7- Turbidity and Suspended Sediment Characterizations

Introduction

A frequently cited environmental concern related to beach nourishment operations involves short- and long-term effects of suspended sediments, either during the actual filling process or over an indefinite period as the new beach profile responds to prevailing physical forces. During the filling process, concerns are generally associated with the presence of very high concentrations of suspended sediments and plumes of turbid water in the vicinity of the sediment discharge. Several factors can contribute to the magnitude of resuspension and spatial extent of plumes, including prevalent meteorological and sea state conditions, granulometry of the fill sediments (e.g., % silts or clays), and mode of placement (e.g., hydraulic pipeline or barge pump-out). In this project the dredging contractor (Great Lakes Dredge and Dock Company) used an offshore pump-out station with a submerged pipeline to the beach. Discharge at the beach occurred at a fixed point in tandem with contouring of the deposited fill by bulldozers. A low-level aerial photograph of a similar fill operation on the south shore of Long Island, New York, is depicted in Figure 7-1 (courtesy of Great Lakes Dredge and Dock Company). This figure illustrates the spatial scale of the discharge (note the numerous bulldozer tracks). The discharge point generally lies well up on the beach and water in the dredged sediment slurry moves down the beach face to a broad interface with the swash zone. Coarser sands readily fall out of the slurry, but fine fractions are carried in suspension into the swash zone, thereby, creating the source of turbid plumes.

Hypothetical impacts can take several forms, linked either to concentrations of suspended sediment particles or the optical properties of turbid water. The former largely deal with direct physiological effects on organisms exposed to elevated suspended sediment concentrations. Abrasion of gill epithelial tissues or mucous membranes, reduced ventilation rates of molluscs, and a host of other effects (see reviews by Moore 1978, Newcombe and MacDonald 1991) are potentially detrimental if above certain thresholds of exposure. Thus knowledge of the concentration gradients to which organisms inhabiting the beach are exposed, both in terms of background and nourishment operation-induced conditions, is critical to the evaluation of the likelihood of impacts. This information should be considered in conjunction with tolerances of appropriate species and their life history stages. Tolerances vary greatly among stages and species, reflecting different degrees of adaptation to suspended sediments (LaSalle et al. 1991).

Turbid conditions may pose risks of detrimental effects in different ways. Altered optical properties of water (e.g., increased light attenuation with depth or horizontal distance) can result in changes in behavior. An example relevant to beach nourishment projects is an avoidance response of fishes encountering a sharp plume boundary. In theory, persistent plumes could disrupt occupation of the surf zone by juvenile fishes, interfere with foraging, or block movements of fishes along the shore. Although such impacts remain speculative, they do underscore the need for information characterizing the spatial scales of plumes attributed to beach filling operations.

Figure 7-1. Aerial view of typical beach nourishment operation showing a pipeline discharge at a project site on Long Island, New York. (Courtesy of Great Lakes Dredge and Dock Company)

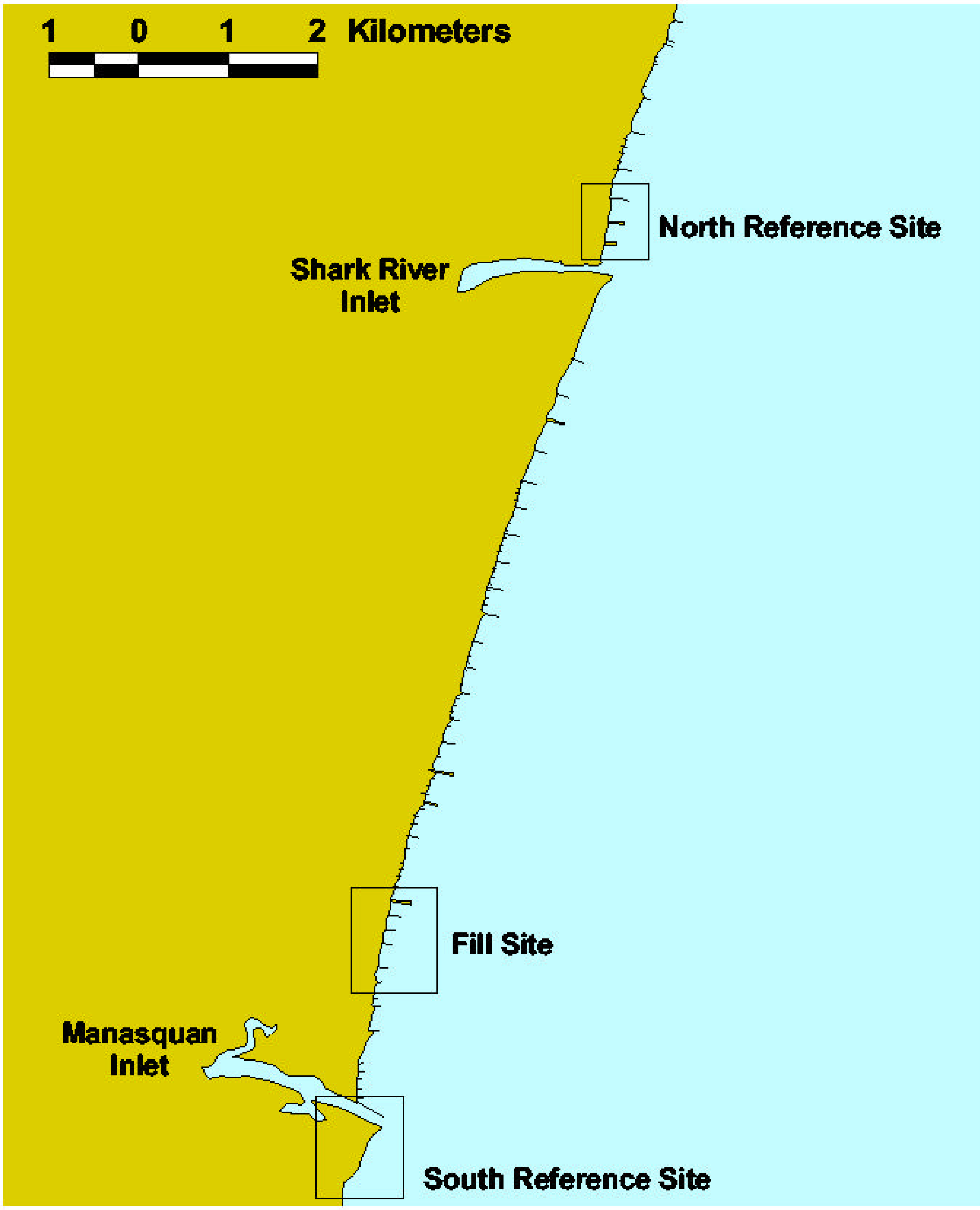

Figure 7-2. Locations of New Jersey suspended sediment concentration study sites for a survey conducted on September 4, 1997.

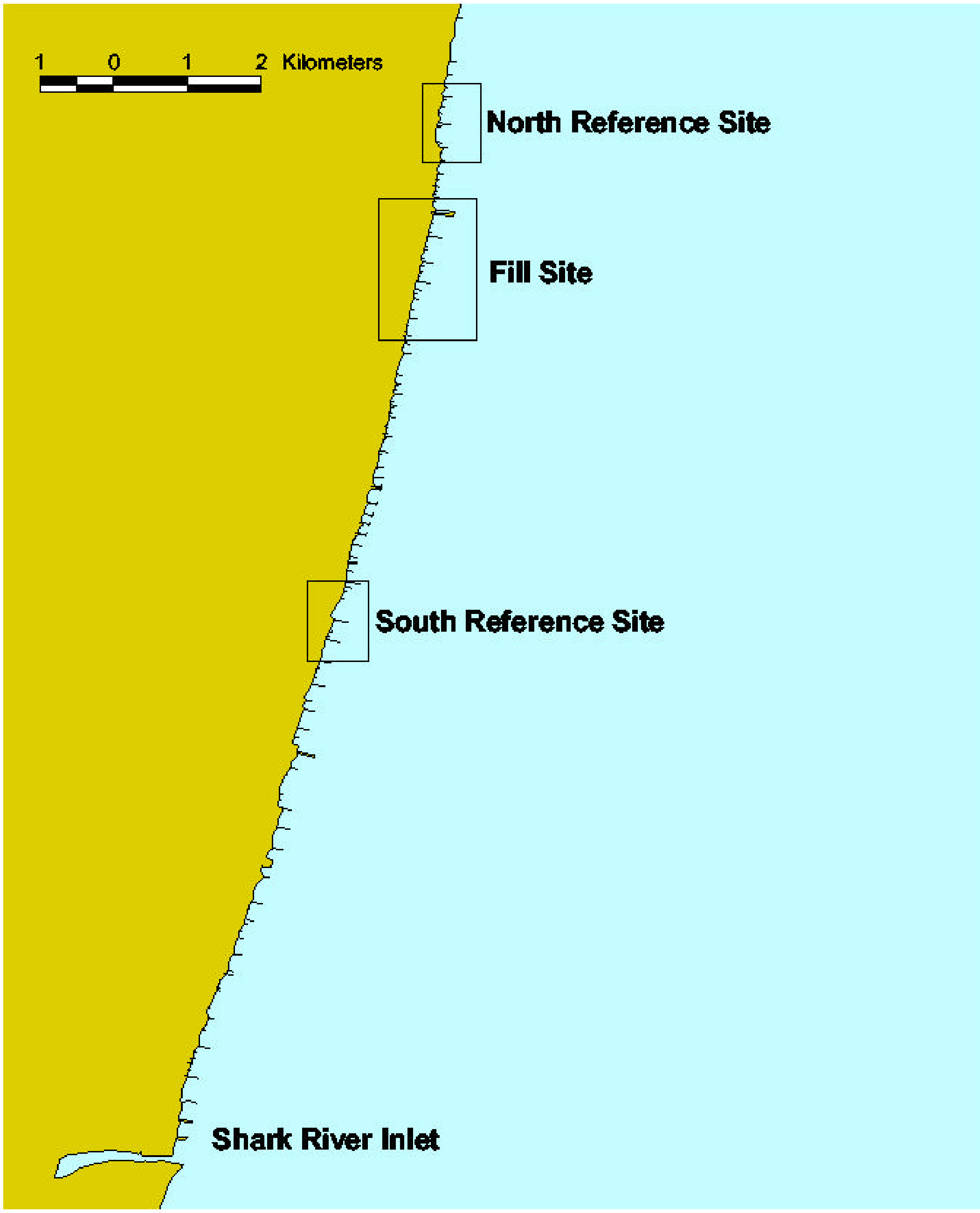

Figure 7-3. Locations of New Jersey suspended sediment concentration study sites for a survey conducted on September 20, 1998.

August 4-7

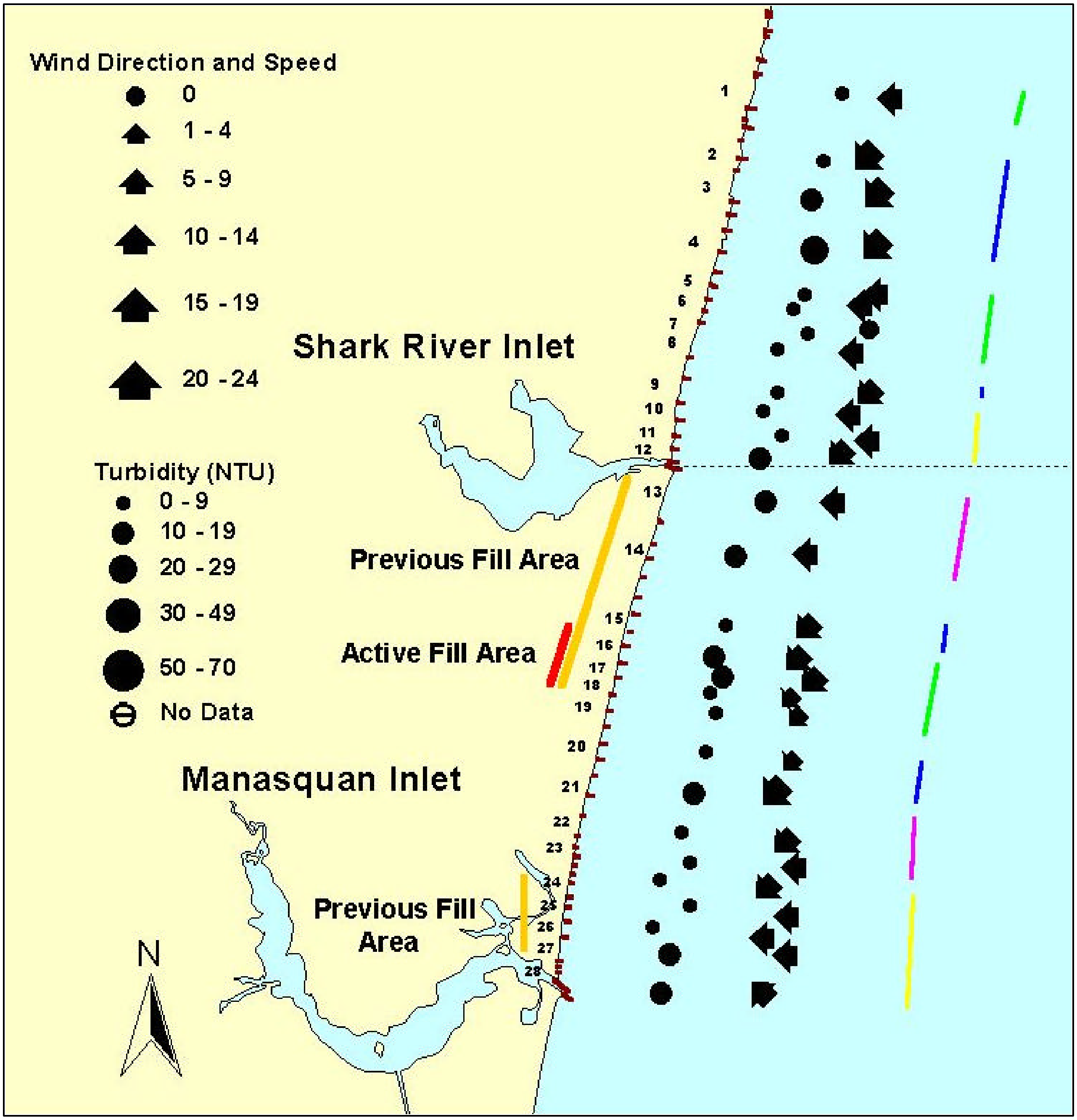

Figure 7-4. Wind direction arrows point in the downwind direction. Lines of the same color indicate stations that were sampled on the same day.

August 19-23

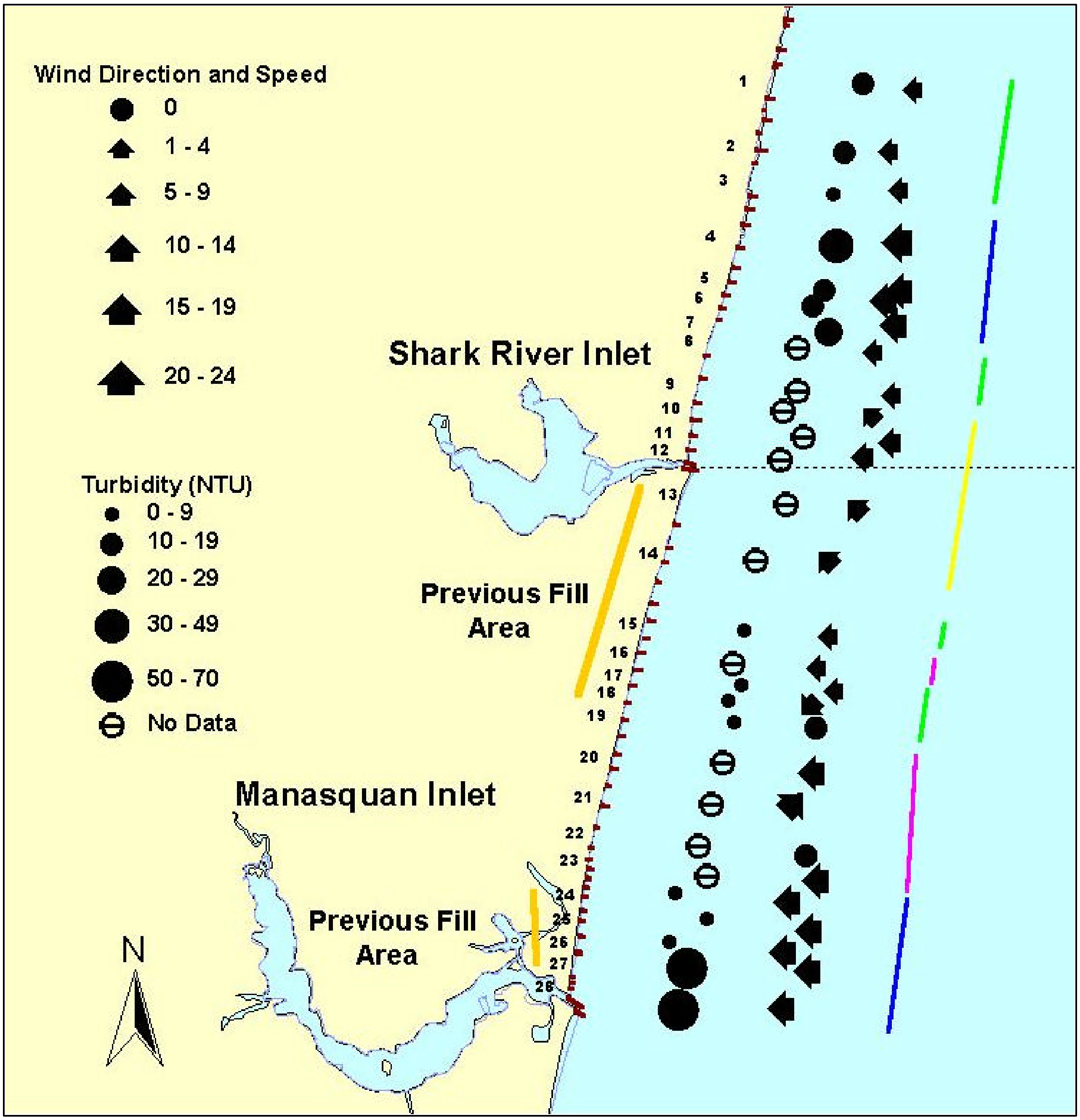

Figure 7-5. Wind direction arrows point in the downwind direction. Lines of the same color indicate stations that were sampled on the same day.

September 2-4

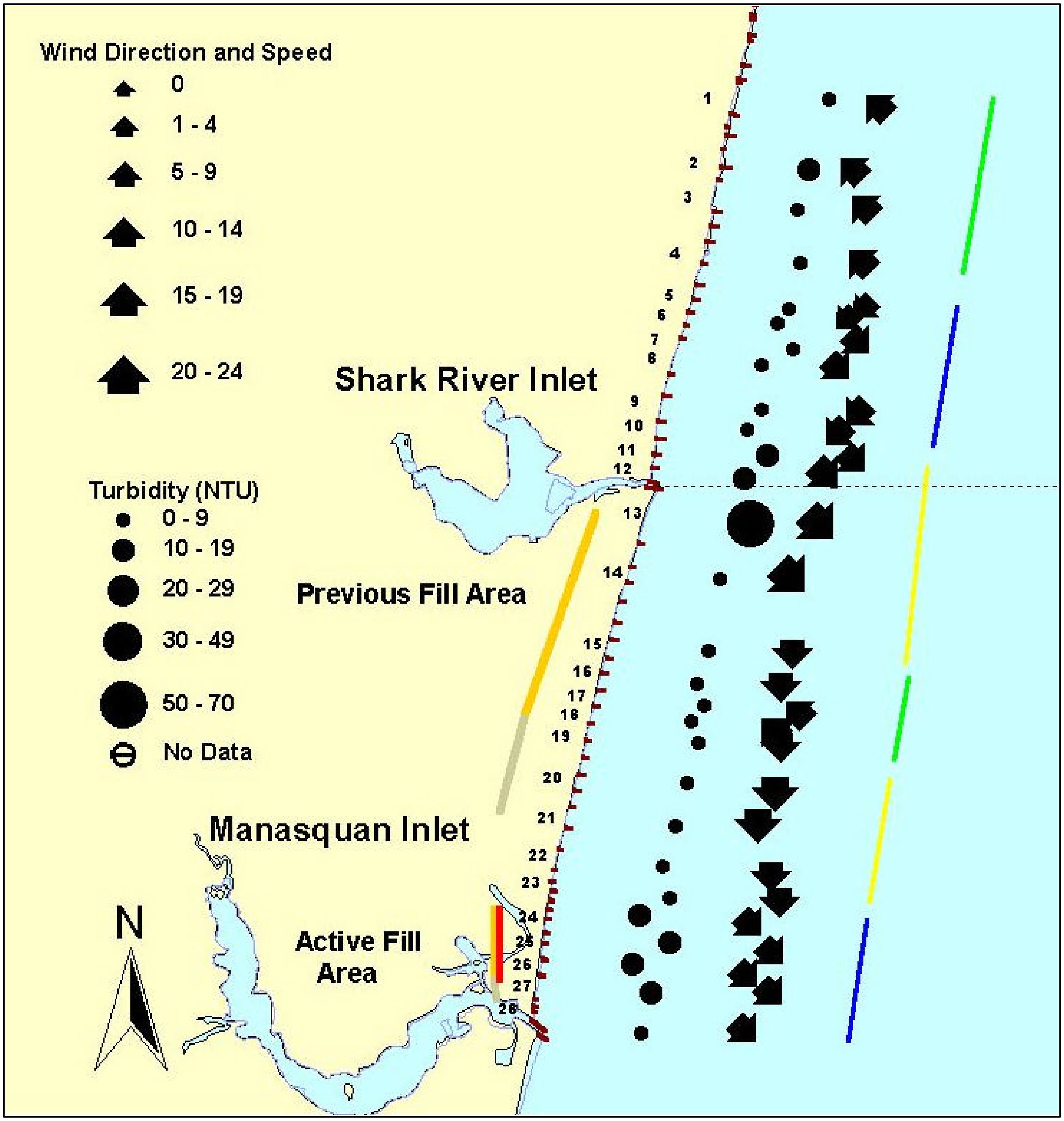

Figure 7-6. Wind direction arrows point in the downwind direction. Lines of the same color indicate stations that were sampled on the same day.

September 15-18

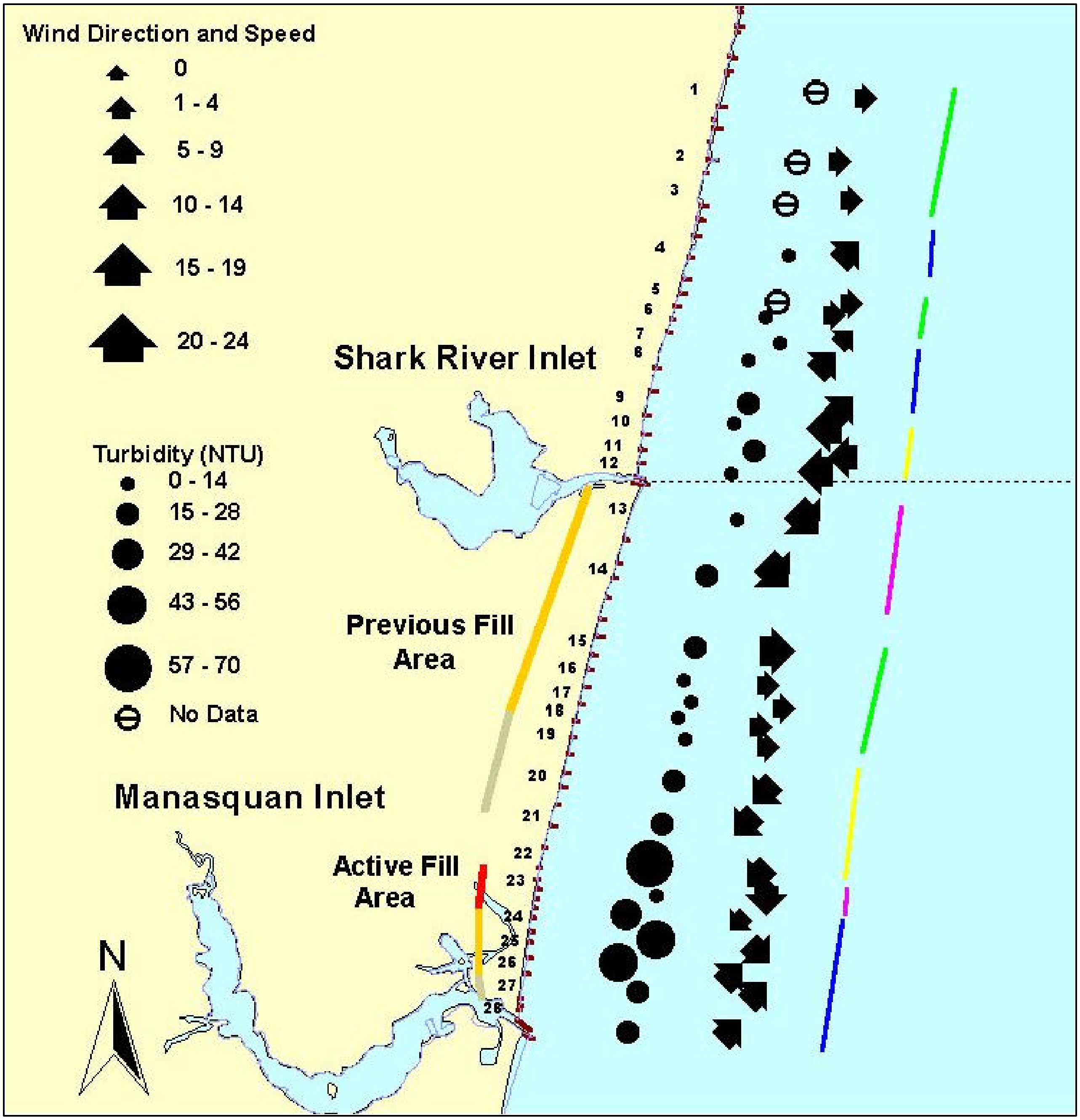

Figure 7-7. Wind direction arrows point in the downwind direction. Lines of the same color indicate stations that were sampled on the same day.

September 30 - October 3

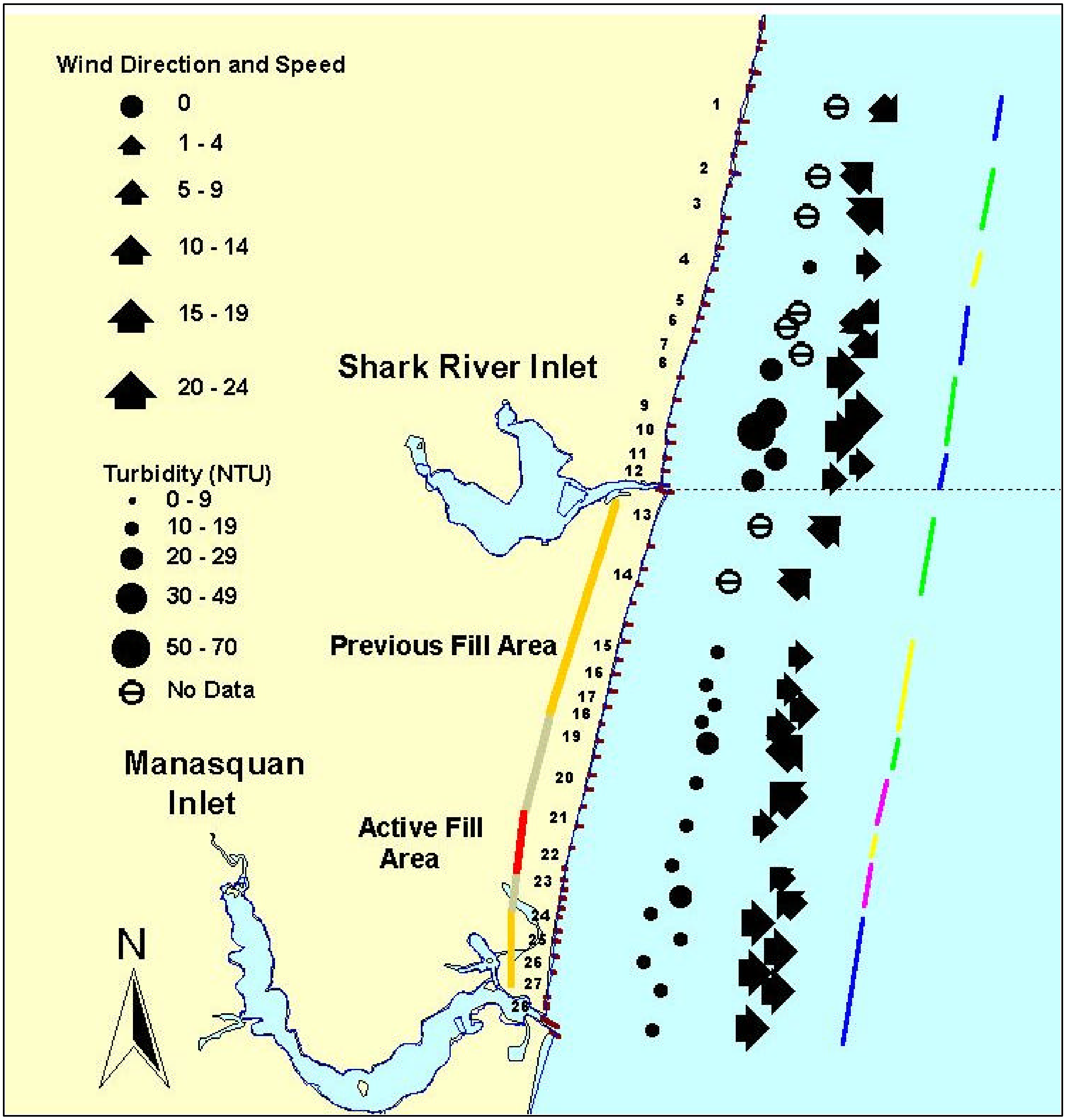

Figure 7-8. Wind direction arrows point in the downwind direction. Lines of the same color indicate stations that were sampled on the same day.

October 14-15

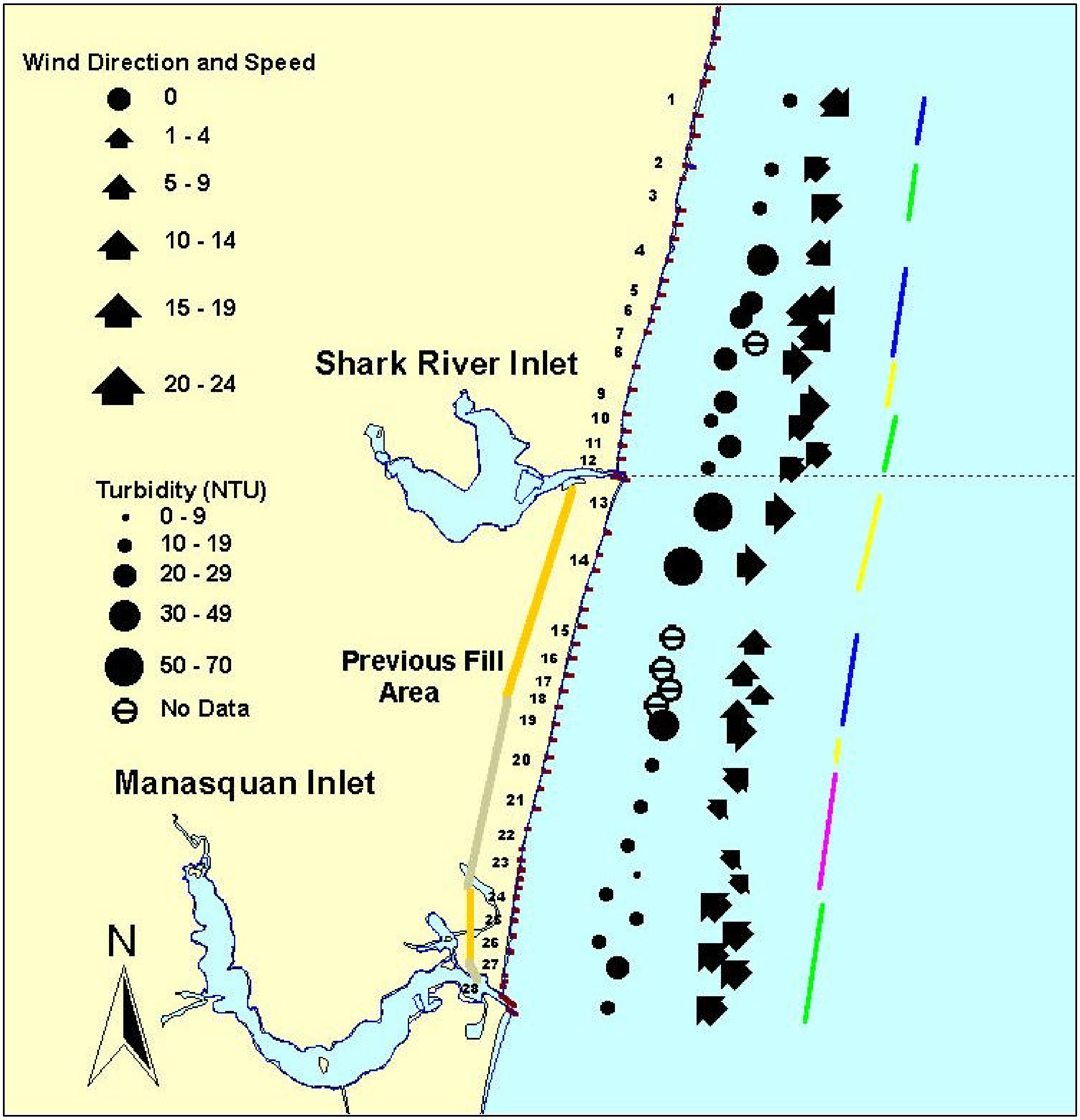

Figure 7-9. Wind direction arrows point in the downwind direction. Lines of the same color indicate stations that were sampled on the same day.

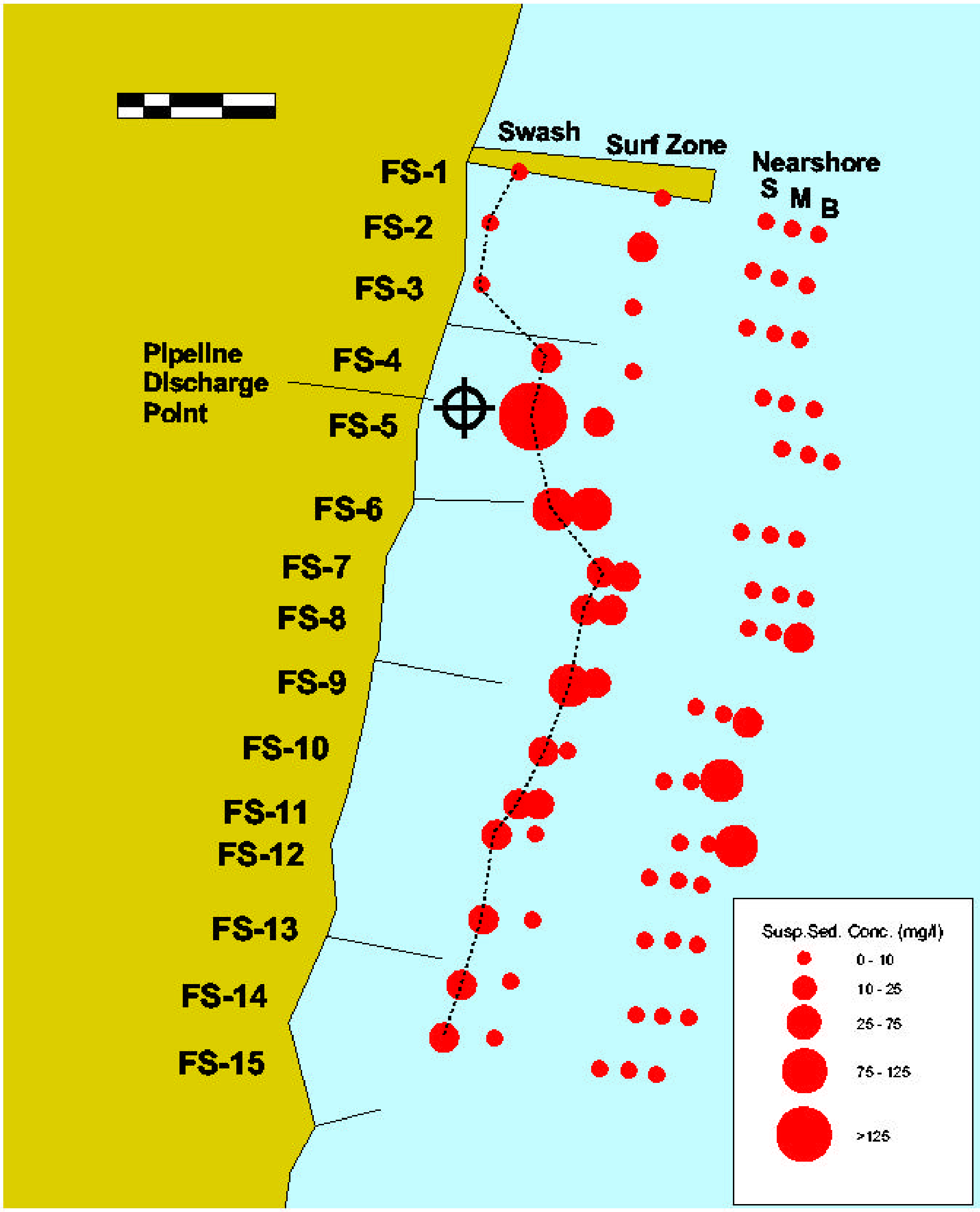

Figure 7-10. Suspended sediment concentrations at an active beach fill site on September 4, 1997. Dotted line represents approximate new beach face. S = Surface, M = Mid Depth, B = Bottom.

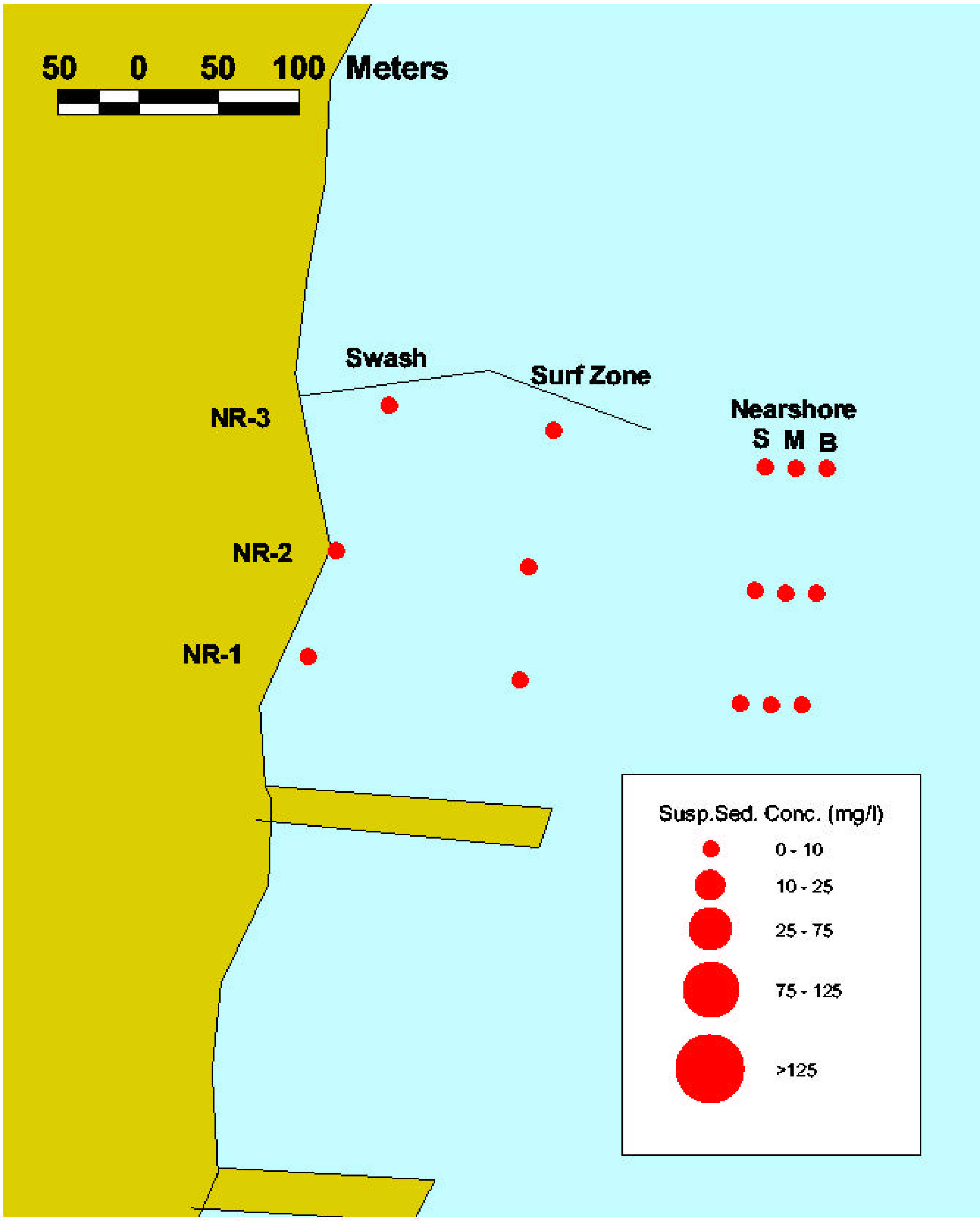

Figure 7-11. Suspended sediment concentrations at the North Reference Site on September 4, 1997.
S = Surface, M = Mid Depth, B = Bottom.

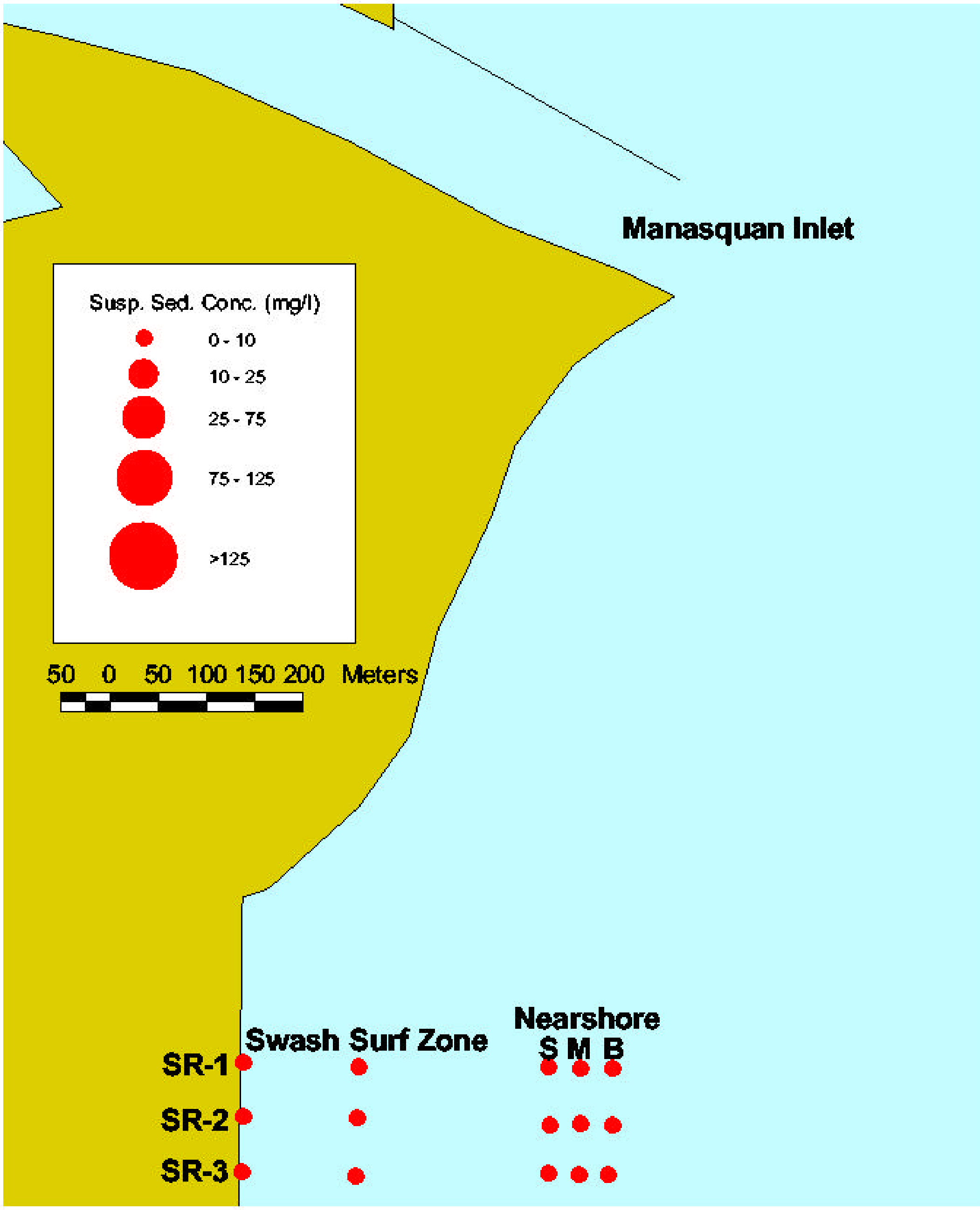

Figure 7-12. Suspended sediment concentrations at the South Reference Site on September 4, 1997. S = Surface, M = Mid Depth, B = Bottom.

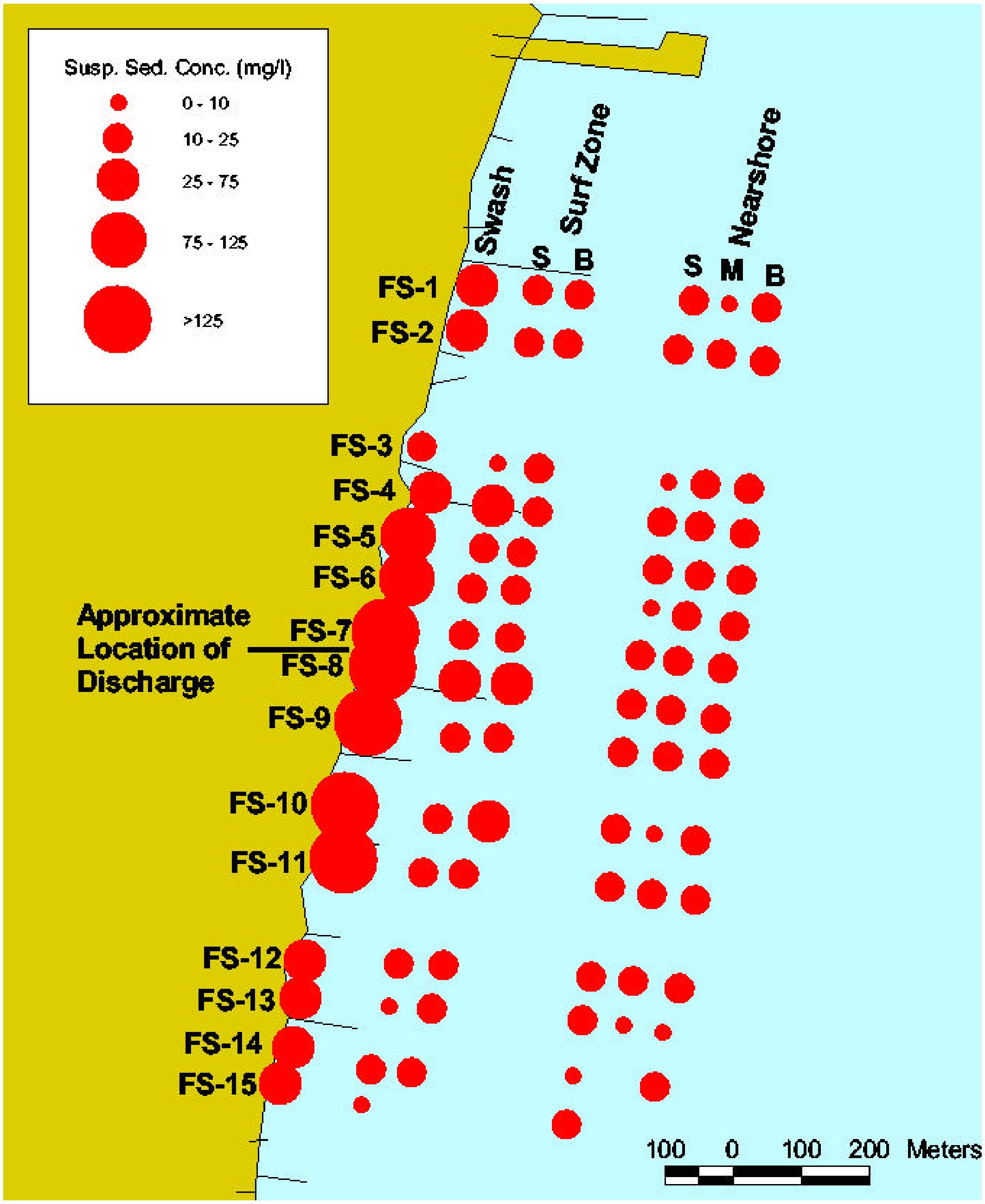

Figure 7-13. Suspended sediment concentrations at an active beach fill site on September 20, 1998.
S = Surface, M = Mid Depth, B = Bottom.

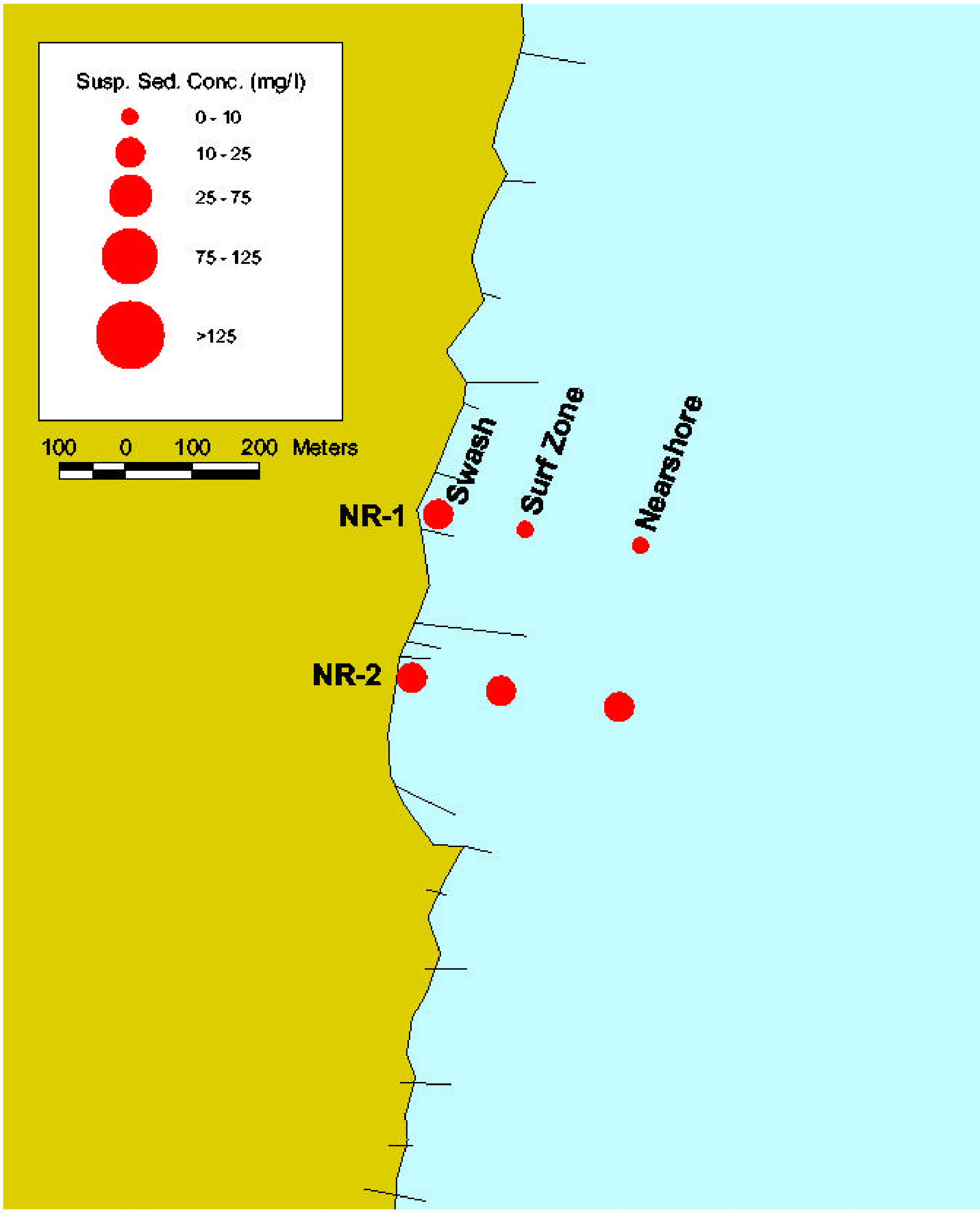

Figure 7-14. Suspended sediment concentrations at the North Reference Site on September 20, 1998.

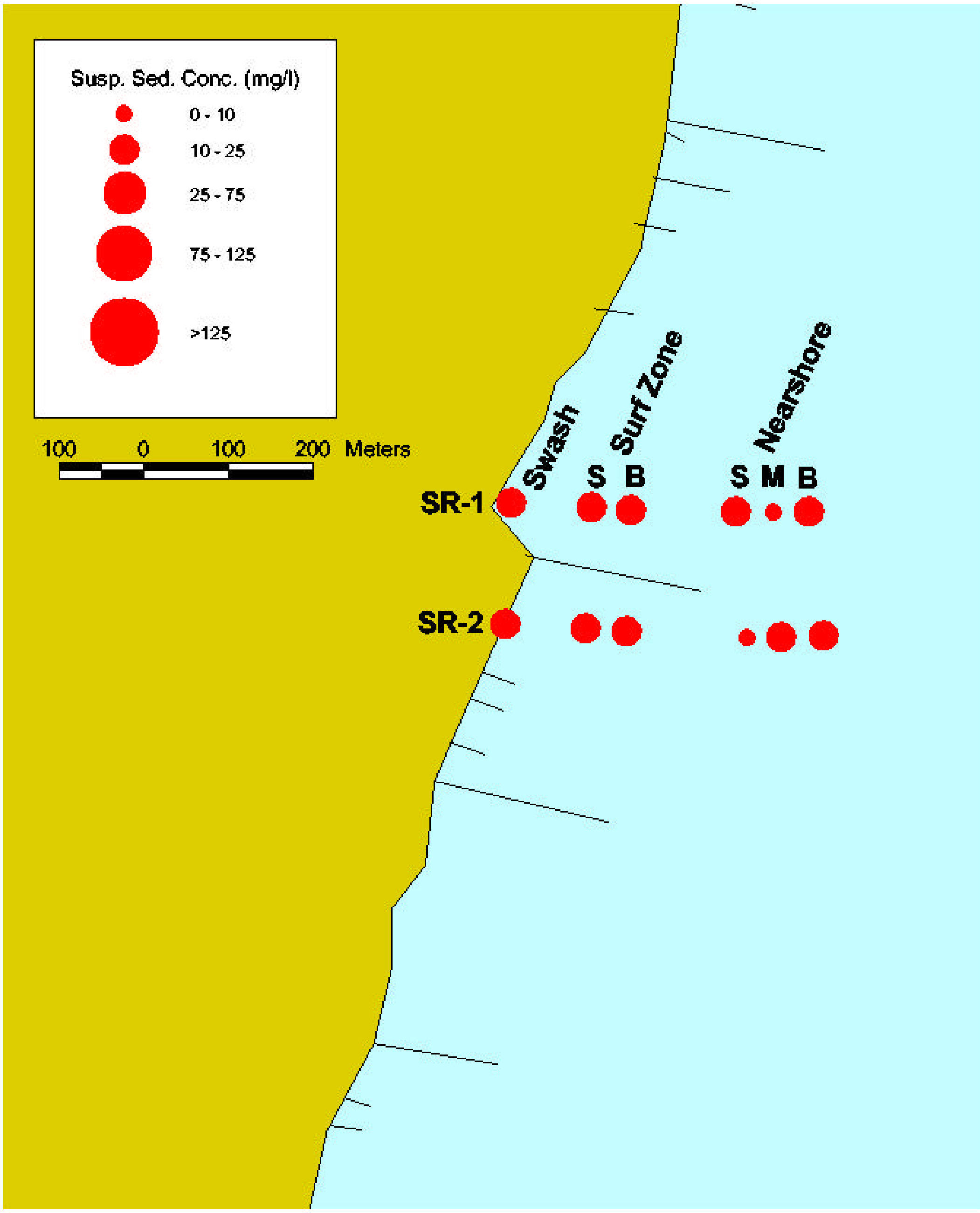

Figure 7-15. Suspended sediment concentrations at the South Reference Site on September 20, 1998. S = Surface, M = Mid Depth, B = Bottom.

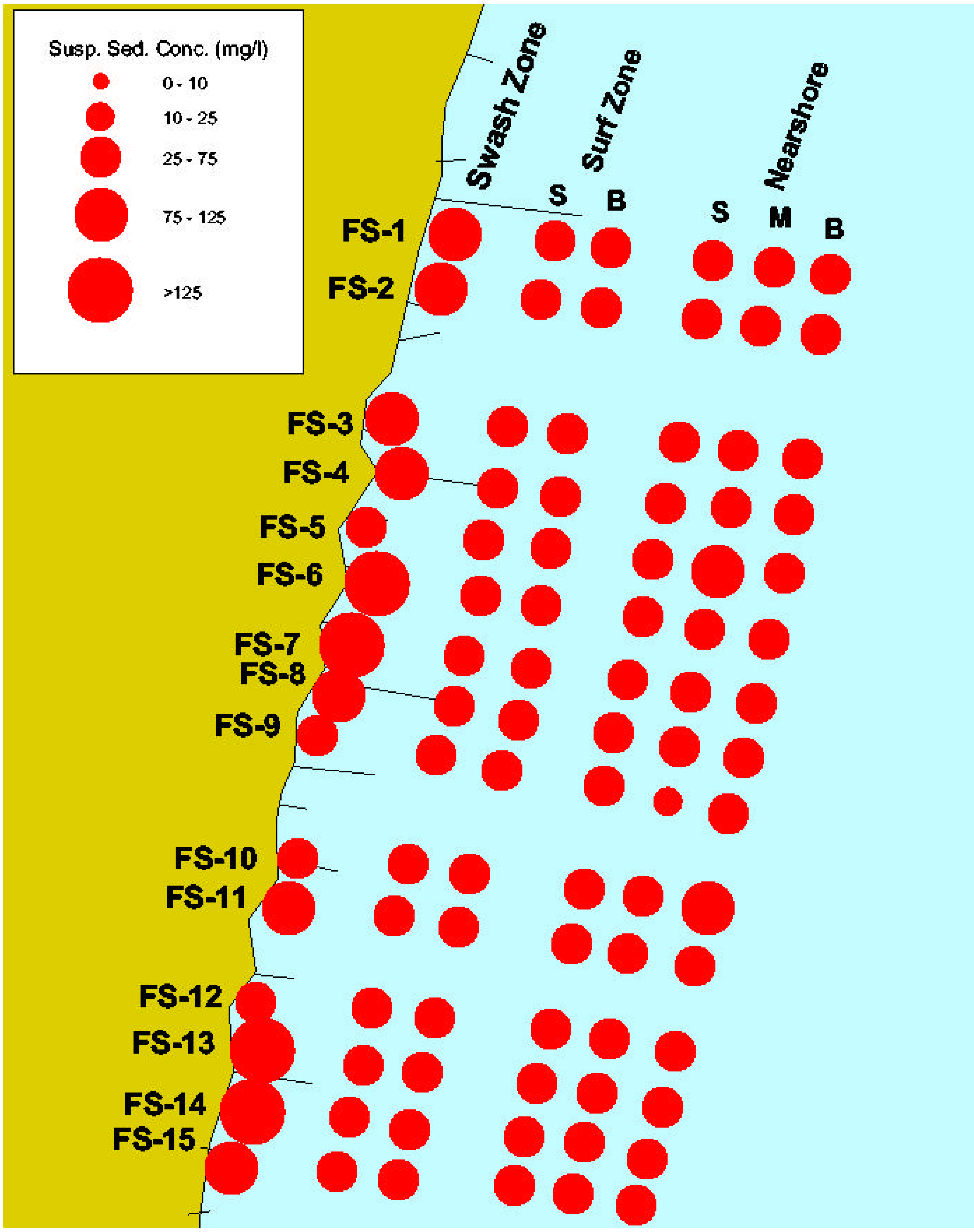

Figure 7-16. Suspended sediment concentrations at the Fill Site on September 9, 1999.
S = Surface, M = Mid Depth, B = Bottom.

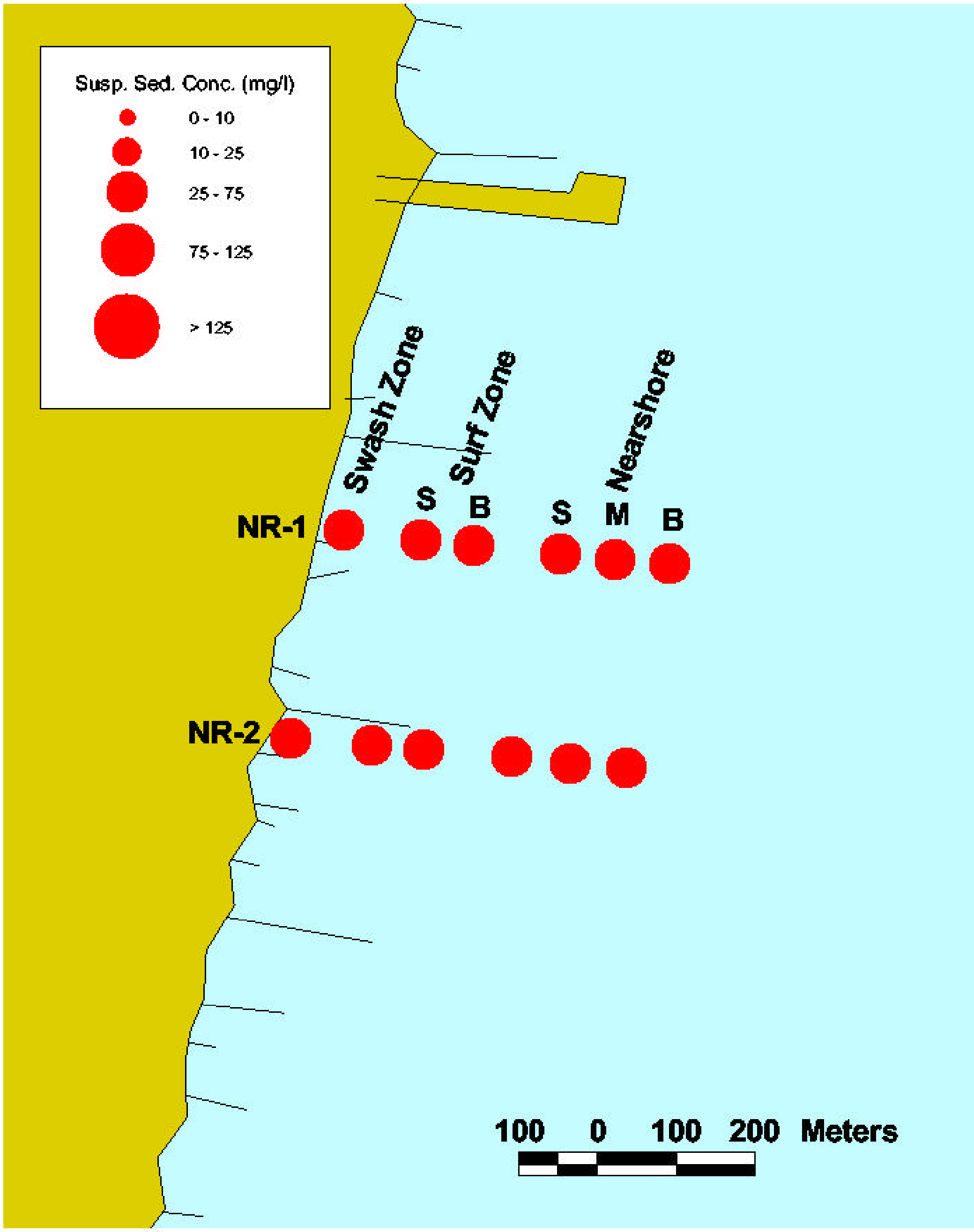

Figure 7-17. Suspended sediment concentrations at the North Reference Site on September 9, 1999.
S = Surface, M = Mid Depth, B = Bottom.

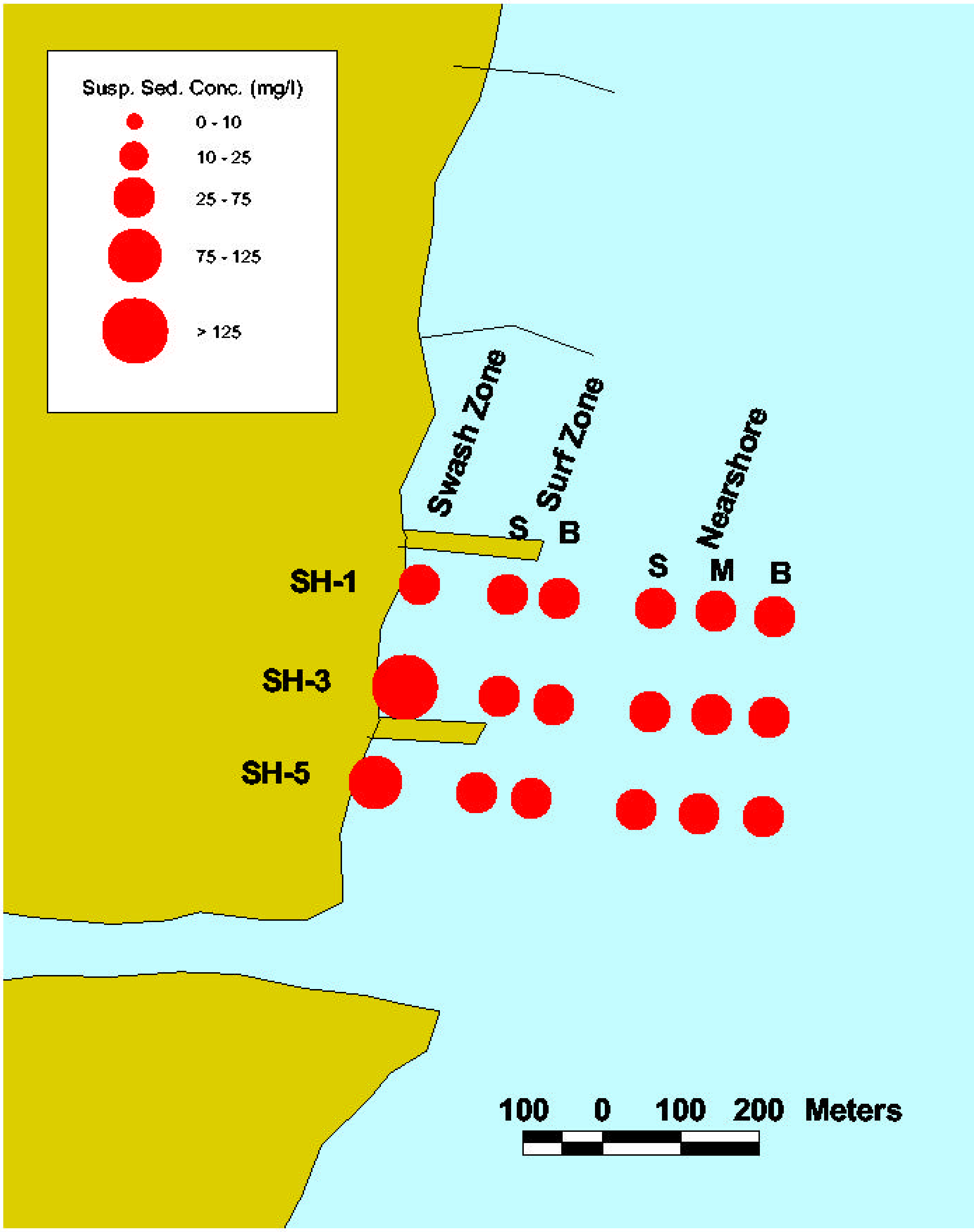

Figure 7-18. Suspended sediment concentrations at the Shark River Reference Site on September 9, 1999. S = Surface, M = Mid Depth, B = Bottom.

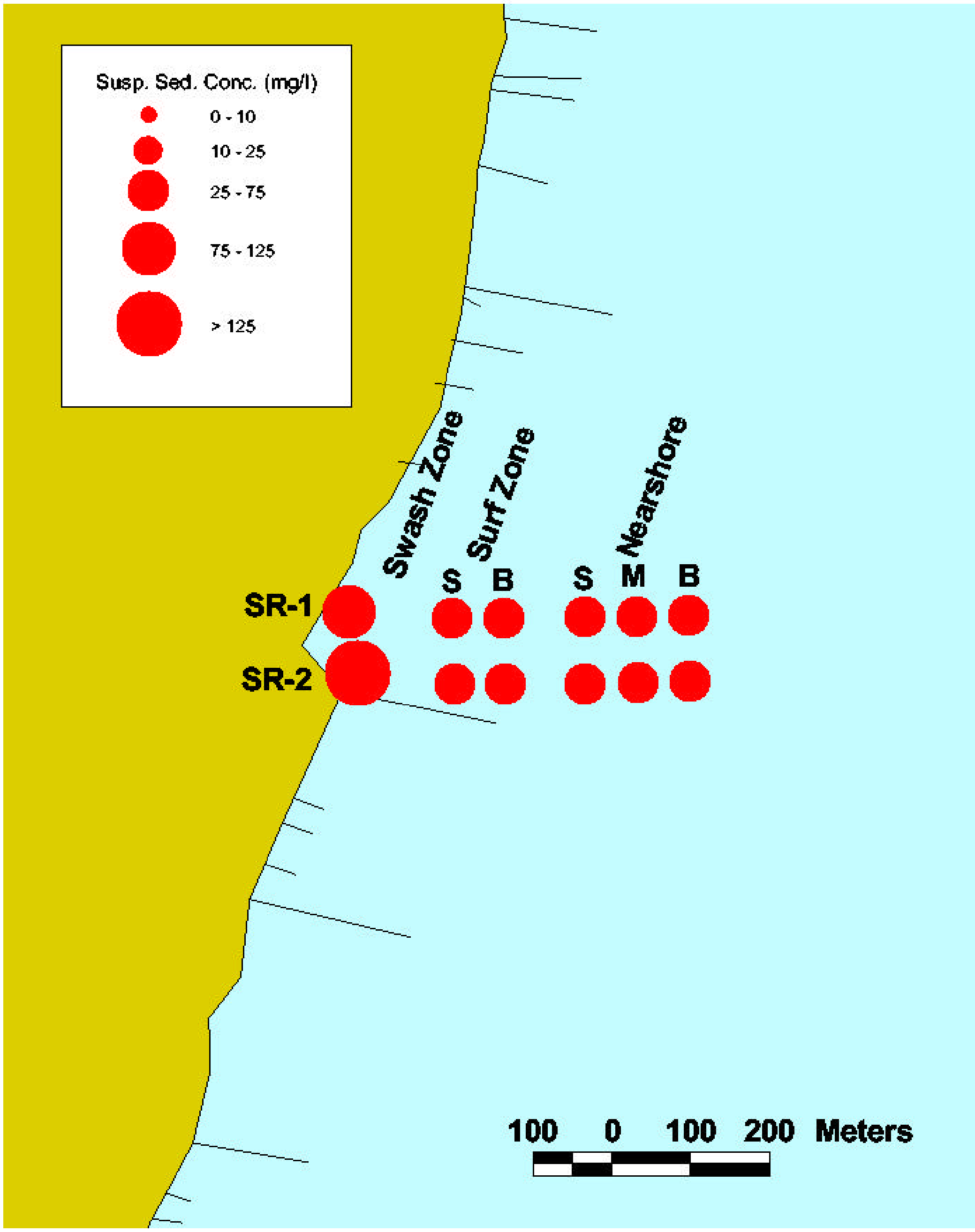

Figure 7-19. Suspended sediment concentrations at the South Reference Site on September 9, 1999. S = Surface, M = Mid Depth, B = Bottom.

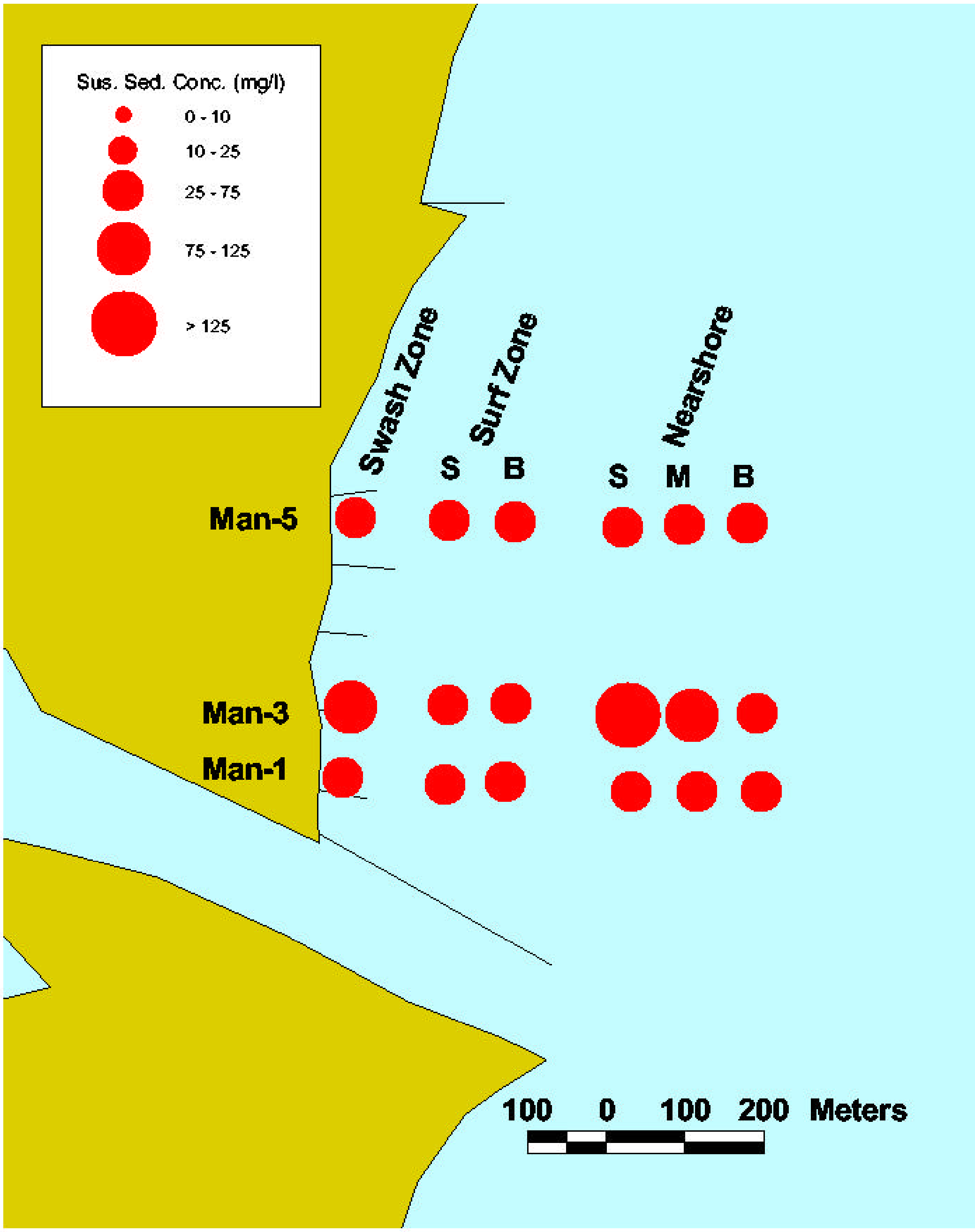

Figure 7-20. Suspended sediment concentrations at the Manasquan Reference Site on September 9, 1999. S = Surface, M = Mid Depth, B = Bottom.

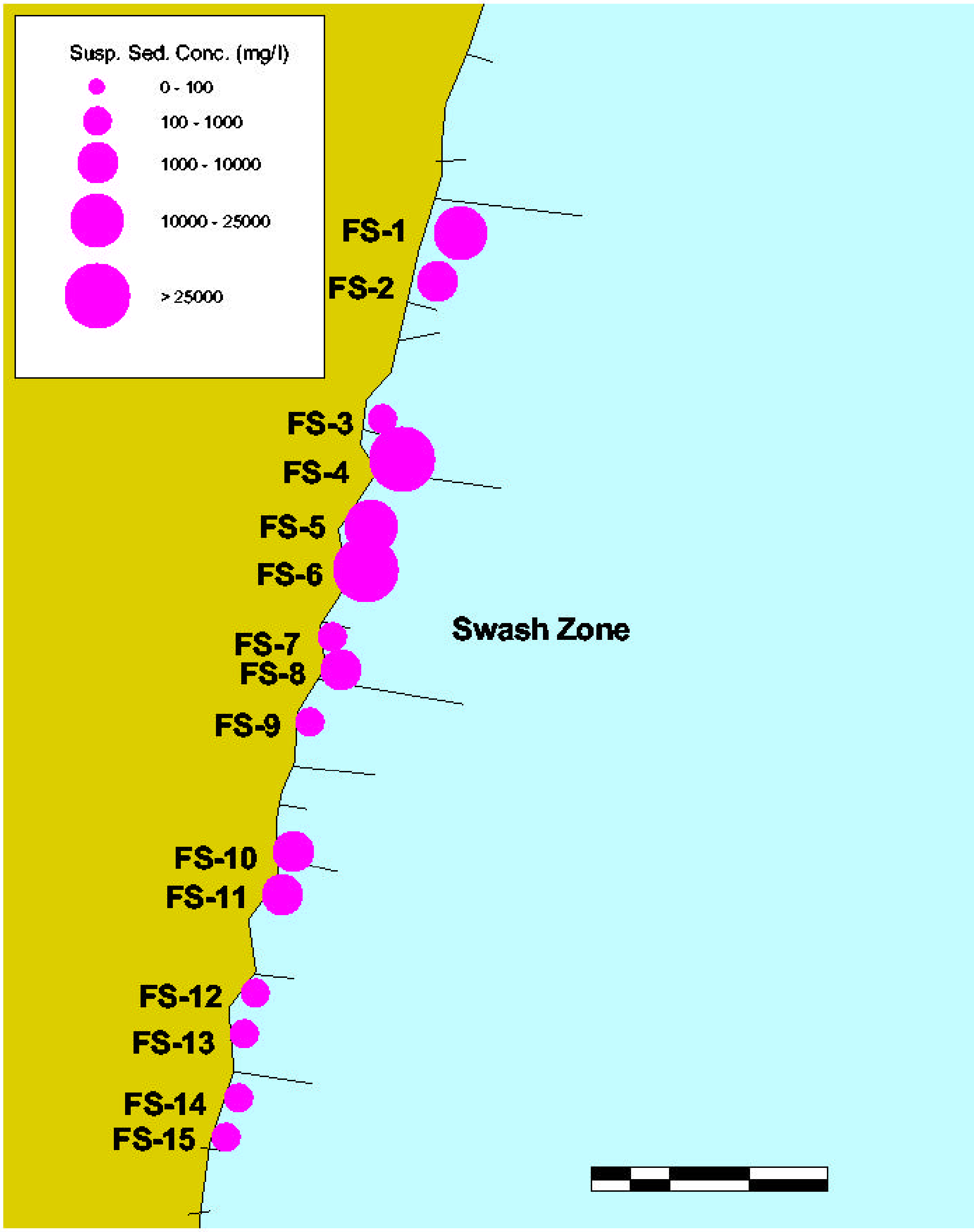

Figure 7-21. Suspended sediment concentrations at the Fill Site swash zone on September 19, 1999.
S = Surface, M = Mid Depth, B = Bottom.

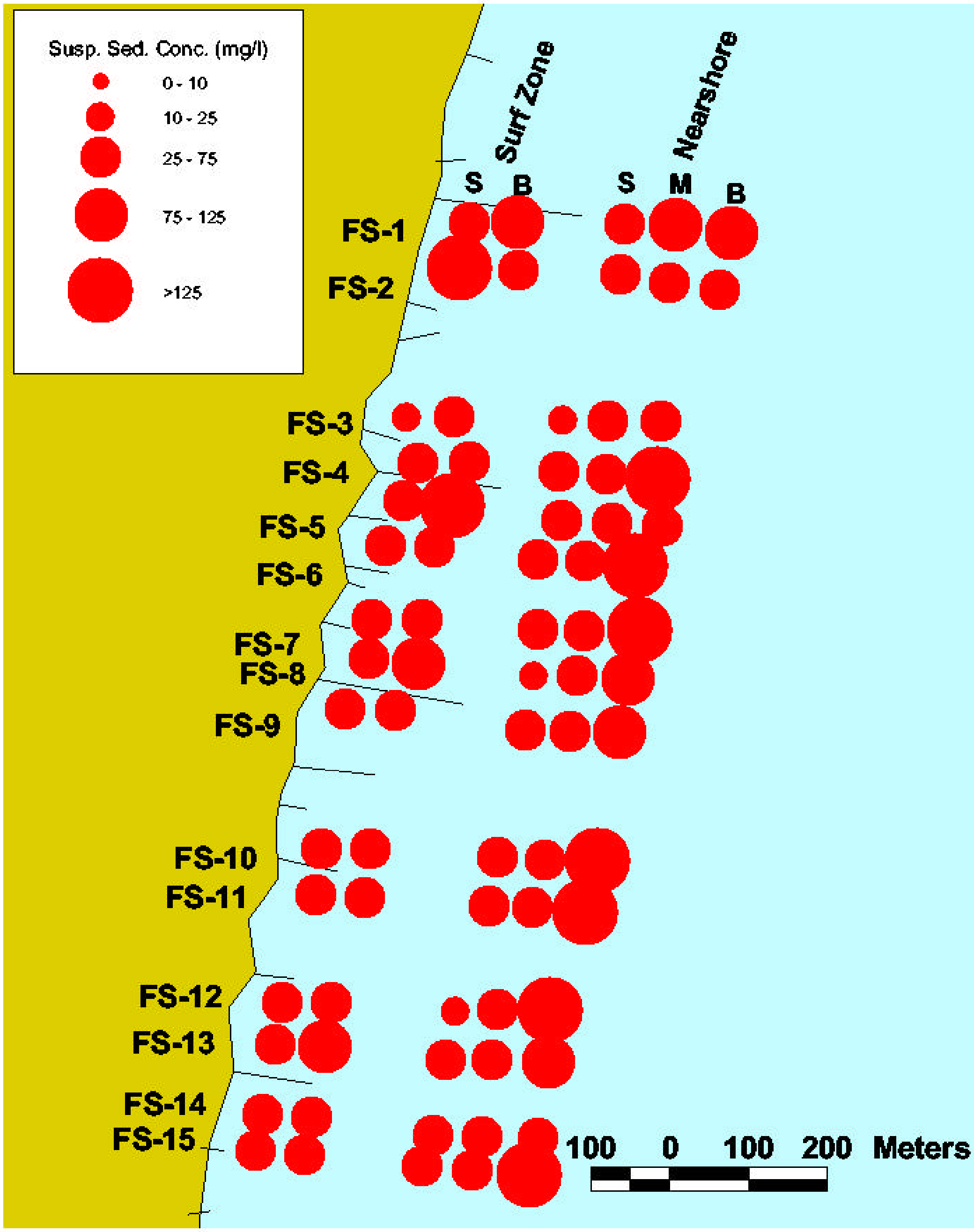

Figure 7-22. Suspended sediment concentrations at the Fill Site on September 19, 1999.
S = Surface, M = Mid Depth, B = Bottom.

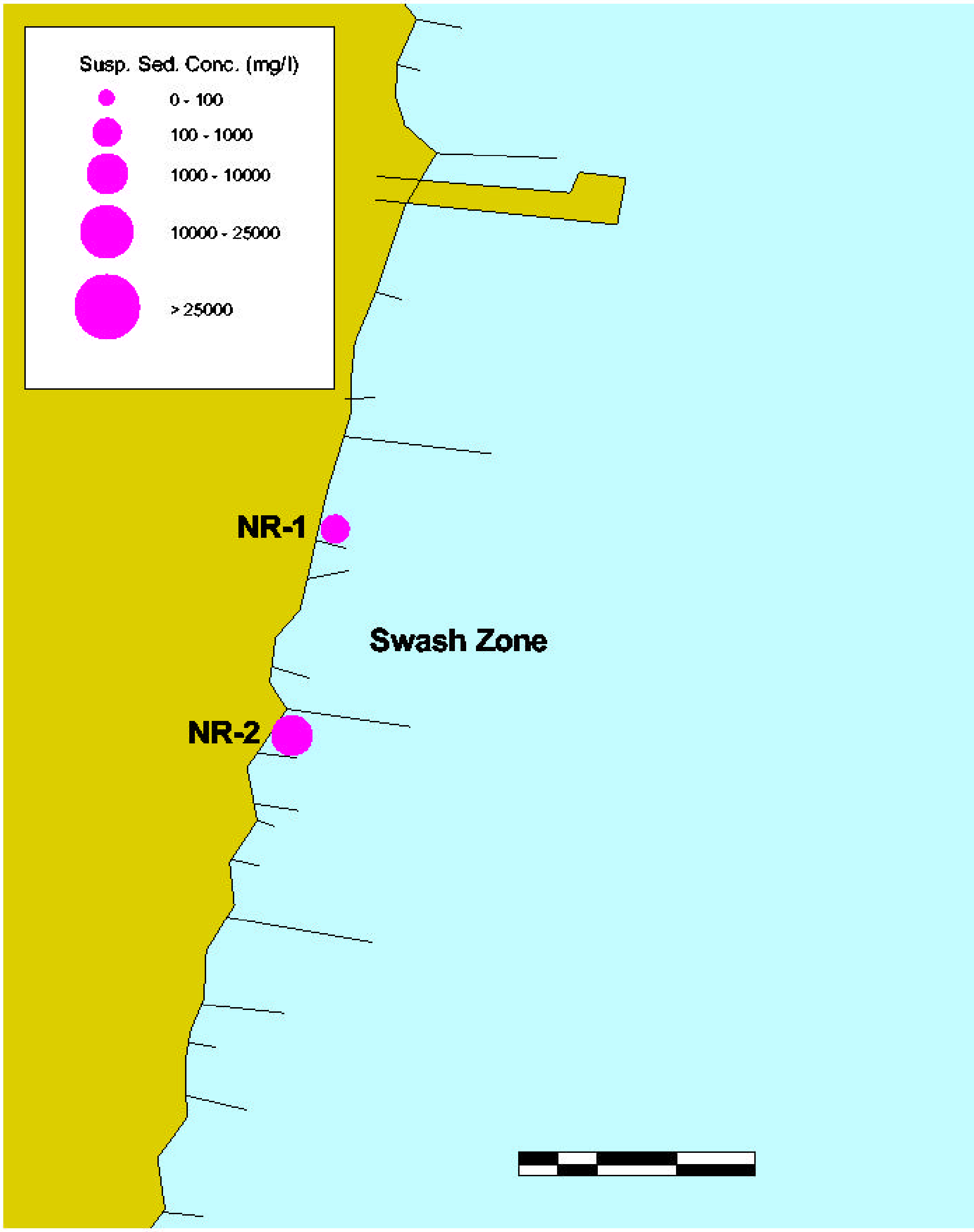

Figure 7-23. Suspended sediment concentrations at the North Reference Site swash zone on September 19, 1999. S = Surface, M = Mid Depth, B = Bottom.

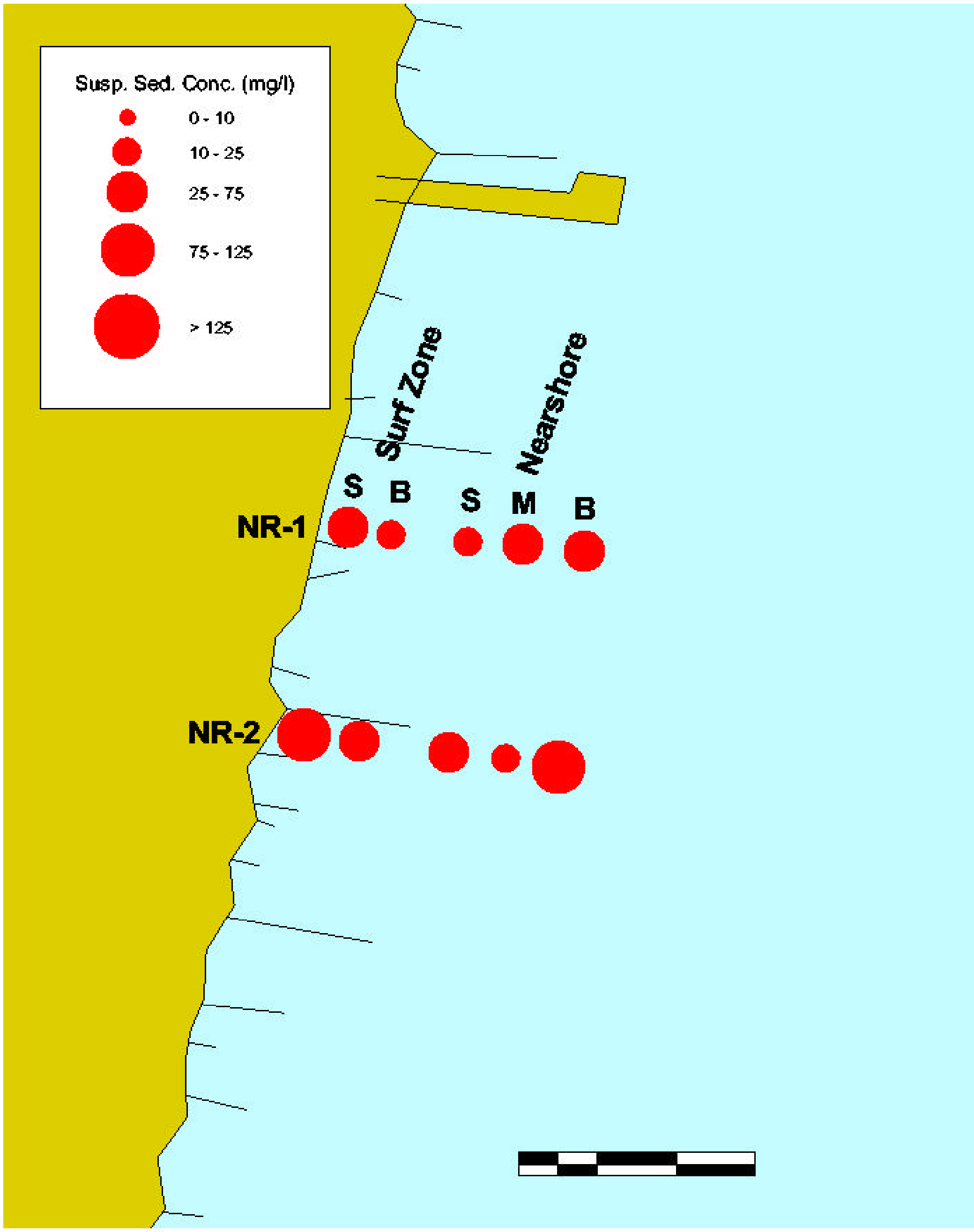

Figure 7-24. Suspended sediment concentrations at the North Reference Site on September 19, 1999. S = Surface, M = Mid Depth, B = Bottom.

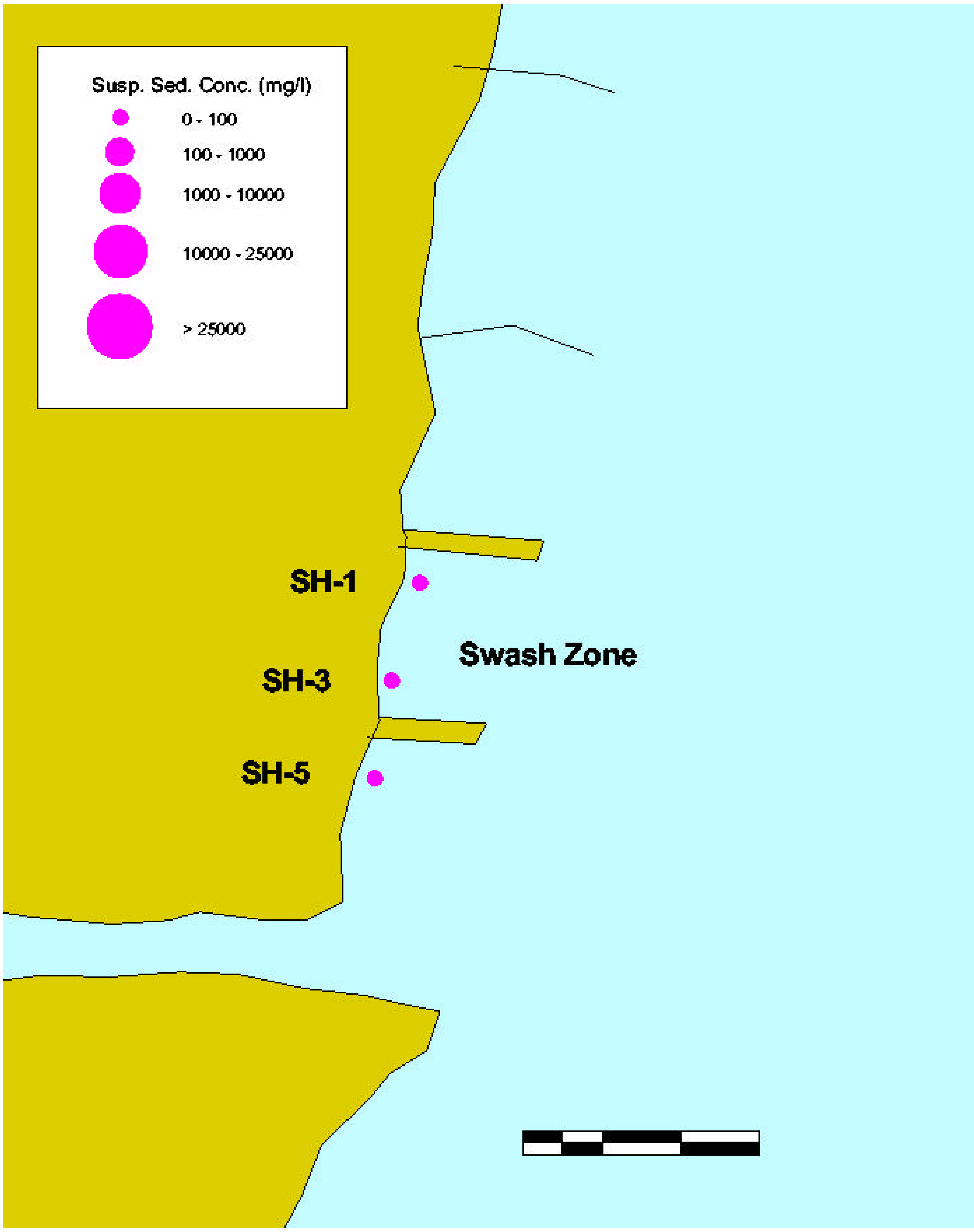

Figure 7-25. Suspended sediment concentrations at the Shark River Reference Site swash zone on September 19, 1999. S = Surface, M = Mid Depth, B = Bottom.

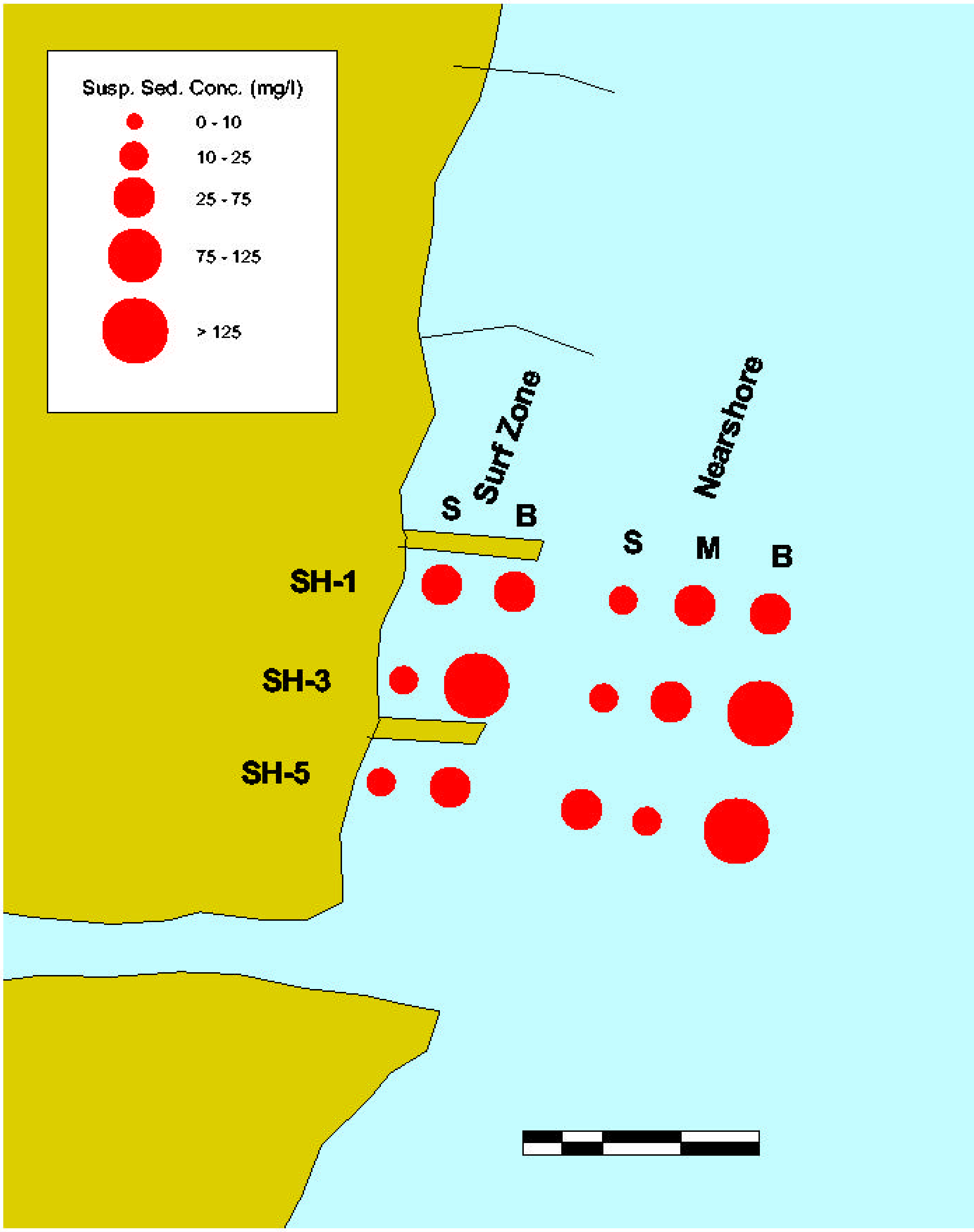

Figure 7-26. Suspended sediment concentrations at the Shark River Reference Site on September 19, 1999. S = Surface, M = Mid Depth, B = Bottom.

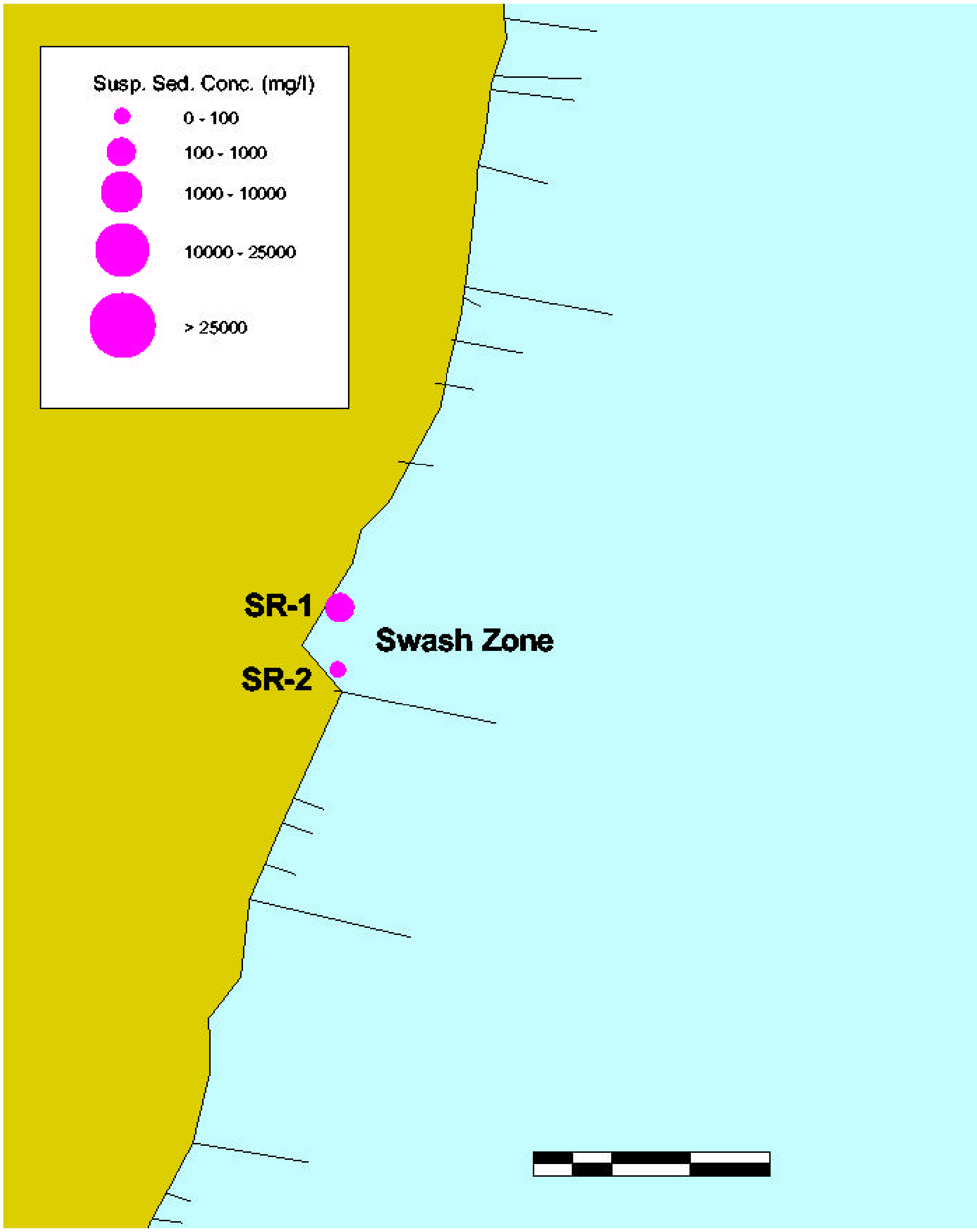

Figure 7-27. Suspended sediment concentrations at the South Reference Site swash zone on September 19, 1999. S = Surface, M = Mid Depth, B = Bottom.

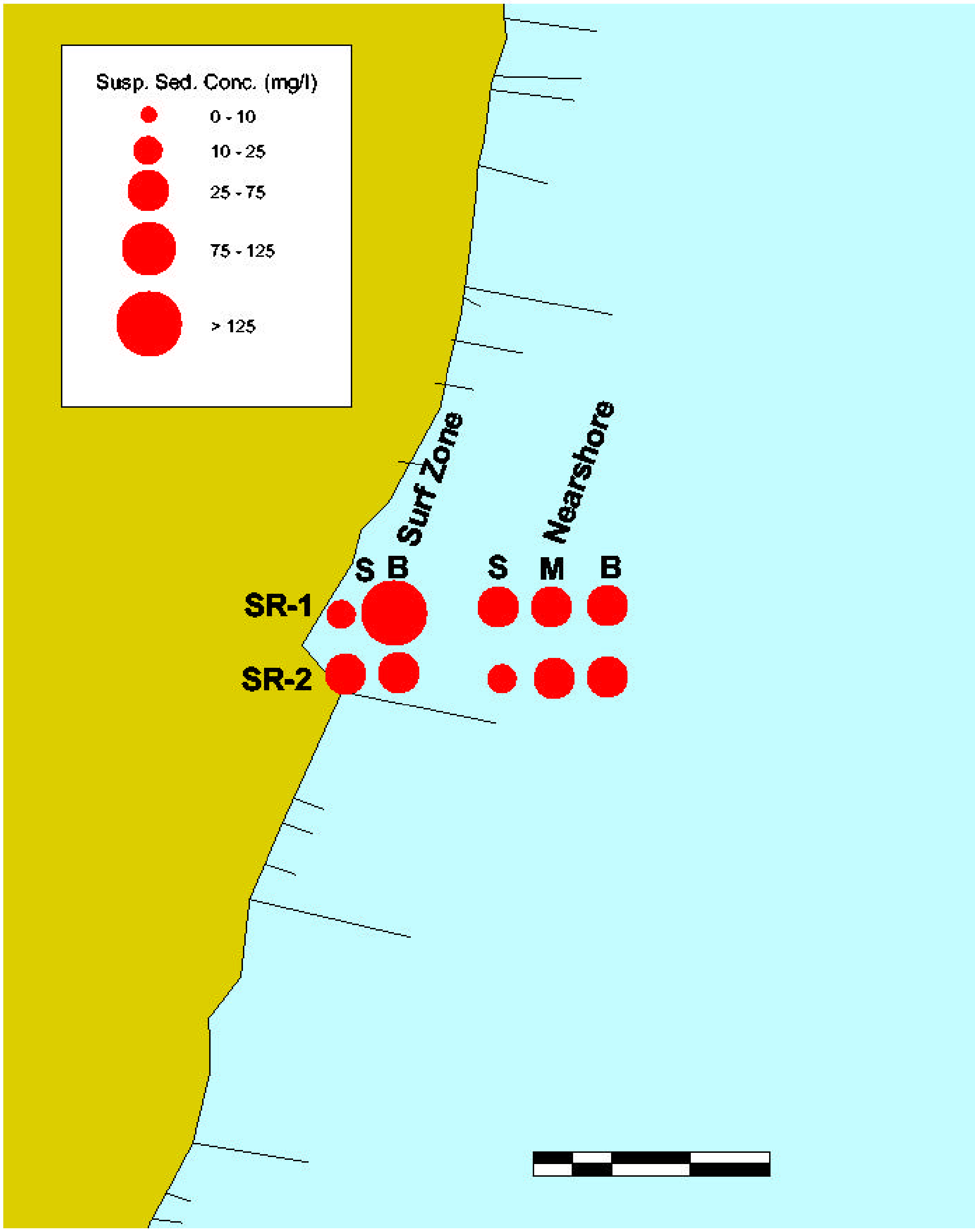

Figure 7-28. Suspended sediment concentrations at the South Reference Site on September 19, 1999.
S = Surface, M = Mid Depth, B = Bottom.

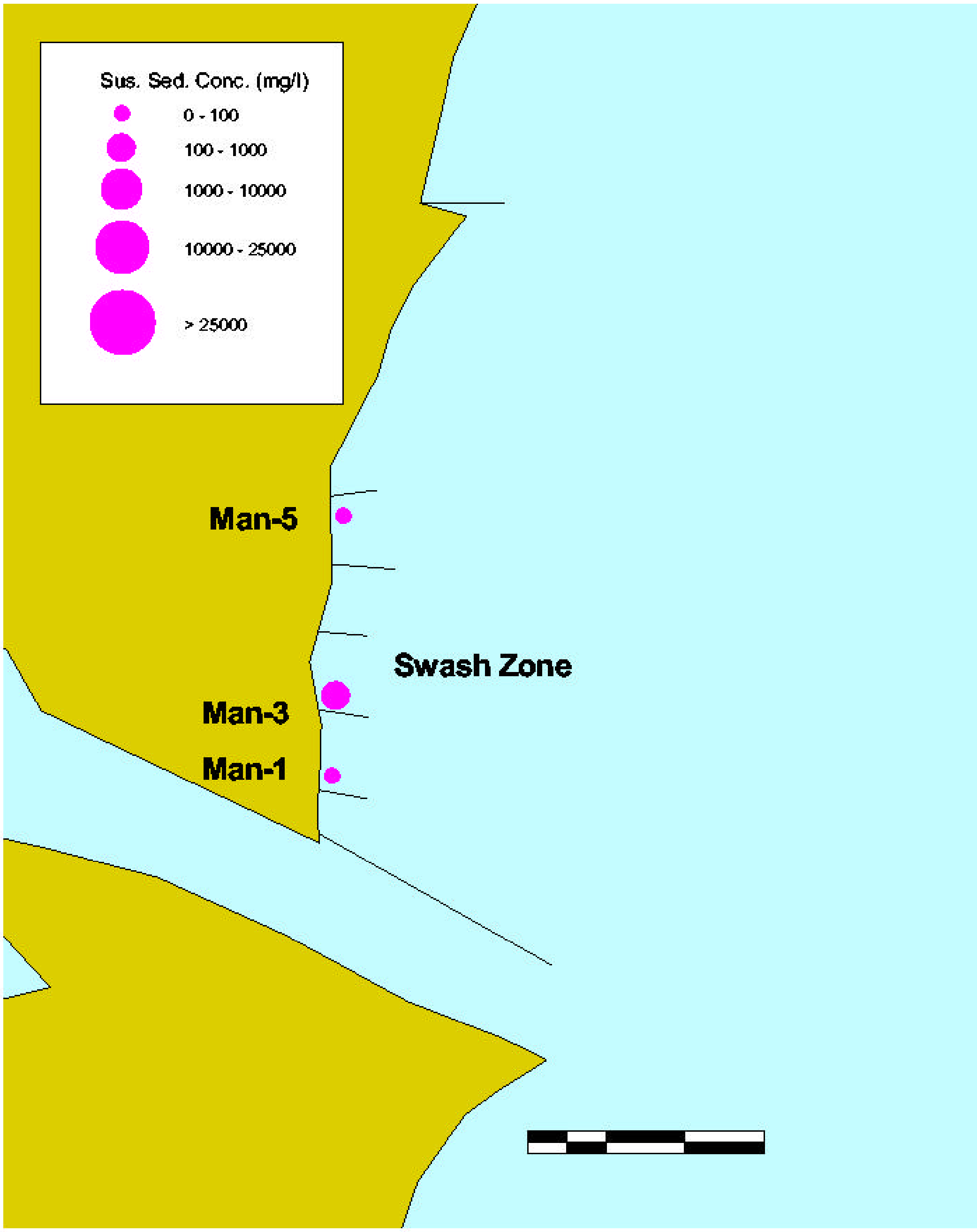

Figure 7-29. Suspended sediment concentrations at the Manasquan Reference Site swash zone on September 19, 1999. S = Surface, M = Mid Depth, B = Bottom.

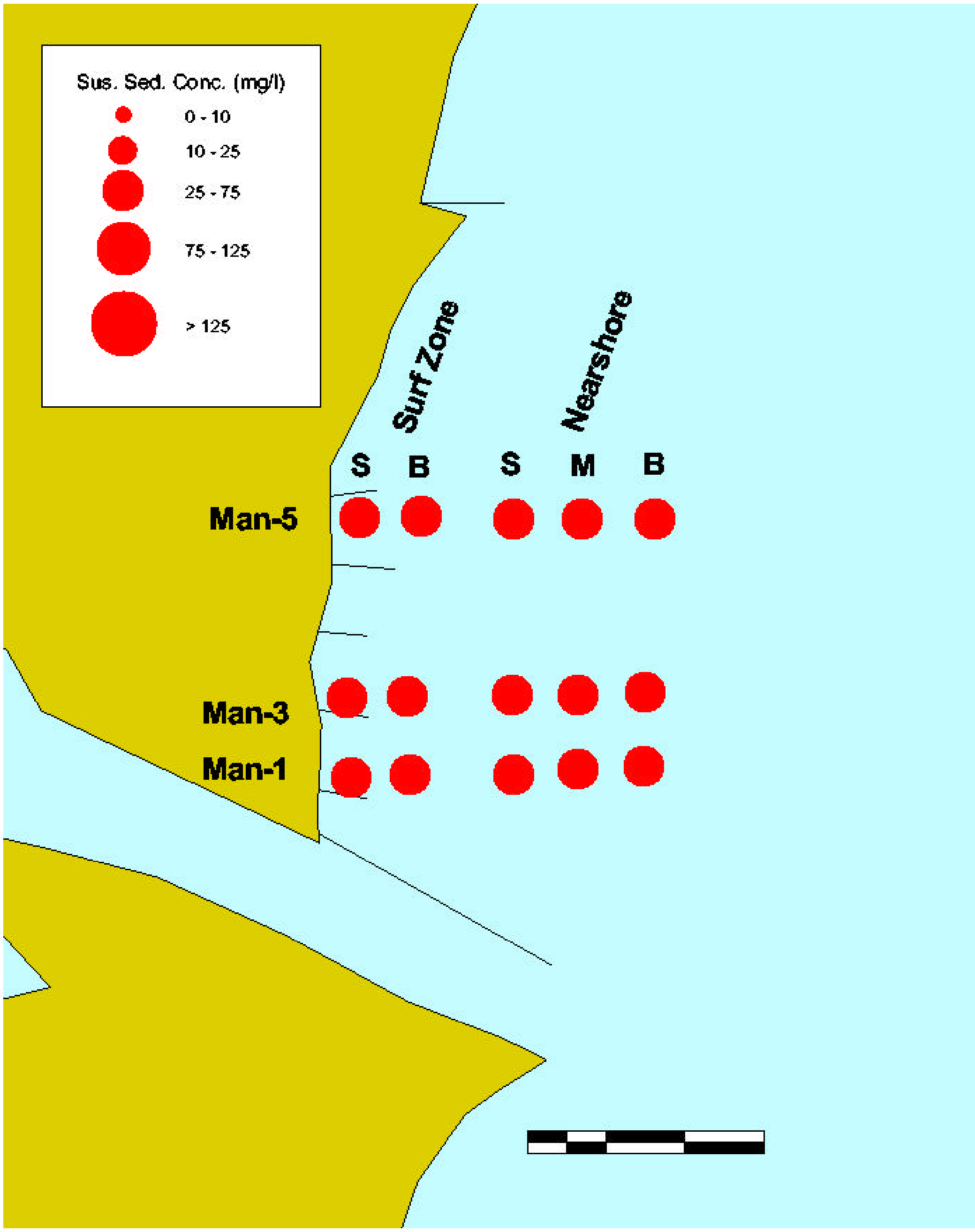

Figure 7-30. Suspended sediment concentrations at the Manasquan Reference Site on September 19, 1999. S = Surface, M = Mid Depth, B = Bottom.

The objective of this section is to describe the results of three types of field data collections; first, turbidity data recorded in conjunction with beach seining efforts in 1997, second, suspended sediment surveys at active filling sites completed in 1997 and 1998, and third, an examination of sediment resuspension at previously filled sites resulting from storm activity in 1999. Turbidity data for 1997 sampling events are considered because filling was underway at various sites between the Shark River and Manasquan Inlets during that time. The 1997 suspended sediment survey also occurred while filling was underway at a location north of Manasquan Inlet (Figure 7-2). In 1998, an opportunity was taken to repeat the suspended sediment survey at a site north of the Biological Monitoring Plan study area, but where essentially identical filling methods were being employed (Figure 7-3). The passage of two hurricanes in September 1999 (Hurricanes Dennis and Floyd) presented an opportunity to examine resuspension of both undisturbed and filled beach sediments by strong storms.

Methods

Wide Area Surveys At each beach seine station a Hydrolab water quality meter was deployed approximately 50 m (generally just beyond the line of breaking surf, if present) from shore for up to one hour, depending on the amount of time required to complete seining activities. The unit was set to record turbidity (NTUs) at 10 minute intervals. These data were later downloaded, yielding 3 to 6 data points per deployment. Mean values for each station were then calculated. Wind velocity (mph) and direction data were estimated at the time of sampling and observations were recorded in a field log at each station. GPS coordinates were determined for all station locations. For plotting purposes these data were entered into ArcView as a data layer superimposed upon NOAA's digitized shoreline projections of the project area.

Site Intensive Surveys For the during-filling surveys, 15 stations were occupied in close proximity to the active discharge. Additional stations were designated at each of two reference areas located at least several km to the north and south of the fill site. These reference areas consisted of 3 stations in the 1997 survey, and 2 stations in the 1998 survey. Because optical measures of turbidity are subject to uncertainties in linking them to potential effects on coastal organisms, gravimetric measures were used in the site intensive surveys. At each station 500 ml water samples were collected in the swash and surf zones by personnel wading to the collection points. When possible, surface and bottom samples were collected at surf zone stations, otherwise, surface samples were taken. Personnel operating from a small boat obtained similar samples at surface, middle, and bottom levels of the water column in the nearshore (approximate 3.5–5.0) m water depths) at each station. Additional samples were collected in the discharge effluent sediment slurry running down the beach face. Individual water samples were placed in coolers and taken to a shore-based facility for processing. Total suspended solids (TSS, mg/l) values were determined using methods specified in Standard Methods (APHA 1998). This procedure involves filtration of the water samples and drying of the filtered residues at 103-105^{o}C. Hydrographic measurements were taken with a Hydrolab water quality meter and station locations determined by a GPS unit. TSS data were plotted in ArcView.

Results

Wide Area Surveys Wide area surveys conducted in conjunction with beach seining activities were completed on six occasions during 1997: August 4 – 7, August 19 – 23, September 2-4, September 15 – 18, September 30 – October 3, and October 14 - 15. Because seining requires several days to complete, the turbidity data for each sampling event reflect a 2 to 5 day span of time. This can be an important consideration, given that wind and surf conditions, which affect local turbidities, can change substantially over relatively short time periods. Figures 7-4 through 7-9 present NTU and corresponding wind velocity and direction values at beach seine stations for individual sampling events. A color-coded line indicates stations that were sampled on the same day.

The August 4-7 survey occurred during a period of consistent, relatively high wind velocities in a predominantly onshore direction (Figure 7-4). Consequently, surf conditions were moderate throughout this sampling event. Filling was underway along a reach of shoreline between stations 15 and 18. Although 2 of 4 turbidity values measured at stations in proximity to the fill were higher than those measured at stations to the north on the same day, absolute values were not very elevated (< 20 NTUs) and did not exceed values noted at scattered stations away from the filling operation on other days.

The August 19–23 survey occurred during moderate to high velocity onshore wind conditions that became so severe that beach seining activities were curtailed (Figure 7-5). There were no active filling operations ongoing during this period. Relatively high turbidities (> 50 NTUs) were measured at stations 4, 27, and 28, likely a result of high surf conditions. Although stations 27 and 28 had received fill prior to this sampling date, and one could speculate that fines were being resuspended from these deposited sediments, station 4 was far removed from any fill.

During the September 2-4 survey, beach filling operations were underway at the southernmost stations (24-28) of the project area (Figure 7-6). Prevailing wind conditions were moderate to high velocity, but shifted in direction during the sampling period and became primarily offshore. Several stations among the active fill stations had higher NTU values than stations to the north, although generally not above 20 NTUs. Highest turbidities were measured at stations near the Shark River Inlet.

Wind conditions during the September 15-18 survey were variable with respect to both velocity and direction (Figure 7-7). Beach fill operations were underway in the vicinity of stations 22 to 24. There is some indication that turbidities were comparatively higher at these and adjacent stations (generally in the 29-70 NTU range) than elsewhere (generally < 28 NTUs) in the survey.

There is little evidence of elevated turbidities at active fill stations in the September 30 – October 3 survey (Figure 7-8). Filling was occurring between stations 21 and 23. Winds again were variable in velocity but predominantly offshore, which may account for the low observed turbidities (< 29 NTUs) with the exception of stations immediately north of the Shark River Inlet.

Beach filling did not occur during the October 14-15 survey. No pattern is evident in the distribution of NTU values (Figure 7-9). Highest turbidities were recorded at stations 13 and 14, which lie just south of the Shark River Inlet.

Site Intensive Surveys Two surveys were completed at active beach fill sites, near the border between the Boroughs of Sea Girt and Manasquan on September 4, 1997, and Long Branch on September 20, 1998. Winds during the former survey were out of the northwest at speeds of 5 to 15 knots, and wave heights were less than 2 ft. An ebbing longshore current was moving to the south. Winds during the latter survey were from the south at less than 10 knots, wave heights were 2 to 4 ft, and during collection of the majority of fill site samples, a flooding longshore current was running to the north. Prevailing conditions may influence short-term dispersion patterns.

Figure 7-10 presents the results of the 1997 active filling site samples. The solid shoreline shown represents the unnourished condition, based on digitized data that is several years old. The approximate post-fill shoreline is represented by a dotted line, based on GPS locations of each swash zone station. An accurate discharge point location is also shown. It is interesting to note the wide spacing of surf zone samples at the northern, unnourished end of the survey area. Newly filled beach faces typically have relatively steep profile, which has the effect of narrowing the distance between the swash and surf zones. Samples taken from the discharge effluent (not indicated in the figure) had extremely high TSS values, ranging from 699 to 1,048 g/l at the discharge point, to 408 to 702 mg/l in the streams running down the beach face. The highest swash zone TSS concentration (176 mg/l) occurred at station FS-5, directly below the discharge. Swash zone TSS concentrations were higher at stations south of the discharge point, ranging from 11 mg/l to 31 mg/l, whereas, the three northernmost stations had concentrations in the 5mg/l to 9mg/l range. Surf zone concentrations were somewhat higher at stations adjacent to and south of the discharge point, ranging from 29 mg/l at station FS-6 down to 13 mg/l at FS-9, whereas, the majority of the remaining surf zone station concentrations fell below 10 mg/l. All concentrations for nearshore surface and mid-water samples were less than 10 mg/l. Bottom samples at nearshore stations FS-8 through FS-11 were elevated by comparison, falling in the 15 mg/l to 34 mg/l range.

Reference area TSS samples for the September 1997 survey are presented in Figures 7-11 and 12. None of the swash, surf zone, or nearshore samples had TSS concentrations above 10 mg/l.

The September 1998 survey results (Figure 7-13) were similar to those of the 1997 survey in several respects, although measured TSS concentrations tended to be higher at all stations other than those in the discharge effluent or runoff streams. Effluent samples ranged from 723 g/l to 842 g/l, and samples in the runoff streams ranged from 378mg/l to 814 mg/l. Swash zone samples located directly below the discharge point had the highest measured concentrations (107, 100, 638, 382, 368, 227, and 461 mg/l at stations FS-5 through FS-11 respectively). Swash zone stations to the north had TSS concentrations in the 20 mg/l to 29 mg/l range, and stations to the south had concentrations in the 25 to 55 mg/l range. Surf zone surface and bottom station concentrations were generally in the 10 to 20 mg/l range, with the notable exception of station FS-8, close to the discharge point, where a maximum concentration of 64 mg/l was measured. Nearshore samples were consistently within the 10-15 mg/l range, with a minimum value of 5.4 mg/l at the surface for station FS-6 and a maximum value of 23 mg/l on the bottom at station FS-8.

Reference area TSS samples for the September 1998 survey are presented in Figures 7-14; 7-15. Swash zone samples fell within a range from 14 mg/l to 18 mg/l; surf zone samples from 5 mg/l to 24 mg/l; and nearshore samples from 9 mg/l to 20 mg/l.

Post-Hurricane Site Intensive Surveys The passage of two hurricanes in September 1999 provided the opportunity to examine resuspension of both undisturbed and filled beach sediments by strong storms. Surveys were conducted at the same sites occupied in 1998 with the addition of three stations just north of Manasquan inlet (Figure 7-20). The first post-storm survey was conducted on September 9, 1999, immediately after Hurricane Dennis and the second, September 19, 1999, immediately after Hurricane Floyd.

After Hurricane Dennis, suspended sediment concentrations in the surf zone and nearshore portions of the Fill area (i.e., the area filled in 1998) averaged less than 75 mg/l (Figure 7-16). In the swash zone, TSS values averaged 75-125 mg/l but exceeded this amount at stations FS-6, FS-7, FS-13, and FS14 (163 mg/l, 690 mg/l, 657 mg/l, and 288 mg/l respectively) (Figure 7-16). TSS values at the North Reference area ranged from 25-75 mg/l (Figure 7-17). Values at Shark River also ranged from 25-75 mg/l with the exception of the station SH-3 swash zone sample, which had 211 mg/l of suspended sediment (Figure 7-18). At the South Reference area, TSS values above 75 mg/l were found only at the two swash zone stations (Figure 7-19), while at the Manasquan stations they were present only in the swash zone and nearshore surface samples (Figure 7-20).

After Hurricane Floyd (September 19, 1999) concentrations of suspended sediments were higher than after Hurricane Dennis particularly in swash zone and bottom samples from the surf zone and nearshore areas. TSS concentrations in the swash zone of the Fill area were >1,000 mg/l at stations FS1 and FS-5 and >25,000 mg/l at stations FS-4 and FS-6 (Figure 7-21). Suspended sediment concentrations >125 mg/l were encountered in the surfzone at stations FS-2 and FS-4 and in nearshore bottom waters at stations FS-1, FS-5 to 7, FS-10 to 12, and FS-15 (Figure 7-22). At the North Reference area TSS values of nearly 1,000 mg/l were measured at station NR-1 and more than 1,000 mg/l at station NR-2 (Figure 7-23). No concentrations over 125 mg/l were found in either the surf zone and nearshore areas of the North Reference area (Figure 7-24). At the Shark River Reference area, no TSS values over 100 mg/l were found in the swash zone (Figure 7-25), surface, or mid depth samples from the surf zone and nearshore areas (Figure 7-26) except surf zone station SH-3 and nearshore stations SH-3 and SH-5

(Figure 7-26). At the South Reference area suspended sediment concentrations in the swash zone were 187 mg/l and 51 mg/l at stations SR-1 and SR-2, respectively (Figure 7-27). In the surf zone and nearshore of the South Reference area TSS values were generally under 75 mg/l with the exception of the surf zone bottom sample at station SR-1 where 175 mg/l was measured (Figure 7-28). Suspended sediment concentrations at the Manasquan Reference site were less than 75 mg/l at all stations regardless of depth (swash zone, surf zone, and nearshore) except for the swash zone station Man-3 (281 mg/l) (Figures 7-29 and 7-30).

Discussion

Results of the wide area and site intensive surveys yield several basic findings. With respect to spatial scales, the effects of beach fill operations on short-term turbidity conditions appear to be limited to a relatively narrow swath (less than 500 m) of beach front. Dispersal of suspended sediments is prominent in the swash zone in the immediate vicinity of the operation and can be traced into nearshore bottom waters. Although these surveys did not extend beyond a depth of 3–5 m, observed concentrations appeared to decline rapidly with dispersal through the surf zone. This may reflect simple mixing and dilution of fine sediments derived from the discharges. Another mitigating factor may be the relatively low fractions of silts and clays of the sediments excavated from the borrow areas, generally less than 10 percent by weight (see Chapter 8).

Dispersal is undoubtedly influenced by prevailing surf and turbulence conditions, as well as by longshore currents. These influences can be seen in the survey data. For example, TSS concentrations were generally higher by 5 mg/l to 10 mg/l throughout the study and reference areas in 1998 than in 1997, likely the result of wave induced turbulent resuspension. Also, the extension of elevated TSS concentrations into nearshore bottom waters is clearly seen in the 1997 site-intensive survey data. Elevated turbidities associated with the September 1997 filling operation effluent runoffs were generally confined to the swash zone within several hundred meters of the discharge point. Slightly elevated turbidities extended into the surf zone along a narrower swath of beach, and into the nearshore bottom portion of the water column, again along a relatively narrow corridor. The pattern of net movement offshore in a southwesterly direction is consistent with the influence of a southerly longshore current which was observed during the survey. According to Ashley et al. (1986), longshore currents in the area between Manasquan Inlet and Sandy Hook run predominantly to the north, but a pattern can only be detected with long-term data. They also point out that circulation patterns can be extremely complex when viewed on small spatial and temporal scales. For example, circulation cells may be approximately 500 m wide. These factors suggest that dispersal patterns of suspended sediment plumes emanating from nourishment discharges may vary considerably as the operation progresses.

The spatial scales of elevated turbidities can also be seen in the results of the wide area surveys, particularly surveys conducted on September 2-4 and 15-18. The latter survey shows a potential area of elevated turbidities at least one km wide. Another perspective on these data, however, can be observed in the highly variable and scattered occurrences of elevated turbidities at wide area survey stations distant from the filling operations. The maximum NTU values measured near the fill operations do not appear to be outside the range that organisms would be exposed to during periods of high wave energies.

Direct comparisons between the wide area and site intensive surveys cannot be made because the NTU data cannot be converted with confidence to mg/l. Also, wide area samples were obtained between the surf zone and nearshore locations designated in the site intensive surveys. Nevertheless, with the exception of swash zone samples, the magnitude of elevation above ambient conditions appears to be negligible. Measured TSS concentrations outside the swash zone seldom exceeded 25 mg/l, which is very comparable to concentrations that many of the dominant fish and invertebrate species of the northern New Jersey shore experience in estuaries. For example, juvenile and adult silversides and anchovies, both of which occur abundantly in turbid estuarine waters, should be tolerant of lengthy exposures to suspended sediments concentration less than 25mg/l. Their transient occurrences and highly mobile behavior would likely serve to limit the duration of exposure.

During calm weather and benign sea state conditions, a turbid plume may represent an optical “barrier” to certain fishes. If the plume observed in the September 1997 site intensive survey can be considered typical of that generated by pipeline discharge operations, the plume would largely affect bottom waters within 100 to 200 m from shore. These data may support the observed shifts in distribution of northern kingfish, which are apparently attracted to newly filled reaches of beach, and of bluefish, which may avoid plumes (see Chapter 5).

Strong storms such as Hurricanes Dennis and Floyd produce high levels of suspended sediments over wide areas with particularly high TSS occurring in the swash zone. Recently filled and undisturbed beach sediments appear to be equally susceptible to resuspension with the highest concentrations of suspended sediments occurring at irregular intervals within each beach type.

Findings of this study are generally consistent with those of other studies characterizing beach nourishment-induced turbidity plumes. Surprisingly, although suspended sediment related issues are often a stated concern in interagency coordination of beach nourishment projects, few attempts have actually been made to monitor such plumes. Most of the available literature on suspended sediment or turbidity conditions in swash, surf, and nearshore zones deals with sediment transport dynamics (e.g., Horn and Mason 1994), rather than environmental issues per se. Some of the sediment transport studies, however, do provide insights relevant to interpretation of nourishment project monitoring results. Masselink and Pattiaratchi (1998) reported that winds had dramatic effects on sediment resuspension in the surf zone. Suspended sediment concentrations increased six-fold to approximately 6 g/l at a height of 0.275 m above the bed during persistent sea breezes. Beach and Sternberg (1992), using optical backscatter sensors, estimated that mean background suspended sediment concentrations 54 cm above the bed at an Oregon beach were approximately 0.5 g/l.

Reilly and Bellis (1978) collected two TSS samples from the surf zone during nourishment operations at Fort Macon State Park, North Carolina. Concentrations were 1.76g/l and 4.70g/l, much higher than concentrations of 0.10g/l and 0.09g/l at Emerald Isle, a reference beach. These concentrations are very high in comparison to those measured in the present study. One possible explanation is that the North Carolina project involved hydraulically dredged maintenance and deepening dredged material comprised of significant clay fractions. The authors noted that numerous clay balls were present in the fill material.

Raymond and Antonius (1977) presented the results of monitoring turbidity at a beach nourishment project in Broward County, South Florida. The average turbidity of the plume at the beach fill site at a distance of 30 m from shore was 92 NTUs. Correlation of turbidity (NTU) values with suspended sediments concentrations (mg/l) for all samples taken in their study indicated that a turbidity measurement of 92 NTUs corresponded to about 110mg/l.

Van Dolah et al. (1992) assessed turbidity conditions associated with a beach nourishment project at Hilton Head, South Carolina. They concluded that elevated turbidities were restricted to a small area near the discharge point during periods of active pumping. Van Dolah et al. (1994) reached similar conclusions for a study of beach nourishment effects at Folley Beach, South Carolina. The spatial extent of the turbid plume in this study, as determined by measurements of NTUs, extended approximately 1,000 m in a down longshore current direction at a distance of 15m from shore, and 500 m at a distance of 30 m from shore. Turbidity levels were variable depending on local weather conditions. During periods of calm winds and seas, turbidities of about 100 NTUs were measured near the discharge. With strong winds and turbulent waves, turbidities increased to 200 NTUs within 300 m of the discharge. Van Dolah et al. (1994) stated that background turbidities approached 100 NTUs during episodes of storm generated turbulence. They concluded that, "Although dredge effluent does increase turbidity levels in the immediate vicinity of the outfall, there are many other factors such as local weather and wave energy that will also produce this effect. The turbidity levels found at Folley Beach during nourishment and the dispersal of the sediment plume were not considered unusual or severe relative to normal fluctuations and background levels."

In summary, the spatial scales of elevated turbidity associated with beach fill operations are relatively small. Likewise, the increment of suspended sediment concentrations above ambient attributable to fill operations is relatively small once sediments have dispersed outside the swash zone.

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