# APPENDIX F
# STORMWATER TREATMENT TRAIN

## Stormwater Treatment Train Example

15A. Ecological Restoration Plan Overview

In the Elwell farm project site the following ecological systems will be restored: Mesic forests, savannas, stream (riparian) course forests (as feasible), wetlands including wet prairies, emergent wetlands, drainage swales, seasonal wetlands located in the forested tract, and prairies including mesic and dry prairies.

Under the plan, the term restoration is used to mean that the existing vegetation systems will be enhanced through active management (e.g. degraded wetlands, forests, etc.) or existing degraded vegetation will be completely replaced with native plant species. The goal of the restoration program is to encourage plant communities primarily dominated by regionally (genetically) adapted native plant species that resemble the structure and spatial patterns and diversity of ecological systems that occupied this land before recent agricultural land-uses began. Other goals are to stabilize soils, reduce nutrients and stormwater runoff from the existing degraded site. The restored vegetation systems will attract and encourage use by animal species and provide the backdrop for passive recreation opportunities on an internal and regional greenway trail network.

The restoration plan for the subject property is comprised of two periods. The first period, the remedial period, involves the major tasks such as brushing buckthorn from the forests, disabling agricultural tiles to provide water to restore drained wetlands, planting and seeding wetlands and prairies and restoration of stream courses. This period usually lasts 3-5 years. The second period is the maintenance period of this program and includes perpetual tasks done annually to maintain and enhance the ecological systems. This includes prescribed burning, noxious weed management, etc.

The Elwell farm restoration program involves three phases correlated with implementation of the site development plan.

The restoration plan for Elwell farms was developed after the ecological resources and their conditions were studied in the property. The findings and conclusions of this process were documented in the natural resources report (Attachment 1).

Major Restoration Tasks

The following provides an outline of key tasks per zone on the conceptual plan.

1. Forests and Savannas
   - Restore diverse ground story vegetation in forests. This will be done by seeding, plugging, brushing and prescribed burning.
   - Reduce invasive shrubs and saplings of buckthorn, tartarian honeysuckle, boxelder and other noxious or invasive plant species.
   - Reduce dense shade contributed in part by these shrubs and saplings to allow ample light to the ground story to support ground cover vegetation growth.
   - Some forest areas are dominated by undesirable and invasive tree species. These areas will be converted from the invasive trees, saplings and shrubs to native species.

2. Old Farm Fields Conversion to Prairies
   Parts of the fallowed farm fields now growing in agronomic grasses and weeds will be restored to prairies. The existing weedy vegetation in these areas will be eradicated using selective herbicides (the same used by the farmer) followed by soil – seed bed preparation, seeding and plugging of native plants. Prescribed burning and other methods will be used for maintenance of the prairies.

3. Wetland Restoration and Enhancement
   Existing tile drained agricultural areas that used to be wetlands, and existing wetlands will be restored. In existing wetlands the weedy growths of Southeast Asian reed canary grass, stinging nettles and cattails will be reduced and the sites will be enhanced by addition of native species seeds and plants. These areas also will be managed with prescribed burning and other methods.

   Tiles that drain existing wetlands will be disabled or redirected to facilitate wetland restoration.

4. Stream Course Restoration
   Several very highly degraded, dredged watercourses are present in the property. These areas will be restored by reducing the dense tree and shrub shading so soil stabilizing ground cover vegetation can again grow. In addition, excavation and plantings to stabilize the very steep and eroding banks may be necessary.

Species Selection for the Restoration Program

Species will be selected that are members of native plant communities found in the region. Seed and plant sources will utilize species of as local a genetic origin as possible.

Operations and Management of the Restoration Program

The project team includes one of the leading national ecological restoration sciences firms in the U.S. and Canada. This firm will conduct the remedial period restoration and also long-term maintenance period.

The development team will finance the remedial period work and develop the budgets necessary for the future homeowner association's implementation of the long-term maintenance phase. Attachment 2 provides the restoration and management specification and performance requirements for this project.

The Stormwater Management Plan

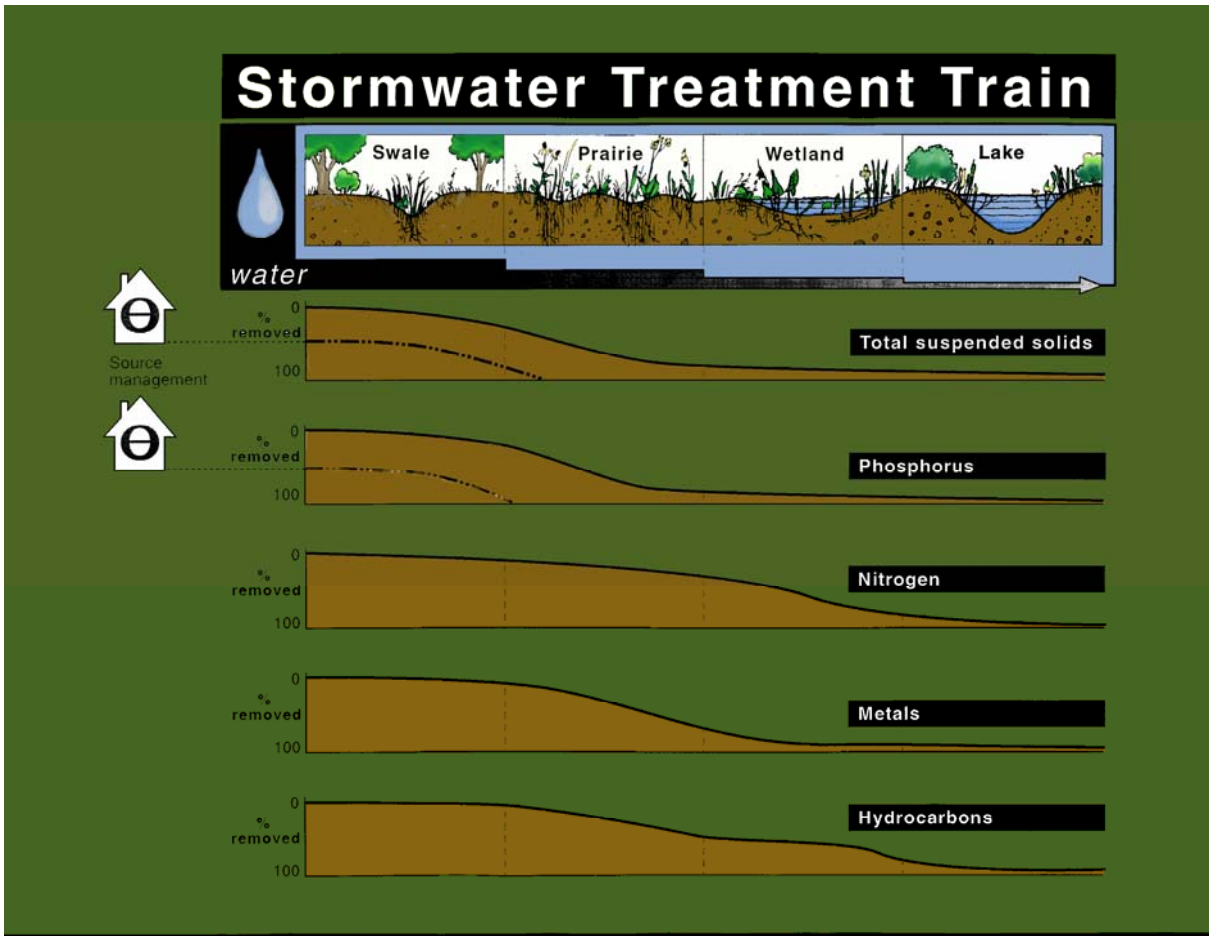
Stormwater currently flows from the site in five locations, including the northeastern corner of the site through an existing creek; overland from the northwestern corner of the site; through an existing wetland at the southern boundary of the site; and through two culverts under County Road 101 on the eastern boundary of the site. Approximately 50.7 acres of offsite drainage is routed into the site from an area west of the western site boundary.
The stormwater runoff within the site is now routed into a degraded agricultural tile system into eroded, degraded and dredged channels which convey water to the outlet locations.

The goals of the stormwater plan for the site are as follows:

1. Meet or exceed requirements for volume and release rate management of stormwater.
2. Exceed the volume management requirements by greatly reducing the volume of stormwater running off the land.
3. Enhance the quality of stormwater leaving the property by reducing phosphorus, sediments, fertilizers, and other materials associated with agricultural uses, and future developed land uses.
4. Use natural systems rather than engineered systems to manage stormwater.
5. Integrate the stormwater system plan with habitat passive recreational open space, etc.

The Stormwater Treatment Train

Stormwater will be managed in the restored landscapes. Localizing restored forests, swales, prairies and wetlands and routing water through these creates a "Stormwater Treatment Train" (STT) where each ecological zone provides specific function for management of the stormwater. Attachment 3 provides a publication we prepared for a similar project and the defines the benefits of the STT approach for stormwater management. Attachment 3 also provides a graphic depiction of the STT design for Elwell farm.



Water Quality Benefits of STT

The contaminants which the Elwell Farms Development stormwater management system is designed to treat include nitrogen, phosphorous, BOD, suspended solids, and some heavy metals.

Nitrogen treatment requires the chemical conversion of organic nitrogen to nitrogen gas using bacteria. The process first converts organic nitrogen to ammonia, then ammonia to nitrite, then nitrate, and finally nitrate to nitrogen gas. Conversion of organic nitrogen to nitrate requires both photosynthetic bacteria and oxygen. In a wetland system, these requirements are supplied in shallow wetlands through which light can penetrate and oxygen can diffuse. The conversion of nitrate to nitrogen gas requires an absence of oxygen since the bacteria responsible for this conversion reduce nitrogen as part of their respiration activity and cannot compete with bacteria using oxygen for respiration. The anaerobic requirement is met in deeper wetlands which do not allow light penetration (suitable for oxygen producing photosynthetic bacteria) or diffusion of oxygen to the wetland sediments.

Since phosphorous is a chemically conservative material, phosphorous removal from stormwater primarily involves a physical process which sorbs phosphates onto either organic materials in the sediment or clay particles in the sediment. Since many of the constituents onto which phosphorous is sorbed become soluble in anaerobic conditions, the highly organic and well aerated prairie buffers are ideally suited to capture phosphorous.

BOD removal is accomplished in both the aerobic prairie soils and the shallow wetland areas, both of which have oxygen available to allow bacterial oxidation of the oxygen demanding substances in the stormwater runoff.

Suspended solid removal is accomplished with a sedimentation process. Effective sedimentation systems provide lengthy travel paths for sediments to settle out of the stormwater runoff. The most efficient basin operates under plug flow (rather than perfect mix) conditions and move runoff through the system with very slow velocities to prevent mixing. Sediment settling velocities are a function of particle mass, shape and surface area ratios. Larger sediment materials including gravels and sands are easily settled due to higher mass/surface area ratios. These larger materials account for much of the suspended material in stormwater runoff. Silts and clays require extended times for settlement and are most effectively settled in shallower depth basins (with less time required for the sediment particle to reach the basin bottom) such as shallow wetlands with extensive vegetation.

The stormwater management system in the Elwell Farms Development is designed to reduce the volume of stormwater runoff by infiltrating precipitation into the ground; reduce the rate of stormwater runoff by using restricted stormwater release structures at the stormwater outlets; disperse the runoff by providing stormwater management in many areas throughout the development; and enhance the stormwater runoff quality using an integrated multi-element treatment system. The treatment system will include grassed swales, prairies, and wetlands to manage the stormwater runoff.

Conceptual modeling was made for two of the proposed developed blocks in the south central part of the project (Attachment 4) to demonstrate the effectiveness of the proposed STT method of stormwater management. These models document the expected performance of the STT in Elwell Farms for a 2-year design storm condition. The treatment analysis model results can be summarized by stating that:

1. Phosphorus levels will be reduced in developed area runoff by between 30 and 60 percent through the utilization of the prairie buffers located between the lots and the wetland in the stormwater management areas and through the use of prairie vegetation in the drainage swales. Phosphorous will be additionally reduced from existing conditions by the elimination of agricultural land uses.
2. Nitrogen levels will be reduced to wetland background concentrations of 1.5 mg/l.
3. Essentially all sediment particles (silt sized or larger) will be removed and there will be partial removal of the clay materials.
4. BOD will be removed to background concentrations of approximately 1.0 mg/l.

Based on this assessment it is expected that the site project stormwater management plan will exceed all requirements of existing and anticipated future regulations.

Stormwater Volume and Release Rates Management

The analysis done for the two concept areas showed that stormwater volume would be reduced for the 2, 10, and 100-year design storms through the use of natural vegetation and larger sized residential lots from the volumes presently generated by the agricultural land uses. Additionally restricted stormwater release rates will be implemented by storing stormwater for the larger storms in the stormwater management areas. A storage depth of 1.0 feet for the 10-year design storm and up to 2.0 feet for the 100-year design storm were used in the conceptual analysis.

For the two conceptual areas, the volume and rates of runoff was reduced for the 2, 10, and 100-year design storms as shown in the following table.

| | Concept Area #1 | Concept Area #2 |
|---|---|---|
| Tributary Area (Acres) | 13.9 Acres | 19.6 Acres |
| Cn Existing | 71 | 71 |
| Cn Proposed | 66.7 | 65.7 |
| 2-Year Design Storm (2.65 inches) | | |
| % Runoff Volume Reduction | 28% | 36% |
| % Peak Release Rate Reduction | 95% | 95% |
| 10- Year Design Storm (3.8 inches) | | |
| % Runoff Volume Reduction | 25% | 26% |
| % Peak Release Rate Reduction | 94% | 92% |
| 100-Year Design Storm (6.0 inches) | | |
| % Runoff Volume Reduction | 14% | 18% |
| % Peak Release Rate Reduction | 86% | 86% |

Landscaping

All open space at Elwell Farm will emphasize native landscaping using the same native species used in natural area restorations.

Lawns and ornamental landscapes are envisioned to be a necessity in yards, some parkways, and other areas.

The project team will encourage use of native landscaping in as large an area of the development as possible even in yards to reduce mowing, irrigation, fertilizer and other contaminant loads generated by the development.

Marketing informational packages will be prepared to introduce buyers to native landscaping (please see Attachment 5 USEPA native landscaping handbook) and this will be useful along with color photographs to educate would be buyers (Attachment 6 Applied Ecological Services, Inc./Taylor Creek Restoration Nurseries photograph booklet).

The development team is committed to demonstrating native landscaping at model homes and training project marketing and sales staff so they can encourage it's use in the project.

Tree Preservation

Because of the focus of this project on protection and restoration of ecological resources, tree preservation, or rather the forests to which they contribute are of prime importance in the site plan (please see Attachment 7, tree/forest preservation plan). Of the 51-acres of forest present, we anticipate 48-acres will be protected and restored. Some lower quality wooded areas that exist in the property will also be restored by conversion of the existing poor conditions and trees to forests with higher quality trees and ground cover vegetation. This conversion will occur over several acres.

In addition to reduce the (squared off edges) of forests resulting from clearing for past agricultured land uses, several acres of reforestation will occur in this project.

Because of the layout of natural resources, including constraints of existing and restorable future wetlands, steep slopes, poor soils, and the design for water quality improvements that uses native landscapes, and setback and right-of-way requirements. Some impacts to forests will occur on four lots of 150, in the development. Attachment 7 includes detail drawings of these lots where tree impacts are unavoidable. If building set backs and right-of-ways widths could be reduced, then less impacts to trees in these four lots and the adjacent road right-of-way would occur. The detail shows detailed tree surveys with tree size and species, and the specific trees that will with high probability be impacted in the building envelope zones. The number of trees impacted varies from 7-16 in three of the lots, and in another lot because of the anticipated road right-of-way impacts, up to 40 trees will be impacted.

When the development is field staked we are committed to exploring creative ways to further reduce tree and forest impacts as possible.

## DESCRIPTION OF PHASING PLAN FOR RESTORATION OF ELWELL FARM (AES 00-022)

### Introduction

The following document is the projected plan for implementation of the remedial phase of the ecological restoration program at Elwell farm. By necessicity, restoration and developmetn phasing are linked. The phasing plan has the following goals:

1. Implement restoration remedial tasks as soon as practical in areas that would nto be reworked or modified by future development activities.
2. Immediately implement a land banking strategy by conversion of large agricultural fields that would not be developed for several years time, to a broadleaf perrenial crop system. This is proposed to control the agronomic weeds now present on the site and prepare the soils for future restoration plantings.
3. Implement visual buffer plantings along highway 101 to coincide with redevelopment of the right of way.
4. Provide key trail links even in a temporary form so that early residents in the development can for example visit the pond, and other features in the property.

5 . Provide flexiblity in the plan to be able to accelerate or slow the pace depending on the response of the ecological systems to restoration and management treatments, and as necessitated by market demands for build-out of this project. For this reason, instead of annual phasing, phasing is lumped in 2 year increments of time. This is also done because some tasks will occur in the winter, and others in the growing seaon.

6. To implement the program in logical, manageable blocks sized, oriented, and positioned for access and to best ensure achievement of the results in the specifications.

The following descibed the intent and assumptions leading to the annual phasing program during the Remedial phase of the two phase restoration progam.

**REMEDIAL PHASE OF RESTORATION**

This program is designed to accomplish all remedial restoration tasks within a period of 6 years. This period can be lenghtened or reduced, depending on ecological system response and development phasing needs. After the Remedial work (e.g. plantings, brushing,etc) occurs, maintenance phase tasks (e.g. prescribed burning, weed control, mowing, etc) begin. So, it is important to realize that maintenance work will occur simultaneuously initially in the areas treated during the remedial phase work. The maintenance tasks will begin to cover a larger area, ultimately, they will be implemented over the entire site on a rotation of 1-3 years time. Annually, the maintenance phase tasks and management units, will be determined by the project ecologist. Thisis customized to effect the greatest restoration success throughout the site.

**YEARS 1-2:**

<u>Land banked agricultural lands for weed control and site preparation for future restoration plantings</u>

During Year 1, all highlighted to be land-banked past agricutural lands will be farmed with Sorghum sudan grass which is an annual grass. Before planting this grass, all exisitng vegetation on the sidtes will be herbicided at least twice with Roundup. This will target the reduction of the nonnative grasses, thistles, and other undesirable plants present.

Sorghum sudan grass plantings will be hayed or green silage harvested, depending on the forage needs of the farmers invovled in the lease of the land.

Broadleaf herbicide will be sprayed at least twice during he growth of the sorghum sudan grass, to further control the stinging nettle and thistles on this site.

After harvesting of sorghum sudan grass by august 2001, a cover crop of oats, barley, winter rye, or wheat and undercrop of alfalfa or other desirable brodleaf will be no-till drilled into the sudan stubble.

The following spring, after harvest of the cover crop, at least twice, grass specific herbicide will be used to continue eridication of reed canary grass, european brome grass, and quack grass in these locations.

Harvesting of alfalfa hay will continue until the agricultural fields are to be phased into restoraiton or development. At that time, the alfalfa fields will be herbicided with roundup, to kill both the alfalfa, and any other perrenial weeds present.

This will happen in areas to be developed, and areas to be restored.

Areas to be restored

*Former agricultural lands*

Site preparation of all former agricultural lands that are to be restored will follow part of the same process as in the land banked agricultural lands. These areas will all be herbicided with two applications to kill exisitng grasses and broadleaf weeds present. Thistle patches will be treated first with a proven herbicide that will kill this group of plants.

This herbicide treatment work will occur before any grading occurs.

Exvacation to create and restore wetlands, will occur next. Wetland hydric soils will be stockpiled (see specification) for later respread. Upland topsoils also will be stockpiled for later respread. Grading will occur followed by topsoil respread, soil preparation for planting, then at least cover crop plantings will be done. If the seasonality and available moisture is appropriate, native species seedings and plantings will be undertaken immediately. If it's the wrong season for planting or droughty, cover crops will beplanted to stablize soils, and at the next appropraite date, native seedings and plantings will occur by no-till drilling seeds through the cover crop vegetation. Any plantings will then occur.

In agricultural locations that are to be restored to wetland and prairies, farm drain tiles will be disabled during the excavation grading process.

Prairie plantings and wetland plantings will occur in most of the former agricutural areas to be restored in years 1-2.

*Stream courses, drainageways, and forest areas:*

*Brush removal will commence immediately along the drainageways and cut brush will be removed to central locations where it will be chipped for later use along trails. Excavation of spoil piles along some locations of the upland adjacent to the drainage way followed by seeding of the exposed banks will also occur immediately.*

*During excavation, swales will be cut and after topsoiling, will be treated as above under the agrcultural lands description.*

*Restoration is proposed in a representative area of the forest system. Brushing and seeding is the antcitipated task, along with some noxious weed control by hand pulling, and hand herbicide treatment.*

**YEARS 3-4:**

Following the same methodology as above, and detailed in the project specifications, additional agricultural, drainage areas, wetlands, and forested areas will be restored during years 3-4. The focus will be in locations associated with Phase 2 of the development phasing in the south and north end of the development.

Reforestation zones will continue in years 3-4 in association with preparation of the six lots that enter the forest. Salvage and transplanting of trees, saplings, and seedlings will occur during these years to establish the reforesation plantings

**YEARS 5-6:**

The large remaining blocks of forest and areas to be planted to prairie and wetland will be restored during this period of time.