Alternative E

Project No 11991.100
Date: 3/15/2015
DRAFT

Item	Unit	Quantity	Unit Cost	Extension	Sub Total
Mobilization	Allow	1	$70,000	$70,000	$70,000
North Rubblemound Groyne Extention					
Salvaged Armor Stone	TON	2,000	$40	$80,000	
Salvaged Filter Stone	TON	1,000	$20	$20,000	
Excavation and remove existing revetment	CY	3,000	$30	$90,000	$190,000
Beach Fill					
Initial Beach Fill Placement	CY	5,000	$50	$250,000	$250,000
Wetland Buffer					
Vegetation, stormwater management buffer	SF	30,000	$15	$450,000	$450,000
Beach Access					
Stairs, Ramps	Allow	1	$40,000	$40,000	$40,000
				Sub Total	$1,000,000
				Contingency 25%	$250,000
				Total	$1,250,000

South Shore Beach Relocation Study

Baird

Itemized Statement of Comparative Construction Costs — Project No 11991.100
Conceptual Design Phase — Date: 3/15/2015
Parking Lot Sketch - Includes All 4 Acres — DRAFT

Item	Unit	Quantity	Unit Cost	Extension	Sub Total
Mobilization	Allow	1	$115,000	$115,000	$115,000
Site 4 Restoration and Revegetation					
Vegetation, stormwater management	SF	20,000	$15	$300,000	$300,000
Parking Lot					
Permeable pavers, vegetative swales	SF	175,000	$10	$1,750,000	$1,750,000
				Sub Total	$2,165,000
				Contingency 25%	$541,250
				Total	$2,706,250

APPENDIX E

USGBC LEED SCORECARD

LEED for New Construction and Major Renovations (v2009)

SUSTAINABLE SITES		POSSIBLE: 26
SSp1	Construction activity pollution prevention	REQUIRED
SSc1	Site selection	1
SSc2	Development density and community connectivity	5
SSc3	Brownfield redevelopment	1
SSc4.1	Alternative transportation - public transportation access	6
SSc4.2	Alternative transportation - bicycle storage and changing rooms	1
SSc4.3	Alternative transportation - low-emitting and fuel-efficient vehicles	3
SSc4.4	Alternative transportation - parking capacity	2
SSc5.1	Site development - protect or restore habitat	1
SSc5.2	Site development - maximize open space	1
SSc6.1	Stormwater design - quantity control	1
SSc6.2	Stormwater design - quality control	1
SSc7.1	Heat island effect - nonroof	1
SSc7.2	Heat island effect - roof	1
SSc8	Light pollution reduction	1

WATER EFFICIENCY		POSSIBLE: 10
WEp1	Water use reduction	REQUIRED
WEc1	Water efficient landscaping	4
WEc2	Innovative wastewater technologies	2
WEc3	Water use reduction	4

ENERGY & ATMOSPHERE		POSSIBLE: 35
EAp1	Fundamental commissioning of building energy systems	REQUIRED
EAp2	Minimum energy performance	REQUIRED
EAp3	Fundamental refrigerant Mgmt	REQUIRED
EAc1	Optimize energy performance	19
EAc2	On-site renewable energy	7
EAc3	Enhanced commissioning	2
EAc4	Enhanced refrigerant Mgmt	2
EAc5	Measurement and verification	3
EAc6	Green power	2

MATERIAL & RESOURCES		POSSIBLE: 14
MRp1	Storage and collection of recyclables	REQUIRED
MRc1.1	Building reuse - maintain existing walls, floors and roof	3
MRc1.2	Building reuse - maintain interior nonstructural elements	1
MRc2	Construction waste Mgmt	2
MRc3	Materials reuse	2
MRc4	Recycled content	2

MATERIAL & RESOURCES		CONTINUED
MRc5	Regional materials	2
MRc6	Rapidly renewable materials	1
MRc7	Certified wood	1

INDOOR ENVIRONMENTAL QUALITY		POSSIBLE: 15
EQp1	Minimum IAQ performance	REQUIRED
EQp2	Environmental Tobacco Smoke (ETS) control	REQUIRED
EQc1	Outdoor air delivery monitoring	1
EQc2	Increased ventilation	1
EQc3.1	Construction IAQ Mgmt plan - during construction	1
EQc3.2	Construction IAQ Mgmt plan - before occupancy	1
EQc4.1	Low-emitting materials - adhesives and sealants	1
EQc4.2	Low-emitting materials - paints and coatings	1
EQc4.3	Low-emitting materials - flooring systems	1
EQc4.4	Low-emitting materials - composite wood and agrifiber products	1
EQc5	Indoor chemical and pollutant source control	1
EQc6.1	Controllability of systems - lighting	1
EQc6.2	Controllability of systems - thermal comfort	1
EQc7.1	Thermal comfort - design	1
EQc7.2	Thermal comfort - verification	1
EQc8.1	Daylight and views - daylight	1
EQc8.2	Daylight and views - views	1

INNOVATION		POSSIBLE: 6
IDc1	Innovation in design	5
IDc2	LEED Accredited Professional	1

REGIONAL PRIORITY		POSSIBLE: 4
RPc1	Regional priority	4

TOTAL 110

40-49 Points	50-59 Points	60-79 Points	80+ Points
CERTIFIED	SILVER	GOLD	PLATINUM

APPENDIX F

Public Information Meeting Minutes

South Shore Beach Relocation Study Public Information Meeting

Wednesday, March 20th, 2013 (6:00 – 7:30p.m.)
South Shore Park Pavilion – Milwaukee, Wisconsin

Baird Attendees: Ben Yahr & Rory Agnew

No.	Item	Who
01.	**Topic**	
	5:00 - 5:30p.m. Arrival/Meeting set-up.	BJY,RPA
02.	**Topic**	
	5:30 - 6:15p.m. Greeted guests upon arrival and facilitated informal discussion with graphics of proposed beach relocation alternatives and modeling results..	BJY,RPA
03.	**Topic**	
	6:15 – 7:00p.m Baird's presentation to the public, followed by a public q/a session moderated by Ms. Dimitrijevic	BJY
04.	**Topic**	
	7:00 – 7:30p.m. **Public q/a session**: • What is the timeline of the project? • What can be done immediately to make a positive impact/reduce beach closures? • How will the cost of the project be delegated? • Has climate change been factored into project results? • Are the South Shore Marina patrons responsible for the cost of parking lot improvements? • Did we look into the possible negative impacts of firework debris? • Did we look into reconfiguring the breakwater to allow for increased water circulation? • What is the current purpose of the existing groyne north of the TBM material • Can we remove this existing groyne? • Will removing the existing groyne increase water circulation/quality? • Does the parking lot run-off or 'Site 4' have a more direct negative impact on the existing conditions? • Why was 'Site 4' non-existent until the past few years/is it possible to remove/dredge this area? • What can be done to stop people from feeding birds at this site/how should the general public approach people when they see this happening/can bilingual signage be provided at this site? • Why are Baird's water quality conclusions different than Dr. McLellan's at the TBM beach south of the existing groyne?	Supervisor Dimitrijevic, Mr. James Kegan, BJY