

4. RESULTS AND DISCUSSION

4.1 Study Site Summary

In July 1999, the NJDEP mitigation database included a total of approximately 223 proposed mitigation sites and included both freshwater and tidal wetland mitigation projects. These sites comprised nearly 1,249 acres of proposed mitigation. The most common type of mitigation goal proposed, both in terms of total area and number of sites, was wetland creation. Wetland creation accounted for 670 acres, representing 54% of all proposed mitigation area. In contrast, restoration accounted for only 134 acres or 11% of the total proposed mitigation area. The average proposed size of all mitigation sites in the NJDEP database was approximately 5.6 acres.

The NJDEP database included 177 approved sites identified as freshwater wetland mitigation, consisting of a total of 562 acres (Table 6) or 45% of the total wetland mitigation contained in the NJDEP database. The most common freshwater wetland community type proposed was forested (PFO), representing 228 acres or 41% of the total approved freshwater wetland mitigation area. Emergent (PEM) accounted for 33% of the total approved freshwater wetland mitigation area. Scrub/shrub (PSS) wetlands and open water (SOW) accounted for the least amount of freshwater mitigation area approved by NJDEP, representing 14% and 13%, respectively. The average proposed size of freshwater mitigation sites was 3.2 acres.

Completeness of information contained in each mitigation file was found to be highly variable precluding a thorough and consistent review of all mitigation sites contained in NJDEP's database. This factor limited the number of field evaluations that could be performed. Most of the files contained some statement regarding goals and area. However, only 71% of sites clearly stated the type of wetland proposed to be built. The proposed source of hydrology was only specified 68% of the time. The availability of grading and landscape plans was 89% and 78%, respectively. For those files that did contain information regarding these goals, the level of this information was often not specific enough to facilitate a complete and reliable field evaluation.

Summary of NJDEP Mitigation Database

Proposed Wetland Mitigation Type					
	Proposed Freshwater Wetland Mitigation	Forested (PFO)	Scrub/Shrub (PSS)	Emergent (PEM)	Open Water (SOW)
Sum	561.91	228.28	76.94	183.91	72.78
Mean	3.17	2.24	1.71	2.70	3.03
Min	0.01	0.01	0.01	0.01	0.07
Max	30.00	30.00	19.00	29.90	29.00
n	177	102	45	68	24
%	-----	41	14	33	13

Table 6: Summary of Proposed Freshwater Wetland Mitigation Sites in the NJDEP Mitigation Database. Includes summary of the type, in acres, of proposed freshwater wetland mitigation sites for which proposed wetland mitigation by community type is identified. Creation and restoration sites are represented. **Note:** Each mitigation site may include more than one type of proposed mitigation.

A total of 90 sites were selected for field evaluation. These study sites were widely distributed throughout the State (Figure 2) including sites within 17 of New Jersey's twenty Watershed Management Areas (WMAs). The study sites included a total of 326 acres of proposed wetland mitigation area. Mitigation goals included 285 acres of creation and 34 acres of restoration. The remaining acres of mitigation goals were identified as enhancement or "other". Study sites ranged in size from 0.08 to 41.20 acres, with an average size of 3.62 acres. Forested (PFO) and emergent (PEM) were the most common type of wetland proposed, accounting for 43% and 33% of total mitigation area, respectively (Table 7). The study sites were generally representative of both size and proposed type in comparison with all freshwater sites contained in the NJDEP mitigation database. Of the 326 acres of proposed mitigation included the study, field delineations were performed on 297 acres (91%) (see section 2.3.1 for an explanation of wetland area evaluated).

The average age of the study sites was six years since implementation (see Appendix A). Study sites ranged from less than one year old to in excess of 12 years old representing a study period from 1988 through 1999. The majority of sites (64%) were implemented more than five years ago, representing 60% of the total area evaluated. Only three sites (3%) were less than two years old.

This study focused on freshwater wetland creation mitigation sites. The majority of the proposed mitigation goals included in the study sites consisted of wetland creation (88%). Wetland restoration and enhancement accounted for only 10% and 2% of the total proposed wetland mitigation, respectively (see Appendix A).

4.2 Wetland Area Achieved

Study findings indicate that a relatively low percentage of proposed mitigation achieved the stated area of wetlands and the wetland type achieved was largely inconsistent with approved plans and specifications. Of the proposed 297 acres of mitigation wetlands evaluated, only 187 acres of wetlands were created suggesting that wetland mitigation is not contributing to the NJDEP's NEPPS wetland resource goal of a net increase in wetland area.

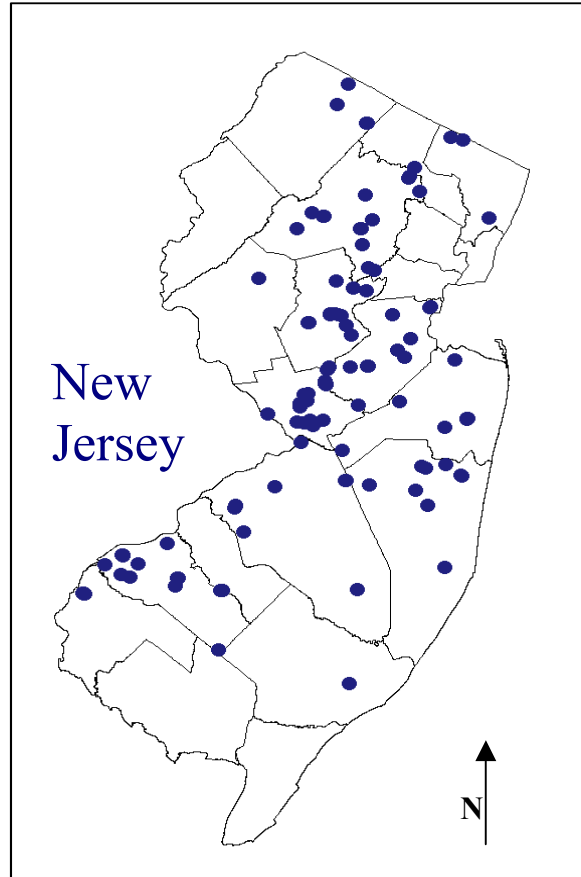


Figure 2: Study Site Location Map

Wetland Mitigation Study Sites

	Proposed Acreage	PFO	PSS	PEM	SOW
Sum	325.60	139.71	21.93	105.77	26.69
Mean	3.62	2.49	0.91	2.78	1.91
STD	6.28	4.89	0.90	5.41	2.82
Min	0.08	0.04	0.01	0.12	0.19
Max	41.20	25.50	3.23	29.90	11.30
n	90	56	24	38	14
%	-----	43	7	33	8

Table 7: Summary of Proposed Wetland Type for 90 Study Sites for which proposed wetland mitigation by type is identified including PFO=Forested, PSS=Scrub/Shrub, PEM=Emergent and SOW=Open Water. Note: Each mitigation site may include more than one type of proposed mitigation.

Wetland Area Achieved was assigned for each mitigation site. The average Wetland Area Achieved indicator score was 45% (Table 8). This represents, on average, approximately 0.45 acres of wetland achieved for every 1.0 acres of mitigation proposed. The total area of wetlands achieved (187 acres) in relation to proposed acreage (297 acres) suggests a higher overall percent wetlands area achieved (63%); however, the average Wetland Area Achieved indicator score of 45% provides a more appropriate measure of percent area achieved. Averaging across all sites is appropriate because this measure reflects a sample of 90 mitigation sites. As Table 8 shows, some sites achieved in excess of the amount of wetland area proposed while some sites achieved no wetlands.

Of the 85 wetland delineations conducted, six sites achieved in excess of 100% of the approved acreage. However, 16 sites failed to achieve any wetlands and 93% of all sites achieved less wetland area than proposed. Although forested (PFO) wetland accounted for in excess of 47% of the total mitigation proposed, only 1% of forested wetland area was achieved on average. On average, scrub/shrub (PSS) wetland was achieved only 11%. Emergent (PEM) wetland was created at close to the same area proposed, with 92% of area achieved. The Percent Wetland Type Achieved value was based upon field evaluation of existing conditions with respect to consistency with approved plans and specifications.

Nearly three times the area of open water was achieved through mitigation as compared with the amount of open water proposed in mitigation plans (Figure 3). Because the statutory authority in New Jersey that regulates activities in and around wetlands also regulates placement of fill in State open waters, and in consideration that mitigation plans are regularly approved by NJDEP that include an open water component, open water was treated as a wetland resource for purposes of this study. For example, if a mitigation site proposed 1 acre of mitigation and a 1 acre open water pond was achieved it would be assigned a Wetland Area Achieved value of 100%.

Of the 90 mitigation sites included in this study, 14 sites proposed a total of 27 acres of open water. However, in excess of 77 acres of open water were achieved, representing in excess of 41% of the total area of “wetlands” achieved through mitigation. This raises a question as to whether the replacement of wetlands of equal ecological value is occurring. If excess open water

	Total Acres Evaluated	Total Acres Achieved	Wetland Area Achieved (%)
Mean	3.49	2.20	45.09
Range	.05-41.20	0-51.51	0-140
Total	296.87	186.91	

Table 8: Results of Wetland Area Achieved Indicator
Note: Mean wetland area achieved represents the average among all study sites.

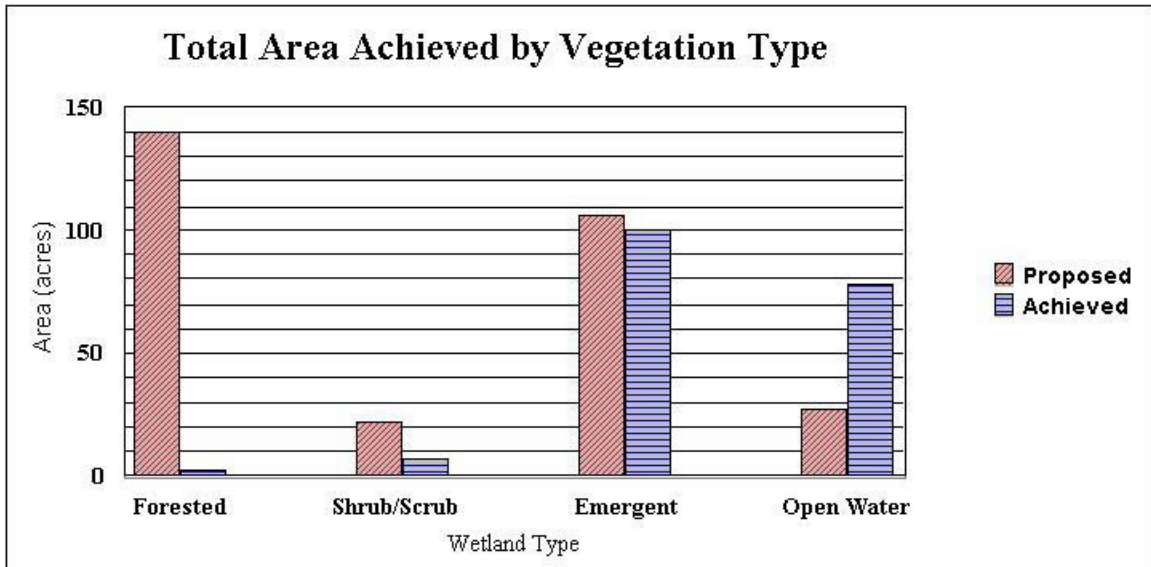


Figure 3: Results of Total Wetland Area Achieved by Vegetation Type Proposed (in acres)

were deleted from the Wetland Area Achieved calculation, the results of this indicator would be lower than 45%, suggesting that type of wetland achieved through mitigation is an important consideration in evaluating the success of mitigation in achieving NJDEP's NEPPS goals.

4.3 Concurrency Evaluation

The results of the Concurrency Evaluation indicator suggest that as-built conditions, on average, are inconsistent with plans and specifications approved by NJDEP. Of the 88 concurrency evaluations performed, the average weighted score was 48% (Table 9). Weighted scores ranged from 0 to 100% concurrence with approved plans. Concurrency evaluations could not be performed on two of the study sites due to insufficient plan information in the mitigation files. Sample size varied with each variable (i.e. Soils, n=53 vs. Hydrology, n=81) reflecting the inability to assign concurrence values for all variables due to insufficient mitigation specifications for a particular site.

Hydrology, the variable that was assigned the highest weighting factor (see Table 2), achieved an average raw score of 47%. Typically, the grading and design variables were most consistent with approved plans. Both of these parameters achieved a raw score of 56%. Vegetation variables of percent cover and percent survival achieved the lowest concurrence scores of 39% and 28%, respectively. There was a high standard deviation evident for all scores suggesting a wide variability in degree of consistency with approved plans among study sites.

As part of the Concurrency Evaluation, a determination was made as to what corrective actions would be needed on each site to make them consistent with their stated goals and objectives. It was found that no corrective actions were needed on only 3% of sites

The following is a brief overview of the findings for each variable, focusing on major reasons for low scores for each variable.

A. Grading – For the 68 sites for which enough information was available in the mitigation file to conduct an evaluation, 56% of grading was consistent with NJDEP approved plans. Low

Concurrence Evaluation Indicator Scores (%)							
	Grading	Hydrology	Soil	Veg. Cover	Veg. Survival	Design	Concurrence Score
Mean	55.51	47.28	50.94	39.46	28.31	56.38	47.52
SD	31.90	31.22	35.90	29.89	27.09	29.97	24.87
Min	0	0	0	0	1	0	0
Max	100	100	100	100	100	100	100
n	68	81	53	80	62	80	88

Table 9: Summary of Concurrence Evaluation Indicator Scores
Note: Table shows individual raw scores and weighted total score.

concurrency scores for grading were attributed primarily to the failure to achieve proposed grade or elevations on part or in some cases the entire site, because too little or too much soil had been removed from the site. It was found that 61 of the 90 study sites (68%) would require some form of re-grading to be consistent with approved plans and specifications.

B. Hydrology – Hydrology was consistent with approved plans, on average, 47% of the time. Sufficient specifications were available in the mitigation file to allow a hydrology concurrency evaluation on 81 study sites. Low hydrology scores were most often attributed to inadequate grading or failure of hydrologic specifications to adequately or sufficiently address the naturally occurring hydrologic regime in the area, including availability of an adequate water supply, seasonal and annual variations, or extreme events such as drought. Only 6 (7%) of the 90 mitigation study sites contained some form of device to monitor whether appropriate hydrology had been achieved.

C. Soil - For the 53 sites for which enough information was available in the mitigation file to conduct an evaluation, soil conditions on 51% of proposed mitigation was consistent with approved plans and specifications. The low sample size reflects a general absence of sufficient soil specifications in mitigation plans among study sites. The most commonly observed departure from plans and specifications was the lack of placement of any topsoil on the site. In some cases, soil was placed, but the soil did not meet topsoil specifications in plans (e.g. depth and/or organic content). A total of 42 of the 90 study sites (47%) required some form of supplemental topsoil.

D. Vegetation Cover - Sufficient information was available for 80 sites to conduct an evaluation for this variable. Vegetation cover was accomplished, on average, on 39% of sites in concurrency with plans and/or the NJDEP requirement that mitigation sites achieve 85% or greater cover of native non-nuisance hydrophytes. Mitigation sites that failed to achieve this goal did so due to high mortality of planted vegetation, lack of propagation of planted vegetation, lack of natural recruitment of hydrophytes, invasion by nuisance and invasive plants (including persistent grasses planted for erosion control purposes), or a combination of all three factors (see Appendix C for a list of nuisance and invasive plants). In some cases low vegetation cover

scores were attributable to the failure to plant specified plant stock consistent with the species, stock type and/or numbers specified in the mitigation plan. In some cases, planted vegetation failed but natural recruitment was sufficient to meet the goal of 85% or greater cover achieved. Based upon field evaluations conducted as part of this study, 76 or 84% of the 90 study sites were determined to require some form of supplemental planting to make them consistent with approved plans and specifications.

E. Vegetation Survival – For the 62 sites for which sufficient information was available in the mitigation file to conduct an evaluation, an average of 28% of vegetation planted survived. Major factors contributing to vegetation mortality were too little or too much water, herbivory by geese or deer, poor planting techniques, poor vegetation stock or failure to comply with the planting specifications contained in the approved mitigation plan. The lower sample size for this variable may be attributed to fewer sites containing sufficient planting specifications such as plant stock type or plant numbers to accommodate a thorough evaluation. Seventy-six of the 90 study sites (84%) were found to need supplemental planting.

F. Design – 80 sites contained sufficient design criteria in the mitigation file to conduct an evaluation for the design variable. This variable was consistent with NJDEP approved plans an average of 56% of the time. Design specifications primarily consisted of general information on proposed size and shape of the mitigation site. Design criteria such as establishment of transition areas and ongoing maintenance requirements were rarely addressed in mitigation plans. Some form of maintenance was needed at 31 of the 90 study sites (34%).

4.4 Wetland Mitigation Quality Assessment (WMQA)

Wetland Mitigation Quality Assessments (WMQAs) were performed on 74 study sites that achieved 187 acres of wetlands. No WMQAs were performed on those 16 sites that did not achieve wetlands based upon the results of the wetland delineations. Relative quality of wetlands achieved was evaluated with respect to individual variables including hydrology, soils, vegetation, wildlife suitability, site characteristics, and landscape features based upon a rating

scale of 0 to 3 (see Table 4). A final WMQA indicator score was based upon an index from 0 to 1.

The average WMQA index score was 0.51 out of a maximum possible score of 1 (Table 10). Scores ranged from 0.25 to 0.83. Overall, scores were low compared to what would be expected if the mitigation sites evaluated had a high potential to function as natural wetlands. With respect to individual variables evaluated, soils and site characteristics achieved the highest scores on a scale of 0 to 3 with scores of 1.67. Hydrology also achieved a relatively high average score of 1.61 out of a possible score of 3. Wildlife achieved the lowest average score of 1.22. A high variability among all parameters was observed suggesting that no one parameter consistently drives the WMQA index.

The following is a brief overview of the findings for each variable, focusing on major reasons for low scores for each variable.

A. Hydrology – Average Score: 1.61. Hydrology of the sites evaluated ranged from areas with too little water to areas with too much water. Areas with too little water included encroachment of transitional and upland vegetation species, high mortality of planted wetland species, and lack of other hydrologic indicators such as plant morphological adaptations, sediment deposition, and hummocks. Areas with too much water generally supported large expanses of open water with little or no vegetated fringe. In both cases, it appeared as if low hydrology scores resulted from inappropriate or inadequate source of hydrology or established grades that were inconsistent with the hydrologic regime of the site.

B. Soil – Average Score: 1.67. Low soil scores were often the result of insufficient or absent topsoil or soil of poor quality for establishing vegetation. In areas where topsoil was inadequate, the soil was often too dry or compacted to the extent that recruitment of desirable wetland plant species was precluded.

C. Vegetation – Average Score: 1.42. Vegetation (both canopy – above 3 ft. in height, and ground cover – below 3 feet in height) often lacked diversity and density that would be expected

WMQA Score							
	Hydrology	Soil	Veg. Total	Wildlife	Site Char.	Landscape	Total WMQA Index
Mean	1.61	1.67	1.42	1.22	1.67	1.43	0.51
SD	0.64	0.77	0.52	0.56	0.57	0.55	0.14
Min	0.5	0	0.5	0	0.5	0.33	0.25
Max	3	3	2.5	2.5	2.5	2.67	0.83
n	74	73	74	74	74	74	74

Table 10: Summary of Wetland Mitigation Quality Assessment (WMQA) Scores.
Note: Table shows individual raw scores based on rating scale from 0-3.
 Weighted WMQA Score based on index from 0-1.

in a system that was becoming a highly functioning wetland. Extensive mortality was evident from deer and goose herbivory, inadequate hydrology, poor planting stock, improper planting techniques, poor growing media, or a combination of several of these factors. In areas where the mitigation site exhibited favorable hydrology and soil conditions, natural recruitment of desirable wetland vegetation negated most of these problems. Establishment of invasive species or persistent grasses was evident on numerous sites and in some instances precluded the establishment of desirable wetland plants.

D. Wildlife – Average Score: 1.22. Mitigation areas often lacked structural or plant species diversity needed to support feeding or breeding requirements for wildlife. Many mitigation sites were located in areas where human disturbances such as housing were incompatible with or detracted from wildlife utilization.

E. Site Characteristics – Average Score: 1.67. Many mitigation sites scored low for this variable due to small size and location in an area with incompatible land uses (e.g. adjacent to a residential or industrial development or in a clover leaf of a highway interchange). Many sites also lacked heterogeneity (e.g. contained 100% State open water with minimal or no littoral fringe). Most sites required at least some ongoing maintenance, such as control of invasive species or periodic maintenance of water control structures. Although the shape of sites was generally designed to be conducive to wetland functions – most sites tended to be more square or circular as opposed to being designed as long, narrow features – this variable may have been influenced by site selection methods.

F. Landscape – Average Score: 1.43. Mitigation areas evaluated often scored low in terms of all three landscape subcategories. Buffers were often narrow or of marginal benefit to the adjoining wetland (e.g. sparsely vegetated or exhibiting high rates of erosion), sites were often not compatible with the surrounding landscape (e.g. a wetland was not contiguous with adjoining wetlands or open space), and the surrounding land use was often developed, contributing to increased rates of stormwater runoff into the mitigation wetland.