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EVALUATING DESIGN AND VERIFYING COMPLIANCE OF WETLANDS CREATED UNDER SECTION 404 OF THE CLEAN WATER ACT IN OREGON

by

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DISCLAIMER

The research described in this report has been funded wholly or in part by the United States Environmental Protection Agency (EPA) under Contract #68-C8-0006 to NSI Technology Services Corporation. It has been subjected to the Agency's peer and administrative review, and it has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

Permit specifications, construction plans, and field measurements were used to examine the correlation between design and conditions "as-built" in a population of 11 palustrine emergent marshes created in the metropolitan area of Portland, Oregon, between 1980-1986. The projects ranged from six months to almost seven years in age. Data on planned and existing hydrology, wetland area, wetland shape, slopes of banks, and vegetation were collected for each site. Information on the plans for each site was gathered from the Section 404 permit files of the Portland District Office of the U.S. Army Corps of Engineers and the permit files of the Oregon Division of State Lands.

Results indicate that none of the wetlands studied were designed or constructed as permitted. Hydrology could not be evaluated since the information in the permit files was inadequate. There was a cumulative loss of 1.48 ha (3.6 acres), or 29% from the 5.10 ha (12.6 acres) that was to be created. Seven of the created wetlands had very regular shorelines; four had irregular shapes. The predominant slope as-built was gentler then what was to be built as determined from the construction plans and permit specifications for nine of the eleven projects (82%). For 45% of the sites (5/11) the predominant slopes to be built and as-built were steeper than the 5:1 maximum recommended in the literature. Vegetation to be planted did not occur on the sites. The proportion of species found on the created wetlands that were to be planted ranged from 0% to 7%.

The differences between the plans and specifications in the project file and the as-built conditions point to the need for verification of projects in both the planning and construction phases of the permitting process. The planning phase should focus on the development of a realistic approach using information from the scientific literature and past projects. The construction phase should culminate in the production of an as-built plan. This would allow immediate checks to ensure that critical features have been included as intended, e.g., wetland area, vegetation type. It would also document any corrective measures that were taken due to unanticipated events during construction. As-built plans of the project would ensure that the details of the actual wetland created were available for future reference in addition to the conceptual design.

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SECTION I

INTRODUCTION

The growing body of information on both the ecological values of wetlands and the documentation of the historic losses of these systems has generated concern about the status of the resource. Reflecting this concern the U.S. Environmental Protection Agency (EPA) initiated a Wetlands Research Program (Zedler and Kentula 1986) to assist the Agency in implementing its responsibilities to protect the Nation's wetlands. In particular, the research program was designed to support the Agency in the administration of Section 404 of the Clean Water Act (CWA).

The CWA was passed in 1972 to restore and maintain the chemical, physical, and biological integrity of the Nation's waters by regulating the discharge of dredge and fill materials. In 1977, the legislation was strengthened to give additional protection to wetlands. The U.S. Army Corps of Engineers (COE) and EPA jointly administer the Section 404 permit program. In brief, the COE is the Federal permitting authority, while EPA is responsible for issuing the environmental criteria for permit review, taking the lead in enforcement against unauthorized discharges, and overseeing state assumption of the program. EPA also has the authority to prohibit or restrict discharges that would have unacceptable adverse effects on certain resource values.

Applicants for 404 permits can be required to mitigate any adverse impacts to the aquatic environment caused by the proposed project. The EPA and COE use a three step process to evaluate Section 404 permit applications. The steps are to (1) avoid impacts by exploring alternatives; (2) minimize potential impacts through project modifications; and (3) compensate for any unavoidable impacts which remain. Compensatory mitigation includes either the restoration of existing degraded wetlands or the creation of man-made wetlands (Memorandum of Agreement 1990).

Interest in compensatory mitigation has generated a number of reports on wetland creation and restoration. In summarizing the results of a recent review of wetland creation and restoration in the United States, Kusler and Kentula (1990) state that the overall status of the literature on wetland creation and restoration is uneven by region and topic. Moreover, the most quantitative and best documented information is available for **Spartina alterniflora** (Lois) marshes along the Atlantic Coast, while information on the creation and restoration of inland freshwater wetlands is spotty, at best. Most of the studies of mitigation projects have been qualitative case studies (e.g., Baker 1984, Reimold and Cobler 1986, Fishman et al. 1987, Good 1987, Mason and Slocum 1987, and Reiner 1989). Furthermore, most are site-specific and do not use reference sites (Quammen 1986).

The research reported in this document was one component of EPA's ongoing research to determine how well compensatory mitigation is working and how the process could be improved. The research was designed to broaden the information base on wetland creation and restoration by examining mitigation projects in the context of the wetlands in a region. Ultimately, the work will lead to a statement on the status of compensatory mitigation as well as an evaluation of individual projects.

The store of information associated with the thousands of mitigation projects that have been constructed nationwide has been used to study completed projects to identify critical design features, develop methods for evaluating projects, determine the functions they perform, and describe how they change with time. To date, studies have been conducted in Oregon. Connecticut, and Florida.

This study focuses on freshwater, compensatory mitigation projects in Oregon. Quantitative measurements were taken to 1) determine if the wetland creation projects were in compliance with their permit specifications, 2) verify that the wetlands were created according to their construction plans, and 3) evaluate the design of those projects.

SECTION II

METHODS

The design and construction of a population of 11 freshwater wetlands created in the Portland metropolitan area as a requirement of a Section 404 permit was examined. Briefly, this involved the comparison of the as-built characteristics of the created wetlands measured in the field with the permit conditions and construction plans. In addition, design and as-built features were compared to the specifications found in the literature. Site selection, data collection in the field and from project records, and the process used to compare the information on specific design features follow.

SITE SELECTION

The created wetlands to be studied were located by searching a database of all wetlands created in Oregon as a condition of a Section 404 permit between January 1977 and January 1987 (Kentula et al. submitted). A population of 11 palustrine emergent wetlands, $\leq$ 1 ha in size, ranging from six months to almost seven years in age was identified in the Portland Metropolitan Area (Table 1). Because of its small size, the entire population was sampled.

DATA COLLECTION

Data on planned and existing hydrology, wetland area, wetland shape, slopes of banks, and vegetation were collected for each site. The general approach is presented below; details are given when each item is discussed in the subsections that follow.

Information on the plans for each site was gathered from the Section 404 permit files of the Portland District Office of the COE. In Oregon, in addition to, and in concurrence with the federal regulations, the Oregon Division of State Lands (ODSL) regulates the removal and discharge of materials into waters of the state and will participate in the review of Section 404 permits. Therefore, the ODSL permit files were also searched to augment the data gathered from the COE. Specifically, the permit conditions, and, when available, project descriptions, blueprints, conceptual drawings, and lists of species to be planted were used.

Information on the existing conditions on the sites was gathered in the field. Sampling of hydrology, wetland area, wetland shape, soils, and vegetation occurred

TABLE 1. Dates when construction and field sampling was completed for the created wetlands.

SITE	CONSTRUCTION COMPLETED	SAMPLED IN THE FIELD
C1-CC	8/80	6/87
C2-TI	8/86	7/87
O3-NS	9/86	6/87
04-MHP	2/86	6/87
C5-MG	7/86	7/87
C6-3I	9/84	7/87
C7-SML	10/85	7/87
C8-BSP	10/86	6/87
C9-GP	9/85	6/87
C10-PP	7/85	7/87
C11-SM	10/86	7/87

during the summer of 1987. Slopes of banks were measured during the summer of 1988.

Evaluating the Hydrology to be Created and Actually Created

Permit files were examined for information on the intended hydrologic regime, water levels, and area of the site to be inundated, and for descriptions of water sources, inlets, outlets, and water control structures.

Sites were evaluated in the field for indicators of wetland hydrology. Evidence that saturation occurred for a time sufficient to support hydrophytic vegetation and create hydric soils were documented (Federal Interagency Committee for Wetland Delineation 1989). Evidence of a hydrophytic plant community was presence and degree of dominance of obligate, facultative wetland, and facultative vegetation as defined by Reed (1988). Evidence of wetland hydrology used were presence of water above the surface of the substrate, presence of water in soil pits, evidence of soil saturation (glistening), and presence of mottles in the soil. In addition, presence of hydric soil was determined on the basis of soil chroma, and percent organic carbon content. Soil chroma was determined using a Munsell Color Book. Percent organic matter was expressed as ash free dry weight. In addition, water sources, inlets, and outlets were located and described and their location documented. Water levels on site were measured in each vegetation plot relative to the soil surface and recorded. Percent of the site inundated was estimated and recorded.

Evaluating the Area to be Created and Actually Created

Three types of information were used to determine how the wetland area in the plans and as-built compared with that listed in the permit conditions--the written permit conditions, permit maps, and field maps. Paired permit and field maps for each site were drawn at the same scale so that each map fit on an 8 1/2 x 11 inch piece of paper. Permit maps were drawn from blueprints and conceptual drawings contained in the permit files. Field maps were drawn from a compass traverse of each wetland (Lounsbury and Aldrich 1986). The field maps represent the perimeter of the wetland as determined from changes in vegetation and slope.

Back sights were taken from each point on the compass traverse as a check of the data points. The accuracy of the maps was checked by a member of the field crew. Closure error was negligible.

A planimeter (Numonics model #1250-1) was used to measure the area of each map in acres. Each map was traced three times and the resulting areas were averaged. A grid was used to check the accuracy of the planimetry on three pairs (27%) of maps drawn at different scales. The relative percent difference between the

areas derived from planimetry and those calculated by the grid was less than 5%. The data were converted from acres to hectares by multiplying by 0.4047.

Evaluating the Shape to be Created and Actually Created

The shape of each wetland as-built was checked against the shape indicated by the construction plans by visually comparing the permit and field maps. Notes on the observations were made. In addition, the literature was searched for information relating shape to ecological function.

Evaluating Slopes to be Created and Actually Created

The permits were searched for slope specifications for the banks of the wetlands. Statements within the permit text and contour lines on the blueprints and conceptual drawings were used.

The slopes of banks leading into the wetland from upland areas were determined in the field by measuring elevation changes with a transit and stadia rod along transects placed on banks characteristic of the site (Lounsbury and Aldrich 1986). Elevation measurements were first made at the top of the bank and then at four meter intervals across the wetland. Readings were taken at one meter intervals where the microtopography of the wetland was irregular or where gradients appeared steep. Another member of the field team checked the accuracy of measurements by repeating the procedure at 5% of the data points. Relative percent difference between the original and duplicate readings was less than 2%.

Elevations measured in the field were calculated relative to the lowest point in the wetland. Calculations were checked and entered into a computer database. Double entry was used to ensure that errors did not occur in transferring the data from the field sheets into the computer. After entry, the two data sets were electronically compared and discrepancies between them corrected by comparison with the field sheets until both data sets were in exact correspondence.

The relative elevations in feet were converted to meters by multiplying by 0.3048. The data were then entered into Statgraphics (Statistical Graphics Corporation 1988) cross-sections of the topography of each wetland generated. The top and bottom of each bank were located on each cross-section. The top of the bank was defined as the uppermost point on each slope. The bottom of the bank was defined as either the first point of inflection or the point where the profile obviously started to flatten out across the bottom of the basin. The slope of each bank was then calculated.

Slopes specified in the permit plans and construction plans were compared to the as-built conditions. The available literature on wetland creation was searched for

recommendations on slopes appropriate for different types of wetlands, soil stabilization, and the establishment of vegetation and wildlife communities. The recommendations were compared to the slopes contained in the permit plans, construction plans, and the as-built conditions.

The evaluations described above were made first with reference to the predominant slopes on the site. In addition, since the information in the permit files was often limited, each slope listed and each measured in the field was compared to the recommended slopes from the literature.

Evaluating the Vegetation to be Established and Actually Found on Site

Permit files were searched for revegetation strategies specified as conditions of the permit and lists of vegetation to be planted on the site. When the planting lists contained common names, scientific names were assigned from the regional flora (Hitchcock and Cronquist 1981) and the regional lists of plant species that occur in wetlands (Reed 1988).

Transects were placed to obtain a representative sample of the plant communities within each wetland studied. All species present in forty 1-m^2 quadrats placed at equal intervals along each transect were identified, and species lists were generated. The accuracy of species identification was checked by a second botanist who resampled 25% of the quadrats. Overall, the same species were identified in a quadrat an average of 80% of the time (A.D. Sherman, NSI Technology Services, pers. comm.).

Each species was assigned to one of the U.S. Fish and Wildlife Service's (USFWS) wetland indicator categories (Reed 1988). This resource and the regional flora (Hitchcock and Cronquist 1981) were also used to determine if species were native to the Pacific Northwest or exotic. Table 2 lists the wetland indicator codes used. All codes assigned were verified by a second person. Any species whose code could not be determined from the above resources was assigned a wetland indicator after consultation with LaRea Johnston, Assistant curator, Oregon State University (OSU) Herbarium. Ms. Johnston co-authored the regional flora on aquatic plants (Steward et al. 1963).

A combined list of all species contained in the planting lists was generated by merging the lists from all sites. In addition, a combined list of all species actually found on the eleven created wetlands was produced. The composition of each list of species to be planted and of the plant community found on the site were compared as to the proportion of 1) native and exotic species, 2) wetland and upland species, and 3) species found on the site that were listed for planting. In addition, the same comparisons were made between the combined list of species contained on the planting lists and the combined list of species found on the sites.

TABLE 2. Wetland indicator codes were assigned to all species found on the created wetlands and on planting lists. Codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988).

INDICATOR CATEGORY	POSITION IN CATEGORY	NATIVE/EXOTIC
ABS = Absent from the list.	+ = Frequency is toward high end of the category (more frequently found in wetlands).	NAT = Native Species
FAC = Facultative. Sometimes found on wetlands (34%--66% estimated frequency), also occurs in nonwetlands.	- = Frequency is toward lower end of the category (less frequently found in wetlands).	EXO = Exotic Species, i.e., species introduced into the region.
NO = No Agreement, Not Considered, or No Review. No agreement was applied when a regional panel was not able to reach a unanimous decision, not considered was applied to plants that have recently been added to the list, and no review was applied to species that have not received any regional review.	\ = Intermediacy within the category.	*** = No information available.
OBL = Obligate Wetland Species. Always found in wetlands under natural conditions (frequency greater than 99%) but may persist in nonwetlands.		
UPL = Upland. Occurs in wetlands in another region, but not found (<1% frequency) in wetlands in the region specified.		
FACU= Facultative Upland. Seldom found in wetlands (1%--33% frequency) and usually occurs in nonwetlands.		
FACW = Facultative Wetland. Usually found in wetlands (67%--99% frequency), but occasionally found in nonwetlands.		
*** = No information available.		

SECTION III

RESULTS

Data on planned and existing hydrology, wetland area, wetland shape, slopes of banks, and vegetation were evaluated for each site. The results are presented in the subsections that follow. Appendix I contains a narrative description and a catalog of all the information gathered on each created wetland from both the field sampling and the permit files.

EVALUATING THE HYDROLOGY TO BE CREATED AND ACTUALLY CREATED

The hydrologic information contained in the permit files was inadequate to use in the comparison of the created wetlands with their permit specifications and construction plans. A summary of the information found is presented in Table 3.

EVALUATING THE AREA TO BE CREATED AND ACTUALLY CREATED

Permit specifications, construction plans, and as-built conditions were compared to evaluate the area of wetland created. Ten of the eleven wetlands studied were compared. Site #C7-SML was a large mosaic of created and natural areas of different wetland types, therefore, it was decided that only the portion that was created palustrine emergent marsh would be studied. Since the entire area of this wetland was not measured, the site was not included in the evaluation of area.

Permit Specifications Compared to Construction Plans

Section 404 permits specified areas ranging from 0.04 ha (0.1 acre) to 1.46 ha (3.6 acres) for the ten wetlands studied (Table 4). The total area to be created was 5.10 ha (12.6 acres). Areas derived from permit maps drafted from construction blueprints and conceptual drawings ranged from 0.04 ha (0.1 acres) to 1.13 ha (2.8 acres) (Table 4). The total area of wetland in the ten permit maps is 4.66 ha (11.5 acres). This was a cumulative loss of 0.44 ha (1.1 acres), or 9% of the area specified by the 404 permits. The net difference between the wetland area on each permit map and the area specified by permit conditions ranged from a loss of 0.40 ha (1.0 acre), to a gain of 0.29 ha (0.7 acres). Five permit maps indicated more area than the permit specified; four indicated less. One permit map indicated the same area as that specified in the permit conditions. Table 3. Information on the hydrology planned for each created wetland studied. Information was taken from the COE and ODSL permit files.

TABLE 3. The hydrology planned for each created wetland studied. Information was taken from the U.S. Army Corps of Engineers (COE) and Oregon Division of State Lands (ODSL) permit files. EPA = U.S. Environmental Protection Agency.

SITE	HYDROLOGY INTENDED AT CREATED WETLAND
C1-CC	Letter from EPA to COE states that a hydraulic connection must be maintained between the project site and the adjacent creek to maintain adequate stream flow for fisheries.
C2-TI	Design plan shows a pipe leading into the created wetland from boat basin in the Columbia River
O3-NS	Special Condition 8 of Attachment A to the Permit states: " . . . connect newly dug wetland into the existing stream."
O4-MHP	Lake to receive water from two streams entering at its NW and SW corners. The streams drain a 572.1 acre watershed.
	Well water is to be supplied to the lake during seasonal low stream flow to maintain the water depth at agreed upon levels.
C5-MG	Drawings show a culvert leading into the wetland from under nearby street.
	Excavation to the level of an adjacent stream to subject area to stream overflows and possible periods of standing water.
C6-SI	Existing creek channel to be rerouted through created wetlands. Stream flow estimated as about 4 cubic feet per second.
C7-SML	New stream channels to be excavated to increase stream length and supply water to project. Existing stream channels to be maintained as overflow channels.
C8-BSP	Drawing shows overflow slough connecting pond with nearby creek.
	The overflow channel is to be created between the existing overflow slough and the SE corner of the project site.
	"Roof water" will be discharged from two buildings into the pond.
	Surface waters from the surrounding developments to be discharged into the basin through diffuser pipes.
	Text states that "there may always be a slight freshwater flow from subsurface seepage".
C9-GP	Existing creek channels enlarged.
	Wetland depression designed to back fill from creek overflows.
	Storm drain system to discharge into wetland depression.
	Numerous springs and sub-surface seeps to supply water to wetland depression.
	An extensive hydraulic analysis was done of the carrying capacity of the stream channels for flood storage and to determine adequate culvert size for road crossing.
C10-PP	A ditch is to be excavated from nearby slough to the pond at elevations lower than the anticipated slough water level.
C11-SM	Drawings show "open ditch - water source" north of the created wetland running along the development's fenceline and a connection between the project and the nearby creek.
	Drawing states "grade ditch to maintain positive drainage".

TABLE 4. Comparison of wetland area required in the permit specifications (PERMIT SPECS) with the area of wetland on the map (PERMIT MAP) drafted from construction plans or conceptual drawings. Area is expressed in hectares. The values in parentheses are the corresponding data expressed in acres. The original information was expressed in acres, which was converted to hectares by multiplying by 0.4047.

SITE	PERMIT SPECS	PERMIT MAP	NET CHANGE
C1-CC	0.89 (2.2)	0.49 (1.2)	- 0.40 (-1.0)
C2-TI	0.45 (1.1)	0.49 (1.2)	+ 0.05 (+0.1)
O3-NS	0.61 (1.5)	0.65 (1.6)	+ 0.04 (+0.1)
O4-MHP	1.46 (3.6)	1.13 (2.8)	- 0.33 (-0.8)
C5-MG	0.40 (1.0)	0.20 (0.5)	- 0.20 (-0.5)
C6-31	0.81 (2.0)	1.10 (2.7)	+ 0.29 (+0.7)
C8-BSP	0.04 (0.1)	0.16 (0.4)	+ 0.12 (+0.3)
C9-GP	0.20 (0.5)	0.28 (0.7)	+ 0.08 (+0.2)
C10-PP	0.12 (0.3)	0.12 (0.3)	0.00 (0.0)
C11-SM	0.12 (0.3)	0.04 (0.1)	- 0.08 (-0.2)
TOTALS	5.10 (12.6)	4.66 (11.5)	- 0.44 (-1.1)

Permit Specifications Compared to Field Conditions

The net change between the area of each wetland as-built and the area specified by the permit conditions ranged from a loss of 0.69 ha (1.7 acres), to a gain of 0.20 ha (0.5 acres). Five of the wetlands were built smaller than intended and five were built larger. None were built exactly as the permit mandated. One wetland (C9-GP), was built as the construction plans indicated, however, the area contained in the construction plans differed from the permit specifications by +0.08 ha (+0.2 acres).

The cumulative effect of all the differences between the permit specifications and the as-built areas was also examined. The area of wetland on the ten field maps totalled 3.62 ha (9.0 acres); the area of wetland specified in the ten permits totalled 5.10 ha (12.6 acres). This represented a loss of 1.48 ha (3.6 acres), or 29% from the total area specified by the permits (Table 5).

EVALUATING THE SHAPE TO BE CREATED AND ACTUALLY CREATED

Seven of the created wetlands studied had very regular, nearly round, oblong, or rectangular shorelines. The other four wetlands were constructed with irregular shorelines.

EVALUATING SLOPES TO BE CREATED AND ACTUALLY CREATED

Slopes to be constructed were evaluated in several ways. The field measurements of slopes as-built and the slopes determined from the permit specifications or construction plans were compared to ascertain if the banks were graded as specified. Then, the slopes in the permit specifications and in the construction plans and the as-built slopes determined from field measurements were compared with slopes recommended in the current literature on wetland creation.

Since any one site could contain banks with different slopes, the evaluations described above were made with reference to the predominant slopes on the site. In addition, each slope listed and each measured in the field was compared to the recommended slopes from the literature.

As-Built Conditions Compared to Construction Plans & Permit Specifications

The predominant slope as-built was gentler than what was to be built as determined from the construction plans and permit specifications for nine of the eleven projects (82%). Slopes at two sites were built as planned.

TABLE 5. Comparison of the wetland area in the permit specifications (PERMIT SPECS) with the area of wetland on each field map of "as-built" conditions (FIELD MAP). Area is expressed in hectares. The values in parentheses are the corresponding data expressed in acres. The original information was expressed in acres, which was converted to hectares by multiplying by 0.4047.

SITE	PERMIT SPECS	FIELD MAP	NET CHANGE
C1-CC	0.89 (2.2)	0.20 (0.5)	- 0.69 (-1.7)
C2-TI	0.45 (1.1)	0.24 (0.6)	- 0.21 (-0.5)
O3-NS	0.61 (1.5)	0.69 (1.7)	+ 0.08 (+0.2)
O4-MHP	1.46 (3.6)	0.97 (2.4)	- 0.49 (-1.2)
C5-MG	0.40 (1.0)	0.28 (0.7)	- 0.12 (-0.3)
C6-3I	0.81 (2.0)	0.40 (1.0)	- 0.41 (-1.0)
C8-BSP	0.04 (0.1)	0.24 (0.6)	+ 0.20 (+0.5)
C9-GP	0.20 (0.5)	0.28 (0.7)	+ 0.08 (+0.2)
C10-PP	0.12 (0.3)	0.16 (0.4)	+ 0.04 (+0.1)
C11-SM	0.12 (0.3)	0.16 (0.4)	+ 0.04 (+0.1)
TOTALS	5.10 (12.6)	3.62 (9.0)	- 1.48 (-3.6)

Eighty-one percent (29/36) of the slopes measured in the field were more gentle (flatter) than their respective permit specifications or construction plans; 6% (2/36) were steeper. Only 14% (5/36) of the as-built slopes agreed with the permit specifications or construction plans.

Comparisons with Recommendations in the Literature

The current literature on wetland creation was reviewed to determine if slopes intended for construction and actually constructed were appropriate for palustrine emergent marshes. A minimum 1% gradient was recommended for bottom contours to facilitate drainage. Bottom contours measured at the sites and stated in the construction plans were all comparable to the recommended 1%.

The recommendation in the literature was that the banks of created wetlands should be graded between 5:1 and 15:1 (horizontal:vertical) to facilitate vegetation establishment and soil stability (Reimold and Cobler 1986, Kruczynski 1990; D.S. Golden, State of Montana Department of Highways, pers. comm.). For the purposes of this study, slopes steeper than 5:1 were considered "steep", and slopes more gentle than 5:1 were considered "gentle".

The recommended range for slopes was compared with the predominant slope to be built for each site as determined from the from the construction plans and permit specifications. The results were that: 1) 45% (5/11) of the sites had predominant slopes specified or drawn that were steeper than 5:1; 2) 18% (2/11) were within the range of 5:1 to 15:1; and 3) 36% (4/11) could not be evaluated because the predominant slope intended could not be determined.

The recommended range for slopes was compared with the predominant slope as determined from the as-built conditions measured at each site. The results were that: 1) 45% (5/11) of the sites had predominant slopes that were steeper than 5:1; 2) 36% (4/11) were within the range of 5:1 to 15:1; and 3) 18% (2/11) could not be evaluated because approximately half of the site had slopes that were within the range, while half of the site had slopes that were steeper than 5:1.

The recommended range for slopes was then compared with a cumulative list of all the slopes specified in the permits and construction drawings. The results were that: 1) 87% (13/15) of the slopes specified or drawn were steeper than 5:1; 2) 13% (2/15) were within the range of 5:1 to 15:1.

The recommended slopes were also compared with a cumulative list of as-built conditions measured in the field. Results of these comparisons were: 1) 43% (15/35) of the slopes were constructed steeper than 5:1; 2) 3% (1/35) were gentler; and 3) 54% (19/35) were within the range of 5:1 to 15:1.

EVALUATING THE VEGETATION TO BE ESTABLISHED AND ACTUALLY ESTABLISHED

Seven (64%) of the eleven permits contained a list of species to be planted at the site. Of these seven planting lists, only five used scientific names. The four permits that did not contain planting lists did not state if the site was to revegetate naturally or if it was to be planted. Therefore, it could not be determined if the absence of a planting list was appropriate or was an oversight. It was learned from the Oregon Department of Fish and Wildlife (ODFW) (G. Herb, Oregon Dept. of Fish and Wildlife, pers. comm.), however, that one (O3-NS) of the four wetland creation projects that lacked a planting list was to revegetate naturally.

Evaluation of Planting Lists

The maximum number of species on a planting list was eleven, with an average of eight species per list. Most lists also contained species intended for the upland or transitional areas surrounding the wetland. The species designated for planting in uplands or transitional areas were not included in this analysis because field inventories of vegetation considered only species actually within the wetland. One permit (C11-SM) contained a list of 24 species "to choose from", however, there was no documentation within the permit of which species were actually planted.

The planting lists were checked for native and exotic species, and wetland and upland species. Exotic species, those not native to the Pacific Northwest which have been introduced from other regions of the United States or the world, were identified from the regional lists of plant species that occur in wetlands (Reed 1988) and the regional flora (Hitchcock and Cronquist 1981).

The regional lists of plant species that occur in wetlands (Reed 1988) were also used to assign each species a "wetland indicator code". Reed's categories, from which the wetland indicator codes were derived, are:

- obligate wetland species (estimated 99% probability of occurring in wetlands),
- facultative wetland species (estimated 67%--99% probability of occurring in wetlands),
- facultative (34%--66% estimated probability of occurring in wetlands),
- facultative upland (67%--99% estimated probability of occurring in nonwetlands), and
- obligate upland (may occur in wetlands in another region, but 99% estimated probability of occurring within nonwetlands in this region).

Species not included in the regional plant list of species that occur in wetlands were assigned wetland indicator codes after consultation with Ms. LaRea Johnston, Assistant Curator of the Oregon State University Herbarium.

Five of the planting lists contained between 57% and 78% native species, one contained all native species, and one contained only 18% native species (Table 6). Fifty-two percent of the species on the combined planting list (made up of the unique species on the seven planting lists) were native to the Pacific Northwest. However, there were species on the planting lists for which a designation of native or exotic could not be determined because common names were used, or only the genus or family name was given. The proportion of unknowns on the planting lists ranged from 0% to 73% (Table 6).

Native, obligate wetland species were included on all planting lists, and made up the largest category (36%) of species to be planted (Table 7). The proportion of unknown species (30%) was the second largest category. Seventy-three percent of one planting list was made up of species for which wetland indicators could not be determined. Native, facultative wetland species constituted the next most frequently planted group (14%), and were included on approximately half the planting lists.

Combining the planting lists gives a total of 44 unique species (Table 8). Of these, seven (16%) were found on the sites at which they were to be planted. Two species, creeping spikerush (**Eleocharis palustris** (L.) R. & S.) and meadow foxtail (**Alopecurus pratensis** L.), were found on two of the wetlands on which they were to be planted. Seventeen of the 44 species on the planting lists were found on sites on which they were not listed to be planted, i.e., as volunteers. The proportion of species found on a site that were also on the corresponding planting list ranged from 0% to 60%.

Evaluation of the Vegetation Found On-Site

The number of species found on each site was much greater than the number of species on the planting lists. The average number of species found was 44 (S.E. = $\pm$ 3). The vegetation at six of the created wetlands was composed entirely of volunteer species. For the remaining five wetlands, between 93% and 98% of the plant communities were made up of volunteer species (Table 8). The combined list of all species that were found on the created wetlands contains a total of 189 unique species. Of these, 4% were species to be planted and 96% are volunteers.

Plant communities found at the created wetlands were composed of both native and exotic species (Table 9). Eight of the sites contained a higher proportion of native species than exotics. Of the 189 different species found on the created wetlands, 55% were native to the Pacific Northwest and 42% were exotic. Native, obligate (20%) and native, facultative wetland (23%) species were the types of species most often found on the created wetlands (Table 10). In contrast, eight of the eleven wetlands sampled had no exotic, obligate wetland species, and the remaining three wetlands had only one,

TABLE 6. Numbers of species and percentages of the total number of species found on each planting list which were native, exotic, and unknown species. Dashes indicate no information. Where planting lists were composed of common names, an effort was made to identify the scientific names. When this was not possible, or if only the genus or family names were given, the species were counted in the UNKNOWN category. A combined list (COMB LIST) was created by merging all the individual planting lists and eliminating duplicate species names.

SITE	TOTAL # LISTED	# NATIVE	# EXOTIC	# UNKNOWN	% NATIVE	% EXOTIC	% UNKNOWN
C1-CC	--	--	--	--	--	--	--
C2-TI	9	7	2	0	78%	22%	0%
O3-NS	0	0	0	0	0%	0%	0%
O4-MHP	7	3	--	4	43%	--	57%
C5-MG	5	5	0	0	100%	0%	0%
C6-3I	--	--	--	--	--	--	--
C7-SML	4	3	1	0	75%	25%	0%
C8-BSP	11	8	2	1	73%	18%	9%
C9-GP	7	4	3	0	57%	43%	0%
C10-PP	--	--	--	--	--	--	--
C11-SM	11	2	1	8	18%	9%	73%
COMB LIST	44	23	8	13	52%	18%	30%

TABLE 7. Proportions of the different types of vegetation composing the planting lists which fell into the categories in the regional list of plant species that occur in wetlands (Reed 1988). Plants were assigned to categories using Reed (1988) and in consultation with LaRea Johnston, Assistant Curator, Oregon State University Herbarium. The categories are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; UNK--species that could not be identified because the planting list used common names or only genus and family names. The combined list (COMB LIST) is composed of all unique species on the planting lists. No species was counted more than once, though species may have been on more than one planting list. Results are expressed as percentages of total numbers of species on the planting list. Numbers of species are in parentheses.

SITE	# SPP	% OBL NATIVE	% FACW NATIVE	% FAC NATIVE	% FACU NATIVE	% UPL NATIVE	% OBL EXOTIC	% FACW EXOTIC	% FAC EXOTIC	% FACU EXOTIC	% UPL EXOTIC	% UNK
C1-CC	--	--	--	--	--	--	--	--	--	--	--	--
C2-TI	9	44% (4)	33% (3)	0	0	0	22% (2)	0	0	0	0	0
O3-WS	0	0	0	0	0	0	0	0	0	0	0	0
O4-MHP	7	14% (1)	29% (2)	--	--	--	--	--	--	--	--	57% (4)
C5-MG	5	80% (4)	0	20% (1)	0	0	0	0	0	0	0	0
C6-3I	--	--	--	--	--	--	--	--	--	--	--	--
C7-SML	4	75% (3)	0	0	0	0	0	25% (1)	0	0	0	0
C8-BSP	11	45% (5)	27% (3)	0	0	0	0	18% (2)	0	0	0	9% (1)
C9-GP	7	43% (3)	0	14% (1)	0	0	.0	14% (1)	0	29% (2)	0	0
C10-PP	--	--	--	--	--	--	--	--	--	--	--	--
C11-SM	11	9% (1)	9% (1)	--	--	--	9% (1)	--	--	--	--	73% (8)
COMB LIST	44	36% (16)	14% (6)	2% (1)	0	0	7% (3)	7% (3)	0	5% (2)	0	30% (13)

TABLE 8. Numbers and percentages of species to be planted that were found on the created wetlands vs the numbers and percentages of volunteer species found. Dashes indicate no information available, therefore, all species found on the site were assumed to be volunteers. The combined list (COMB LIST) was created by merging all the individual planting lists. Species were only counted once, though they may have been found at more than one site. # SPECIES PLANTED is the number of species to be planted on that site. # SPECIES PLANTED FOUND is the number of species found on the site that was included on the planting list. # VOLUNTEER SPECIES is the number of species found on the site that was not on the planting list for that site. % OF SPECIES PLANTED FOUND is the proportion of species on the planting list that was found on the site. % PLANTED SPECIES OF TOTAL FOUND is the proportion of all species found on the site that was to be planted. % VOLUNTEERS OF TOTAL FOUND is the proportion of the total species found on the site that was volunteers (not on the planting list).

SITE #	# SPECIES PLANTED	# SPECIES PLANTED FOUND	# VOLUNTEER SPECIES	% OF SPECIES PLANTED FOUND	% PLANTED SPECIES OF TOTAL FOUND	% VOLUNTEERS OF TOTAL FOUND
C1-CC	--	--	48	--	--	100%
C2-TI	9	1	39	11%	3%	98%
O3-NS	0	0	37	0%	0%	100%
O4-MHP	7	0	48	0%	0%	100%
C5-MG	5	3	39	60%	7%	93%
C6-31	--	--	69	--	--	100%
C7-SML	4	1	54	25%	2%	98%
C8-BSP	11	2	27	18%	7%	93%
C9-GP	7	2	36	29%	5%	95%
C10-PP	--	--	38	--	--	100%
C11-SM	11	0	43	0%	0%	100%
COMB LIST	44	7	189	16%	4%	96%

TABLE 9. Native and exotic species found at the created wetlands expressed as numbers per site and as a proportion of the total. Species in the UNKNOWN categories were those found that could not be identified. The combined list (COMB LIST) is composed of all unique species found at the created sites. No species was counted more than once, though it may have been identified at more than one site.

SITE	TOTAL # SPECIES	# NATIVE SPECIES	# EXOTIC SPECIES	# UNKNOWN SPECIES	% NATIVE SPECIES	% EXOTIC SPECIES	% UNKNOWN SPECIES
C1-CC	48	32	16	0	67%	33%	0%
C2-TI	40	24	15	1	60%	38%	3%
O3-NS	37	24	11	2	65%	30%	5%
O4-MHP	48	24	22	2	50%	46%	4%
C5-MG	42	16	25	1	38%	60%	2%
C6-3I	69	33	34	2	48%	49%	3%
C7-SML	55	33	21	1	60%	38%	2%
C8-BSP	29	11	17	1	38%	59%	3%
C9-GP	38	24	14	0	63%	37%	0%
C10-PP	38	22	15	1	58%	40%	3%
C11-SM	43	27	14	2	63%	33%	5%
COMB LIST:	189	104	80	5	55%	42%	3%

TABLE 10. Proportions of the different types of vegetation found on site which fell into the categories in the regional list of plant species that occur in wetlands (Reed 1988). Plants were assigned to categories using Reed (1988) and in consultation with LaRea Johnston, Assistant Curator, Oregon State University Herbarium. Categories are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; and UNK--species that could not be identified or for which the wetland indicator could not be determined. The combined list (COMB LIST) is composed of all unique species found at the created sites. No species was counted more than once, though it may have been identified at more than one site. Results are expressed as percentages of total number of species found on site. Actual numbers of species are in parentheses.

SITE #	# SPP.	% OBL NATIVE	% FACW NATIVE	% FAC NATIVE	% FACU NATIVE	% UPL NATIVE	% OBL EXOTIC	% FACW EXOTIC	% FAC EXOTIC	% FACU EXOTIC	% UPL EXOTIC	% UNK
C1-CC	48	17% (8)	35% (17)	4% (2)	10% (5)	0	0	8% (4)	6% (3)	8% (4)	10% (5)	0
C2-TI	40	23% (9)	20% (8)	18% (7)	0	0	3% (1)	8% (3)	13% (5)	13% (5)	3% (1)	3% (1)
O3-NS	37	35% (13)	22% (8)	8% (3)	0	0	0	11% (4)	5% (2)	8% (3)	5% (2)	5% (2)
O4-MHP	48	6% (3)	27% (13)	8% (4)	6% (3)	2% (1)	0	4% (2)	15% (7)	13% (6)	15% (7)	4% (2)
C5-MG	42	21% (9)	10% (4)	2% (1)	2% (1)	2% (1)	2% (1)	7% (3)	10% (4)	21% (9)	19% (8)	2% (1)
C6-31	69	19% (13)	22% (15)	6% (4)	0	0	0	6% (4)	14% (10)	12% (8)	19% (13)	3% (2)
C7-SML	55	31% (17)	24% (13)	5% (3)	0	0	2% (1)	11% (6)	4% (2)	13% (7)	9% (5)	2% (1)
C8-BSP	29	7% (2)	24% (7)	7% (2)	0	0	0	14% (4)	10% (3)	7% (2)	28% (8)	3% (1)
C9-GP	38	29% (11)	24% (9)	11% (4)	0	0	0	11% (4)	5% (2)	13% (5)	8% (3)	0
C10-PP	38	29% (11)	18% (7)	11% (4)	0	0	0	13% (5)	13% (5)	11% (4)	3% (1)	3% (1)
C11-SM	43	33% (14)	21% (9)	9% (4)	0	0	0	14% (6)	9% (4)	9% (4)	0	5% (2)
COMB LIST:	189	20% (38)	23% (44)	6% (11)	4% (8)	1% (2)	2% (3)	7% (14)	8% (16)	10% (19)	13% (24)	5% (10)

exotic, obligate wetland species each. In addition, the proportion of exotic, facultative wetland species on the created sites was very low ($\leq$ 7%). The most notable characteristic of the plant communities found on-site was the absence of native, upland species. Native, facultative upland and native, upland species were found on only three of the sites while exotic upland, and exotic facultative upland species were found at all the created wetlands (Table 10).

SECTION IV

DISCUSSION

Wetlands are, and undoubtedly will continue to be, created as compensation for those destroyed by development permitted under Section 404. It is important to ensure that the wetlands created compensate fully for those destroyed. This includes ensuring that wetland design is appropriate for the type of wetland desired and its location, and that all losses are accounted for. The following discussion examines wetland design and planning, and presents suggestions for improving the process.

DESIGN OF CREATED WETLANDS

Hydrology

Hydrology was not included in the comparisons of as-built conditions with permit specifications and construction plans because information in the permit files was inadequate. Hydrology is one of the most important aspects of wetland establishment. Therefore, the design of a created wetland should include specific statements of the hydrology intended. Statements that a source of water must (or will) be provided are not sufficient. The plans must explicitly state at minimum 1) how and from where the water will be supplied to the site, 2) the depth of water intended to inundate the site, and 3) the timing and duration of inundation.

Area of Wetland to be Created

Losses of area occurred due to differences between the permit conditions and the construction plans, often found in the same file. When the area of the wetland as-built was determined, it often was less than the area indicated in the construction drawings. Cumulatively, both discrepancies amounted to a loss of 29% of the wetland area that was to be created. One cause of such an error is not differentiating the project boundary (the actual area being turned into wetland) from the property boundary and accounting for the space required for banks and a transitional zone. Thus, the actual wetland area created may be smaller than intended.

Shape of the Wetland to be Created

The shape of a wetland can influence its function as wildlife habitat. An irregular shoreline with small vegetated fingers and open water bays will provide more edge than will an even-sided shoreline. Greater edge tends to increase waterfowl usage by providing isolated areas for feeding and loafing (Crawford and Rossiter 1982). It is easier and less

expensive, however, to create regularly shaped wetlands with even sides. Seven of the created wetlands studied had very regular, nearly round, oblong, or rectangular shorelines. The other four wetlands were constructed with irregular shorelines.

Slopes

Garbisch (1977) states that slopes are one of the most important factors in preparing a site for marsh establishment. He suggests designing slopes to be as gentle as possible without impounding water. One method of calculating slopes that will be proper for the vegetation type desired, is to determine the slopes of non-eroding, vegetated sections of banks contiguous to the site. For example, Shisler and Charette (1984) recommend the grading of slopes and topography to the relative elevations of adjacent natural marshes.

Kruczynski (1990) recommends slopes between 5:1 and 15:1 (horizontal:vertical) to provide maximum flooding of wetland area, to minimize erosion, and for the successful establishment of wetland vegetation. He states that many mitigation sites have been unsuccessful because of the steepness of their slopes. In this study, 45% (5/11) of the sites both as planned and constructed had slopes steeper than 5:1 predominant on the site. Moreover, 87% (13/15) of all the slopes listed within the permits or drawn in the construction plans were steeper than 5:1. In specifications for the creation of wetlands to mitigate impacts from highway construction in Montana, Golden (State of Montana Department of Highways, pers. comm.) included several requirements to ensure slopes constructed were appropriate. The criteria were that at least 50% of the non-flooded area must have a 10:1 or flatter slope, and no more than 10% of the non-flooded area may have a 4:1 or steeper slope.

Field sampling showed that 43% (15.35) of the all slope measurements taken within the created wetlands studied were steeper than 5:1. D'Avanzo (1990) stated that the failure of plantings in created wetlands is often caused by incorrect slope, and the resulting erosion and increased rate of sedimentation. Erosion, accompanied by sedimentation and siltation, was noted at some of the sites with steep slopes (Figure 1A). The banks of site C10-PP were so steep that field workers had to pull themselves along with their hands to keep from sliding into the pond (Figure 1B).

Water fluctuations and the corresponding changes in the duration and frequency of inundation of the site are likely to be greater when slopes are steep than when gradual. Any influx of water into a small area with steep slopes will cause a rapid deepening of the water as it rises up the banks, while the same influx of water will cause a much smaller increase in depth where the topography is gentle and slopes are gradual. The effect is analogous to the way water rises in a narrow glass versus in a shallow bowl. These differences in water fluctuations, and hence, the differences in the duration and frequency of inundation, influence the amount, zonation, and form of the vegetation community.

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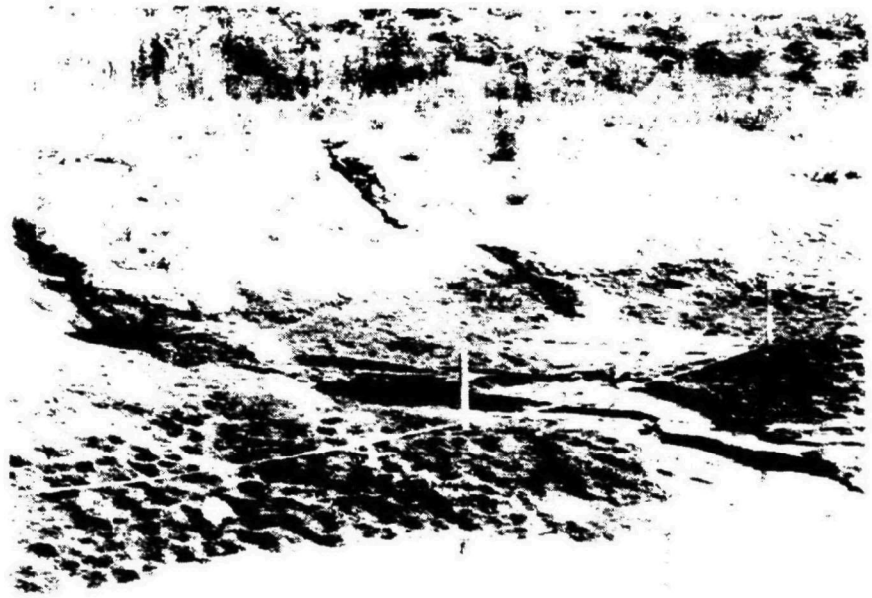
A.



B.

FIGURE 1. Photographs of the steep slopes at two of the created wetlands. Note signs of erosion on photo 1A.

Another consequence of steep banks is less area with the appropriate hydrology for wetland vegetation to become established. A narrow fringe of wetland vegetation is likely to occur around a steep-sided pond, whereas, on a gradual slope, wetland vegetation will occupy a broad expanse (Figure 2). A narrow fringe of vegetation was observed at several of the wetlands studied (e.g., O4-MHP, C6-3I, C8-BSP, C10-PP).

Wetlands abruptly confined by developed land lack the potential for vegetation communities to adjust to changing hydroperiod by shifting up and down the banks, and, therefore, force the loss of plant species, animals, and habitat. Transition areas between the wetland and surrounding land uses are needed. Transition areas should have gentle, gradual slopes to allow the plant communities a large area over which to expand and contract, and, thus, increase the probability of their persistence (Willard and Hiller 1990).

Vegetation to be Established and Actually Found on the Sites

Planting Lists--

Vegetation of the site is imperative to the creation of a palustrine emergent marsh. If planting is to be done, a list of species to be planted should be included in the project plans. Planting lists were found for seven of the eleven projects studied. However, these planting lists were problematic: 1) two used only common names, 2) several used family and genus names instead of names of species, 3) nearly all planting lists included exotic species, 4) several included upland and transitional species, without direction on where they should be planted, 5) several included commercial cultivars, and 6) none specified planting methods. In addition, a list of species recommended for planting in wetlands by ODFW used only common names. Scientific names, both genus and species, should be used to identify species for planting, and, whenever possible, the native variety should be specified. Common names may be included with the scientific names, but should not be the sole means of species identification because a common name often can apply to more than one species.

All but one of the projects studied contained exotic species on its planting list. Exotic species should not be planted for two reasons. First, some are not adapted to the regional climatic conditions and may not survive. Bald cypress (**Taxodium distichum** (L.) Rich), a native of the Southeastern United States, was a found on both a list of species recommended by ODFW for planting in Pacific Northwest wetlands, and on the planting list for project (C11-SM). Second, if an exotic species does have the ability to adapt to the regional environmental conditions, it may have the potential to become a pest by outcompeting native species. Examples of invasive pest species are purple loosestrife (**Lythrum salicaria** L.), a species introduced from Eurasia, and crabgrass (**Digitaria ischaemum** [Schreb.] Schreb.), a ubiquitous weedy species. Purple loosestrife was not included on any of the planting lists, however, crabgrass was.

A.

B.

FIGURE 2. A. Photograph of the broad expanse of vegetation found on a created wetland with gradual slopes. B. Photograph of the narrow fringe of vegetation found on a created wetland with steep-sided slopes. Arrows indicate boundaries of wetland vegetation.

Commercial cultivars should not be substituted for native species (Josselyn et al. 1990). For example, the plans for project O4-MHP stipulated the planting of "multiflora rose". This is not a species of rose (L. Johnston, OSU Herbarium, pers. comm.), but a generic name for cultivated roses with a tall, cascading form and many blooms. The temptation to use cultivated varieties will be great if it is difficult to find sources of native species while cultivated varieties are easy to locate and purchase. To prevent this, the contractor must be made aware of the differences between native species and their cultivated varieties, and the importance of planting native wetland species.

The season for planting, type of planting materials, planting density, and required survival rates, should be stated within the permit conditions (Kruczynski 1990). None of the permits examined contained such specifications. When considering type of plant material to use, several factors should be considered. Seeding is the least expensive method, but its success is the least predictable. Seeds may be washed away by fluctuating water levels or consumed by wildlife. Their germination and development in shallow water depend upon uncontrollable parameters such as the temperature and turbidity of the water. If used, seeding should be done in early spring to take full advantage of the growing season (Garbisch 1986).

Transplanting of peat-potted plants, plugs, sprigs, and dormant underground plant parts (tubers, bulbs, and rhizomes) is both the most successful and most expensive method of revegetating. Generally, peat-potted plants in either a growing or dormant condition can be transplanted at any time of the year. Therefore, the timing of the completion of construction of the site should not affect the success of establishment. Plugs, sprigs, tubers, bulbs, and rhizomes must be planted while dormant, which limits optimal planting times to winter and spring months (Garbisch 1986).

The transplants or seeds used should be of local origin. Native wetland plants grown from non-local genetic stock may not be adapted to local climatic conditions. Garbisch (1977) recommends that plant stock used should originate from within a 100-mile radius of its intended destination. However, ensuring that plant stock originates in a climate similar to its intended destination is probably more important than strictly following the 100-mile radius recommendation. Recently, some Pacific Northwest nurseries have begun providing locally grown, native species for wetland revegetation. However, when large volumes of plants are needed, contractors must order plant stock from nurseries outside the region, usually the midwest (R. Van Wormer, Independent Ecological Services, pers. comm.).

Survival of Species Planted--

Overall, approximately 96% of the species on the created wetlands were volunteers, while less than 4% were species found on the planting lists. This poses the question: Why weren't species on the planting lists found in greater abundance on the sites?

It is possible that planting did not take place. In this study it was assumed that species included on planting lists were planted on the created wetlands. However, there was no documentation within the files as to which species were actually planted, where they were planted, or when they were planted. Also, no evidence of planting (e.g., rows of sprigs) was observed within the wetlands during field sampling.

Assuming planting took place, environmental conditions at the created wetlands may have been incorrect. It may be necessary to change the conditions of the site (hydrology, slopes, location, etc.) to allow the types of species planted to persist on the created wetlands. Future research might include exploring the type of environmental conditions necessary for the successful establishment of desired species.

Another possibility is that the species listed for planting were not appropriate. Species appropriate for planting in palustrine emergent marshes of the Pacific Northwest might be determined from inventories of the species that occur on natural marshes of the region, or from inventories of the species that volunteered on the created sites.

Planting vs Natural Revegetation of the Site--

Natural revegetation may be a viable option, since approximately 96% of the species found on the created sites were volunteers. During visits to site O3-NS, which was allowed to naturally revegetate, we observed that vegetation cover increased over the three summers after construction (1987, 1988, and 1989). Shisler and Charette (1984) recommended that small disturbed areas less than 0.20 ha (0.50 acres) in size occurring within a natural marsh be allowed to revegetate naturally. This might also apply to created wetlands less than 0.20 ha (0.5 acres), especially if a potential seed source is nearby. However, the amount of time required for the site to become fully revegetated naturally is generally longer than if the wetland is planted. Therefore, the time period required for the site to fully revegetate through natural means constitutes a wetland loss. Planting lessens this temporal loss because it hastens the establishment of a functional wetland (Kruczynski 1990).

Mulching the created wetland by applying a layer of topsoil removed from the destroyed wetland may enhance and accelerate the revegetation process by providing a supply of propagules. In addition, Kruczynski (1990) recommends mulching to provide an organic surface horizon and soil microflora. Mulching also helps to reduce evaporation of soil pore water, runoff and soil loss, and surface compaction and crusting (Thornburg 1977). Created wetlands in Florida and other areas of the southeastern United States are routinely mulched. This has accelerated the successful establishment of wetland vegetation on the sites (M. Brown, University of Florida, pers. comm.).

If the created wetland is mulched with topsoil taken from the wetland destroyed, the created wetland will revegetate from the seed bank of the wetland destroyed. However, the species present in the wetland when it was destroyed may not be the ones that germinate from the topsoil placed in the new wetland. The species composition within a seedbank results from the accumulation of seeds over many years, during which time, the vegetation in the wetland may have changed. In a study comparing the seedbanks of different vegetation zones within prairie marshes, van der Valk and Davis (1976) found that the seedbanks of wetlands with open water regimes (an early stage of marsh succession) contained the seeds of species characteristic of wet meadows (a later stage of marsh succession). Moreover, the seedbank of the wet meadow contained seeds of plants typical of the earlier, open water wetland. Therefore, the type of vegetation present at any time is primarily a function of water level, although the potential floristic composition of the vegetation community is a function of the makeup of the seedbank (van der Valk and Davis 1976).

Instances Where Planting May be Advisable--

It may be necessary to plant the required species to ensure their establishment if a specific wetland community or wildlife habitat is desired. The value of a wetland for wildlife habitat and food depends upon water depth, the density of the vegetation, seed production, accessibility of edible plant parts, and the associated production of invertebrates. Vegetation stands that are too dense may be impenetrable to waterfowl, while those that are too sparse will be unattractive. The plant parts consumed must be abundant and available at the right times and in the right places (Kadlec and Wentz 1974).

If erosion is a concern, especially where the banks slope steeply into the wetland, species should be chosen on the basis of their capacity for soil stabilization. Those with extensive root systems, rhizomes and erect stems that form dense bunches or turf, are best (Allen and Klimas 1986). Perennial species are probably more effective at erosion control than annuals (G. Herb, Oregon Dept. of Fish and Wildlife, pers. comm.)

It may be easier to control the spread of invasive species by planting early in the wetland construction process. Some marsh species have difficulty colonizing if more aggressive species become established first. Planting of desired species may give them a competitive edge over invasive species (Josselyn et al. 1990).

If the created wetland is isolated from appropriate seed sources, planting may be advisable. The majority of the created wetlands in this study were located within residential developments, or commercial and light industrial complexes, and were at least partially isolated from appropriate seed sources. Although these wetlands appear to have revegetated naturally, others placed in similar surroundings might not receive sufficient propagules to revegetate naturally and, therefore, will require planting (Josselyn et al. 1990).

Planting also may be advisable because, in contrast to the seedbank studies cited above, other studies suggest that the vegetation of an area cannot be used to predict the composition of the seedbank and vice versa. In a project undertaken to study the correlation of freshwater tidal wetland seedbanks with vegetation change, Leck and Simpson (1987) found that marsh species have different dependence on seedbanks. Some species have transient seedbanks (**Impatiens capensis** Meerb.) and others have persistent seedbanks (**Typha** sp.). In addition, they concluded that freshwater marshes affected by drought (such as inland marshes in the Pacific Northwest) have vegetation that is not closely related to the seedbank. Thus, the vegetation of these wetlands cannot be used to predict the composition of their seedbanks and vice versa.

Another study of the correlation of seedbanks with vegetation indicated that weedy and early-successional species tend to be long-lived in the seedbank (Glass 1989). This suggests that weedy and early successional species are likely to appear on a disturbed site (such as a newly created wetland), and that the seedbank cannot be counted on to produce the desired vegetation community.

RECOMMENDATIONS TO IMPROVE WETLAND CREATION UNDER SECTION 404

Permit conditions, construction plans and conceptual drawings often did not reflect as-built conditions of the created wetlands. However, judgments of non-compliance cannot be made without proper documentation of the construction process. In some instances, it is likely that necessary changes were made during construction that made it appear the site was out of compliance. As-built drawings of the wetland, drawn after the completion of the construction process, would be an accurate method of portraying the newly constructed site for a determination of compliance. To be most useful, as-built drawings should contain a location map for the created wetland, a map of its size and shape, the plan scale, vertical elevations, and the datum used. All sketches, lettering, scales, etc., should be clear and legible. The as-built drawings should also include the actual slopes built within the wetland, where vegetation species were planted, and documentation of any mid-course changes. In addition, the plans should contain the specific objectives of the creation. These should be related to specific vegetation or habitat types, wildlife values or other functional values (Fishman, et al. 1987).

Flexibility to make changes along the way is a crucial component of the wetland creation process. However, if mid-course changes are not documented by either the contractor or agency personnel, there are no means by which to determine if the project is out of compliance or if differences merely reflect a necessary change in the plans due to unanticipated conditions encountered during construction.

Many developers have short-term goals and create wetlands only to fulfill regulatory obligations; to ensure the created wetland persists in the landscape, the long-term goals (including monitoring) should be specified in the permit (Shisler and Charette 1984). No specific long-term goals or plans for monitoring were stated within any of the permit files examined. Moreover, monitoring would have been difficult to implement due to the lack of baseline data. As-built drawings and documentation of changes made during the construction process would provide the baseline information from which monitoring could be conducted.

Complete documentation that is organized in a consistent manner and composed of specific data would allow resource agencies to more easily investigate and assess projects as they proceed. If inspections were recorded on a standard "data sheet" which contained the same parameters for all projects, future projects could then use the information to evaluate the methods and techniques used (Shisler and Charette 1984, Erwin 1990). None of the permit files examined included documentation of the sequence of construction events, dates of inspections, or mid-course changes.

Mason and Slocum (1987) conducted an evaluation of 32 wetlands created in Virginia's coastal zone. Criteria used were establishment of vegetation, compliance with permit conditions, and evidence of wildlife use. They concluded that when permits contained specific conditions for creating the wetland, 86% were successful, whereas only 44% of projects without specific permit conditions were successful. Where time limits for completion of the wetland creation were specified in the permit, 100% of the projects were successful compared to only a 50% success rate when no time limits or deadlines were set. It appears that specific permit conditions help to ensure compliance with the permit and the establishment of the created wetland.

In summary, the differences between the plans and specifications in the project file and the as-built conditions point to the need for verification of projects in both the planning and construction phases of the permitting process. The planning phase should focus on the development of a realistic approach using information from the scientific literature and past projects. The construction phase should culminate in the production of an as-built plan. This would allow immediate checks to ensure that critical features have been included as intended, e.g., wetland area, vegetation type. It would also document any corrective measures that were taken due to unanticipated events during construction. As-built plans of the project would ensure that the details of the actual wetland created were available for future reference in addition to the conceptual design.

SECTION VI

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APPENDIX I

DATA COLLECTED FOR EACH SITE: DESCRIPTIONS, PERMIT AND FIELD MAPS, BASIN MORPHOLOGY PROFILES, AND SPECIES LISTS

DESCRIPTION: SITE C1-CC

Function/Purpose

This project was mitigation for wetlands lost during the development of approximately 24.28 ha (60 acres) of industrially zoned land. The development entailed the (1) relocation of approximately 650 linear feet of Phillips Creek, requiring the backfilling of the existing creek with approximately 4,000 cubic yards of fill material; (2) placement of about 1,400 cubic yards of fill material in a pond/wetland area adjacent to Phillips Creek; (3) placement of approximately 3,500 cubic yards of fill material for the construction of a road adjacent to the pond/wetland area; (4) placement of approximately 500 cubic yards of fill material in a wetland for the construction of a road and site development; (5) placement of approximately 250 cubic yards of riprap and the construction of a 60-foot long, 6 by 30 foot concrete box culvert for the construction of a road across Mt. Scott Creek; and (6) placement of about 200 yards of rock for the construction of a weir at the east end of an overflow channel. The loss of approximately 1.38 ha (3.4 acres) of pond/wetland habitat was to be compensated by the creation of approximately 0.77 ha (1.9 acres) of pond/wetland habitat within the Mt. Scott Creek containment berm.

The goal of the wetland's creation was functional replacement of the wetland area lost. Functional replacement at this site consisted of flood storage and desynchronization, wildlife habitat, food chain support, non-consumptive and consumptive recreation, and fisheries habitat.

In August of 1981, about one year after the mitigation work was completed, the Oregon Department of Fish and Wildlife (ODFW) inspected the site and found several problems. These included the lack of a water supply to the wetland, the lack of aquatic vegetation at the site, the lack of a buffer strip of vegetation around the perimeters of the ponds, and that an excessive amount of riparian vegetation had been removed during construction (G. Herb, ODFW, pers. comm.).

The water supply for the wetland originates from a spring approximately 100 yards up a nearby hill. Originally, the pipes that had been designed to carry water from the spring to the wetland had been installed upside-down. Therefore, water was being diverted <u>from</u> the wetland. This problem has been corrected and water is now being supplied to the wetland (G. Herb, ODFW, pers. comm.).

Aquatic and emergent plant species have become established within the wetland since water has been supplied. However, local children have discovered the area and are using the excavated areas between the trees as motorcycle paths. This is destroying much of the wetland.

This wetland was created in August of 1980; the water supply was corrected in 1982. It was nearly 7 years old when sampled in June of 1987.

General Description

The created wetland is a mosaic of ponds, emergent marsh, trees on hummocks, motorcycle paths and upland grasses. It was created within the Mt. Scott Creek containment berm and is

separated by it from a grassy meadow to the north and parking lots to the south. When this site was created, the ground between the trees was excavated and covered with a thin layer of soil from the destroyed wetland. Many of the large existing trees were allowed to remain, and now sit on hummocks interspersed throughout the wetland. The excavated areas exhibit three conditions: 1) water ponded with emergent vegetation; 2) no standing water, but moist soils supporting vegetation; and 3) bare ground, primarily trails created by the motorcycle traffic.

Water is supplied to the wetland via pipes from a spring on the slope above. It enters the site on the north bank of a small pond that occupies the eastern quarter of the wetland. There is a small pipe leading from this pond through a hummock to the remaining area, but when sampled, water level in the pond was lower than the pipe and only a small stream of water was flowing.

At the western end of the wetland, the marsh narrows into a stream flowing west. However, there was no visible flow of water from the wetland into the stream during sampling.

Elevation changes both between the wetland and the neighboring meadow, and within the wetland were quite large. The slopes of the berm were rather steep and the general topography within the site was uneven and hilly due to the mosaic of hummocks and depressions.

Hydrology and Substrate

Water was clear, odorless, and stagnant. There was a thick layer of duckweed (Lemna sp.) covering the surface of the main pond, however if this layer was disturbed, the pond's bottom could be easily seen.

A very small stream of water was flowing from the pond into the adjacent depressions. This flow was too small to allow ponding to develop during the dry summer months, as the water was obviously being absorbed into the soil.

There was evidence that when high water conditions exist, channels form around the trees/hummocks.

The Munsell Color Book indicated soil chromas were borderline hydric (i.e., 2). Although a layer of wetland soil had been spread over the excavated areas (G. Herb, ODFW, pers. comm.), no definite break in soil color, texture, or appearance was observed within the top 30 cm. A few of the soil pits were not dug to 30 cm because a clay hardpan, or cobbles and gravel was encountered. Mottles were observed in the top 5 cm of the soil indicating periodic inundation (Soil Conservation Service 1975).

Dominant Vegetation

Pond water surfaces were choked with aquatic and emergent vegetation, primarily (Lemna minor L.) and species of Polygonum.

Many Oregon ash (Fraxinus latifolia Benth.) and cottonwood (Populus trichocarpa T. & G.) on the hummocks were beginning to die. Possible causes include root damage from the excavating process (or from motorcycle traffic), and the periodic inundation of the bases of the trees. The hummocks were also covered with upland grasses, sedges, and blackberry vines (Rubus sp.). Of interest was the presence of blue wild-rye (Elymus glaucus Buckl.), a native perennial grass normally found in prairie areas of western Oregon.

The slopes of the containment berm were vegetated with introduced grasses (mostly species of Poa and Bromus) tansy ragwort (Senecio jacobeae L.), blackberry vines (Rubus sp.), and other upland plants.

Hydrophytic vegetation inhabiting the excavated areas that hadn't been disturbed by motorcycle traffic consisted mainly of species of Eleochoris.

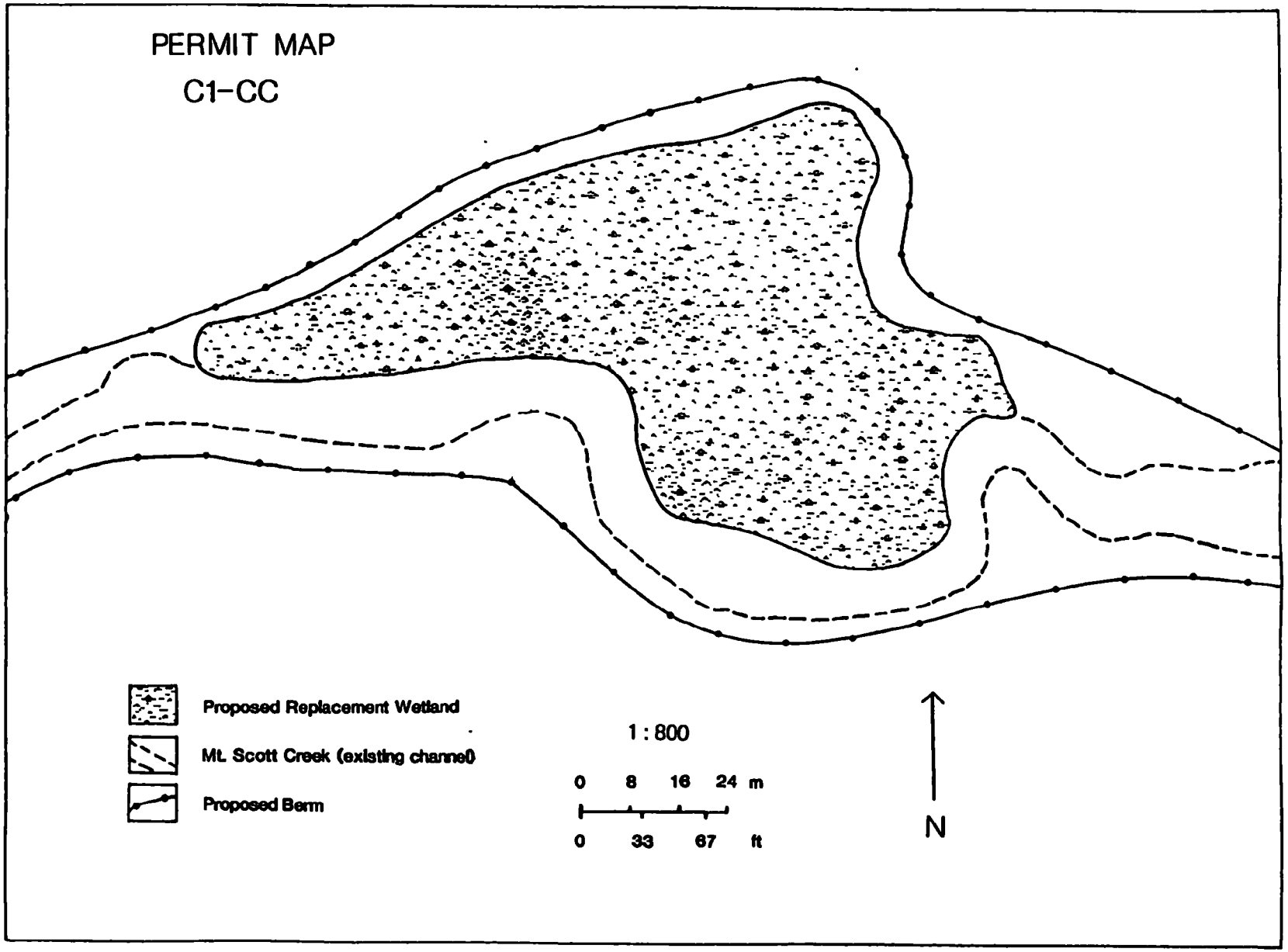
See the list of "Species Found On Site C1-CC" for an explicit account of the species identified.

Wildlife

Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined. Many birds were observed and heard at this site. They included robins, red-tailed hawks, starlings, and song sparrows. Deer tracks were seen in the mud. However, the noise from the nearby highway was often loud enough to drown out the bird calls, and this disturbance may influence wildlife use.

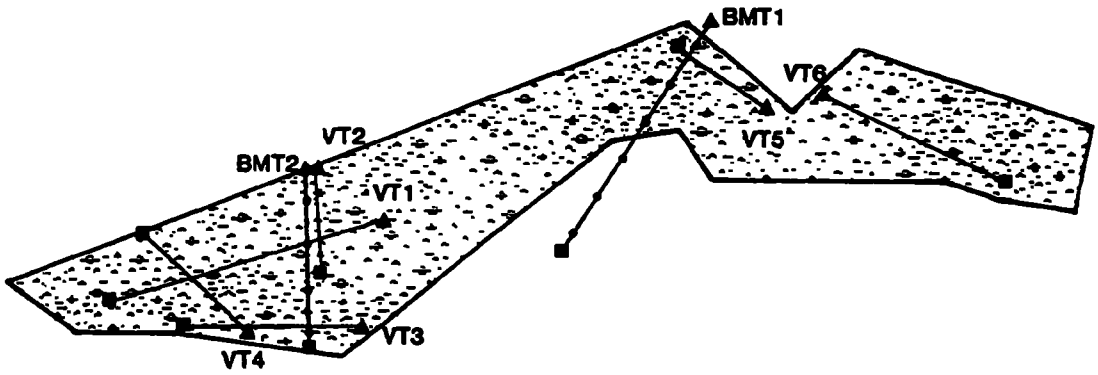
Impressions of the Site One Year Later

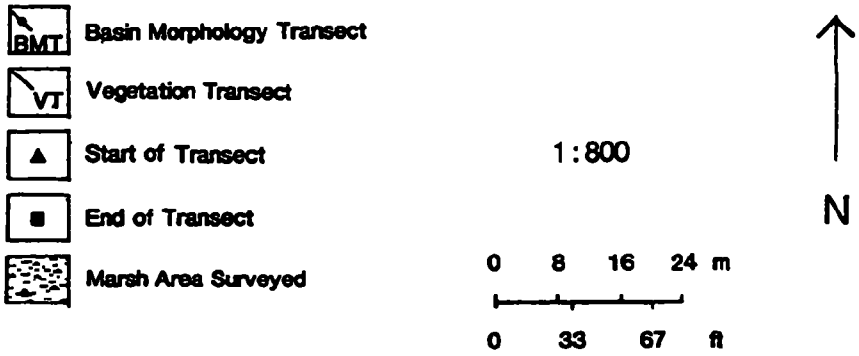
Overall, the site appeared very similar to conditions observed the previous year. A few differences were noted, however. The easternmost pond in the mosaic was more choked with Polygonum than the previous year. Duckweed (Lemna minor L.) was still present, but was being crowded out by the Polygonum. The vegetated areas between the hummocks were drier and more sparsely vegetated, and the bare areas were more extensive--possibly due to heavier motorcycle traffic.


PERMIT MAP
C1-CC
Proposed Replacement Wetland
Mt. Scott Creek (existing channel)
Proposed Berm
1 : 800
0 8 16 24 m
0 33 67 ft
N

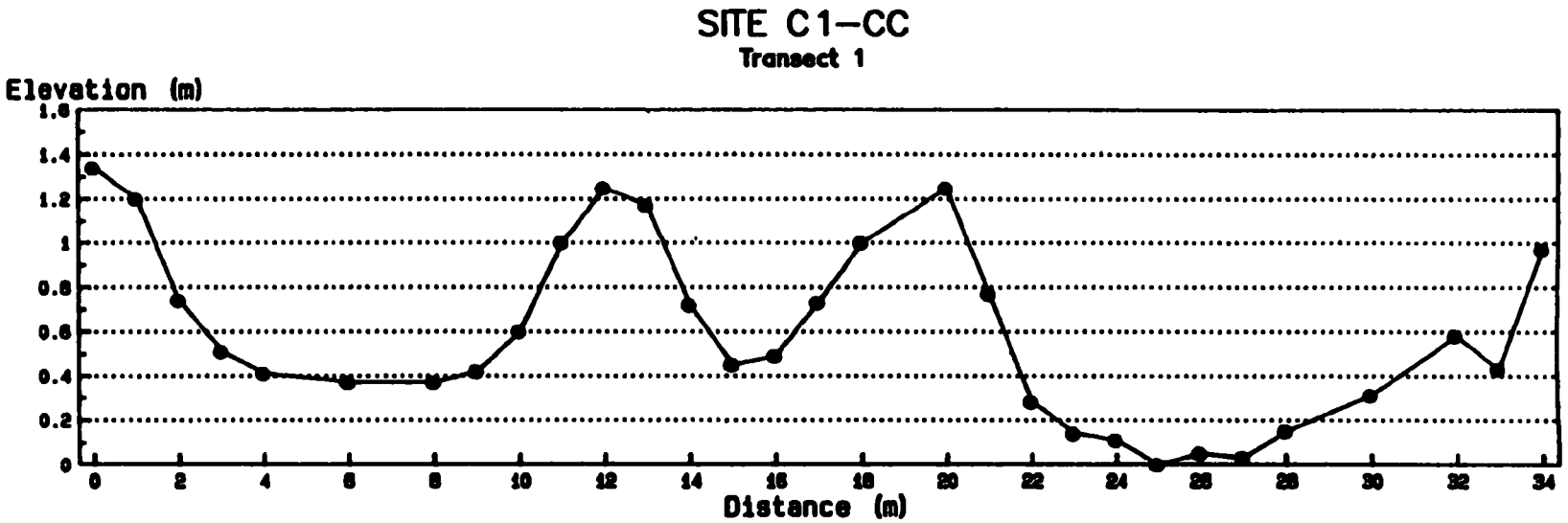
FIELD MAP

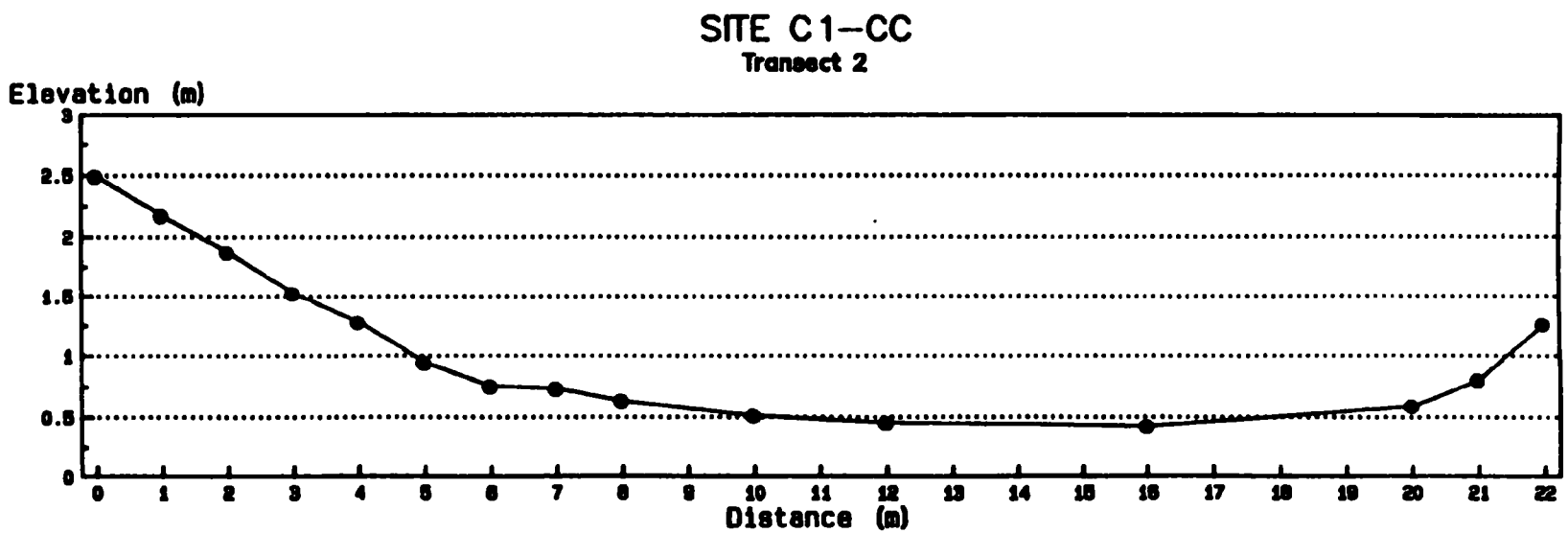
C1-CC





Source: Data collected by Stephanie Gwin & Sheri Confer July, 1987
Map drafted by T. Smith


SITE C1-CC
Transect 1
Elevation (m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Distance (m)


SITE C1-CC
Transect 2
Elevation (m)
3
2.5
2
1.5
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C1-CC

There was no planting list included in the permit file for this site.

Species Found On Site C1-CC During Summer 1987

Species	Wetland Indicator Code
Juncus effusus	FACW+NAT
Holcus lanatus	FAC\EXO
Rubus discolor	FACU-EXO
Geum macrophyllum	FACW+NAT
Stachys cooleyae	FACW\NAT
Carex stipata	OBL\NAT
Galium aparine	FACU\NAT
Agrostis alba	FACW\EXO
Lotus corniculatus	FAC\EXO
Polygonum hydropiperoides	OBL\NAT
Eleocharis palustris	OBL\NAT
Veronica americana	OBL\NAT
Carex laeviculmis	FACW\NAT
Vicia tetrasperma	UPL\EXO
Carex unilateralis	FACW\NAT
Geranium dissectum	UPL\EXO
Fragaria vesca	FACU\NAT
Dactylis glomerata	FACU\EXO
Senecio jacobaea	UPL\EXO
Tellima grandiflora	FACU\NAT
Juncus ensifolius	FACW\NAT
Scirpus microcarpus	OBL\NAT
Alopecurus pratensis	FACW\EXO
Poa palustris	FAC\EXO
Epilobium watsonii	FACW-NAT
Cornus stolonifera	FACW\NAT
Phalaris arundinacea	FACW\NAT
Alnus rubra	FAC\NAT
Fraxinus latifolia	FACW\NAT

Rubus ursinus	FACW\NAT
Anthoxanthum odoratum	FACU\EXO
Vicia sativa	UPL\EXO
Hedera helix	UPL\EXO
Circaea alpina	FACW\NAT
Ranunculus repens	FACW\EXO
Camassia leichtlinii	FACW-NAT
Symphoricarpos albus	FACU\NAT
Carex feta	FACW\NAT
Eleocharis ovata	OBL\NAT
Juncus bufonius	FACW+NAT
Lemna minor	OBL\NAT
Leersia oryzoides	OBL\NAT
Populus trichocarpa	FACW\NAT
Juncus tenuis	FAC\NAT
Plantago lanceolata	FACU+EXO
Alopecurus geniculatus	FACW+NAT
Oemleria cerasiformis	FACU\NAT
Rumex crispus	FACW\EXO

DESCRIPTION: SITE C2-TI

Function/Purpose

This project was mitigation for the construction of a marina facility providing moorage space for approximately 800 boats. The construction of the moorage involved dredging approximately 500,000 cubic yards of sand. In addition, approximately 90,000 cubic yards of fill material were used as bank protection material and approximately 20,000 cubic yards of rock riprap were used to stabilize and protect 6,000 linear feet of bankline. Approximately 50,000 cubic yards of fill material was placed in an existing 1.21 ha (3 acre) wetland to establish sufficient area for a dredge disposal area, access, and parking for the project. Approximately 250 pilings were driven to secure an estimated 11,000 linear feet of floating access walkways, fingerfloats, a fueling float, and a sewage pumpout facility.

Proposed functions and purposes of the wetland created as mitigation for impacts caused by construction of the marina facility are food chain support, wildlife habitat, fisheries habitat, sediment trapping, and flood storage and desynchronization.

General Description

The created wetland is a pond in the bottom of a bowl-shaped depression with very steep banks. The sandy berm separating it from Oregon Slough on the south stands several meters above the water level. The street and parking lots to the north of the site sit over 20 feet above the level of the pond--this bank is also very steep. The EPA permit log states that the project is in violation of the permit, but does not state why. The steepness and height of the banks might be the reason.

There is very little vegetation within the wetland. The plants are mostly small seedlings except for some shrubs on the western slope and on top of the berm separating the pond from Oregon Slough. Ornamentals have been planted along the top of the north bank next to the parking lot. These plants are being watered by sprinklers. This is creating a strange vegetation regime. The plants being watered are growing lushly, and the volunteers just below them on the bank are also growing well because of runoff from the watering. There are more "wetland" type plants growing in this area, high above the natural water line, than are growing adjacent to the pond. The area just below these plants is quite bare and dry. Further down the slope, just above the pond, wetland vegetation occurs again, but the area is mostly mudflats with young seedlings.

Water marks on the steep banks indicate that water level fluctuates greatly. A large culvert enters the pond midway on the north side. This culvert appears to be both the inlet and outlet to the pond, depending upon water levels in the adjacent water bodies. When the field crew sampled this wetland, water in the pond was two to three feet deep. It appears that the pond also accepts runoff from the surrounding areas because all are at higher elevations, and erosion from water flowing down the banks was evident.

This project was 11 months old when sampled in July of 1987.

Hydrology and Substrate

Water in the pond was stagnant but clear and odorless. Small amounts of suspended materials were visible, but the bottom of the pond could be seen easily. The water appeared to be several feet deep near the culvert and approximately six inches to a foot deep around the margins of the pond.

The substrate appeared to be about 95% sand. The Munsell Color Book indicated soil sample chromas ranging from /3 (non-hydric) to /1 (hydric). Mottling was seen in most soil pits, but usually not within 5 cm of the soil surface. Water was observed in only a few soil pits, indicating the level of the water table was lower at that point in time than the depth of most soil pits dug.

Dominant Vegetation

Mudflats surrounding the pond are vegetated with small, young seedlings. Many of these seedlings are the same species as plants observed in a nearby remnant of a natural marsh (E. Alverson, Botanist, pers. comm.). Salix sp., among other shrubs and trees, were growing on the berm separating the pond from Oregon Slough and on the bank west of the pond leading up to a boat yard.

See the list of "Species Found On Site C2-TI" for an explicit account of the species identified.

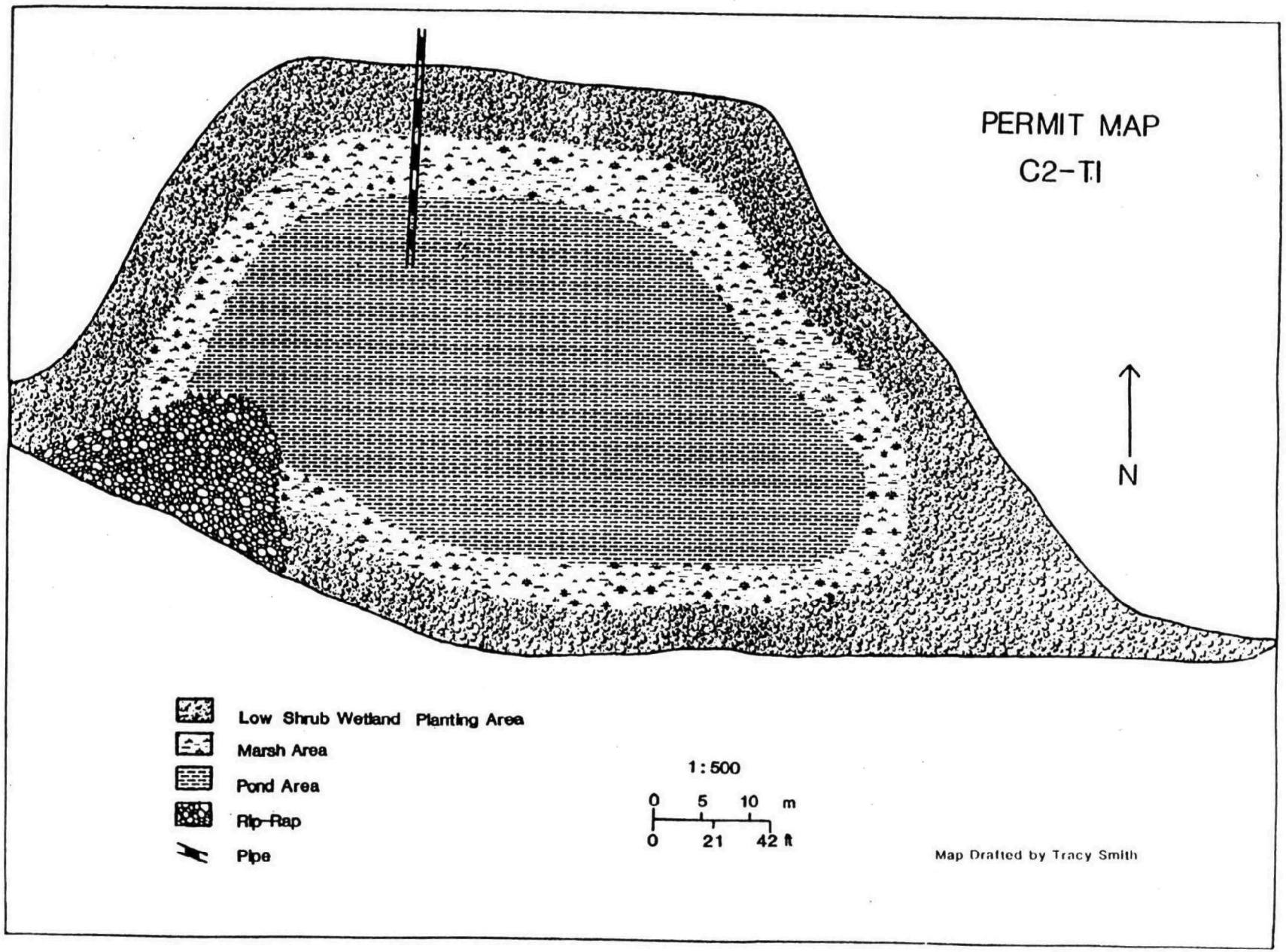
Wildlife

Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined. Very little wildlife was observed at this site. We saw a frog, some redwing blackbirds, barn swallows, and a killdeer.

The area was covered with dog tracks and a man walking his dog was observed in the filled area adjacent to the pond.

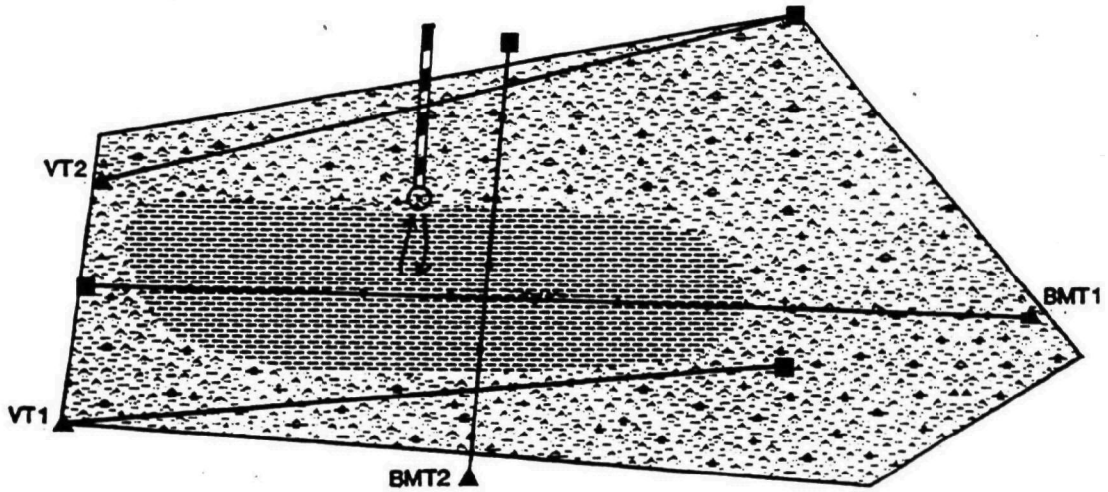
Impressions of the Site One Year Later

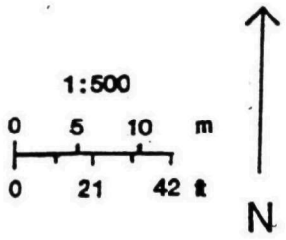
Overall, this site appeared unchanged from the previous summer. The water level in the pond may have been slightly lower. Vegetation cover of the site had increased, especially Salix seedlings growing in the mudflat/sandy areas. Also, the vegetation along the berm and banks was thicker and taller. However, the wetland was still mostly unvegetated mudflats.


PERMIT MAP
C2-TI
N
Low Shrub Wetland Planting Area
Marsh Area
Pond Area
Rip-Rap
Pipe
1:500
0 5 10 m
0 21 42 ft
Map Drafted by Tracy Smith

FIELD MAP

C2-TI



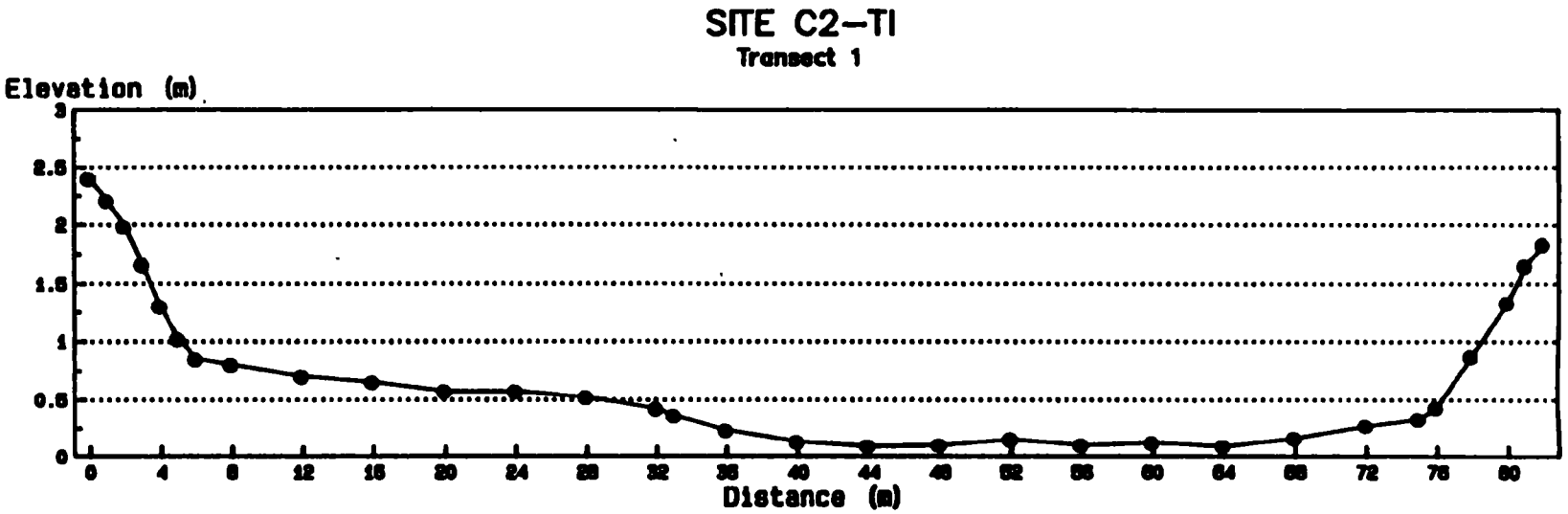


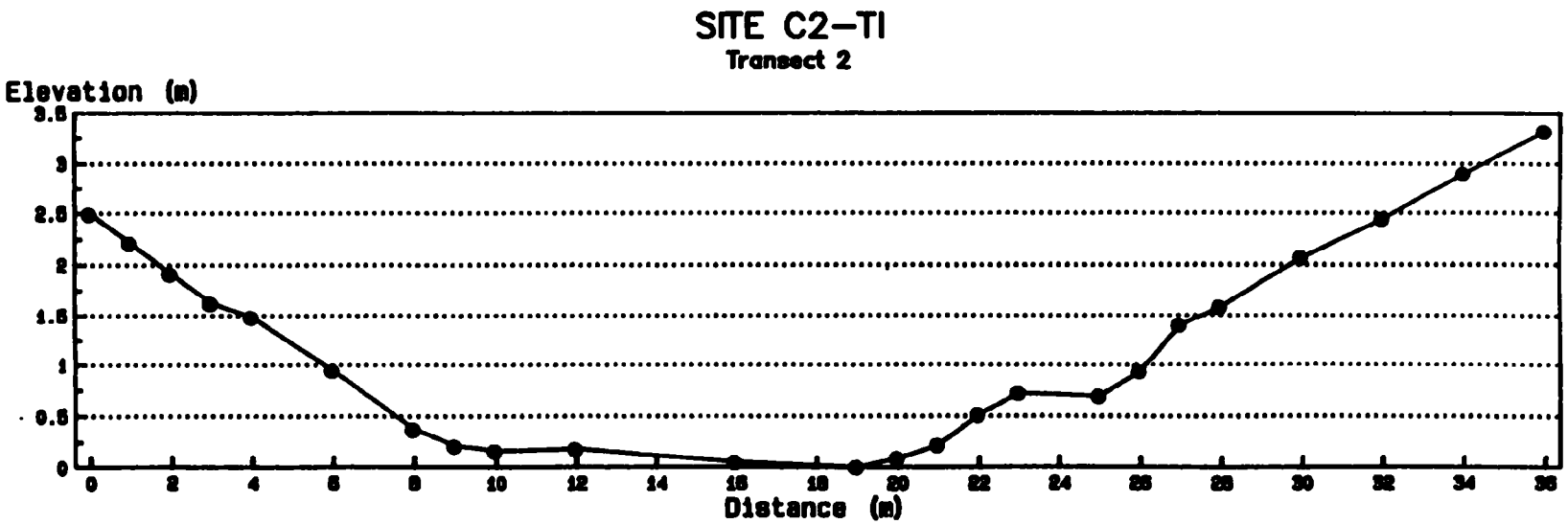
VT	Vegetation Transect
BMT	Basin Morphology Transect
▲	Start of Transect
■	End of Transect
	Dam
	Culvert
	Wetland Outlet or Inlet
	Pond
	Emergent Vegetation
	Survey
	Pipe (underground)

Pond and emergent vegetation boundaries are the approximate locations observed in July, 1987

Data collected by Stephanie Gwin & Sheri Confer

Map drafted by Tracy Smith


SITE C2-TI
Transect 1
Elevation (m)
3
2.5
2
1.5
1
0.5
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80
Distance (m)


SITE C2-TI
Transect 2
Elevation (m)
3.5
3
2.5
2
1.5
1
0.5
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C2-TI

	Species	Wetland Indicator Code
1	Scirpus validus	OBL\NAT
2	Potamogeton crispus	OBL\EXO
3	Cyperus esculentus*	FACW\NAT
4	Potentilla anserina	OBL\NAT
5	Polygonum hydropiper	OBL\EXO
6	Eleocharis palustris	OBL\NAT
7	Sagittaria latifolia	OBL\NAT
8	Spiraea douglasii	FACW\NAT
9	Salix sitchensis	FACW\NAT

Species Found On Site C2-TI During Summer 1987

	Species	Wetland Indicator Code
1	Juncus effusus	FACW+NAT
2	Juncus tenuis	FAC\NAT
3	Plantago major	FAC+EXO
4	Veronica americana	OBL\NAT
5	Salix fluviatilis	OBL\NAT
6	Veronica serpyllifolia	FAC\EXO
7	Gratiola neglecta	OBL\NAT
8	Chenopodium ambrosioides	FAC\EXO
9	Gnaphalium uliginosum	FAC\NAT
10	Tillaea aquatica	OBL\NAT
11	Heleochloa alopecuroides	OBL\EXO
12	Agrostis exarata	FACW\NAT
13	Epilobium watsonii	FACW-NAT
14	Eragrostis pectinacea	FAC\NAT
15	Gnaphalium palustre	FAC+NAT
16	Polygonum persicaria	FACW\EXO
17	Spergularia rubra	FAC-EXO
18	Polygonum aviculare	FACW-EXO
19	Cyperus esculentus*	FACW\NAT

20	Mollugo verticillata	FAC\NAT
21	Equisetum arvense	FAC\NAT
22	Limosella aquatica	OBL\NAT
23	Juncus bufonius	FACW+NAT
24	Lindernia dubia	OBL\NAT
25	Cyperus erythrorhizos	OBL\NAT
26	Panicum capillare	FAC\NAT
27	Arctium minus	FACU\EXO
28	Lindernia anagallidea	OBL\NAT
29	Peplis portula	FACW\EXO
30	Polygonum hydropiperoides	OBL\NAT
31	Cyperaceae 1 (seedling)	???
32	Rorippa curvisiliqua	FACW+NAT
33	Chenopodium botrys	FACU\EXO
34	Trifolium repens	FACU+EXO
35	Solidago occidentalis	FACW\NAT
36	Festuca arundinacea	FACU-EXO
37	Echinochloa crusgalli	FACW\NAT
38	Euphorbia supina	UPL\EXO
39	Digitaria ischaemum	FACU\EXO
40	Chenopodium album	FAC\EXO

DESCRIPTION: SITE O3-NS

Function/Purpose

This project was mitigation for the placement of up to 7,960 cubic yards of fill material and rock riprap in the 100 year flood plain of Fanno Creek to elevate Nimbus Avenue (south of Scholl's Ferry Road) above the floodplain. The pre-existing field between Nimbus Avenue and Fanno Creek was excavated. The excavation work was intended to maintain flood storage volumes and result in wetter soil conditions to allow natural revegetation by wetland species. Other functions and purposes of this mitigation are flood desynchronization, wildlife habitat, nutrient cycling, and sediment trapping.

General Description

As called for in the project permit, there is a grassy berm separating the detention area from Fanno Creek. It has steep sides that stand approximately 4 to 6 feet above the creek edge except at a narrow opening that serves as the connection between the wetland and the creek.

The northern half of the wetland was covered by shallow water. Pond edges were gradually sloped and the water appeared to be a few feet deep in some places. At the northeast corner, rock riprap created a steep bank up to Nimbus Avenue. There was very little emergent vegetation in this half of the wetland, so it was not sampled.

The southern half of the wetland consisted of mudflats and emergent vegetation interspersed with ponds of stagnant water and slowly flowing rivulets. The edges gradually sloped up to Nimbus Avenue on the east side, to a grassy field on the south side, and to the berm separating the wetland from Fanno Creek on the west side.

A small underground spring flowed into the wetland near its southwest corner. Water from this spring was slowly flowing over the wetland in no established channel toward the connection with Fanno Creek. This spring was considered the inlet to the wetland; the point where the water entered Fanno Creek, the outlet. At the outlet, the water formed a small channel. When high water conditions exist, water from Fanno Creek will flood the wetland, entering the site through what usually is the outlet.

When sampled in June 1987, this project was approximately 6 months old.

Hydrology and Substrate

Water in the wetland was odorless, slightly murky, and very shallow in the sampled area. As mentioned above, the water was much deeper and formed a pond in the northern half of the wetland. It flowed very slowly across the wetland toward the connection with Fanno Creek and formed stagnant pools in many places.

Most soil samples taken exhibited Munsell Color chromas of /1, indicating hydric soil. A few samples exhibited a /2 chroma, indicating a "borderline" hydric soil. All sample pits had mottling in the upper 5 cm of the soil, which indicates periodic inundation (Soil Conservation Service 1975). Most of the soil pits immediately filled with water when dug. A few filled rapidly to the surface. The soil was a very heavy, fine, mixture of silt and clay.

Dominant Vegetation

The area surrounding the wetland was covered primarily with upland grasses, including species of **Bromus**, **Poa**, and **Dactylis**. There was one large ash tree (**Fraxinus latifolia** Benth.) and a thicket of wild roses (**Rosa** sp.) on the east edge of the wetland. Emergent vegetation was sparse across the mudflats, possibly due to the young age of the wetland. However, most species appeared reproductive. A very notable aspect was the unusually high number of native herbs present. These include **Gratiola neglecta** Torr., **Lindernia dubia** (L.) Pennell, and several **Ranunculus** species. Seeds of these taxa presumably arrived via Fanno Creek, although transport by waterfowl is also possible. Another interesting note was the presence of thalloid liverworts (possibly **Riccia** sp.) along the mudflat's east shore. About 75% of the water's edge had a brownish or greenish algal bloom.

See the list of "Species Found On Site 03-NS" for an explicit account of the species identified.

Wildlife

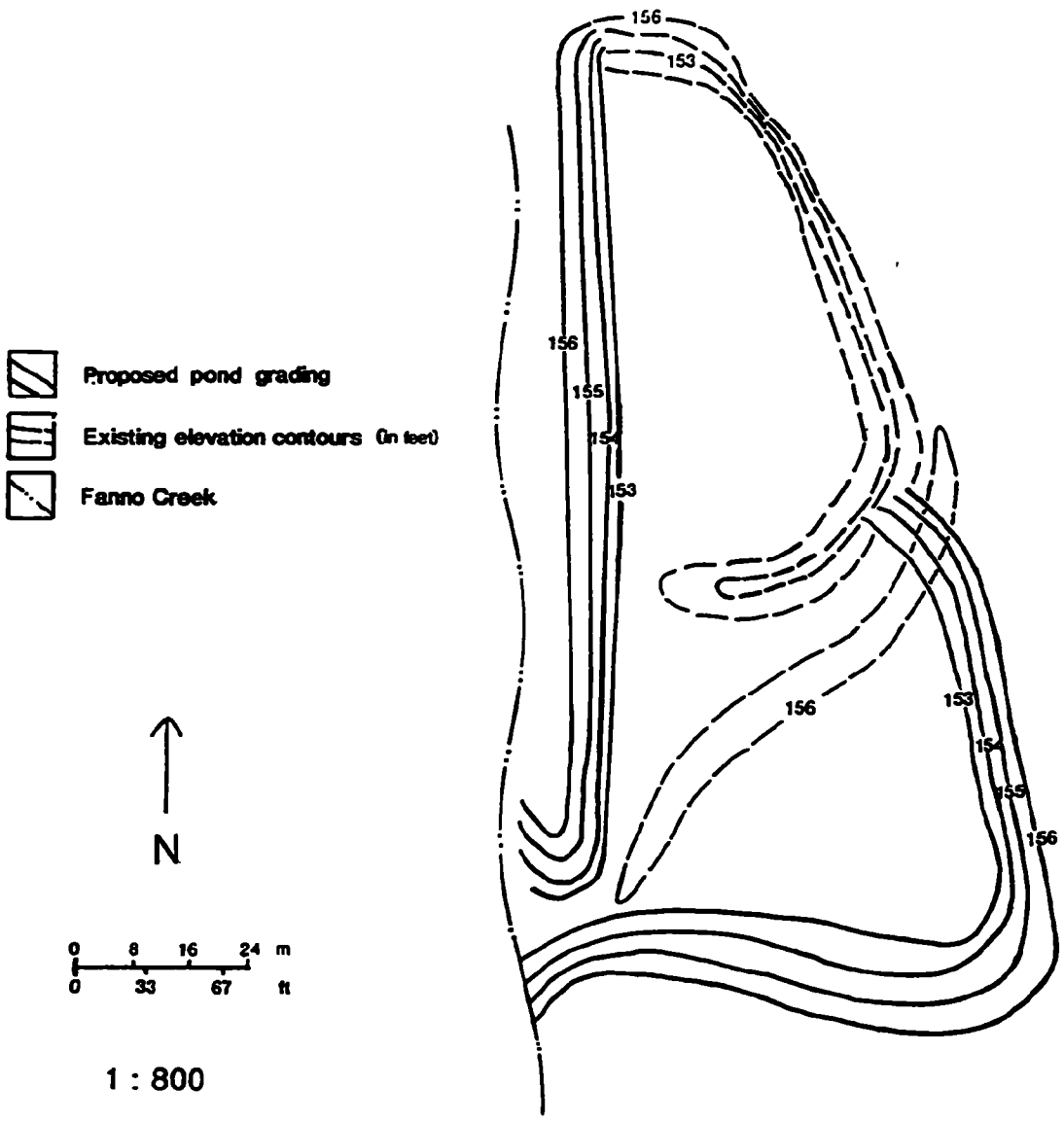
Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

Birds observed included mourning doves, killdeer, robins, mallard ducks, ringneck pheasants, and red winged blackbirds. Dragonflies and frogs were also observed.

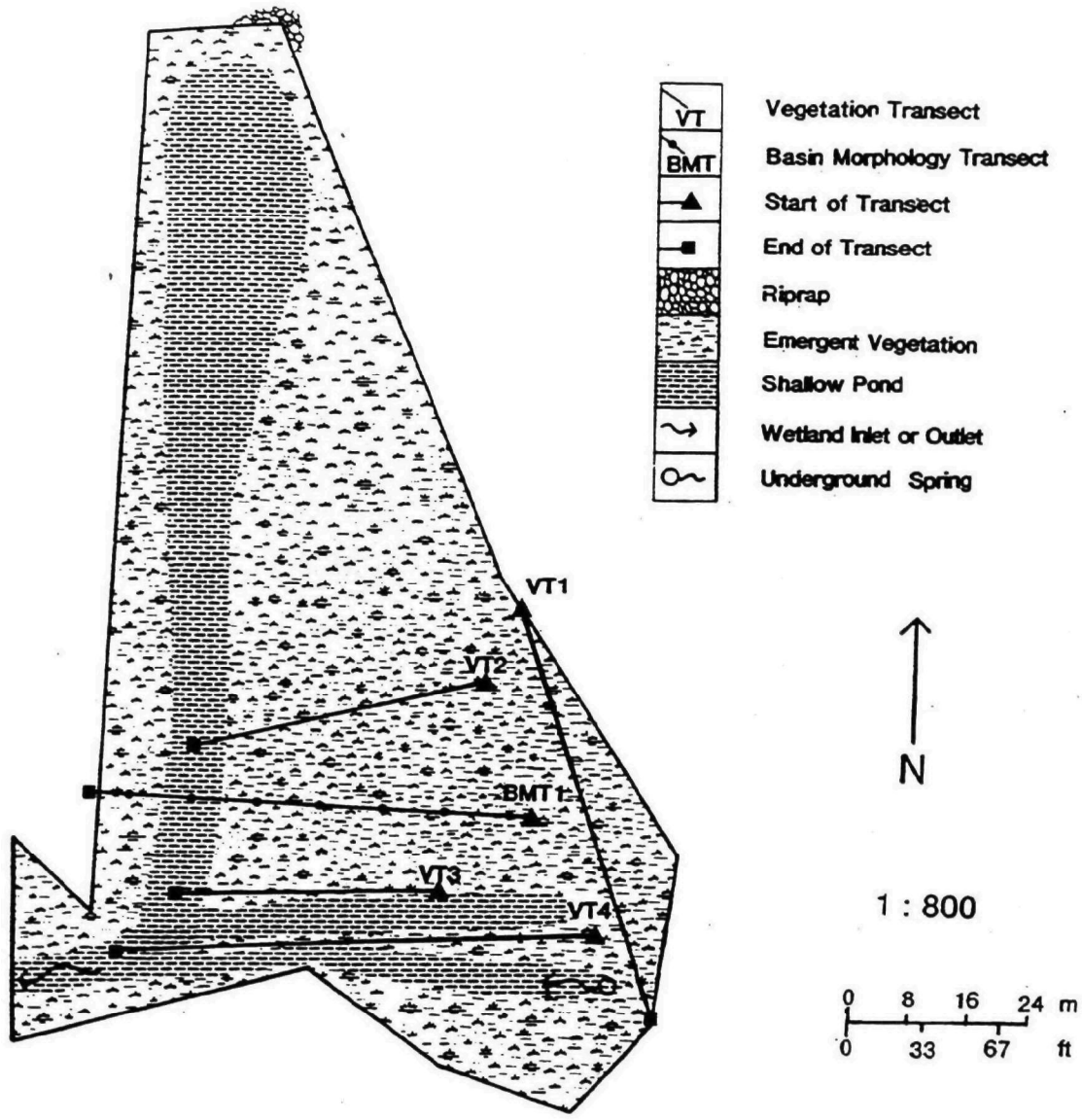
Impressions of the Site One Year Later

This wetland seemed to be maturing well. Shallow water covered almost the entire site. The vegetation was mostly wetland species. Whereas last summer most plants were seedlings, this summer many were mature and more seedlings were present.

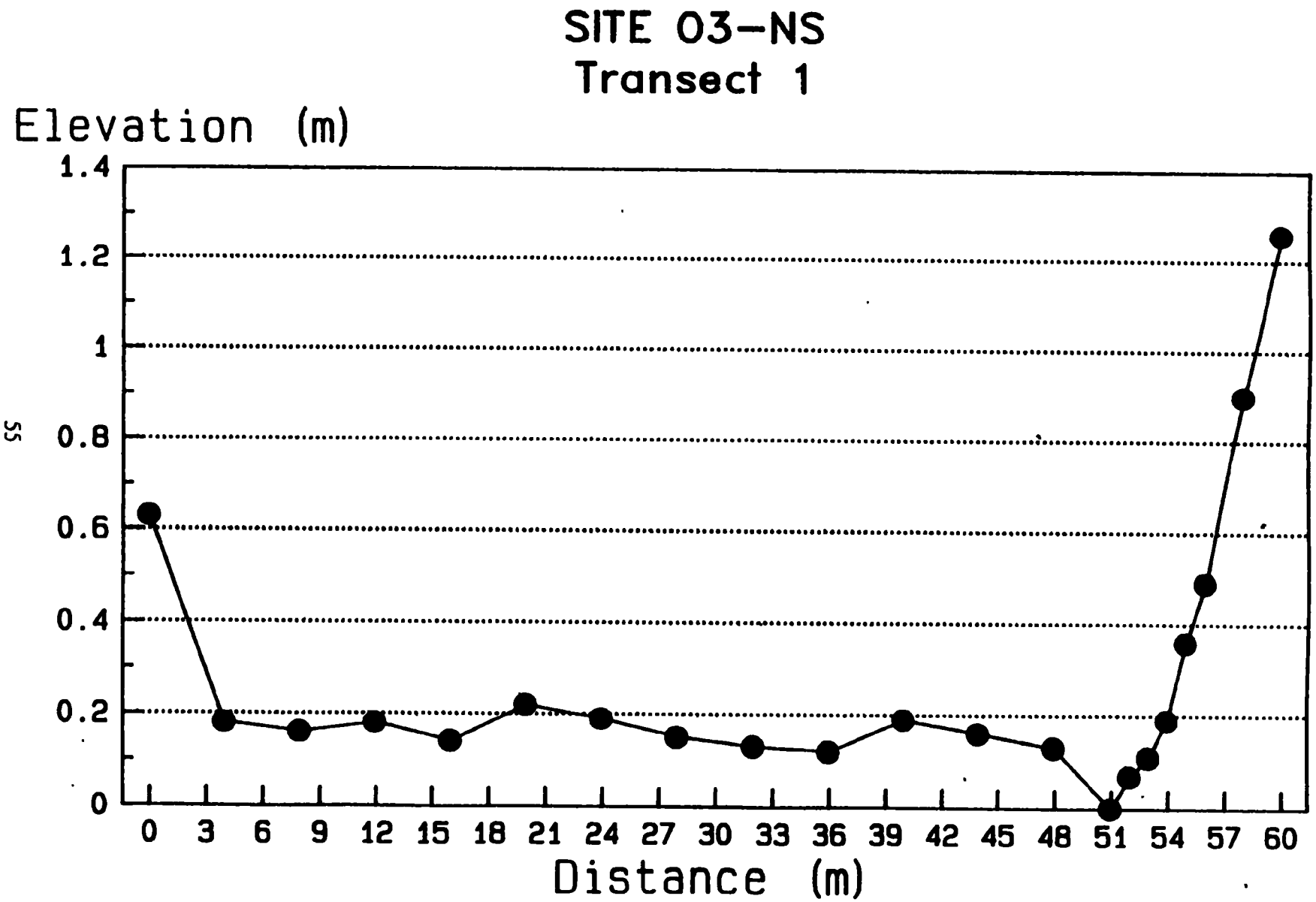
PERMIT MAP
03-NS



FIELD MAP
03-NS



Map drafted by Tracy Smith
Data collected by Stephanie Gwin & Sheri Confer
Pond and emergent vegetation boundaries are the approximate locations observed in July, 1987


SITE 03-NS
Transect 1
Elevation (m)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland O3-NS

There was no planting list included in the permit files for this site. This site was to be allowed to revegetate naturally (G. Herb, ODFW, pers. comm.).

Species Found On Site O3-NS During Summer 1987

	Species	Wetland Indicator Codes
1	Eleocharis ovata	OBL\NAT
2	Ranunculus repens	FACW\EXO
3	Epilobium watsonii	FACW-NAT
4	Rorippa curvisiliqua	FACW+NAT
5	Gnaphalium uliginosum	FAC\NAT
6	Callitriche stagnalis	OBL\NAT
7	Lindernia dubia	OBL\NAT
8	Juncus bufonius	FACW+NAT
9	Scirpus validus	OBL\NAT
10	Alopecurus pratensis	FACW\EXO
11	Carex stipata	OBL\NAT
12	Salix sp.	???
13	Echinochloa crusgalli	FACW\NAT
14	Alopecurus geniculatus	FACW+NAT
15	Poa trivialis	FACW-EXO
16	Myosotis laxa	OBL\NAT
17	Phalaris arundinacea	FACW\NAT
18	Rorippa islandica	OBL\NAT
19	Lolium perenne	FACU\EXO
20	Trifolium repens	FACU+EXO
21	Cirsium arvense	FACU+EXO
22	Trifolium dubium	UPL\EXO
23	Unknown Herb 2	???
24	Ludwigia palustris	OBL\NAT
25	Typha latifolia	OBL\NAT
26	Juncus tenuis	FAC\NAT
27	Juncus effusus	FACW+NAT
28	Pyrus malus	UPL\EXO

29	Veronica americana	OBL\NAT
30	Plantago major	FAC+EXO
31	Glyceria leptostachya	OBL\NAT
32	Gnaphalium palustre	FAC+NAT
33	Ranunculus sceleratus	OBL\NAT
34	Solanum dulcamara	FAC\EXO
35	Polygonum persicaria	FACW\EXO
36	Rumex salicifolius	FACW\NAT
37	Leersia oryzoides	OBL\NAT

DESCRIPTION: SITE O4-MHP

Function/Purpose

This project was mitigation for a residential development and shopping center requiring the placement of up to 13,600 cubic yards of fill material in an un-named tributary of Ash Creek. A lake has been created, of which 0.3 acres of its southwest shore have been planted with wetland vegetation. Emergent vegetation was to be planted along the lake edges and in the shallows. Proposed functions of the created lake and wetlands include: provide wildlife habitat (especially wildfowl), create an aesthetically pleasing "open space" within the development, detention and storage of surface water runoff, and reduction of erosion below the site by the desynchronization of storm waters coming from above the lake. Surface runoff was expected to increase upon completion of the development due to the greatly enlarged area of impervious surfaces. According to the "Development and Management Plan for Stream and Lake System" designed for this site, the area was a forested woodland prior to development.

General Description

The wetland area comprised a very small section of this site. The bulk of the site was occupied by a small lake and the clover covered lawns surrounding it. Portland General Electric's buildings sit on the hill to the south of the site, and the new shopping center is on the hill to the north. Murray Boulevard borders the lake at its eastern edge. A culvert runs under Murray and connects the lake with a system of ponds in the housing development across the road.

The lake receives water from two streams. One enters the lake at its northwest corner and the other enters the lake at its southwest corner. A road separates the streams from the lake, therefore, water from the streams enter the lake via weirs and culverts running under the road. Both of these creeks are to be converted to emergent marshes directly upstream of the road. The area where the SW stream abuts the road looked like a marshy area with woody shrubs at sampling time. Although the design plans called for it to be graded to lower elevations, it had not yet been dredged. The area where the NW stream abuts the road had already been excavated and flooded to create a very small pond.

The lake empties through the culvert under Murray Boulevard into the ponds on the other side of the road.
The lake bottom and sides have been covered with a clay liner to prevent seepage and water loss. The area of lake edge indicated by the construction plans as "emergent marsh" has been covered with a thin layer ("20 buckets") of soil dredged from the marsh just upstream and northwest of the lake. This is the only portion of the lake edge that supported emergent vegetation. The bulk of the lakeshore was a very steep drop-off (almost vertical) from the level of the lawns. This is contrary to the mitigation plans which state that "side slopes will not exceed 3:1 around the perimeter of the lake". Clover grew up to the lake's edge.

A fountain was located in the center of the eastern half of the lake. It provided artificial circulation to the lake to prevent it from stagnating during low water summer conditions.

This project was completed in December of 1986. When sampled in June of 1987, the site was approximately six months old.

Hydrology and Substrate

The water in the lake was odorless. Visibility into the water was limited to the upper few inches due to its dark green color. This coloring was probably caused by a bloom of unicellular blue-green algae visible on the water's surface and floating just under the surface.

The lake was to be 6 feet deep on the average. This was impossible to verify because of the limited visibility. The construction crew field boss informed me that the water level has been lowered and raised depending upon existing construction plans. These plans have changed several times. During sampling (June 23, 1987), the water level was at the very top of the banks. During a revisit to the site a few weeks later, the water level was approximately half as high.

Digging soil pits was very difficult because of the clay liner applied to the bottom and sides of the lake. The construction plans stated that the purpose of the liner was to prevent water loss due to seepage and to discourage the rooting of "nuisance" aquatic plants. The liner seemed to be effectively preventing seepage along the lake edge because all soil pits but two were completely dry, both at the time of digging and after the 30 minute stabilization period.

The Munsell Color Book indicated non-hydric soil chromas (/3 and /4) for eight of the ten plots sampled. The remaining two plots had chromas of /2 which indicates a borderline hydric soil. Mottling was present in the upper 5 cm of the soil, indicating periodic inundation (Soil Conservation Service 1975).

Substrate particle size was approximately 90% fine (clays) with a trace of cobble and gravel.

Dominant Vegetation

As stated above, the lake was surrounded by wide lawns of clover that extend from the development down to the water's edge. The slope from the east bank of the lake up to Murray Boulevard was mulched with bark dust and planted with ornamental shrubs and herbaceous plants. There are a few large conifers at the southeast corner. Judging from their large size, they probably were left standing when the forested woodland was cleared from this site. The area west of the lake between the two streams was thickly forested when we sampled.

A narrow strip of wetland vegetation was confined to the western edge of the lake shore. Here the slope was slightly less steep.

See the list of "Species Found On Site 04-MHP" for an explicit account of the species identified.

Wildlife

Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

Several species of swallow were observed skimming over the surface of the lake, including: violet-green swallows, barn swallows, cliff swallows and tree swallows. Starlings and other birds were heard in the nearby forest but not seen. Several different types of dragonflies were observed.

Addendum

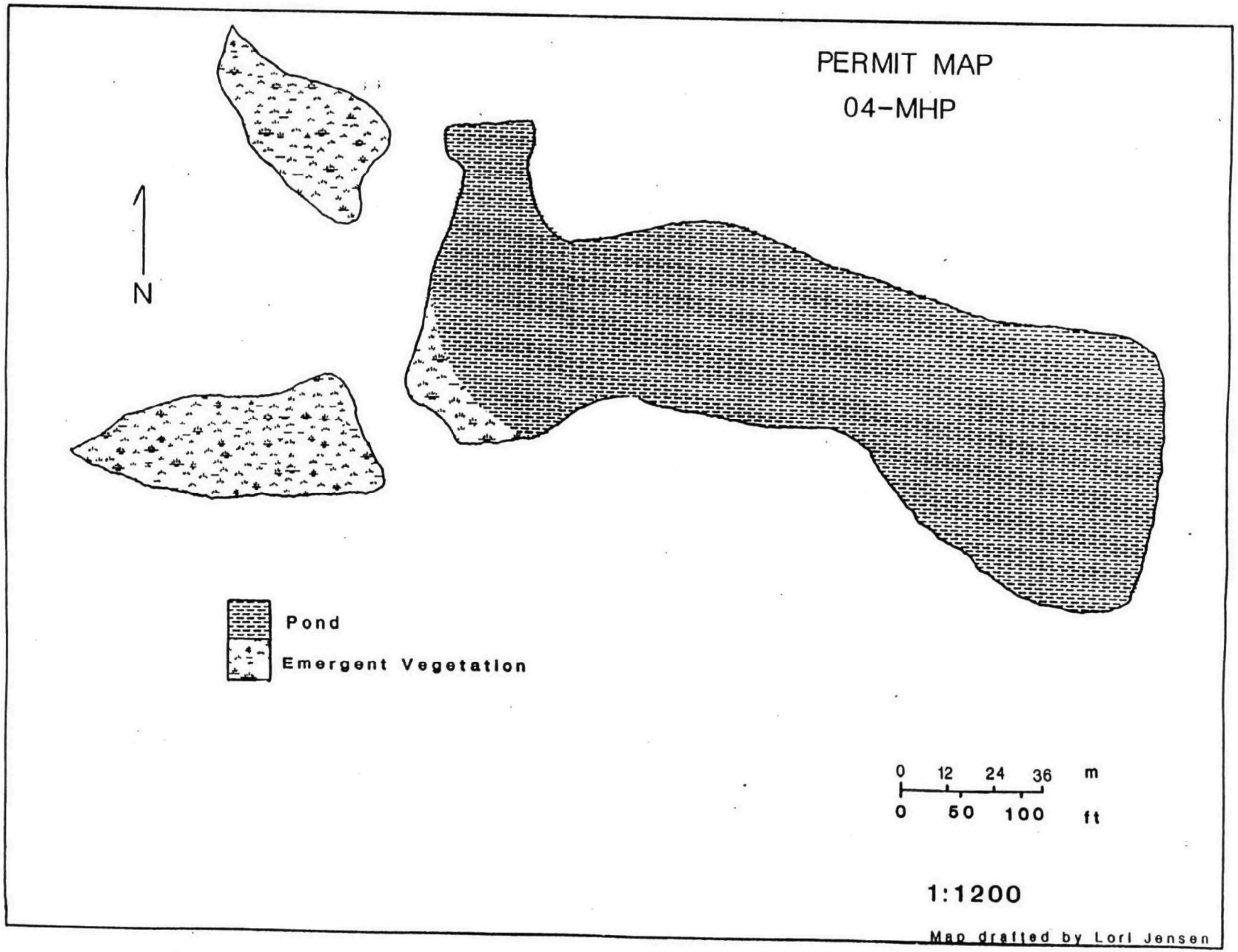
On August 8, 1987, Ed Alverson and Sheri Confer (two members of the field team) revisited the site to collect vegetation samples. They reported that the lake had been completely drained and heavy equipment was working in and around it. The soil had been scraped away from all the banks, so that they appeared less steep than when we sampled. The stream entering the lake from its southwest corner had been widened into a bowl shaped impoundment at the point where it abuts the road separating it from the lake.

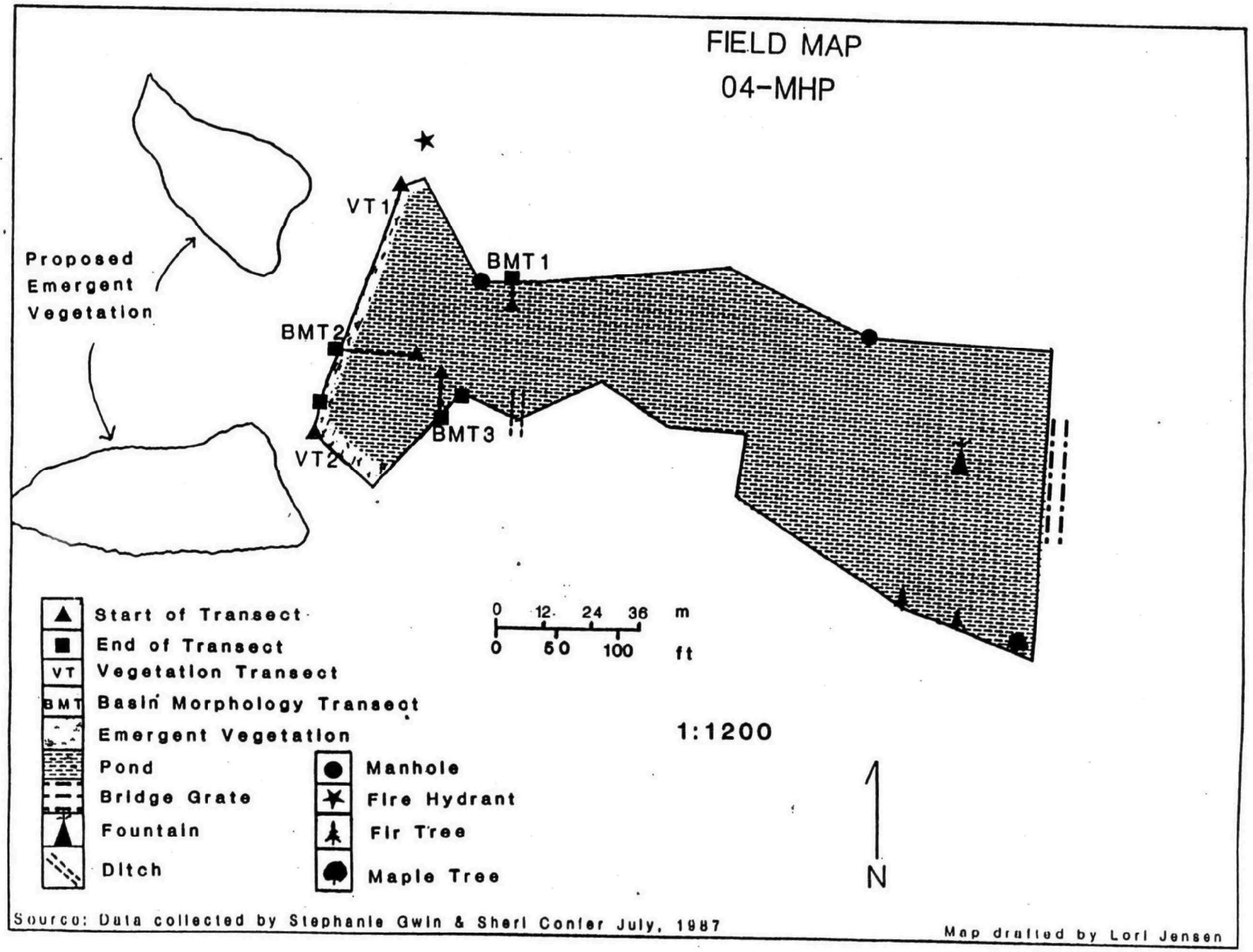
Impressions of the Site One Year Later

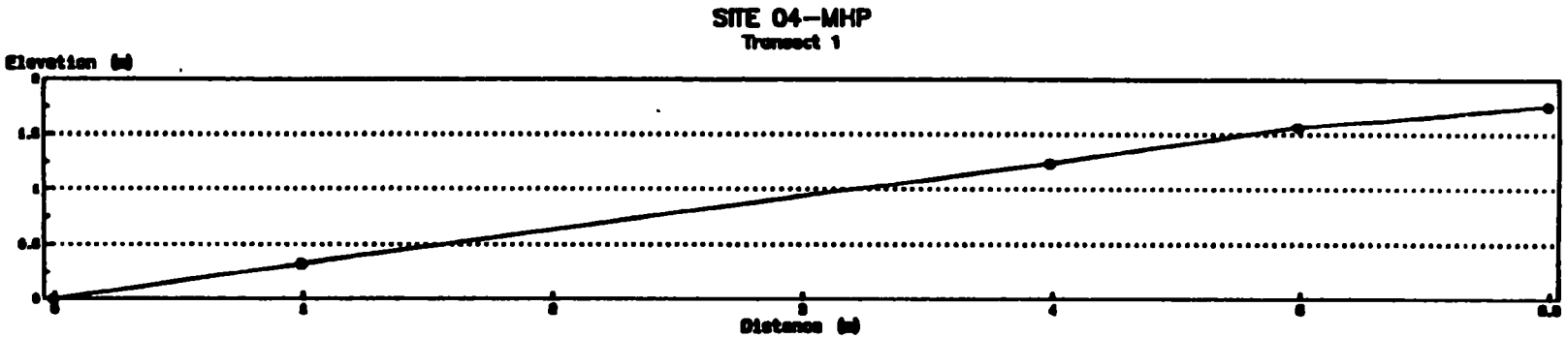
As noted in the Addendum above, the lake had been completely regraded, particularly the western half. It had been enlarged, and the north and south banks steepened. The lawn on the north bank had been removed. The lake bottom had been made very regular and the water level lowered so that it was approximately 0.3m deep in the west end extending out several meters toward the center, where it again deepened. Three fountains were present. The effects of erosion were visible. The clover has been replaced by upland grasses at the west end.

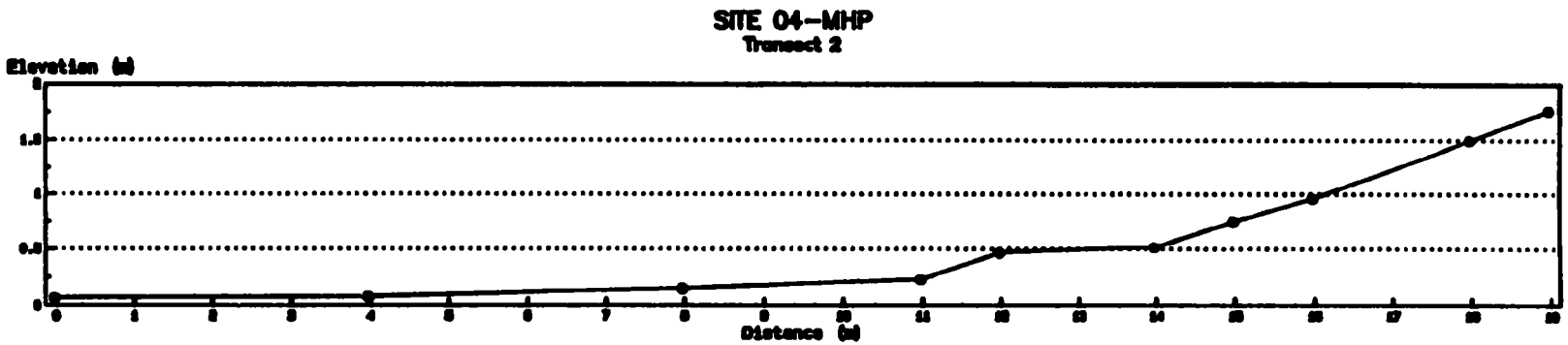
The intended wetland strip along the western edge of the lake had slightly more vegetation than during sampling the previous summer. The bank was more irregular than it was previously. This area was being watered with a sprinkler system.

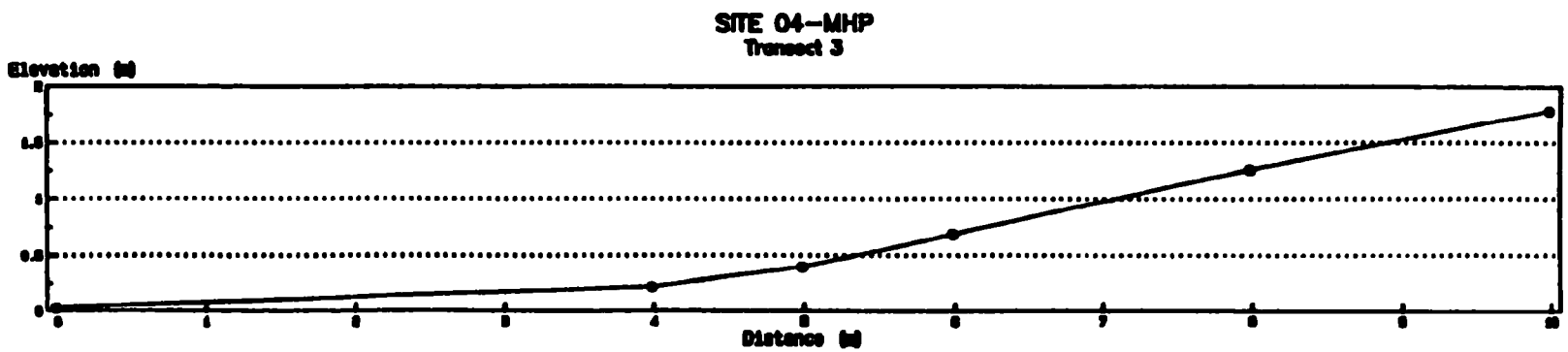
The stream coming into the southwest corner of the lake has been widened and islands constructed within it. A cyclone fence was installed around the perimeter of this area.


PERMIT MAP
04-MHP
N
Pond
Emergent Vegetation
0 12 24 36 m
0 50 100 ft
1:1200
Map drafted by Lori Jensen


FIELD MAP
04-MHP
Proposed
Emergent
Vegetation
VT1
BMT1
BMT2
BMT3
VT2
Start of Transect
End of Transect
VT Vegetation Transect
BMT Basin Morphology Transect
Emergent Vegetation
Pond
Bridge Grate
Fountain
Ditch
Manhole
Fire Hydrant
Fir Tree
Maple Tree
0 12 24 36 m
0 50 100 ft
1:1200
N
Source: Data collected by Stephanie Gwin & Sheri Conler July, 1987
Map drafted by Lori Jensen


SITE 04-MHP
Transect 1
Elevation (m)
Distance (m)


SITE 04-MHP
Transect 2
Elevation (m)
Distance (m)


SITE 04-MHP
Transect 3
Elevation (m)
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland O4-MHP

	Species	Wetland Indicator Code
1	Spiraea douglasii	FACW\NAT
2	Cornus stolonifera var occidentalis	FACW\NAT
3	Scirpus microcarpus	OBL\NAT
4	Ranunculus sp.	???
5	Typha sp.	OBL\???
6	Salix sp.	???
7	"Great bulrush"	???

Common names only were used for all plants listed for this site. Where possible, genus and species were determined for the common names given.

Species Found On Site 04-MHP During Summer 1987

	Species	Wetland Indicator Code
1	Trifolium dubium	UPL\EXO
2	Lolium perenne	FACU\EXO
3	Leontodon nudicaulis	UPL\EXO
4	Trifolium pratense	FACU\EXO
5	Vicia sativa	UPL\EXO
6	Trifolium repens	FACU+EXO
7	Glyceria leptostachya	OBL\NAT
8	Juncus bufonius	FACW+NAT
9	Spergularia rubra	FAC-EXO
10	Deschampsia elongata	FACW-NAT
11	Polygonum aviculare	FACW-EXO
12	Gnaphalium palustre	FAC+NAT
13	Agrostis exarata	FACW\NAT
14	Holcus lanatus	FAC\EXO
15	Cardamine oligosperma	FACW\NAT
16	Navarretia squarrosa	UPL\NAT
17	Epilobium watsonii	FACW-NAT
18	Antirrhinum orontium	FAC\NAT

19	Equisetum telmateia	FACW\NAT
20	Carex sp.	???
21	Cirsium vulgare	FACU\EXO
22	Festuca bromoides	FAC\EXO
23	Daucus carota	FAC\EXO
24	Capsella bursa-pastoris	FAC-EXO
25	Taraxacum officinale	FACU\EXO
26	Juncus ensifolius	FACW\NAT
27	Myosotis laxa	OBL\NAT
28	Crepis setosa	UPL\EXO
29	Poa compressa	FACU\NAT
30	Geum macrophyllum	FACW+NAT
31	Vicia americana	FAC\NAT
32	Alopecurus geniculatus	FACW+NAT
33	Alnus rubra	FAC\NAT
34	Cirsium arvense	FACU+EXO
35	Lactuca serriola	FAC-EXO
36	Juncus effusus	FACW+NAT
37	Centaurea cyanus	UPL\EXO
38	Veronica americana	OBL\NAT
39	Lupinus polyphyllus	FACU-NAT
40	Phalaris arundinacea	FACW\NAT
41	Boisduvalia densiflora	FACW-NAT
42	Echinochloa crusgalli	FACW\NAT
43	Cerastium viscosum	NO\EXO
44	Geranium dissectum	UPL\EXO
45	Rumex crispus	FACW\EXO
46	Luzula campestris	FACU\NAT
47	Chrysanthemum leucanthemum	FAC\EXO
48	Hypericum perforatum	UPL\EXO

DESCRIPTION: SITE C5-MG

Function/Purpose

This permit allowed the filling of approximately 0.12 ha (0.3 acres) of wetland within the 100 year flood plain of Fanno Creek to provide a parking area and landscaping improvements for an upland development. Approximately 0.17 ha (0.4 acres) were excavated to create a wetland to replace the functions of flood storage and desynchronization, wildlife habitat, food chain support, fisheries habitat, nutrient retention and removal, and sediment trapping.

General Description

The created wetland was a narrow strip of marsh running north/south between the development's east parking lot and a stream running into the extensive natural marsh. It was considered "Mitigation Area 2" in the development proposal.

The bank sloping down from the parking lot east of the created marsh was rather steep. It was covered with bark dust and planted with shrubs (mostly ornamental dogwood) in an effort to control erosion.

The north edge of the created marsh was bordered by large buildings housing offices and light industry. The building directly north of the sampled area was built on pillars above the marsh.

An extensive natural wetland consisting of ponds, stream channels, and emergent marsh was located west of the created marsh. It was heavily vegetated and supported many birds and other wildlife (G. Herb pers. comm.). A small stream (about two meters across and between one and two meters deep), separated the created area from the natural marsh, and was designated the western boundary.

Directly south of the created marsh was a small filled area that extends from the parking lot and separates the marsh from several acres of forest.

A large culvert was located at the northeast corner of the sampled area. The development/mitigation plans show it running from Nimbus Avenue under the east parking lot. The field team regarded this culvert as the inlet to the wetland. The plans showed another culvert running into the wetland at its southeast corner and mentioned the existence of a "seep", but neither were observed by the field crew.

The stream running alongside the created wetland toward the natural marsh was considered to be the created wetland's outlet by the field crew.

The site was sampled in July of 1987, and was almost three years old.

Hydrology and Substrate

Water was channelized, but flowing very slowly. The water in the stream was cloudy and odorless, and relatively deep. The stream bottom could not be seen. Probing with the stadia rod indicated depths ranging from 0.8-2.2 m at midstream.

Munsell chromas indicated all but one soil sample were hydric (/1). The one non-hydric sample was from a pit dug on Transect 1 in the neighboring fill area. This sample had a chroma indicating "borderline" hydric (/2). All sample pits were mottled in the upper 5-cm, indicating periodic

inundation (Soil Conservation Service 1975). Near the fill area, soil pits were not dug to 30 cm because we hit gravel/cobbles at shallower depths.

Most soil sample pits had water in them within 30 minutes of digging. Exceptions were those pits on Transect 1 (See Field Map) nearest the fill area, and one pit on Transect 2 (See Field Map), also near the fill area. There was a detrital layer present and soil particle size was 100% fines.

Dominant Vegetation

A heavy, dense mixture of **Typha latifolia** L., **Leersia oryzoides** (L.) Swartz, **Juncus effusus** L., and **Phalaris arundinacea** L. covered most of this site. Some of the T. **latifolia** was over two meters tall. Emergent vegetation was observed along the edges of the streambed, and algal growth coated many of the stems of the emergent plants. The most diversity occurred along the periphery of the site, where the T. **latifolia** and J. **effusus** were less robust. Numerous introduced weeds prevailed along the periphery, as well as a few natives like **Epilobium watsonii** Barbey and **Geum macrophyllum** Willd. Some interesting aquatics and semi-aquatics occurred in the stream, including **Hydrocotyle ranunculoides** L.

See the list of "Species Found On Site C5-MG" for an explicit account of the species identified.

Wildlife

Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

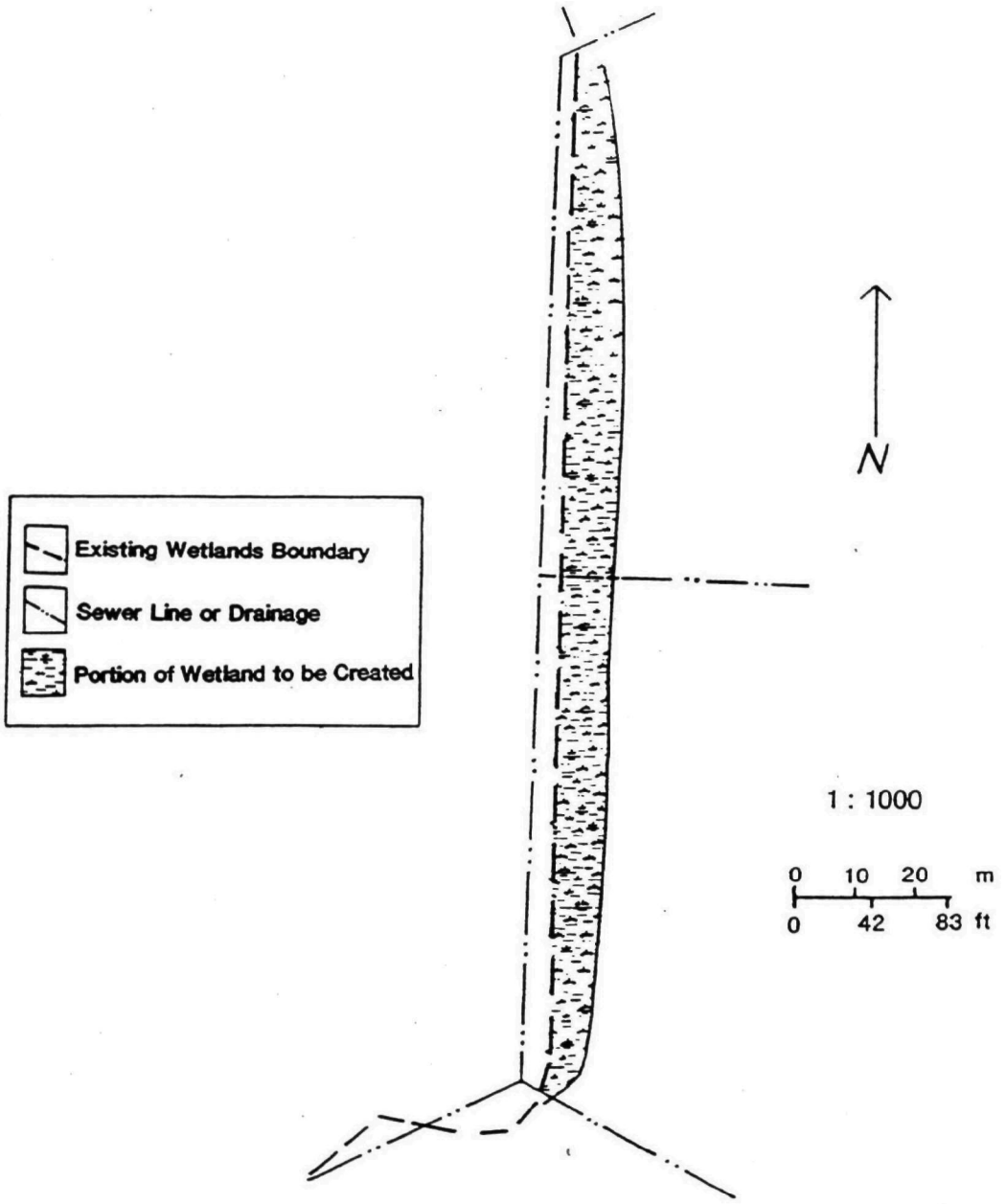
Birds observed included red tailed hawks, redwing blackbirds, song sparrows, robins, mallard ducks, great blue heron, sora, and yellow throat. The birds were very abundant. Frogs and minnows were observed in the creek.

Impressions of the Site One Year Later

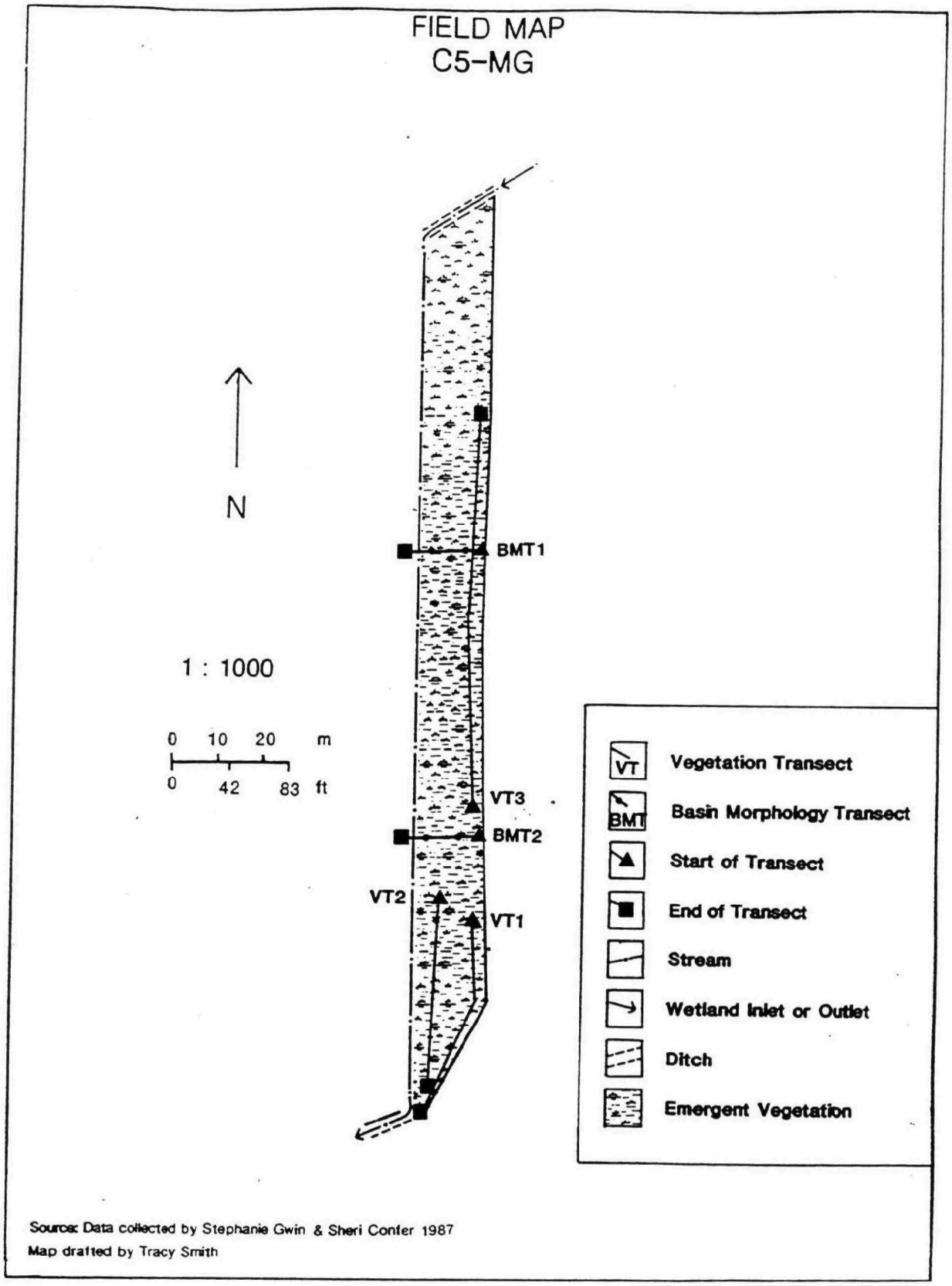
Water levels within the wetland and neighboring natural marsh appeared higher than last summer. The stream separating the natural and created portions of the marsh appeared wider and deeper than the previous year. Also, there appeared to be large patches of open water in the natural marsh which had been heavily vegetated last summer. Much of the T. **latifolia** was standing dead.

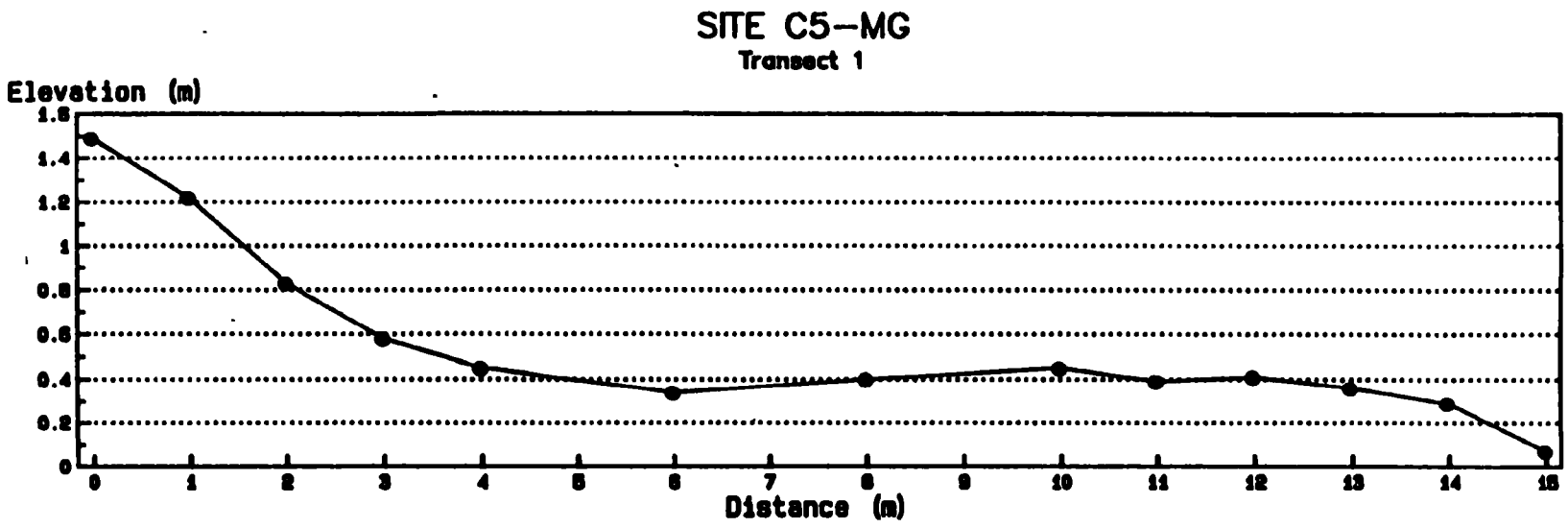
The bank sloping up to the parking lot was now vegetated and the ornamental dogwoods planted along its crest were doing well. The area surrounding the marsh was being developed rapidly. There were buildings under construction and many newly completed.

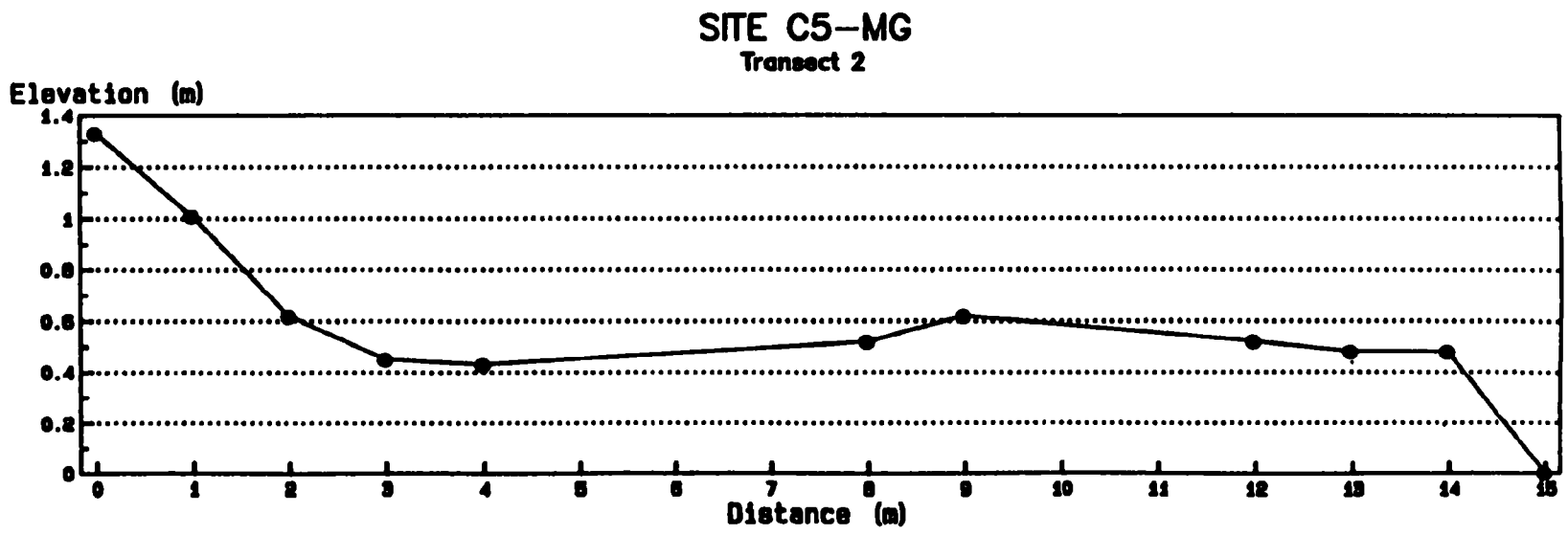
PERMIT MAP
C5-MG



Map drafted by Tracy Smith


FIELD MAP
C5-MG
N
1 : 1000
0 10 20 m
0 42 83 ft
BMT1
VT3
BMT2
VT2
VT1
VT
Vegetation Transect
BMT
Basin Morphology Transect
Start of Transect
End of Transect
Stream
Wetland Inlet or Outlet
Ditch
Emergent Vegetation
Source: Data collected by Stephanie Gwin & Sheri Confer 1987
Map drafted by Tracy Smith


SITE C5-MG
Transect 1
Elevation (m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Distance (m)


SITE C5-MG
Transect 2
Elevation (m)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C5-MG

	Species	Wetland Indicator Code
1	Eleocharis palustris*	OBL\NAT
2	Glyceria borealis	OBL\NAT
3	Scirpus acutus*	OBL\NAT
4	Typha latifolia*	OBL\NAT
5	Agrostis palustris	FAC+NAT

Species Found On Site C5-MG During Summer 1987

	Species	Wetland Indicator Code
1	Typha latifolia*	OBL\NAT
2	Agrostis tenuis	UPL\EXO
3	Veronica americana	OBL\NAT
4	Eleocharis palustris*	OBL\NAT
5	Phalaris arundinacea	FACW\NAT
6	Scirpus acutus*	OBL\NAT
7	Juncus effusus	FACW+NAT
8	Poa annua	FAC-NAT
9	Carex stipata	OBL\NAT
10	Epilobium watsonii	FACW-NAT
11	Poa palustris	FAC\EXO
12	Phleum pratense	FACU\EXO
13	Lolium perenne	FACU\EXO
14	Cirsium vulgare	FACU\EXO
15	Plantago major	FAC+EXO
16	Geranium dissectum	UPL\EXO
17	Cichorium intybus	UPL\EXO
18	Agropyron repens	NO\EXO
19	Epilobium paniculatum	UPL\NAT
20	Plantago lanceolata	FACU+EXO
21	Alopecurus pratensis	FACW\EXO
22	Holcus lanatus	FAC\EXO
23	Dipsacus sylvestris	FACU\EXO

24	Rubus discolor	FACU-EXO
25	Ranunculus repens	FACW\EXO
26	Senecio jacobaea	UPL\EXO
27	Geum macrophyllum	FACW+NAT
28	Lapsana communis	UPL\EXO
29	Rumex conglomeratus	FACW\EXO
30	Taraxacum officinale	FACU\EXO
31	Daucus carota	FAC\EXO
32	Festuca arundinacea	FACU-EXO
33	Trifolium dubium	UPL\EXO
34	Symphoricarpos albus	FACU\NAT
35	Trifolium repens	FACU+EXO
36	Vicia tetrasperma	UPL\EXO
37	Vicia sativa	UPL\EXO
38	Sparganium eurycarpum	OBL\NAT
39	Lemna minor	OBL\NAT
40	Leersia oryzoides	OBL\NAT
41	Glyceria grandis	OBL\EXO
42	Eleocharis ovata	OBL\NAT

DESCRIPTION: SITE C6-3I

Function/Purpose

This project was mitigation for a fill between Cornell Road and the south and west right-of-way of Sunset Highway. The property will be developed according to approved zoning. The pre-existing creek channel was realigned along the easterly portion of the property, along the toe of the fill. The flood storage displaced by the placement of fill on the northwesterly portion of the property was compensated through the creation of a wetland by removing material within the eastern portion, located south of the Sunset Highway at the intersection of Cornell Road and 158th street. When the excavation work was completed, the native topsoil was replaced and the entire disturbed area was reseeded with native grasses. The project was implemented in a way that retained as much of the natural character of the property as possible. In addition to flood storage, proposed purposes of this created wetland were flood water desynchronization, wildlife habitat, nutrient cycling, non-consumptive recreation, and sediment trapping.

General Description

Three shallow ponds connected by narrow channels were created as an enhancement of existing emergent marshland. Each pond contained an irregularly shaped island vegetated with grasses and herbs. The banks of the ponds were uneven and gradually sloped. Emergent vegetation and algae were growing along the pond edges, both on the banks and in the water. South of the ponds was a steep sided berm covered with grasses. A wooded hedge situated along its summit screened and separated the wetland from adjacent cultivated hayfields.

A stream approximately 2 meters wide entered the pond system midway down the north edge of the easternmost pond. Water in the stream was flowing slowly into the wetland. Another, smaller stream was separated from the easternmost pond by a narrow isthmus and was flowing into the channel leading from the east pond to the center pond.

Water flowed from the westernmost pond into a channel leading to a culvert under 158th street. This channel appeared to be the outlet from the wetland.

This project was completed in September of 1984. The berm was reconstructed one year later. The created wetland was sampled in July of 1987.

Hydrology and Substrate

Water in the ponds was odorless and turbid with visibility to a depth of about 0.3 meters. The water was flowing slowly from pond to pond via the connecting channels.

The soil was very hard and dry along all the transects except Transect 3 (See Field Map). Field crew members weren't able to reach 30 cm on all pits because of the difficulty of digging.

The Munsell Color Book indicated non-hydric soils with chromas ranging from /4 to /2 on all sampled plots except one. Plot 9 of Transect 1 had hydric soil with a chroma of /1. Periodic inundation was indicated in all soil pits by mottles observed in the upper 5 cm of the soil (Soil Conservation Service 1975).

Soil pits dug along Transects 2 and 4 were dry. These two transects were on each of the banks opposite the center pond. A few of the pits dug along Transect 1, located along the south bank of the westernmost pond, filled slowly during the 30 minutes allowed for stabilization. Pits along

Transect 3 flooded almost immediately after being dug. This transect was placed along the narrow isthmus separating the easternmost pond from the stream bordering it.

Dominant Vegetation

A filamentous greenish alga (probably Spirogyra spp.) was observed floating on the water's surface and along the edges of the ponds. A blue-green, filamentous alga was attached to the channel bottoms between the ponds. Also present was the green alga Hydrodictyon reticulatum Roth (B. Meinke pers. comm.). Extensive stands of Typha latifolia L., species of Salix, and Spiraea douglasii Hook. were observed to the north and northeast of the ponds, and along the southern borders of the eastern and westernmost ponds.

The westernmost pond was almost completely surrounded by wetland vegetation, but the center pond had only a narrow band of wetland vegetation along its edges. The eastern pond had a thick band of wetland vegetation along its south and east borders, but a very narrow band along the northern border.

The diversity of vegetation at this site was high, likely due to the close proximity of the pre-existing natural marsh (B. Meinke, Botanist, pers. comm.). The diversity will probably diminish in time, as the more aggressive perennial such as T. latifolia and Juncus effusus L. occupy more of the site.

See the list of "Species Found On Site C6-3I" for an explicit account of the species identified.

Wildlife

Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

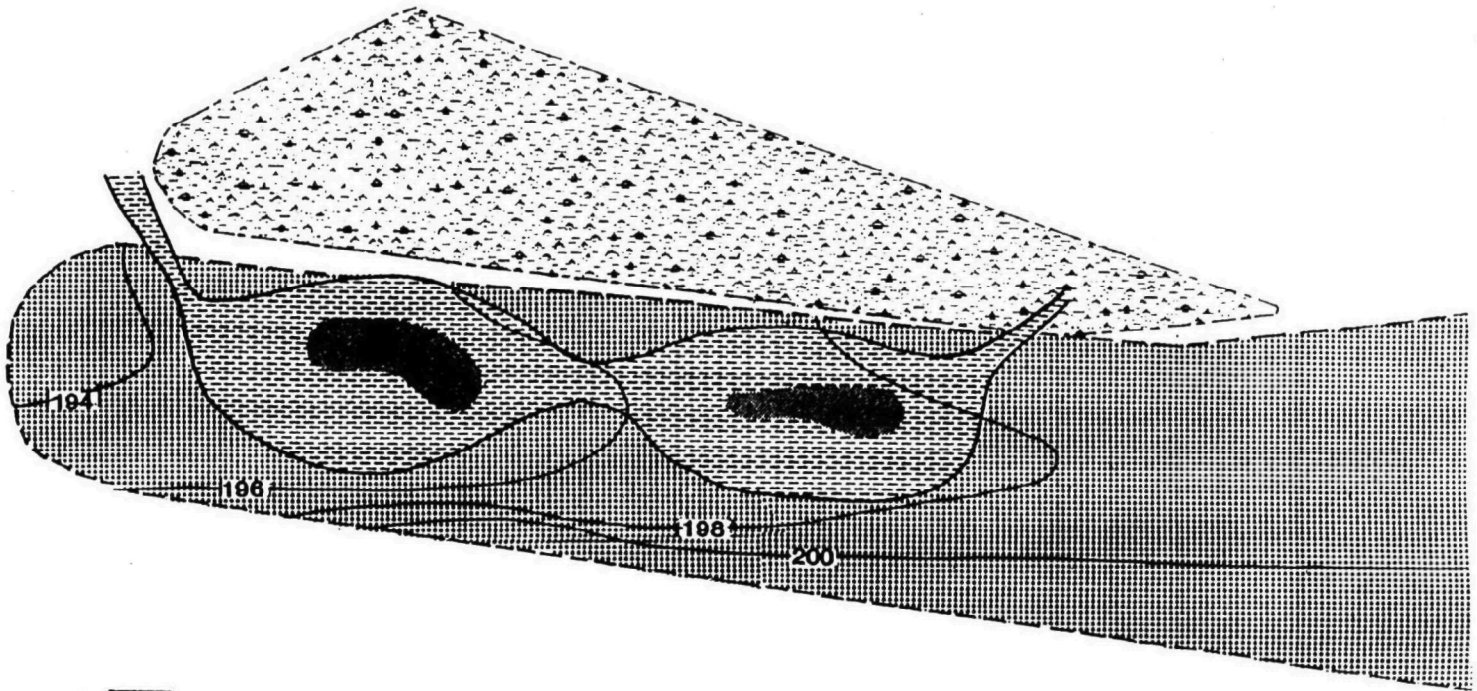
Birds observed included starlings, a great blue heron, robins, chickadees, yellow throat, and mallard ducks. There were tadpoles in the ponds and several types of dragonflies and damselflies were observed skimming over the water's surface.

Impressions of the Site One Year Later

The wetland had not yet been disturbed by the proposed highway development. It seemed to be very much as it was the previous summer. The only difference noted was that the vegetation was possibly taller and more dense in both the wetland and upland areas. The T. latifolia was extending into the larger open areas of the ponds in the shallow water as evidenced by many new shoots.

PERMIT MAP

C6-3I



Existing Wetland Area

Portion of Excavated Area

Ponds to be Created

Islands to be created

Ground Contours (in feet) to be Created

N

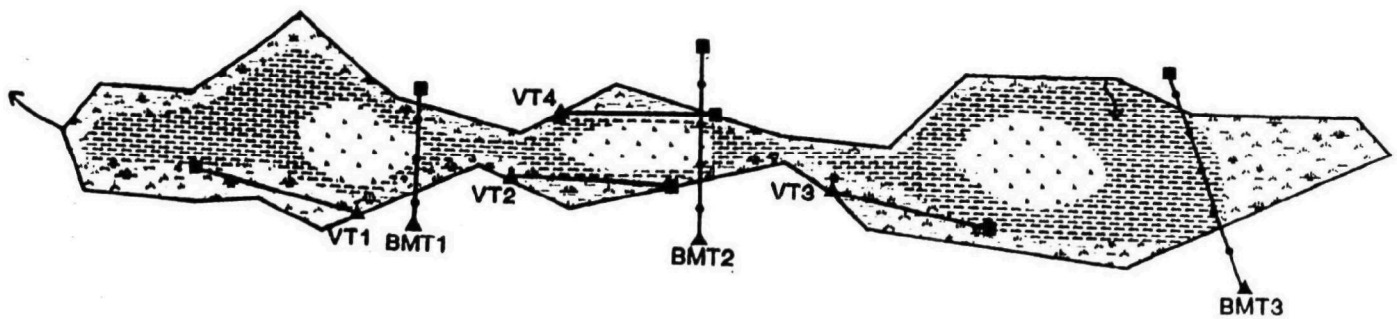
0 10 20 30 m

0 42 83 ft

1 : 1000

Map Drafted by T. Smith

FIELD MAP
C6-3I



BMT Basin Morphology Transect
VT Vegetation Transect
▲ Start of Transect
■ End of Transect
Emergent Vegetation
Island
Pond
Pond Inlet or Outlet

1 : 1000

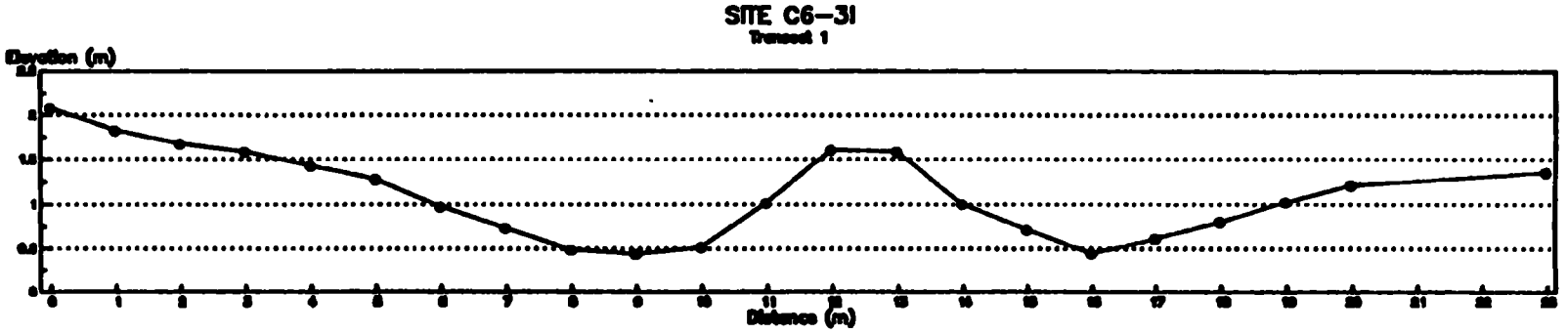
0 10 20 30 m
0 42 83 ft

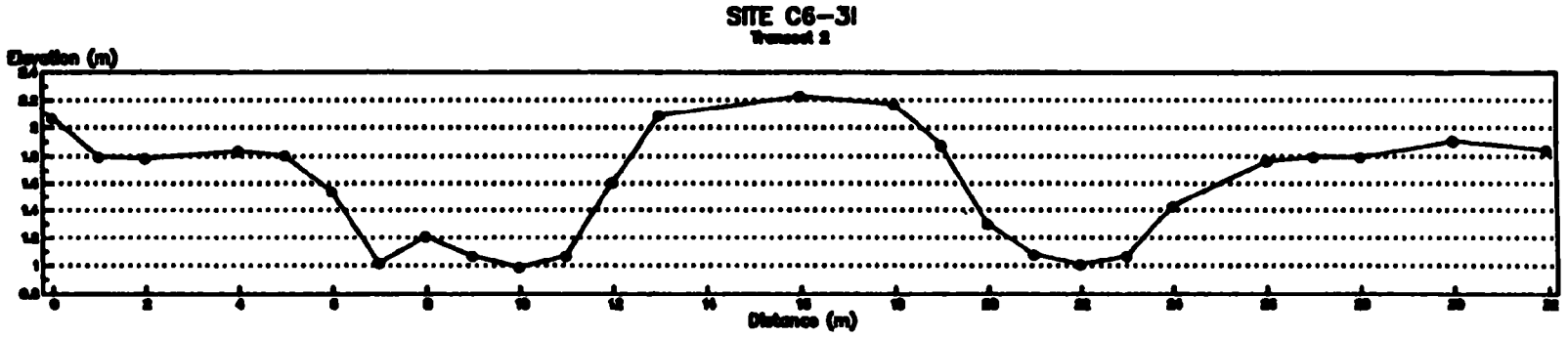
N

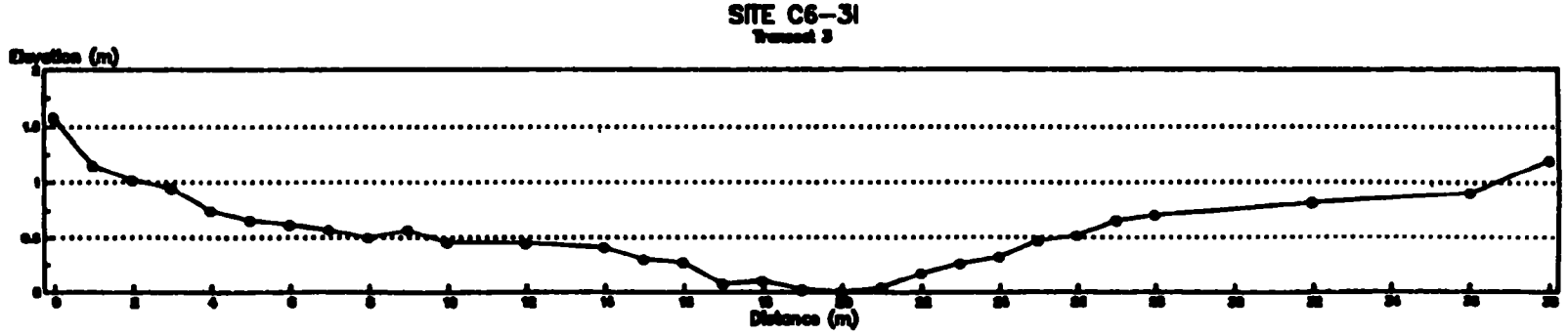
Pond and vegetation boundaries are the approximate locations observed in July, 1987

Source: Data collected by Stephanie Gwin & Sherl Confer

Drafted by T. Smith


SITE C6-3I
Transect 1
Elevation (m)
Distance (m)


SITE C6-3I
Transect 2
Elevation (m)
Distance (m)


SITE C6-3I
Transect 3
Elevation (m)
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed.1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C6-3I

There was no planting list included in the permit file for this site. However, the permit stated that the area should be seeded with legumes, grasses, shrubs, and trees; and that the project "will be landscaped . . . will include revegetation of natural grasses and planting of bushes and trees".

Species Found On Site C6-3I During Summer 1987

	Species	Wetland Indicator Code
1	Lotus corniculatus	FAC\EXO
2	Juncus tenuis	FAC\NAT
3	Carex stipata	OBL\NAT
4	Epilobium watsonii	FACW-NAT
5	Agrostis tenuis	UPL\EXO
6	Lemna minor	OBL\NAT
7	Glyceria leptostachya	OBL\NAT
8	Juncus bufonius	FACW+NAT
9	Potamogeton filiformis	OBL\NAT
10	Poa palustris	FAC\EXO
11	Vicia tetrasperma	UPL\EXO
12	Carex unilateralis	FACW\NAT
13	Oenanthe sarmentosa	OBL\NAT
14	Eleocharis palustris	OBL\NAT
15	Juncus ensifolius	FACW\NAT
16	Juncus effusus	FACW+NAT
17	Stellaria media	FAC\EXO
18	Galium trifidum	FACW+NAT
19	Lactuca serriola	FAC-EXO
20	Holcus lanatus	FAC\EXO
21	Cirsium arvense	FACU+EXO
22	Agropyron repens	NO\EXO
23	Alopecurus pratensis	FACW\EXO
24	Myosotis discolor	FACW\EXO
25	Phalaris arundinacea	FACW\NAT
26	Rumex crispus	FACW\EXO
27	Beckmannia syzigachne	OBL\NAT

28	Potamogeton amplifolius	OBL\NAT
29	Callitriche stagnalis	OBL\NAT
30	Equisetum arvense	FAC\NAT
31	Senecio jacobaea	FAC\EXO
32	Eleocharis ovata	OBL\NAT
33	Trifolium repens	FACU+EXO
34	Hordeum brachyantherum	FACW\NAT
35	Stachys palustris	FACW+NAT
36	Hypericum perforatum	UPL\EXO
37	Chrysanthemum leucanthemum	FAC\EXO
38	Carex athrostachya	FACW\NAT
39	Festuca arundinacea	FACU-EXO
40	Veronica americana	OBL\NAT
41	Centaurium umbellatum	FAC-EXO
42	Trifolium dubium	UPL\EXO
43	Typha latifolia	OBL\NAT
44	Rubus discolor	FACU-EXO
45	Gnaphalium uliginosum	FAC\NAT
46	Rorippa curvisiliqua	FACW+NAT
47	Salix lasiandra	FACW+NAT
48	Alopecurus geniculatus	FACW+NAT
49	Crepis setosa	UPL\EXO
50	Sonchus asper	FAC-EXO
51	Geranium molle	UPL\EXO
52	Leontodon nudicaulis	UPL\EXO
53	Verbascum blattaria	UPL\EXO
54	Epilobium paniculatum	UPL\NAT
55	Trifolium subterraneum	UPL\EXO
56	Deschampsia elongata	FACW-NAT
57	Plantago major	FAC+EXO
58	Polygonum lapathifolium	FACW+EXO
59	Lolium multiflorum	FACU\EXO
60	Lolium perenne	FACU\EXO
61	Cirsium vulgare	FACU\EXO
62	Anthoxanthum odoratum	FACU\EXO
63	Agrostis exarata	FACW\NAT
64	Gnaphalium palustre	FAC+NAT
65	Solanum dulcamara	FAC\EXO
66	Daucus carota	FAC\EXO
67	Geranium dissectum	FAC\EXO
68	Polygonum spergulariaeforme	ABS\NAT
69	Veronica peregrina	OBL\NAT

DESCRIPTION: SITE C7-SML

Function/Purpose

This wetland was created to mitigate for the removal of up to 28,289 cubic yards of material and the placement of up to 25,977 cubic yards of material in the 100 year floodplain of Beaverton Creek and Johnson Creek. This was done to accommodate parking and landscaping improvements for a proposed high-tech development. Specific functions and purposes for this created wetland included flood storage and desynchronization, groundwater modification, habitat for fisheries, food chain support, non-consumptive recreation, habitat for wildlife, and increased plant diversity.

General Description

The entire mitigation area included several acres of pre-existing natural marsh and newly created wetland. The mitigation project includes an area of mudflats, several ponds, and created and natural creek channels. Because of the diversity of wetland types and the large size of the project, we sampled only a depression/water detention area to the north of an elbow of a channel jutting off of, and running parallel to, Beaverton Creek.

There was a steep bank leading down to the wetland from 153rd street, but elevation changed very little inside the bowl-shaped depression. A filled area just west of this detention area was planted with ornamental trees and shrubs. This was done in an effort to provide a buffer zone between the wetland and the industrial developments (G. Herb, ODFW, pers. comm.). However, most of these shrubs and trees were dying.

Water entered the sampled area from two sources. There was a culvert at the northwest corner, coming from under 153rd Street and the neighboring fill. Water entering the detention area from this culvert flowed across the wetland and emptied into a created channel that connected to Beaverton Creek. When high water conditions exist, water will flood the detention area through the created channel. At time of sampling, water conditions were low enough that the channel simply by-passed the detention area. The only water entering it was from the culvert mentioned above.

This mitigation project was approximately 10 months old when sampled in July of 1987.

Hydrology and Substrate

As mentioned above, water in this wetland was channelized and flowed across the wetland from the culvert to the created channel. It was odorless and murky and had a greenish algal bloom.

Soil chromas ranged from /3 to /0. These values indicated both hydric (/1 and /0) and non-hydric soils (/3). /2 chroma indicated a "borderline" hydric soil.

Dominant Vegetation

There was moderate floristic diversity along the transect located nearest the filled areas (See Field Map). The transect nearest the stream channel had less diversity, with mostly Juncus effusus L. growing along it. The size of the J. effusus plants was such that an herbaceous understory was

largely shaded out. A species observed in the floor of the detention area was **Lythrum hyssopifolia** L. A terrestrial algal bloom grew profusely from the culvert to about midway across the site.

See the list of "Species Found On Site C7-SML" for an explicit account of the species identified.

Wildlife

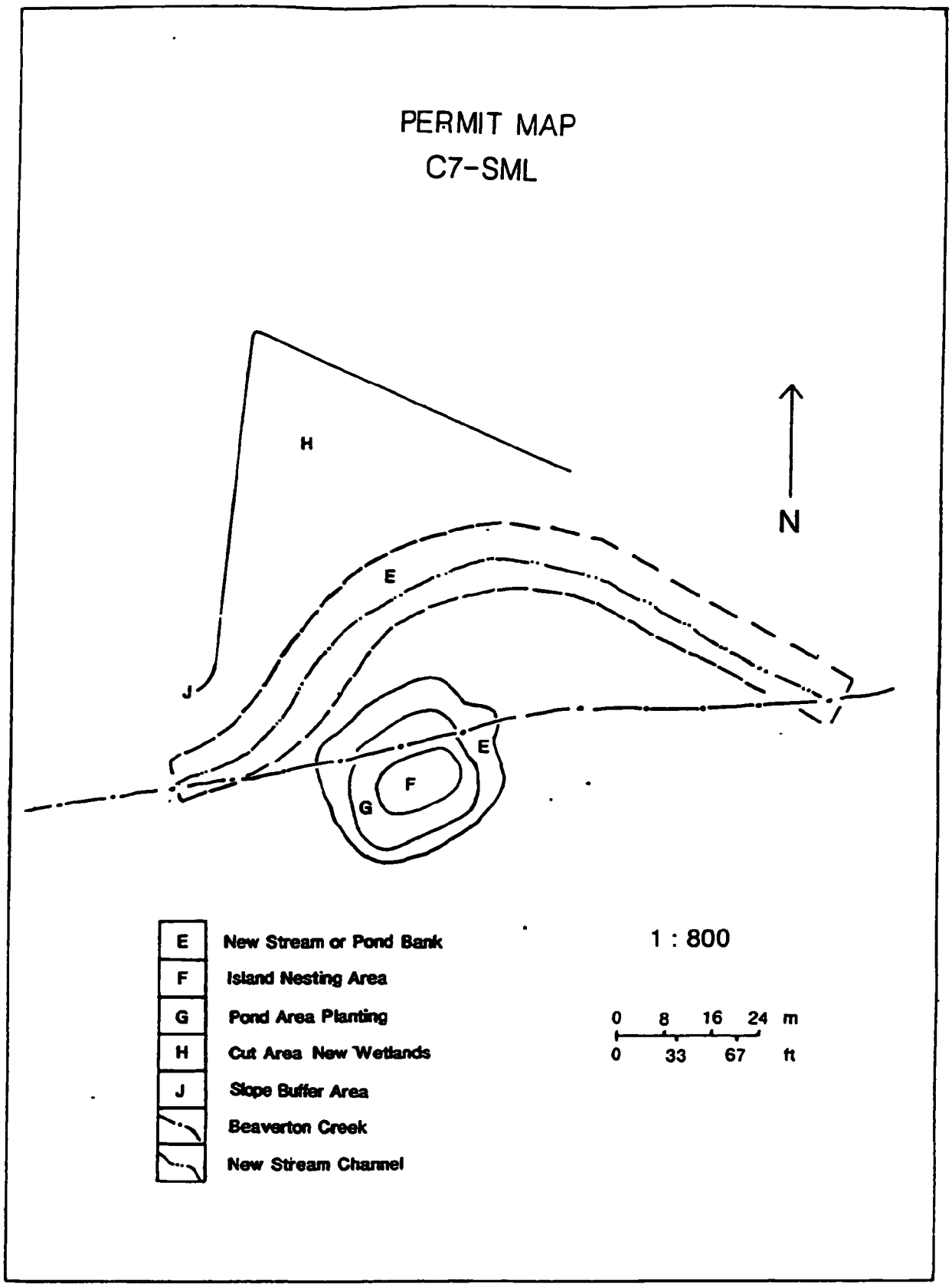
Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

Many birds were observed. These included swallows, starlings, great blue heron, ducks, red tail hawk, kingfisher, and yellowthroat. There were minnows and bullfrogs in the creek channel.

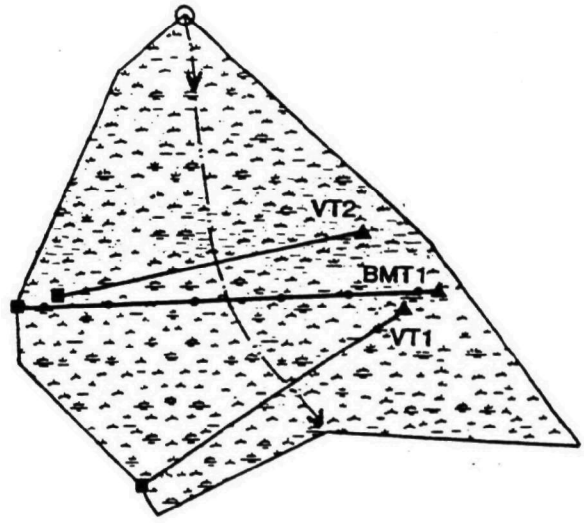
Impressions of the Site One Year Later

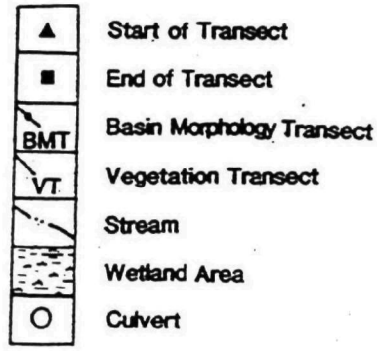
Water levels appeared much the same as the previous year. However, the edge of the main channel where the rivulet from the culvert enters was not as heavily vegetated as previously. It appeared to be grazed by ducks and geese. Although no birds were actually seen, sign of them was evident.

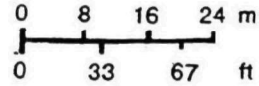
Vegetation throughout the site was thicker and taller than the previous year.


PERMIT MAP
C7-SML
H
N
E
J
E
F
G
E New Stream or Pond Bank
F Island Nesting Area
G Pond Area Planting
H Cut Area New Wetlands
J Slope Buffer Area
Beaverton Creek
New Stream Channel
1 : 800
0 8 16 24 m
0 33 67 ft

FIELD MAP
C7-SML



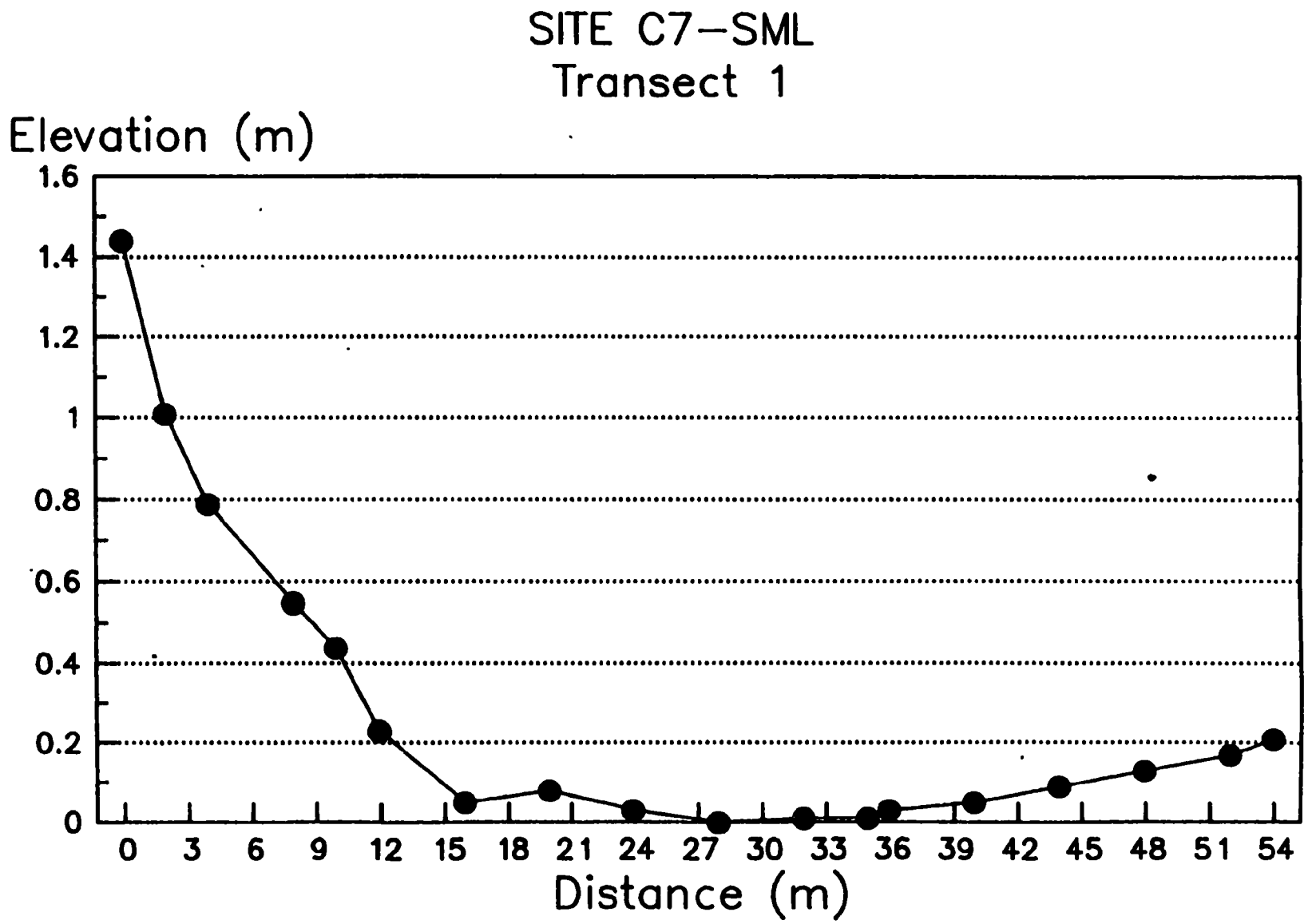




1 : 800

Source: Data Collected by Stephanie Gwin & Sheri Conler July, 1987

Map Drafted by Tracy Smith


SITE C7-SML
Transect 1
Elevation (m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C7-SML

	Species	Wetland Indicator Code
1	Carex lyngbeii	OBL\NAT
2	Scirpus microcarpus	OBL\NAT
3	Sparganium emersum	OBL\NAT
4	Alopecurus pratensis*	FACW\EXO

Species Found On Site C7-SML During Summer 1987

	Species	Wetland Indicator Code
1	Salix lasiandra	FACW+NAT
2	Typha latifolia	OBL\NAT
3	Bidens cernua	FACW+EXO
4	Callitriche verna	OBL\NAT
5	Juncus effusus	FACW+NAT
6	Leersia oryzoides	OBL\NAT
7	Eleocharis ovata	OBL\NAT
8	Alisma plantago-aquatica	OBL\NAT
9	Salix piperi	FACW\NAT
10	Trifolium pratense	FACU\EXO
11	Polygonum lapathifolium	FACW+EXO
12	Ranunculus repens	FACW\EXO
13	Phalaris arundinacea	FACW\NAT
14	Scirpus acutus	OBL\NAT
15	Plantago major	FAC+EXO
16	Polygonum punctatum	OBL\NAT
17	Trifolium dubium	FAC\EXO
18	Veronica peregrina	OBL\NAT
19	Rorippa islandica	OBL\NAT
20	Juncus bufonius	FACW+NAT
21	Lythrum hyssopifolia	OBL\EXO
22	Anthemis cotula	FACU\EXO
23	Agrostis tenuis	UPL\EXO
24	Echinochloa crusgalli	FACW\NAT

25	Polygonum aviculare	FACW-EXO
26	Lindernia dubia	OBL\NAT
27	Lolium multiflorum	FACU\EXO
28	Tanacetum vulgare	ABS\EXO
29	Agrostis exarata	FACW\NAT
30	Rumex crispus	FACW\EXO
31	Alopecurus pratensis*	FACW\EXO
32	Trifolium repens	FACU+EXO
33	Oenanthe sarmentosa	OBL\NAT
34	Ludwigia palustris	OBL\NAT
35	Epilobium watsonii	FACW-NAT
36	Leontodon nudicaulis	UPL\EXO
37	Carex stipata	OBL\NAT
38	Populus trichocarpa	FACW\NAT
39	Lotus corniculatus	FAC\EXO
40	Gratiola neglecta	OBL\NAT
41	Bidens frondosa	FACW+NAT
42	Gnaphalium uliginosum	FAC\NAT
43	Lolium perenne	FACU\EXO
44	Juncus tenuis	FAC\NAT
45	Salix sitchensis	FACW\NAT
46	Ranunculus lobbii	OBL\NAT
47	Ranunculus sceleratus	OBL\NAT
48	Veronica americana	OBL\NAT
49	Rorippa curvisiliqua	FACW+NAT
50	Carex unilateralis	FACW\NAT
51	Lathyrus hirsutus	UPL\EXO
52	Equisetum arvense	FAC\NAT
53	Vicia tetrasperma	UPL\EXO
54	Cirsium arvense	FACU+EXO
55	Dipsacus sylvestris	FACU\EXO

DESCRIPTION: SITE C8-BSP

Function/Purpose

This wetland was created as mitigation for an illegal fill. The area was excavated to form a detention pond to replace storm water/surface runoff detention area that was filled. The plans called for the creation of 0.06 ha (0.14 acres) of "rush-sedge-canarygrass" wetland with the construction of the surface detention pond.

General Description

A very steep-sided pond has been created. The pond itself appeared several feet deep along the south, east and west edges, but very shallow along the north edge. Mudflats extended from the north edge out toward the center of the pond. There was some emergent vegetation growing on the mudflats, but none in the deeper water along the other edges.

There were several inlets to the pond--4 visible culverts, a small stream, and, according to G. Herb (ODFW), an underground seep. There was a large culvert (Inlet 1 on the Field Map) midway along the west bank. When the pond was sampled, this inlet was dry and above the water level of the pond. The other 3 culverts (Inlets 2, 3, & 4 on the Field Map) were smaller in diameter than Inlet 1. All were flowing at sampling time. These inlets appeared to carry water from the neighboring City Operations plant.

The pond outlet was a drainage ditch dug from the southwest corner of the pond, leading to Fanno Creek.

The project was completed in September of 1986. At the time it was sampled (June, 1987), it was about 9 months old.

Hydrology and Substrate

The pond's surface was covered with patches of a filamentous blue-green algae and petroleum slicks which gave the water a bluish cast. The water in the main pond area was almost stagnant, but flowing slowly toward the outlet. The water was odorless. Water from Inlet 2 had a very strong petroleum odor. This water was probably runoff from the City Operations parking lot. Water flowing in from Inlet 3 was odorless. The pond surface near this inlet supported a thick algal growth.

The culvert midway down the east bank, Inlet 4, had a strong sewage odor, was brownish in color, and had a plume of brownish water extending from it out into the pond.

Inlet 5 was a small stream flowing over the surface of the bank at the southeast corner of the pond. This water was both clear and odorless. Water flow at the outlet was very slow.

Eight of the ten soil pits were dug on Transects 1 & 2 which were placed along the edges of the pond (See Field Map). Only one pit each was dug on Transects 3 & 4 (across the mudflats) because our crew leader was worried about possible sewage contamination. Soil sample chromas (according to the Munsell Color Book) were all in the hydric range, either /1 or /0. There was mottling in the upper 5 cm of most soil samples, indicating periodic inundation (Soil Conservation Service 1975). Soil structure was heavy and clayey on all transects, but on Transects 1 & 2 large particles and pebbles were also present. The two soil pits dug on the mudflats (Transects 3 & 4)

contained a layer of straw at depths of approximately 25 to 30 cm. The straw was intact and showed little sign of decomposition.

Dominant Vegetation

Vegetation along the periphery of the pond on the disturbed sides was mostly annual herbs, primarily **Juncus bufonius** L. A variety of weedy taxa existed on the upper banks. The area to the south of the created pond was a lush forest, including a thick herbaceous layer, a deciduous understory, and an overstory of both conifers and deciduous trees. This forested marsh was the natural vegetation regime that existed before the area was disturbed (Gene Herb, ODFW, pers. comm.). Species here included **Pseudotsuga menziesii** (Mirbel) Franco., **Oemleria cerasiformis** H. & A., and **Lysichitum americanum** Hulten & St. John.

See the list of "Species Found On Site C8-BSP" for an explicit account of the species identified.

Wildlife

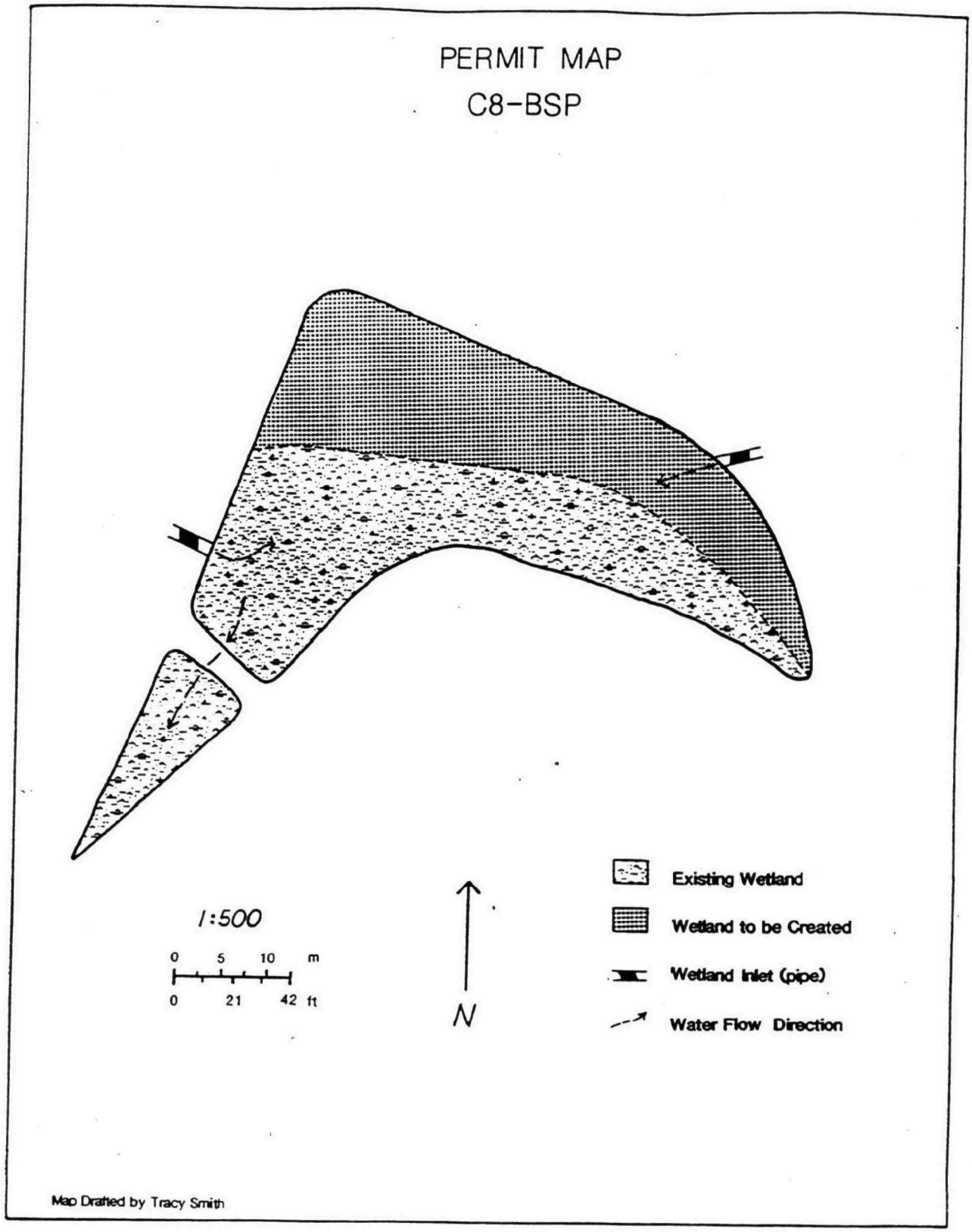
Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

Mallard ducks were seen in the pond and various birds were heard in the forest nearby. Upon returning to this site a few days later to gather water samples, one of the mallards was found dead.

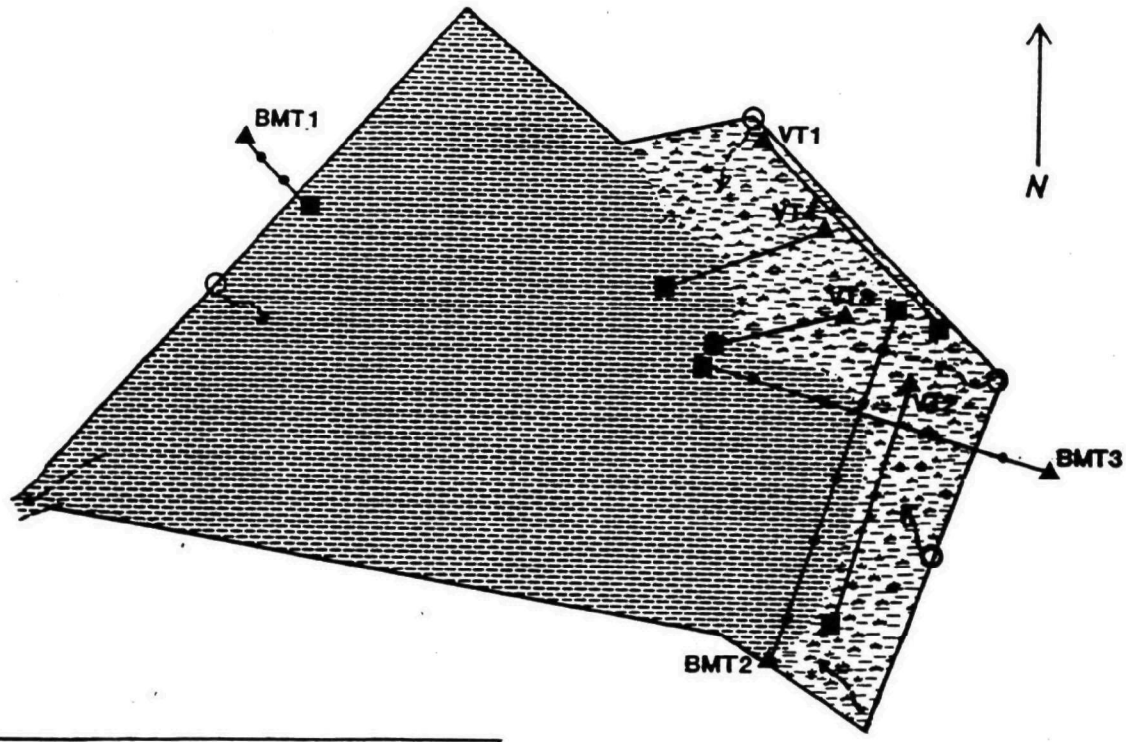
Impressions of the Site One Year Later

The mudflats along the northeast edges of the pond extending toward its center were becoming vegetated. The plants seemed stunted. The banks of the pond were much more heavily vegetated than the previous year. In some cases, the rocky banks were completely covered with vegetation.

The water level appeared higher than the previous year, and the pollution seemed less (at least it was less visible). The south bank, between the natural forested wetland and the water, had become vegetated. The pond still was occupied by ducks. This year they were tame and wanted fed.


PERMIT MAP
C8-BSP
1:500
0 5 10 m
0 21 42 ft
N
Existing Wetland
Wetland to be Created
Wetland Inlet (pipe)
Water Flow Direction
Map Drafted by Tracy Smith

FIELD MAP
C8-BSP



VT — Vegetation Transect

BMT —•— Basin Morphology Transect

▲ Start of Transect

■ End of Transect

⊙ Culvert

Wetland Outlet or Inlet

Pond

Emergent Vegetation

Survey Boundary

1:500

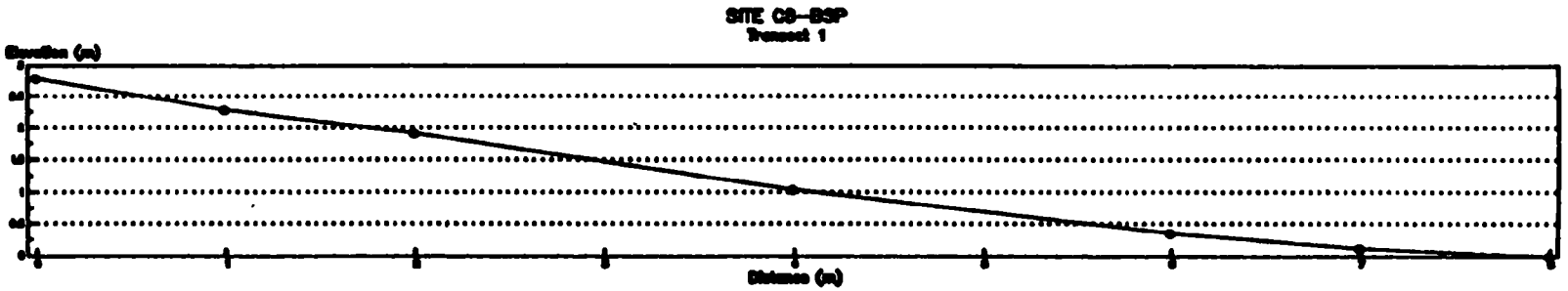
0 5 10 m

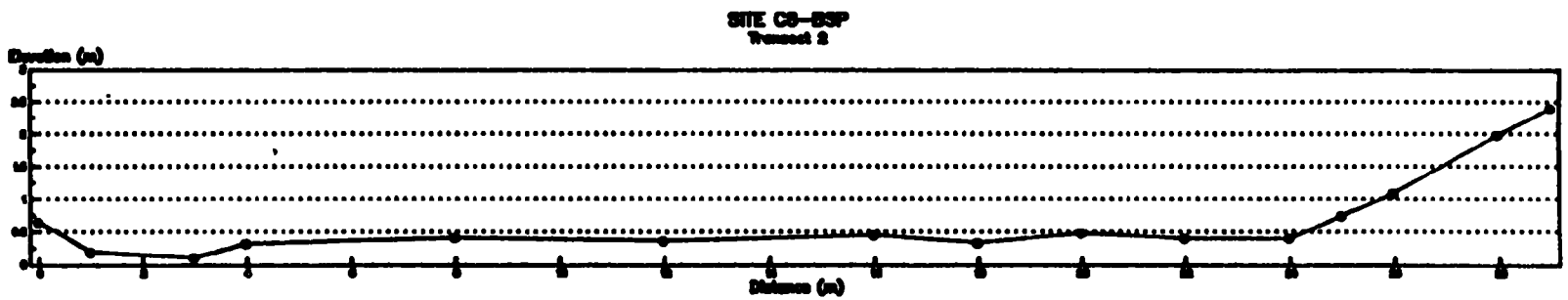
0 20.8 41.6 ft

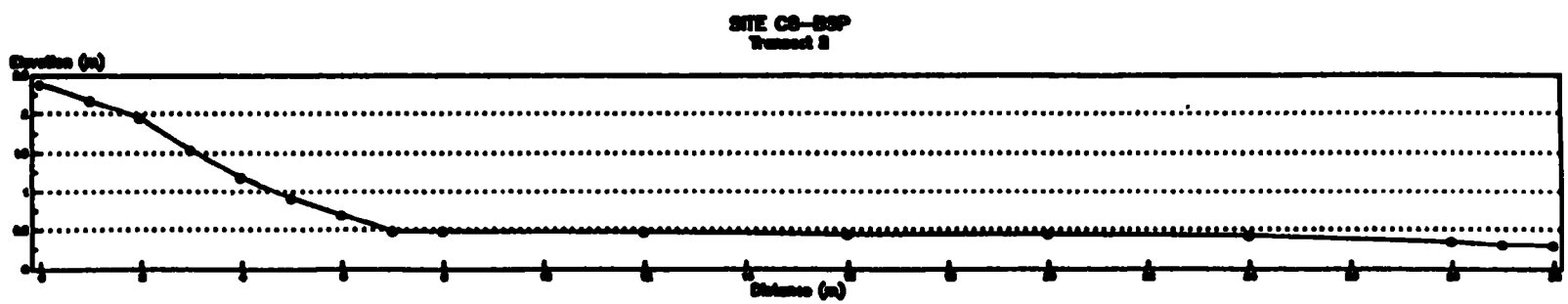
Pond and emergent vegetation boundaries are the approximate locations observed in July, 1987

Data collected by Stephanie Gwin & Sheri Confer

Map drafted by Tracy Smith


SITE C9-BSP
Transect 1
Elevation (m)
Distance (m)


SITE C9-BSP
Transect 2
Elevation (m)
Distance (m)


SITE C9-BSP
Transect 3
Elevation (m)
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C8-BSP

	Species	Wetland Indicator Code
1	Carex obnupta	OBL\NAT
2	Polygonum persicaria*	FACW\EXO
3	Polygonum lapathifolium	FACW+NAT
4	Potentilla anserina	OBL\NAT
5	Echinochloa crusgalli	FACW\EXO
6	Cyperus esculentus	FACW\NAT
7	Scirpus americanus	OBL\NAT
8	Sparganium eurycarpum	OBL\NAT
9	Phalaris arundinacea*	FACW\NAT
10	Lysichiton americanum	OBL\NAT
11	"Nutsedge"	???

The planting list for this site included common names. Efforts were made to determine the correct genus and species. Where this was not possible, the common name was listed above in "quotes".

Species Found On Site C8-BSP During Summer 1987

	Species	Wetland Indicator Code
1	Juncus bufonius	FACW+NAT
2	Trifolium pratense	FACU\EXO
3	Vicia tetrasperma	UPL\EXO
4	Eleocharis ovata	OBL\NAT
5	Trifolium hybridum	UPL\EXO
6	Alnus rubra	FAC\NAT
7	Lolium perenne	FACU\EXO
8	Vicia sativa	UPL\EXO
9	Juncus ensifolius	FACW\NAT
10	Epilobium watsonii	FACW-NAT
11	Holcus lanatus	FAC\EXO
12	Equisetum telmateia	FACW\NAT
13	Daucus carota	FAC\EXO

14	Phalaris arundinacea*	FACW\NAT
15	Hypochaeris radicata	UPL\EXO
16	Agrostis alba	FACW\EXO
17	Trifolium dubium	UPL\EXO
18	Trifolium arvense	FAC\EXO
19	Lamium amplexicaule	UPL\EXO
20	Geum macrophyllum	FACW+NAT
21	Rumex conglomeratus	FACW\EXO
22	Poa palustris	FAC\EXO
23	Agropyron repens	NO\EXO
24	Impatiens capensis	FACW\NAT
25	Rumex crispus	FACW\EXO
26	Oenanthe sarmentosa	OBL\NAT
27	Panicum capillare	FAC\NAT
28	Polygonum persicaria*	FACW\EXO
29	Lapsana communis	UPL\EXO

DESCRIPTION: SITE C9-GP

Function/Purpose

This wetland was created to mitigate the placement of approximately 5,000 cubic yards of clay, gravel and rock to construct 400 feet of roadway embankment across Rock Creek and the adjacent wetland. The project plans called for the existing creek channels to be enlarged to improve their hydraulic capacity and the stability of the channel banks. The plans also stated that the existing man-made channel was to be improved by widening and sloping the channel banks to create flatter slopes and more stable banks. The banks of this channel were to be planted with riparian vegetation to prevent erosion and provide cover for wildlife. The pond on the northwest side of the roadway was to be enlarged and revegetated with native and introduced wetland-type vegetation. In addition to the original plans, an area south of the roadway was excavated to form a pond within the marshy meadow. This was the portion of the project most recently completed. It was the area sampled by the field team because it was the area Gene Herb (ODFW) indicated was important.

This pond had several proposed functions. It was designed to allow storage and detention of surface water runoff, contain backfill from creek overflow, maintain wildlife habitat, and provide a quiet and aesthetically pleasing setting.

General Description

Rock Creek was split into two channels that flow under the new roadway via two large culverts. The pond sampled lies south of the road just west of where the two channels rejoin. A small dam separated the pond from the creek channel at the pond's southwestern-most point. When high water conditions occur, the channel will overflow its banks and water will collect in the pond. During low water/drought conditions, water will be maintained in the pond by the dam. The dam is the pond's outlet when water level in the pond is above the height of the dam.

There was a large culvert leading into the pond from under the hillside at its northeastern-most point. This culvert may divert upland runoff from abandoned sewage ponds north of the project. Other than creek overflow and some underground seeps that G. Herb (ODFW) indicated might be present, this culvert was the only direct inlet to the pond.

The pond's banks sloped steeply from a hayfield on the west side. The north and east banks have very gradual, almost level slopes that form mudflats from the edge of the grass to the water level. There was very little established vegetation on the mudflats. The southeast bank of the pond was formed by a grassy berm that separated the pond from the creek channel. The sides of the berm were steeply sloped.

The bulk of the pond appeared shallow and had patches of emergent vegetation growing in it. The deepest area was directly behind the dam.

The area directly north of the pond, between it and the roadway, was a grassy meadow. The meadow included both dry, upland areas and wet, marshy areas with standing water.

The project was approximately one year and nine months old when sampled (June of 1987).

Hydrology and Substrate

The pond water was odorless. It had a tan, cloudy color. It contained patches of emergent vegetation and a filamentous, green alga.

The water was stagnant and below the level of the dam at the outlet. Very little water flowed in via the culvert.

The chroma of soil samples along Transects 1 & 2 (See Field Map) indicate hydric soils (/1 and /0). The chroma of soil samples taken along Transect 3 were "borderline" hydric (/2). Mottling occurred in the upper 5 cm of all soil samples, indicating periodic inundation (Soil Conservation Service 1975). Soils were very fine and clayey.

Dominant Vegetation

The pond supported patches of emergent vegetation. An algal bloom was especially lush along the pond's banks, extending from one to five feet across the water's surface. The dominant vegetation types in the meadow and along the berm were upland grasses, Douglas fir (**Pseudotsuga menziesii** (Mirbel) Franco.), and ash (**Fraxinus latifolia** Benth.). Wetland vegetation was starting to propagate along the mudflats of the north and east sides of the pond, and was well established in the area closest to the culvert. Species that were to be planted by the contractor, including **Scirpus americanus** Pers. and **Eleochoris palustris** (L.) R. & S., seemed to be taking hold, and will probably dominate the area within the next decade (B. Meinke, Botanist, pers. comm.). The steep banks of the west and south edges supported mostly upland grasses.

See the list of "Species Found On Site C9-GP" for an explicit account of the species identified.

Wildlife

Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

A population of tiny, biting, black flies was in residence. They were most abundant near the culvert and along the northwest banks of the pond.

Birds observed included Mallard ducks, killdeer, redwing blackbirds, starlings, goldfinches, tree swallows, barn swallows, and violet-green swallows. A bullfrog was heard and many dragonflies were observed.

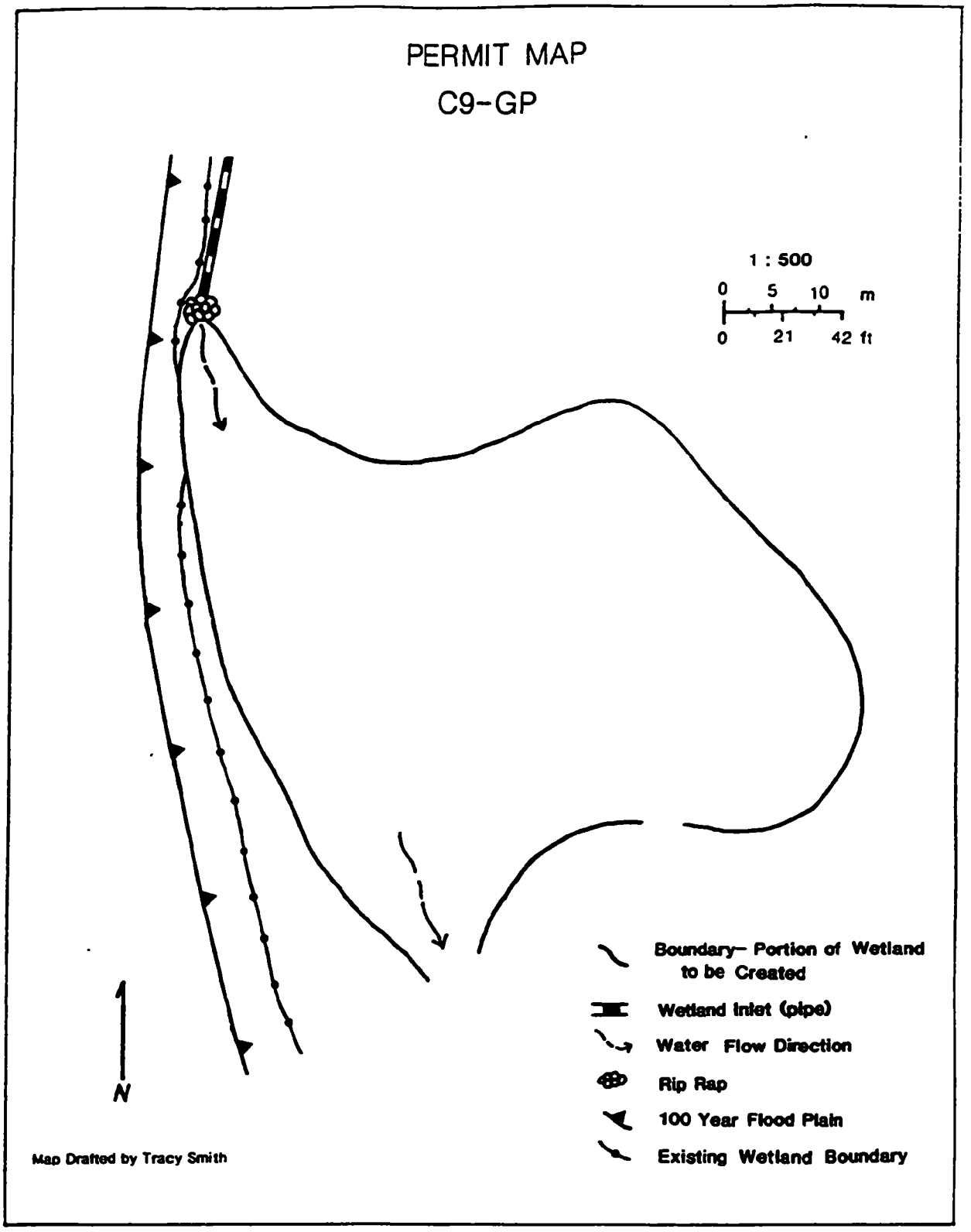
Addendum

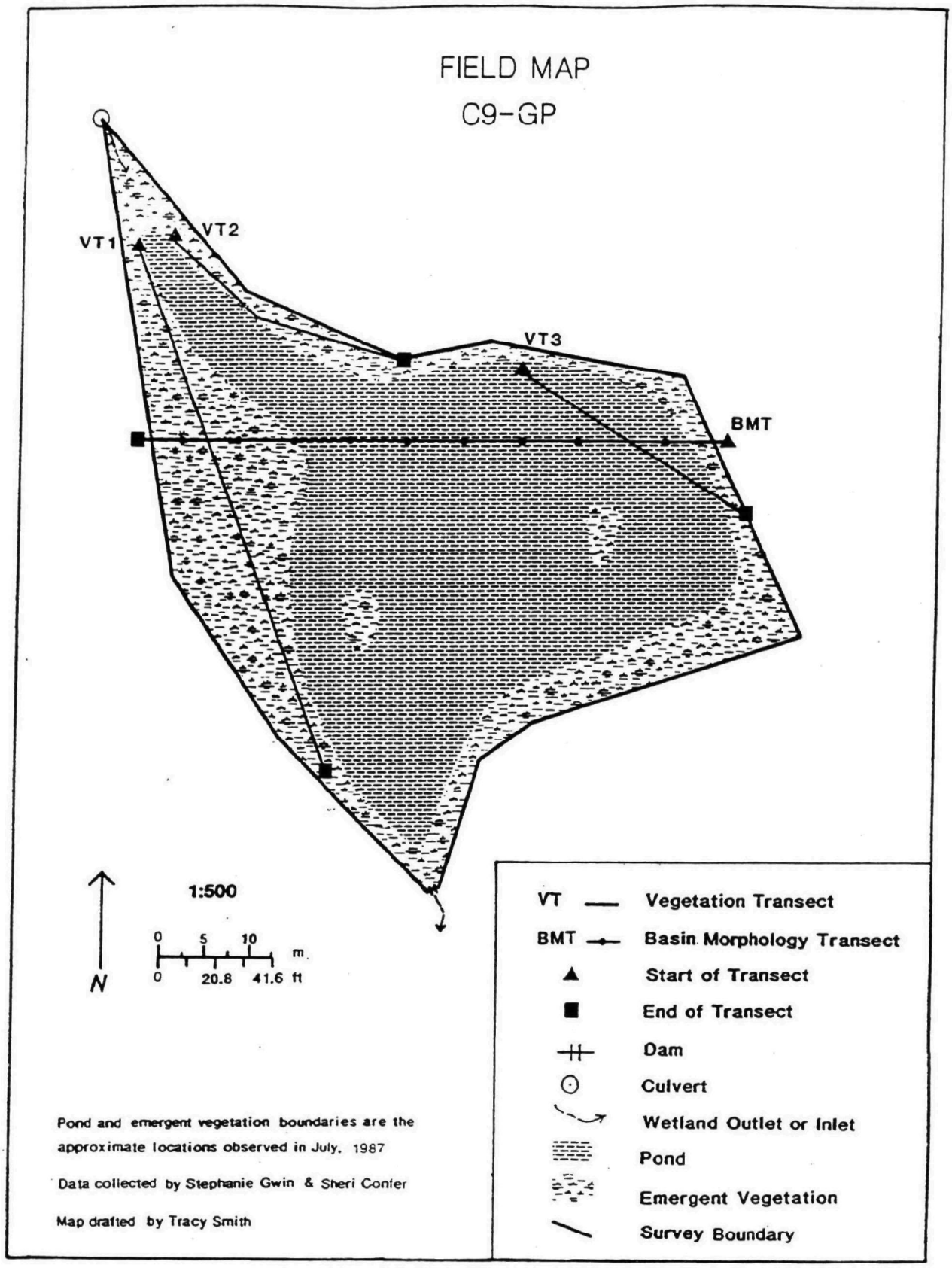
After studying the permit file for this project, I have concluded that the area sampled was not included in the original plans. It seems to have been an afterthought. The area sampled was denoted as a "meadow" on Exhibit F-1, and the pond was referred to only once in the mitigation/permit paperwork: "....especially the new pond created south of Evergreen". This statement was included in a letter from Gene Herb (ODFW) to the applicant concerning changes made in the project.

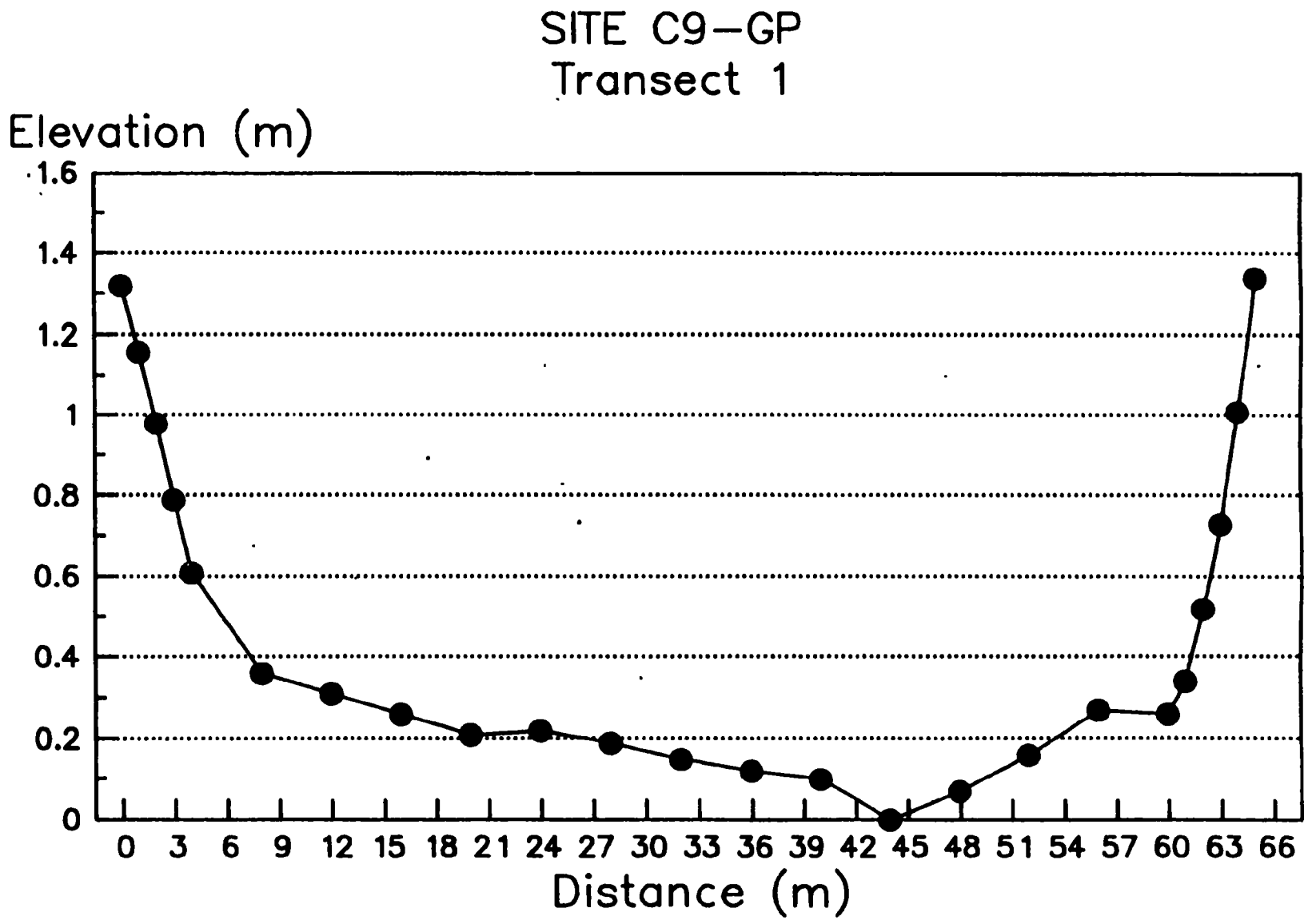
Impressions of the Site One Year Later

The reduced amount of upland area along the shoreline indicated that water levels were higher during 1988 than during sampling the previous summer. However, there were more patches of emergent vegetation growing throughout the pond, indicating that the pond may be silting in. While sampling during the summer of 1987, the pond was shallow but almost entirely open water, there were no large patches of emergent vegetation.

Aesthetics was one of the major objectives of this mitigation project. In this respect, the wetland seemed to be fulfilling its purpose.


PERMIT MAP
C9-GP
1 : 500
0 5 10 m
0 21 42 ft
N
Boundary- Portion of Wetland to be Created
Wetland Inlet (pipe)
Water Flow Direction
Rip Rap
100 Year Flood Plain
Existing Wetland Boundary
Map Drafted by Tracy Smith


FIELD MAP
C9-GP
VT1
VT2
VT3
BMT
1:500
0 5 10 m.
0 20.8 41.6 ft
N
VT Vegetation Transect
BMT Basin Morphology Transect
Start of Transect
End of Transect
Dam
Culvert
Wetland Outlet or Inlet
Pond
Emergent Vegetation
Survey Boundary
Pond and emergent vegetation boundaries are the approximate locations observed in July, 1987
Data collected by Stephanie Gwin & Sheri Confer
Map drafted by Tracy Smith


SITE C9-GP
Transect 1
Elevation (m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C9-GP

	Species	Wetland Indicator Code
1	Agrostis palustris	FAC+NAT
2	Alopecurus pratensis*	FACW\EXO
3	Bromus inermis	FACU\EXO
4	Dactylis glomerata	FACU\EXO
5	Scirpus americanus	OBL\NAT
6	Cyperus erythrorhizos	OBL\NAT
7	Eleocharis palustris*	OBL\NAT

Species Found On Site C9-GP During Summer 1987

	Species	Wetland Indicator Codes
1	Alopecurus geniculatus	FACW+NAT
2	Eleocharis acicularis	OBL\NAT
3	Epilobium watsonii	FACW-NAT
4	Callitriche stagnalis	OBL\NAT
5	Scirpus fluviatilis	OBL\NAT
6	Veronica americana	OBL\NAT
7	Gnaphalium uliginosum	FAC\NAT
8	Plantago major	FAC+EXO
9	Juncus patens	FACW\NAT
10	Agrostis alba	FACW\EXO
11	Juncus tenuis	FAC\NAT
12	Juncus bufonius	FACW+NAT
13	Holcus lanatus	FAC\EXO
14	Ranunculus sceleratus	OBL\NAT
15	Plagiobothrys scouleri	FACW\NAT
16	Poa trivialis	FACW-EXO
17	Cirsium arvense	FACU+EXO
18	Agrostis tenuis	UPL\EXO
19	Trifolium repens	FACU+EXO
20	Trifolium dubium	UPL\EXO
21	Bidens vulgata	FACW+NAT

22	Alopecurus pratensis*	FACW\EXO
23	Polygonum lapathifolium	FACW+EXO
24	Lemna minor	OBL\NAT
25	Leontodon nudicaulis	UPL\EXO
26	Carex arcta	FACW+NAT
27	Leersia oryzoides	OBL\NAT
28	Centunculus minimus	FACW\NAT
29	Scirpus microcarpus	OBL\NAT
30	Eleocharis palustris*	OBL\NAT
31	Typha latifolia	OBL\NAT
32	Rorippa curvisiliqua	FACW+NAT
33	Lolium perenne	FACU\EXO
34	Gnaphalium palustre	FAC+NAT
35	Eleocharis ovata	OBL\NAT
36	Poa annua	FAC-NAT
37	Anthemis cotula	FACU\EXO
38	Senecio vulgaris	FACU\EXO

DESCRIPTION: SITE C10-PP

Function/Purpose

This project was mitigation for the removal of up to 1,500 cubic yards of silt and the placement of up to 6,100 cubic yards of material in the Columbia Slough to provide railroad access for a new automobile shipping facility. To replace the emergent marsh lost within the Columbia Slough, a pond was excavated, and the slopes seeded with clover. Proposed functions of the new pond included food chain support, habitat for wildlife, habitat for fisheries, nutrient retention and removal, and non-consumptive recreation.

General Description

The pond was deep, and was at the bottom of a very steeply sloped excavation within several feet of the Columbia Slough. A high, grassy, and shrub-covered berm separated the pond from the slough. A deep ditch has been cut in the berm to connect the pond with the slough. The pond had very steep banks, so steep that field crew members had difficulty walking along the pond edge. The mitigation design plans show that the pond was 150 by 75 feet across, and an average of twelve feet deep from the top of the bank to the pond floor. The water's surface was several feet lower than the top of the bank, but the bank appeared to continue at the same steep angle under the water. The bottom could not be seen.

The channel connecting the pond and Columbia Slough appears to be both the inlet and outlet for the pond. Water level in the pond was lower than the floor of the channel. The sides of the ditch appeared to drop almost vertically from the meadow to the floor.

The banks of the pond edge have been seeded with mostly Trifolium pratense L. in an effort to control erosion. However, ravines from erosion were beginning to form on the sides of the banks in several places.

The project was completed in August of 1985. When sampled in July of 1985, it was almost two years old.

Hydrology and Substrate

Water in the pond was odorless and very murky. The pond contained stagnant water, and the channel connecting it to Columbia slough was dry. When high water conditions exist, water will flow into the pond from Columbia Slough via this channel.

Soils consisted of very heavy and fine clays with some sand. The Munsell Color Book indicated non-hydric soil chromas, ranging from /4 to /2. However, there were mottles in the upper 5 cm of all soil samples indicating periodic inundation (Soil Conservation Service 1975). Most of the soil pits remained dry during the sampling protocol's required 30 minute period to allow for stabilization of water levels, but a few nearest the pond edge did fill with a few centimeters of water.

Dominant Vegetation

Wetland vegetation was found only in a narrow band (about two feet wide) in and around the water's edge. Clover extended from this band up the slopes to the meadow above. Our crew leader and head botanist believed the clover had been seeded into the bank to try to prevent erosion, but

because of its tenacity, he feared that it might also prevent wetland species from establishing (B. Meinke, Botanist, pers. comm.).

Green algae grew around the edge of the pond. **Phalaris arundinacea** L. and **Salix** species grew on top of the berm separating the pond from the slough. There was a variety of native wetland species present, but all had a low frequency of occurrence. This diversity probably reflects input of propagules from the nearby slough. Colonization by wetland species may be retarded, however, by the depth of the pond (and its steep banks) and the pervasive weedy species already well established (ie., the clover). **Sagittaria latifolia** Willd., the dominant herbaceous species in the slough was present as scattered individuals in the mitigated area, along with several species of **Carex** and **Juncus**.

See the list of "Species Found On Site C10-PP" for an explicit account of the species identified.

Wildlife

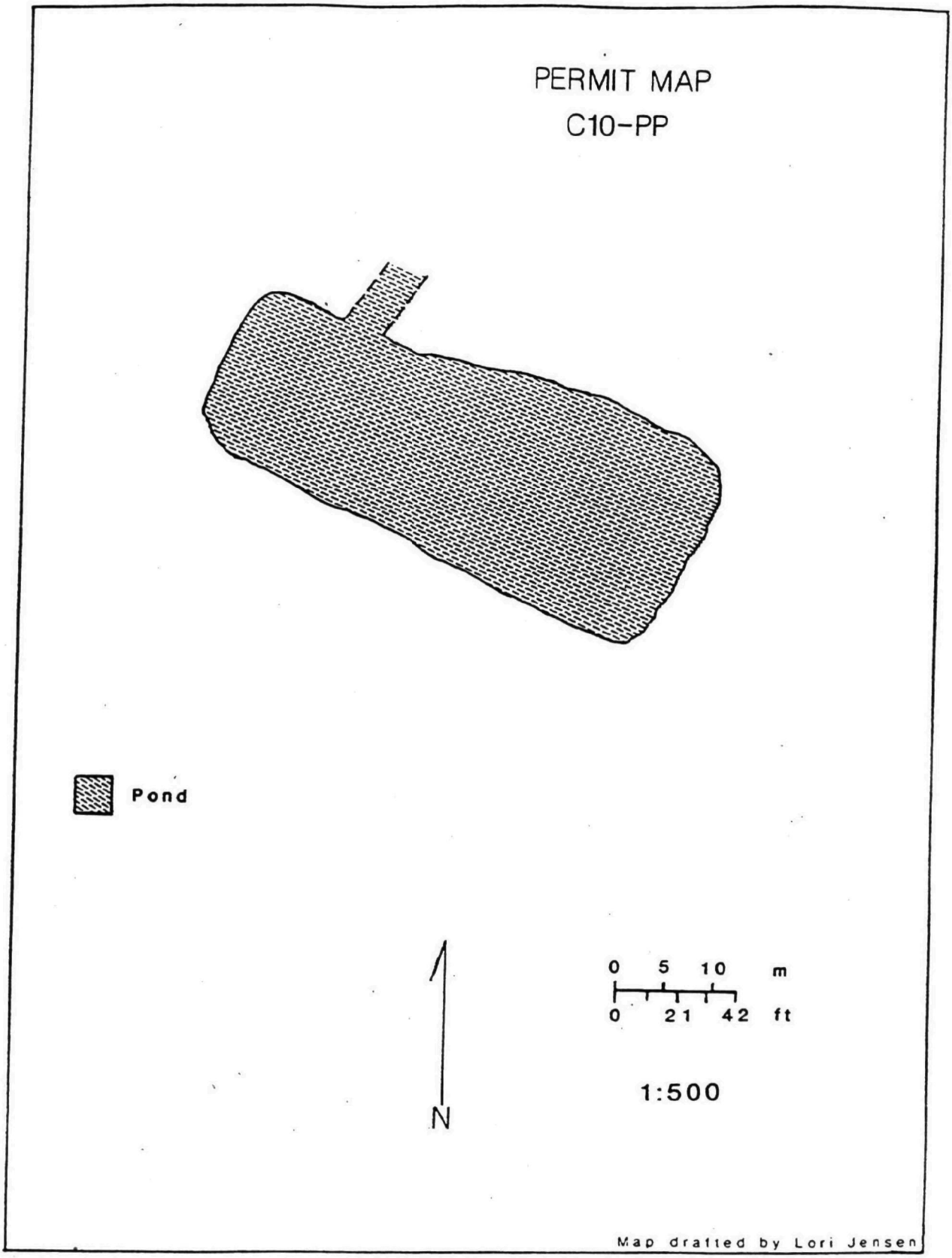
Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

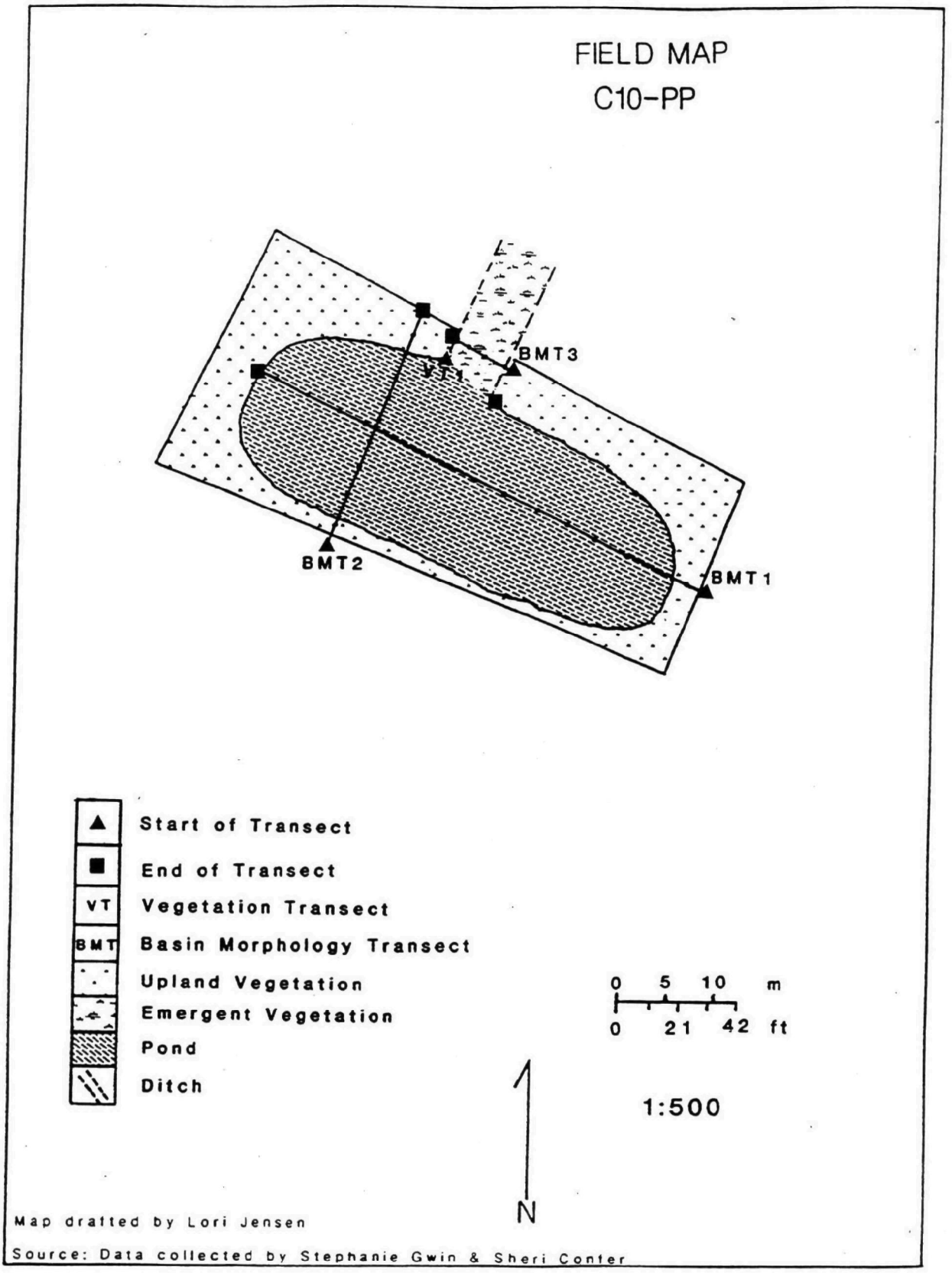
Many small fish fry and a bullfrog were observed in the pond. Gold finches, swallows, and a red tailed hawk were the only birds sighted.

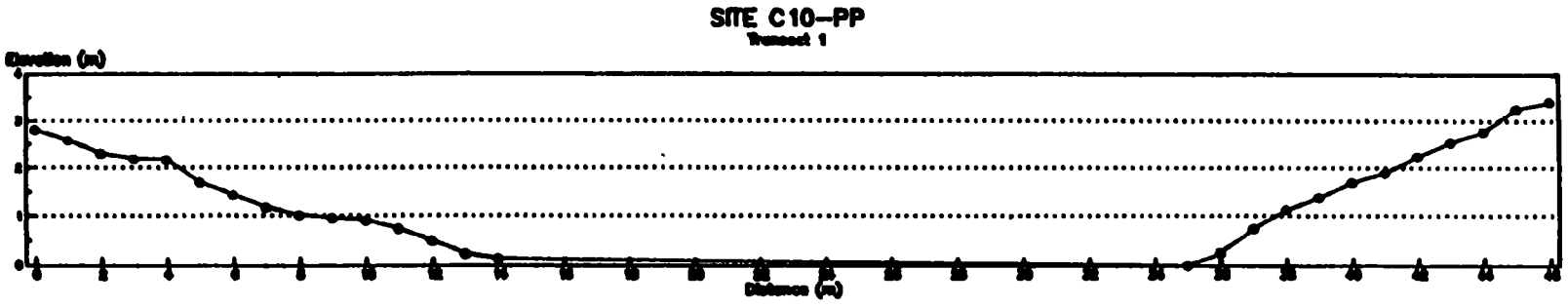
Southern Pacific Railroad's tracks were several hundred feet across the meadow from the pond and ran parallel to its south side.

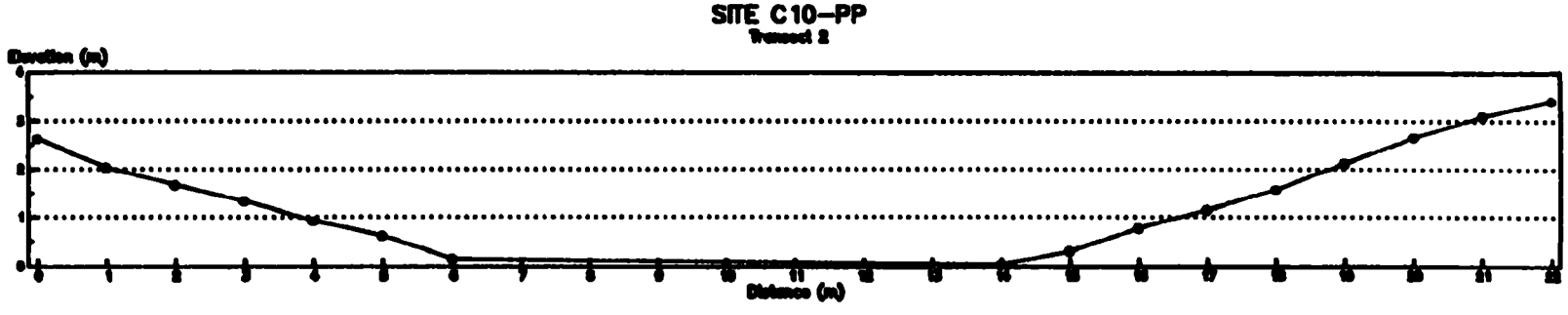
Impressions of the Site One Year Later

This wetland appeared much the same as the previous summer. The banks were becoming more vegetated, mostly with clover, which appears to be minimizing erosion of the steep banks. Wetland vegetation was located in a narrow band along the water's edge about one meter below the top of the bank.


PERMIT MAP
C10-PP
Pond
N
0 5 10 m
0 21 42 ft
1:500
Map drafted by Lori Jensen


FIELD MAP
C10-PP
BMT3
VT1
BMT2
BMT1
Start of Transect
End of Transect
VT
Vegetation Transect
BMT
Basin Morphology Transect
Upland Vegetation
Emergent Vegetation
Pond
Ditch
0 5 10 m
0 21 42 ft
1:500
N
Map drafted by Lori Jensen
Source: Data collected by Stephanie Gwin & Sheri Conter


SITE C10–PP
Transect 1
Elevation (m)
Distance (m)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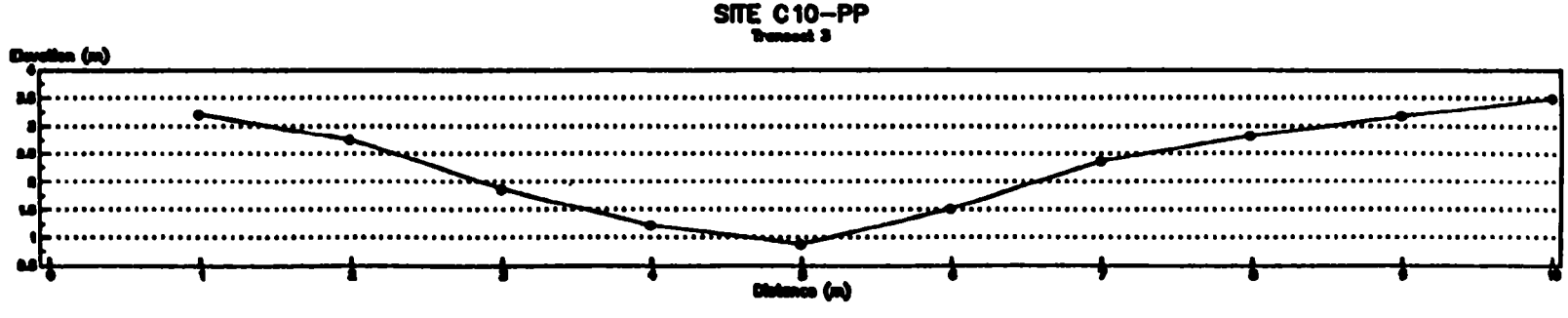
Transect 2
Elevation (m)
Distance (m)


SITE C10–PP
Transect 3
Elevation (m)
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C10-PP

There was no planting list included in the permit file for this site. However, the banks were to be seeded with grasses and legumes.

Species Found On Site C10-PP During Summer 1987

	Species	Wetland Indicator Code
1	Phalaris arundinacea	FACW\NAT
2	Lolium perenne	FACU\EXO
3	Salix piperi	FACW\NAT
4	Lotus corniculatus	FAC\EXO
5	Epilobium watsonii	FACW-NAT
6	Eleocharis palustris	OBL\NAT
7	Gnaphalium uliginosum	FAC\NAT
8	Trifolium repens	FACU+EXO
9	Cirsium arvense	FACU+EXO
10	Polygonum spergulariaeforme	ABS\NAT
11	Juncus oxymeris	FACW+NAT
12	Eleocharis ovata	OBL\NAT
13	Trifolium pratense	FACU\EXO
14	Bidens tripartita	FACW\EXO
15	Juncus tenuis	FAC\NAT
16	Sonchus asper	FAC-EXO
17	Festuca bromoides	FAC\EXO
18	Leersia oryzoides	OBL\NAT
19	Trifolium dubium	UPL\EXO
20	Plantago major	FAC+EXO
21	Carex lenticularis	FACW+NAT
22	Sagittaria latifolia	OBL\NAT
23	Bidens cernua	FACW+EXO
24	Cyperus erythrorhizos	OBL\NAT
25	Salix fluviatilis	OBL\NAT
26	Fraxinus latifolia	FACW\NAT
27	Lindernia dubia	OBL\NAT
28	Rumex crispus	FACW\EXO

29	Equisetum arvense	FAC\NAT
30	Poa palustris	FAC\EXO
31	Gratiola neglecta	OBL\NAT
32	Veronica peregrina	OBL\NAT
33	Rorippa islandica	OBL\NAT
34	Sparganium emersum	OBL\NAT
35	Mazus japonicus	FACW\EXO
36	Poa annua	FAC-NAT
37	Agrostis exarata	FACW\NAT
38	Agrostis alba	FACW\EXO

DESCRIPTION: SITE C11-SM

Function/Purpose

The function of this wetland creation was to mitigate for the placement of 2,600 cubic yards of earth fill in a 0.13 ha (0.3 acre) wetland area adjacent to Fanno Creek. The fill was required to provide an elevation above the 100 year flood plain for construction of additional parking and storage area. The primary objective of the mitigation was functional replacement of the wetland area destroyed, including wildlife habitat, flood storage and desynchronization, and habitat for fisheries.

General Description

The project's design called for the creation of two small sumps, at least 30 feet by 60 feet, with an island in the center and an irregular shoreline. The field team found a shallow pond with an isthmus connecting an island to the southeast shoreline. As required in the design plans, the island stood a couple of feet above water level at its' highest point, and the wetland had an irregular shoreline. There was emergent vegetation growing in the very shallow water (5 cm) covering the isthmus, and along the shorelines of the bank and the island.

The inlet was a narrow, shallow ditch running along the north edge of the parking lot. There was water flowing into the wetland through this inlet at the time of sampling. A dry streambed leading from the wetland to Fanno Creek was assumed to be the wetland's outlet. When high water conditions exist, Fanno Creek will overflow its banks and flood this wetland.

A wire mesh fence approximately 9 feet tall separated the wetland from the parking lot. Young pine trees were planted between the fence and the pond. Directly south and southeast of the created wetland was a large marshy area almost completely covered with reed canary grass (Phalaris arundinacea L.). The fill and the created wetland were extensions of this area prior to development (G. Herb, ODFW, pers. comm.).

A pile of broken asphalt was found on the slope leading up from the wetland to the parking lot. Old tires and other debris were also observed. The landowner informed us that they would be cleaned up as per the design plans.

This project was approximately ten months old when sampled in July of 1987.

Hydrology and Substrate

Although there was flow into the wetland via the inlet, water in the sump was stagnant and turbid, and had a brown-colored algal growth. The water had no odor.

All but one of the chromas of the soil samples were in the hydric range, either /1 or /0 (as determined using a Munsell Color Book). The one non-hydric chroma was /2 (borderline hydric). Periodic inundation was indicated by mottling in the upper 5 to 10 cm of the soil samples (Soil Conservation Service 1975). Water was observed in all soil pits dug along transect 2, and most pits along transect 1 (See Field Map). No water was observed in soil pits dug along transect 3.

Dominant Vegetation

The created wetland was bordered by an upland grassy meadow to the North, and a marshy stand of reed canary grass (Phalaris arundinacea L.) to the south. Within the wetland, emergent

vegetation was prevalent. At sampling time, there was a large mudflat area where vegetation was not growing. Some of the plants on the site were weeds known to be established only along the Columbia River near Portland, where they were apparently established from seed that was carried in the ballast of ships (E. Alverson, OSU, pers. comm.). A few were native, such as jointed rush (**Juncus articulatus** L.).

See the list of "Species Found On Site C11-SM" for an explicit account of the species identified.

Wildlife

Common names were used for wildlife sighted or heard because information was taken from notes made during field sampling by an amateur birdwatcher. No definitive wildlife survey was done and therefore, scientific names were not determined.

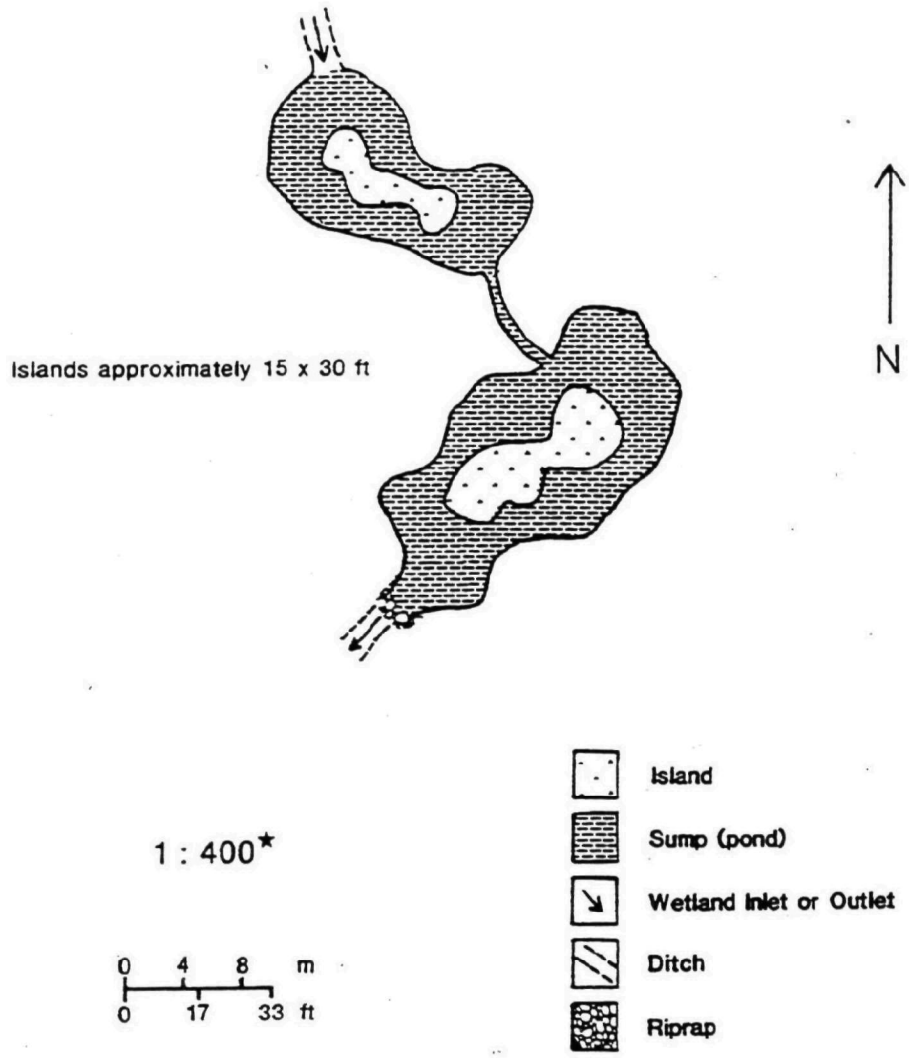
Swallows, killdeer, goldfinches, and the tracks of a great blue heron were observed. The design plans specified that the ponds were to be stocked with a species of **Gambusia**, a mosquito-eating fish, but none were observed.

Impressions of the Site One Year Later

Most of the debris littering the site during the summer of 1987 was removed. The broken asphalt near the gate in the fence along the east side of the wetland was becoming vegetated.

Water levels appeared much higher. The isthmus reaching from the south bank to the island was flooded. The water appeared very clear. Although the water level was higher than during the previous summer, the pond had become dotted with patches of emergent vegetation. The island and banks of the pond had become heavily vegetated, and the wetland seemed to be maturing well.

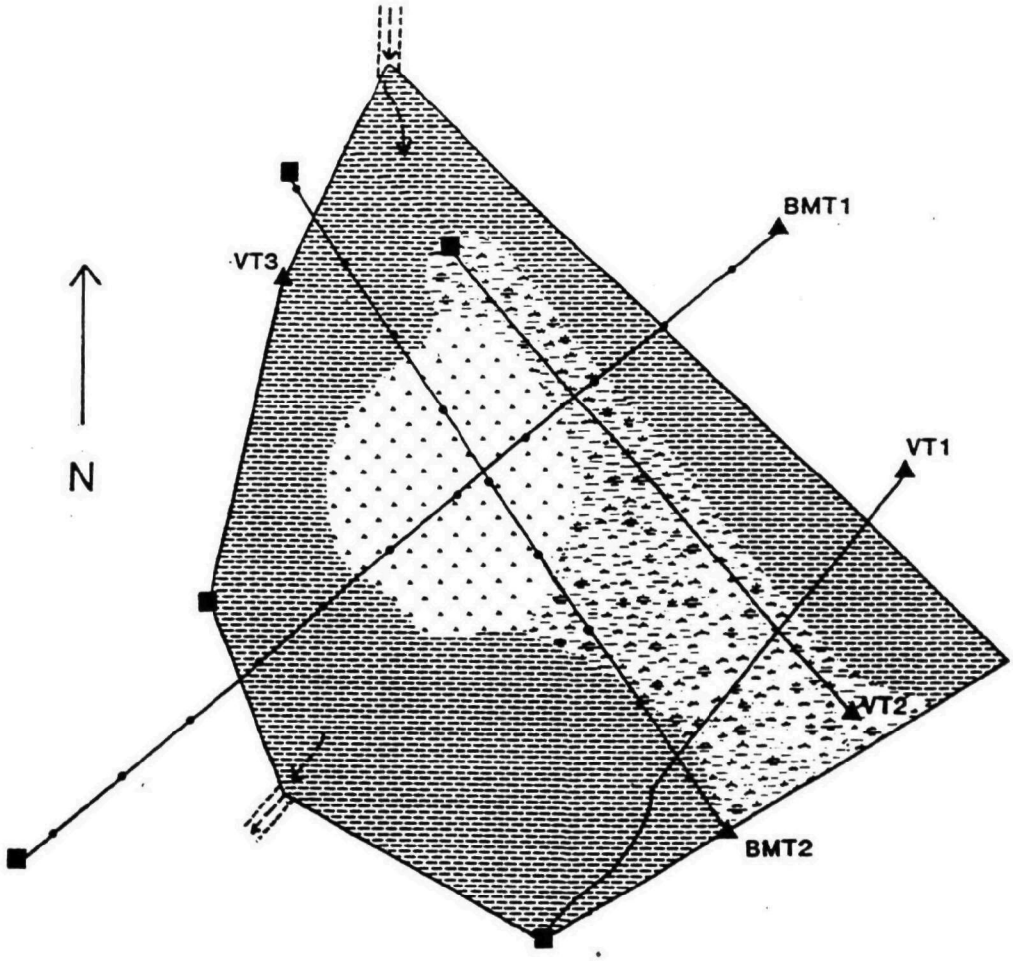
PERMIT MAP
C11-SM



★(Because no scale was given on source map this scale is approximated from dimensions given on source map)

Map drafted by Tracy Smith

FIELD MAP
C11-SM



1 : 400

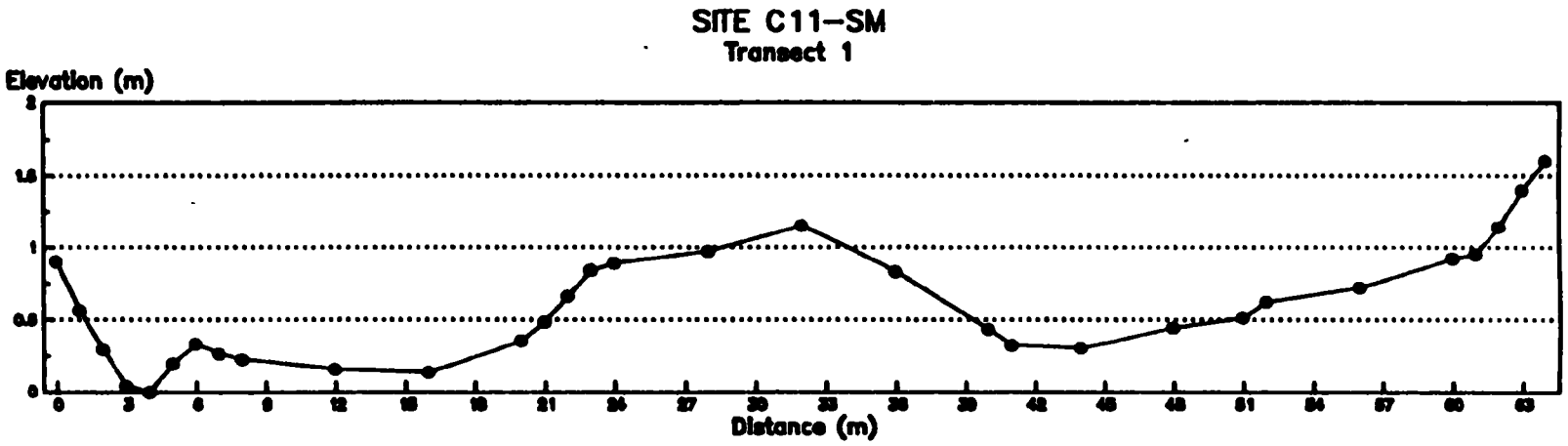
0 4 8 m
0 17 33 ft

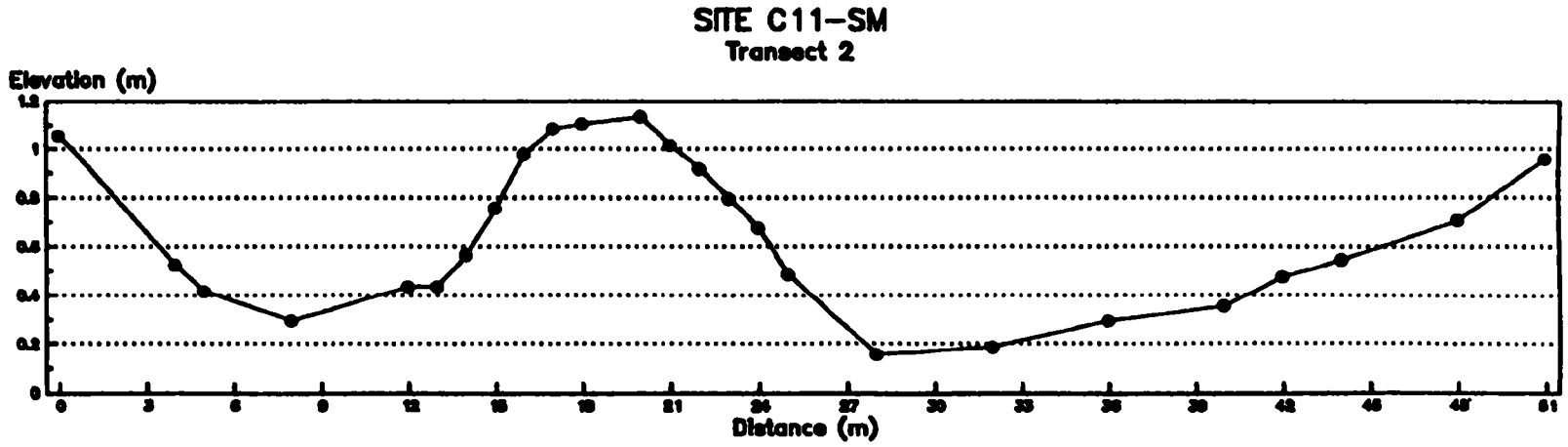
Map drafted by Tracy Smith

Pond and vegetation boundaries are
the approximate locations observed in July, 1987

Source: Data collected by Stephanie Gwin & Sheri Confer

- BMT — Basin Morphology Transect
- VT — Vegetation Transect
- Upland Vegetion
- Emergent Vegetation
- Pond
- Wetland Inlet or Outlet
- Ditch
- Start of Transect
- End of Transect


SITE C11-SM
Transect 1
Elevation (m)
Distance (m)


SITE C11-SM
Transect 2
Elevation (m)
Distance (m)

VEGETATION ANALYSIS

Following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "Species Listed for Planting in Created Wetland" and the list of "Species Found On Site".

Species Listed for Planting in Created Wetland C11-SM

	Species	Wetland Indicator Code
1	Salix sp.	???
2	Populus sp.	???
3	Taxodium distichum	OBL\EXO
4	Potamogeton pectinatus	OBL\NAT
5	Polygonum sp.	???
6	Cyperaceae	???
7	Scirpus sp.	???
8	Sparganiaceae	???
9	Sagittaria sp.	???
10	Fraxinus latifolia var oregana	FACW\NAT
11	Crataegus sp.	???

Only common names were used to designate species for planting on this site. Efforts were made to determine the correct genus and species. Where this was not possible, the family or genus name was determined.

Species Found On Site C11-SM During Summer 1987

	Species	Wetland Indicator Code
1	Juncus bufonius	FACW+NAT
2	Holcus lanatus	FAC\EXO
3	Alopecurus geniculatus	FACW+NAT
4	Phalaris arundinacea	FACW\NAT
5	Lindernia dubia	OBL\NAT
6	Gnaphalium uliginosum	FAC\NAT
7	Eleocharis ovata	OBL\NAT
8	Lemna minor	OBL\NAT
9	Typha latifolia	OBL\NAT
10	Leersia oryzoides	OBL\NAT
11	Callitriche stagnalis	OBL\NAT
12	Ludwigia palustris	OBL\NAT
13	Alisma plantago-aquatica	OBL\NAT

14	Agrostis alba	FACW\EXO
15	Echinochloa crusgalli	FACW\NAT
16	Eleocharis palustris	OBL\NAT
17	Juncus tenuis	FAC\NAT
18	Polygonum persicaria	FACW\EXO
19	Polygonum punctatum	OBL\NAT
20	Salix sitchensis	FACW\NAT
21	Mimulus moschatus	FACW+NAT
22	Trifolium repens	FACU+EXO
23	Equisetum arvense	FAC\NAT
24	Rorippa islandica	OBL\NAT
25	Gratiola neglecta	OBL\NAT
26	Epilobium watsonii	FACW-NAT
27	Gnaphalium palustre	FAC+NAT
28	Veronica americana	OBL\NAT
29	Rorippa curvisiliqua	FACW+NAT
30	Ranunculus repens	FACW\EXO
31	Sparganium emersum	OBL\NAT
32	Polygonum aviculare	FACW-EXO
33	Unknown Seedling 1	???
34	Plantago major	FAC+EXO
35	Juncus oxymeris	FACW+NAT
36	Lotus corniculatus	FAC\EXO
37	Anthemis cotula	FACU\EXO
38	Trifolium pratense	FACU\EXO
39	Poa trivialis	FACW-EXO
40	Cirsium vulgare	FACU\EXO
41	Vicia disperma	ABS\EXO
42	Sonchus asper	FAC-EXO
43	Rumex crispus	FACW\EXO

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Soil Conservation Service. 1975. Soil Taxonomy--A Basic System of Soil Classification for Making and Interpreting Soil Surveys. Soil Survey Staff, Soil Conservation Service, U.S. Department of Agriculture. Agriculture Handbook No. 436.

APPENDIX II

LISTS OF PLANT SPECIES TO BE ESTABLISHED AND ACTUALLY ESTABLISHED ON EACH SITE

Following are the list of all species intended for planting and the list of all species found on the created wetlands studied. Wetland indicator codes were adapted from categories in the regional list of plant species that occur in wetlands (Reed 1988) and in consultation with LaRea Johnston, Assistant Curator of the Oregon State University Herbarium. Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol + indicates the species is toward the high end of the category (more frequently found in wetlands); - indicates the species is toward the low end of the category (less frequently found in wetlands); and \ indicates the species is intermediate within the category. ??? indicates no information. Species names followed by * were common to both the "List of All Species Intended for Planting" and the "List of All Species Found on Created Wetlands".

LIST OF ALL SPECIES INTENDED FOR PLANTING

The following list includes all species intended for planting within wetland areas of the created wetlands studied. Species listed for planting in buffer areas, banks, and adjacent upland areas are not included.

	Scientific Name	Common Name	Code
1	Agrostis palustris\A. stolonifera	Spreading bentgrass	FAC+NAT
2	Alopecurus pratensis*	Meadow foxtail	FACW\EXO
3	Bromus inermis	Smooth brome-grass	FACU\EXO
4	Carex lyngbeii	Lyngbye's sedge	OBL\NAT
5	Carex obnupta	Slough sedge	OBL\NAT
6	Crataegus sp.	Hawthorne	???
7	Cyperaceae (family)	Sedges	???
8	Cyperus erythrorhizos*	Red-root flatsedge	OBL\NAT
9	Cyperus esculentus*	Chufa	FACW\NAT
10	Dactylis glomerata*	California oatgrass	FACU\EXO
11	Echinochloa crusgalli*	Barnyard grass	FACW\EXO
12	Eleocharis palustris*	Creeping spikerush	OBL\NAT
13	Fraxinus latifolia var oregana*	Oregon ash	FACW\NAT
14	Glyceria borealis	Small floating mannagrass	OBL\NAT
15	Lysichiton americanum	Yellow skunk cabbage	OBL\NAT
16	Phalaris arundinacea*	Reed canary grass	FACW\NAT
17	Polygonum hydropiper	Marshpepper smartweed	OBL\EXO
18	Polygonum lapathifolium*	Willow-weed	FACW+NAT
19	Polygonum persicaria*	Lady's thumb	FACW\EXO
20	Polygonum sp.	Smartweeds	???
21	Populus sp..	Cottonwoods	???
22	Potamogeton crispus	Curly pondweed	OBL\EXO
23	Potamogeton pectinatus	Sago pondweed	OBL\NAT
24	Potentilla anserina	Silverweed	OBL\NAT

25	Ranunculus spp.	Buttercups	???
26	Sagittaria latifolia*	Broad-leaf arrowhead	OBL\NAT
27	Sagittaria sp.	Arrowhead	???
28	Salix sitchensis*	Sitka willow	FACW\NAT
29	Salix sp.	Willow	???
30	Scirpus acutus*	Hard-stem bulrush	OBL\NAT
31	Scirpus americanus	Olney's bulrush	OBL\NAT
32	Scirpus microcarpus*	Small-fruit bulrush	OBL\NAT
33	Scirpus sp.	Bulrush	???
34	Scirpus validus*	Soft-stem bulrush	OBL\NAT
35	Sparganiaceae (family)	Burreed family	???
36	Sparganium emersum*	Narrow-leaf burreed	OBL\NAT
37	Sparganium eurycarpum*	Giant burreed	OBL\NAT
38	Spiraea douglasii	Douglas' spiraea	FACW\NAT
39	Symphoricarpos spp.	Snowberry	???
40	Taxodium distichum	Bald cypress	OBL\EXO
41	Typha latifolia	Broad-leaf cattail	OBL\NAT
42	Typha spp.	Cattails	OBL\NAT
43	???	Nutsedge	???
44	???	Great bulrush	???

LIST OF ALL SPECIES FOUND ON CREATED WETLANDS

The following list includes all species found along transects that were placed to represent the vegetation communities of each created wetland studied. Transects were located within the wetland areas of the sites only. They were not placed in buffer areas, banks, and adjacent upland areas.

	Scientific Name	Common Name	Code
1	Agropyron repens	Quackgrass	NO\EXO
2	Agrostis alba	Redtop	FACW\EXO
3	Agrostis exarata	Spike bentgrass	FACW\NAT
4	Agrostis tenuis	Colonial bentgrass	UPL\EXO
5	Alisma plantago-aquatica	Broadleaf water-plantain	OBL\NAT
6	Alnus rubra	Red alder	FAC\NAT
7	Alopecurus geniculatus	Meadow foxtail	FACW+NAT
8	Alopecurus pratensis*	Meadow foxtail	FACW\EXO
9	Anthemis cotula	Mayweed	FACU\EXO
10	Anthoxanthum odoratum	Sweet vernal grass	FACU\EXO
11	Antirrhinum orontium	Snapdragon	FAC\NAT
12	Arctium minus	Common burdock	FACU\EXO
13	Beckmannia syzigachne	American sloughgrass	OBL\NAT
14	Bidens cernua	Nodding beggar-ticks	FACW+EXO
15	Bidens frondosa	Devil's beggar-ticks	FACW+NAT
16	Bidens tripartita	Tree-lobe beggar-ticks	FACW\EXO
17	Bidens vulgata	Tall beggar-ticks	FACW+NAT
18	Boisduvalia densiflora	Dense-flower spike-primrose	FACW-NAT
19	Callitriche stagnalis	Pond water-starwort	OBL\NAT
20	Callitriche verna	Spiny water-starwort	OBL\NAT
21	Camassia leichtlinii	Leichtlin's camassia	FACW-NAT
22	Capsella bursa-pastoris	Common shepard's purse	FAC-EXO

23	Cardamine oligosperma	Few-seed bitter-cress	FACW\NAT
24	Carex arcta	Northern clustered sedge	FACW+NAT
25	Carex athrostachya	Slender-beak sedge	FACW\NAT
26	Carex feta	Green-sheath sedge	FACW\NAT
27	Carex laeviculmis	Smooth-stem sedge	FACW\NAT
28	Carex lenticularis	Shore sedge	FACW+NAT
29	Carex sp.	Sedges	???
30	Carex stipata	Stalk-grain sedge	OBL\NAT
31	Carex unilateralis	One-side sedge	FACW\NAT
32	Centaurea cyanus	Bachelor's button	UPL\EXO
33	Centaurium umbellatum	Centaury	FAC-EXO
34	Centunculus minimus	Chaffweed	FACW\NAT
35	Cerastium viscosum	Sticky chickweed	NO\EXO
36	Chenopodium album	White goosefoot	FAC\EXO
37	Chenopodium ambrosioides	American wormseed	FAC\EXO
38	Chenopodium botrys	Jerusalem-oak	FACU\EXO
39	Chrysanthemum leucanthemum	Oxeye daisy	FAC\EXO
40	Cichorium intybus	Chicory	UPL\EXO
41	Circaea alpina	Small enchanter's nightshade	FACW\NAT
42	Cirsium arvense	Creeping thistle	FACU+EXO
43	Cirsium vulgare	Bull thistle	FACU\EXO
44	Cornus stolonifera	Red-osier dogwood	FACW\NAT
45	Crepis setosa	Rough hawksbeard	UPL\EXO
46	Cyperaceae (seedling)	Sedge	???
47	Cyperus erythrorhizos*	Red-root flatsedge	OBL\NAT
48	Cyperus esculentus*	Chufa	FACW\NAT
49	Dactylis glomerata*	Orchard grass	FACU\EXO
50	Daucus carota	Queen Anne's lace	FAC\EXO
51	Deschampsia elongata	Slender hairgrass	FACW-NAT
52	Digitaria ischaemum	Smooth crabgrass	FACU\EXO
53	Dipsacus sylvestris	Teasel	FACU\EXO
54	Echinochloa crusgalli*	Barnyard grass	FACW\NAT
55	Eleocharis acicularis	Least spikerush	OBL\NAT
56	Eleocharis ovata	Ovate spikerush	OBL\NAT
57	Eleocharis palustris*	Creeping spikerush	OBL\NAT
58	Epilobium paniculatum	Autumn willow-weed	UPL\NAT
59	Epilobium watsonii	Watson's willow-weed	FACW-NAT
60	Equisetum arvense	Field horsetail	FAC\NAT
61	Equisetum telmateia	Giant horsetail	FACW\NAT
62	Eragrostis pectinacea	Purple lovegrass	FAC\NAT
63	Euphorbia supina	Milk spurge	UPL\EXO
64	Festuca arundinacea	Kentucky fescue	FACU-EXO
65	Festuca bromoides	Barren fescue	FAC\EXO
66	Fragaria vesca	Woods strawberry	FACU\NAT
67	Fraxinus latifolia*	Oregon ash	FACW\NAT
68	Galium aparine	Catchweed bedstraw	FACU\NAT
69	Galium trifidum	Small bedstraw	FACW+NAT
70	Geranium dissectum	Cut-leaf geranium	UPL\EXO
71	Geranium molle	Dovefoot geranium	UPL\EXO
72	Geum macrophyllum	Large-leaf avens	FACW+NAT
73	Glyceria grandis	Reed mannagrass	OBL\EXO
74	Glyceria leptostachya	Slender-spike mannagrass	OBL\NAT

75	Gnaphalium palustre	Western marsh cudweed	FAC+NAT
76	Gnaphalium uliginosum	Marsh cudweed	FAC\NAT
77	Gratiola neglecta	Clammy hedgehyssop	OBL\NAT
78	Hedera helix	Ivy	UPL\EXO
79	Heleochloa alopecuroides	Heleochloa	OBL-EXO
80	Holcus lanatus	Common velvet-grass	FAC\EXO
81	Hordeum brachyantherum	Meadow barley	FACW\NAT
82	Hypericum perforatum	Common St. John's-wort	UPL\EXO
83	Hypochaeris radicata	Spotted cats-ear	UPL\EXO
84	Impatiens capensis	Spotted touch-me-not	FACW\NAT
85	Juncus bufonius	Toad rush	FACW+NAT
86	Juncus effusus	Soft rush	FACW+NAT
87	Juncus ensifolius	Three-stamen rush	FACW\NAT
88	Juncus oxymeris	Pointed rush	FACW+NAT
89	Juncus patens	Spreading rush	FACW\NAT
90	Juncus tenuis	Slender rush	FAC\NAT
91	Lactuca serriola	Prickly lettuce	FAC-EXO
92	Lamium amplexicaule	Common dead-nettle	UPL\EXO
93	Lapsana communis	Nipplewort	UPL\EXO
94	Lathyrus hirsutus	Hairy peavine	UPL\EXO
95	Leersia oryzoides	Rice cutgrass	OBL\NAT
96	Lemna minor	Lessor duckweed	OBL\NAT
97	Leontodon nudicaulis	Hairy hawkbit	UPL\EXO
98	Limosella aquatica	Northern mudwort	OBL\NAT
99	Lindernia anagallidea	False pimpernel	OBL\NAT
100	Lindernia dubia	Yellow-seed false pimpernel	OBL\NAT
101	Lolium multiflorum	Australian ryegrass	FACU\EXO
102	Lolium perenne	Perennial ryegrass	FACU\EXO
103	Lotus corniculatus	Birds-foot trefoil	FAC\EXO
104	Ludwigia palustris	Marsh seedbox	OBL\NAT
105	Lupinus polyphyllus	Large-leaved lupine	FACU-NAT
106	Luzula campestris	Sweep's brush	FACU\NAT
107	Lythrum hyssopifolia	Hyssop loosestrife	OBL\EXO
108	Mazus japonicus	Japanese mazus	FACW\EXO
109	Mimulus moschatus	Muskflower	FACW+NAT
110	Mollugo verticillata	Green carpet-weed	FAC\NAT
111	Myosotis discolor	Yellow and blue forget-me-not	FACW\EXO
112	Myosotis laxa	Bay forget-me-not	OBL\NAT
113	Navarretia squarrosa	Skunkweed	UPL\NAT
114	Oemleria cerasiformis	Indian plum	FACU\NAT
115	Oenanthe sarmentosa	Water-parsley	OBL\NAT
116	Panicum capillare	Witchgrass	FAC\NAT
117	Peplis portula	???	FACW\EXO
118	Phalaris arundinacea*	Reed canary grass	FACW\NAT
119	Phleum pratense	Timothy	FACU\EXO
120	Plagiobothrys scouleri	Scouler popcorn-flower	FACW\NAT
121	Plantago lanceolata	English plantain	FACU+EXO
122	Plantago major	Common plantain	FAC+EXO
123	Poa annua	Annual bluegrass	FAC-NAT
124	Poa compressa	Canada bluegrass	FACU\NAT
125	Poa palustris	Fowl bluegrass	FAC\EXO
126	Poa trivialis	Rough bluegrass	FACW-EXO

127	Polygonum aviculare	Prostrate knotweed	FACW-EXO
128	Polygonum hydropiperoides	Swamp smartweed	OBL\NAT
129	Polygonum lapathifolium*	Willow-weed	FACW+EXO
130	Polygonum persicaria*	Lady's thumb	FACW\EXO
131	Polygonum punctatum	Dotted smartweed	OBL\NAT
132	Polygonum spergulariaeforme	Spurry knotweed	ABS\NAT
133	Populus trichocarpa	Black cottonwood	FACW\NAT
134	Potamogeton amplifolius	Large-leaf pondweed	OBL\NAT
135	Potamogeton filiformis	Fine-leaf pondweed	OBL\NAT
136	Pyrus malus	Apple (cultivated)	UPL\EXO
137	Ranunculus lobbii	Lobb's water buttercup	OBL\NAT
138	Ranunculus repens	Creeping buttercup	FACW\EXO
139	Ranunculus sceleratus	Celery-leaf buttercup	OBL\NAT
140	Rorippa curvisiliqua	Curve-pod yellowcress	FACW+NAT
141	Rorippa islandica	Marsh yellowcress	OBL\NAT
142	Rubus discolor	Himalayan blackberry	FACU-EXO
143	Rubus ursinus	Pacific blackberry	FACW\NAT
144	Rumex conglomeratus	Clustered dock	FACW\EXO
145	Rumex crispus	Curly dock	FACW\EXO
146	Rumex salicifolius	Willow dock	FACW\NAT
147	Sagittaria latifolia*	Broad-leaf arrowhead	OBL\NAT
148	Salix fluviatilis	River willow	OBL\NAT
149	Salix lasiandra	Pacific willow	FACW+NAT
150	Salix piperi	Dune willow	FACW\NAT
151	Salix sitchensis*	Sitka willow	FACW\NAT
152	Salix sp.	Willow	???
153	Scirpus acutus*	Hardstem bulrush	OBL\NAT
154	Scirpus fluviatilis	River bulrush	OBL\NAT
155	Scirpus microcarpus*	Small-fruit bulrush	OBL\NAT
156	Scirpus validus*	Soft-stem bulrush	OBL\NAT
157	Senecio jacobaea	Tansy ragwort	UPL\EXO
158	Senecio vulgaris	Common groundsel	FACU\EXO
159	Solanum dulcamara	Climbing nightshade	FAC\EXO
160	Solidago occidentalis	Western goldenrod	FACW\NAT
161	Sonchus asper	Prickly sowthistle	FAC-EXO
162	Sparganium emersum*	Narrow-leaf burreed	OBL\NAT
163	Sparganium eurycarpum*	Giant burreed	OBL\NAT
164	Spergularia rubra	Purple sandspurry	FAC-EXO
165	Stachys cooleyae	Cooley's hedgenettle	FACW\NAT
166	Stachys palustris	Marsh hedgenettle	FACW+NAT
167	Stellaria media	Chickweed	UPL\EXO
168	Symphoricarpos albus	Snowberry	FACU\NAT
169	Tanacetum vulgare	Common tansy	ABS\EXO
170	Taraxacum officinale	Common dandelion	FACU\EXO
171	Tellima grandiflora	Fringecup	FACU\NAT
172	Tillaea aquatica	Pigmy-weed	OBL\NAT
173	Trifolium arvense	Hare's foot	UPL\EXO
174	Trifolium dubium	Suckling clover	UPL\EXO
175	Trifolium hybridum	Alsike clover	UPL\EXO
176	Trifolium pratense	Red clover	FACU\EXO
177	Trifolium repens	White clover	FACU+EXO
178	Trifolium subterraneum	Subterranean clover	UPL\EXO

179	Typha latifolia*	Broadleaf cattail	OBL\NAT
180	Unknown Herb 2		???
181	Unknown Seedling 1		???
182	Verbascum blattaria	Moth mullein	UPL\EXO
183	Veronica americana	American speedwell	OBL\NAT
184	Veronica peregrina	Purslane speedwell	OBL\NAT
185	Veronica serpyllifolia	Thyme-leaf speedwell	FAC\EXO
186	Vicia americana	American purple vetch	FAC\NAT
187	Vicia disperma	Vetch	ABS\EXO
188	Vicia sativa	Common vetch	UPL\EXO
189	Vicia tetrasperma	Slender vetch	UPL\EXO