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RESTORATION AND MAINTENANCE PLAN FOR PETTIBONE CREEK RAVINE NS GREAT LAKES IL

7/1/2000

ENVIRONMENTAL QUALITY MANAGEMENT, INC.

482

RESTORATION AND MAINTENANCE PLAN FOR PETTIBONE CREEK RAVINE NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

Prepared for:

ACOS Installation & Environment
Environmental Dept. (Code N457C)
201 Decatur Ave.
Great Lakes Naval Training Center
Great Lakes, Illinois 60088-5600

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July 2000

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EXECUTIVE SUMMARY

Environmental Quality Management, Inc., conducted an analysis of substrate stability, natural vegetation, and invasive plant species for Pettibone Creek Ravine, a forested ravine located within the boundaries of the Naval Training Center (NTC), Great Lakes, Illinois. The ravine's substrate exhibits various stages of instability, and a variety of invasive plant species are visibly impacting the ravine's natural flora.

This report provides the Department of Navy with a comprehensive master plan that identifies, describes, and prioritizes restoration and maintenance activities based on the ravine's current conditions. This report provides recommendations for restoring and maintaining the natural integrity of Pettibone Creek Ravine as it relates to the natural vegetation and invasive plant species. The analysis and recommendations for substrate instability are provided as Attachment 1. The recommendations in reference to the natural vegetation and invasive plant species in procedural order are as follows:

- Develop a Policy Statement as part of a Master Control Plan for invasive species for the entire NTC, Great Lakes, Illinois. Such a comprehensive plan will set standards for targeted species base-wide and standardize control and maintenance procedures.

- Use girdling to eliminate saplings of boxelder and sugar maple (8 inches or less in diameter). Girdling is a method used to kill the tree by severing or damaging the cambium layer by using a hatchet or special tool to cut through these layers.

- Aggressively plant/seed graminoid (grass-like) species throughout.

- Eliminate garlic mustard by a low-intensity control burn during the early spring over several years until the seed bank is exhausted. For those areas immediately adjacent to the access road, cutting and removing flowering stems of second-year plants at or near ground level is an acceptable alternative.

- Cut stems and paint remaining stumps of both bush honeysuckle and multiflora rose with a 20 percent solution of glyphosate.

- Ensure maintenance includes monitoring the results of all recommended actions on a yearly basis. Each of the above species can be expected to revegetate the area if monitoring and spot removal are not accomplished. Establishing permanent plots in those areas where active management occurs for quantitative comparisons is highly recommended.

SECTION 1

INTRODUCTION

Environmental Quality Management, Inc. (EQM) was contracted by the Department of Navy (BPA N68950-99-A-5590) to develop a restoration and maintenance plan for Pettibone Creek Ravine. Pettibone Creek Ravine is located on the Main Side of the Naval Training center (NTC), Great Lakes, between Sheridan Road and the western shoreline of Lake Michigan. The Creek originates in North Chicago and enters the main branch of Pettibone Ravine at the northwest corner of NTC Great Lakes, meandering through Main Side and terminating into Lake Michigan. The depth of the ravine ranges from approximately 50 to 100 feet with 30- to 70-degree slopes.

Slope and bluff substrates are in various stages of instability due in part to uncontrolled storm run-off and improper repair and maintenance techniques. This combined with additional man-made disturbances has allowed invasive plants to dominate much of the landscape. The natural integrity of Pettibone Ravine continues to be severely compromised. NTC Great Lakes is dedicated to restoring and ultimately maintaining the natural integrity of Pettibone Creek's Ravine.

A reconnaissance survey was conducted on May 2 and 3, 2000. Mr. Landon McKinney conducted the survey for natural vegetation and invasive plant species. Mr. Steve Nicosin conducted the survey for substrate instability. The opinions, observations, and recommendations rendered in this report are based solely on a site visit, literature review, and consultation with state and local officials. The analysis and recommendations for substrate instability are provided as a separate attachment (Attachment 1).

SECTION 2

METHODS

2.1 General

Prior to conducting a field survey of Pettibone Creek ravine, all appropriate and available maps and reports were studied. Additionally, Keith M. Shank, Program Manager for the Endangered Species Consultation Program, Illinois Department of Natural Resources, was contacted to obtain existing records of federal- or state-listed species known to occur within Pettibone Creek Ravine or in the immediate vicinity. The result of this communication is included in Appendix A.

Ken Click and Jim Anderson with the Lake County Forest Preserve District and Steve Christy with the Lake County Forest lands Trust were contacted as a matter of courtesy and for additional information on restoration activities in the county. Steven M. Byers, a field representative for the Illinois Nature Preserves Commission, was contacted for information regarding current restoration efforts in forested ravines along Lake Michigan. Additionally, Mr. Byers provided recommended guidelines from the State of Illinois on the control and/or eradication of invasive species. Each of these individuals has offered to provide additional comments and consults at any time. Their names, addresses, and phone numbers are provided in Appendix B.

2.2 Vegetation Analysis

A field analysis of invasive and native vegetation was conducted on May 2 and 3, 2000. The entire ravine was surveyed. The dominant flora was noted as well as the condition of the substrate and man-made disturbances. Particular attention was given to both invasive and non-invasive non-native species. Representative photos taken are provided in Appendix C.

SECTION 3

STUDY AREA

The study area (Lake County, Illinois) lies within the Wheaton Morainal country of the Eastern Lake Section of the Central Lowland physiographic province (Lobeck 1950, Paschke and Alexander 1970). Lying along the shore of Lake Michigan, the study area is located in the Upper Illinois River Basin just outside of the Chicago River Drainage Basin (Arnold 1999). Although most of the county drains into the Des Plaines River, the study area drains into Lake Michigan. The gently rolling topography is the result of glaciation with typically less than 300 feet of relief (Arnold 1999). Glacial moraines are the most prominent topographic features, and unconsolidated glacial (Quaternary) deposits cover much of the study area (Arnold 1999).

The soils associated with the study area include the following series based on the Soil Survey for Lake County (Paschke and Alexander 1970).

- Hennepin loam, 30 to 60 percent slopes (25G) – Occurs on bluffs along Lake Michigan and steep ravines such as Pettibone that extend back into the uplands. Hennepin loam consists of steep to very steep well-drained soils and occurs on the lower, middle, and upper slopes of Pettibone Ravine.

- Beach Sand (367) – Consists of sand and water-rounded stones as part of the stream base at and just above the junction of Pettibone Creek and Lake Michigan.

- Morley silt loam, 2 to 4 percent slopes (194B) – Occurs at the top of morainic ridges. Morley silt loam consists of deep, steep to gently sloping well-drained to moderately well-drained soils. It occurs on the northern section of the upper slope of Pettibone Ravine just west of the Ravine's junction with Lake Michigan.

Although it is part of the Beech-Maple forest region as described by Braun (1950), American beech (*Fagus grandifolia)* is largely absent from portions of northeastern Illinois including the study area and is replaced by American basswood (*Tilia americana)* (Braun 1950). The Maple-Basswood Association covers portions of southeastern Minnesota, southern Wisconsin, and extreme northern Illinois. Generally,

sugar maple (*Acer saccharum)* and American basswood dominate the canopy of these forests with northern red oak (*Quercus rubra)* and sometimes white oak (*Quercus alba*) occurring as common subordinants (Vankat 1979).

SECTION 4

RESULTS

4.1 Native Vegetation

Pettibone Creek Ravine is an example of the ravine bluff ecosystem as described in the "Biodiversity Recovery Plan" (Chicago Wilderness 1999). This ecosystem may be subdivided into an eroding bluff system and a ravine system, both of which are considered unique plant communities (Byers 1991). The best remaining examples of this ecosystem in Illinois occur south of the NTC, Great Lakes, at Fort Sheridan. There, Jane's Ravine, as part of the McCormick Nature Preserve owned by the city of Lake Forest, is considered the best remaining example of the ravine system community type. Pettibone Creek Ravine is an example of the ravine system.

Canopy dominants include sugar maple and cottonwood (*Populus deltoides*). Based on a literature review, basswood's dominance in the canopy layer was expected. Upon field investigations, however, this was not evident. Northern red oak, American elm (*Ulmus americana*), and boxelder (*Acer negundo*) are significant subordinants. Sugar maple and boxelder dominate the subcanopy.

The shrub layer is dominated by saplings of boxelder, sugar maple, black cherry (*Prunus serotina*), and American elm, as well as dogwood (*Cornus florida*), bush honeysuckle (*Lonicera tatarica*), multiflora rose (*Rosa multiflora*), and eastern black current (*Ribes americanum*). Dominance in the herbaceous layer varies from place to place. Dominant species include garlic mustard (*Alliaria petiolata*), bedstraw (*Galium aparine*), wild leek (*Allium tricoccum*), trout lilies (*Erythronium albidum* and *americanum*), wild onion (*Allium* sp.), hispid buttercup (*Ranunculus hispidus*), and false Solomon's seal (*Smilacina racemosa*).

Boxelder and, to a lesser extent, sugar maple were quite abundant in the sapling or subcanopy layer, often shading out more desirable herbaceous species as well as more desirable but slower growing woody species. Both have reached undesirable

levels in many areas throughout the ravine. Thickets of small saplings, especially boxelder, occur in several places.

4.2 Invasive Species

The escape and naturalization of invasive plants is becoming increasingly problematic. Although many species are considered weeds, those that are able to move into and dominate an otherwise natural community are considered invasive. Invasive species are generally considered non-native species although other terms are frequently used including non-indigenous, alien, exotic, adventive, or naturalized (The Nature Conservancy 1998).

The introduction of an invasive species into a natural community may result in the following:

- Altering of ecosystem processes such as sedimentation and nutrient cycling such that native more-desirable species may not persist.
- Outcompeting native species for habitat and niche requirements.
- Prevention or depressing the recruitment or regeneration of native species.

In Illinois, approximately 29 percent of the state's flora are naturalized from foreign countries. Luckily, not all are considered problems. However, several species such as multiflora rose, bush honeysuckle, Japanese honeysuckle (*Lonicera japonica*), purple loosestrife (*Lythrum salicaria*), crown vetch (*Coronilla varia*), and Johnson grass (*Sorghum halepense*) are causing farmers, foresters, land managers, grounds keepers, and natural area stewards considerable problems throughout much of the state (Harty 1997).

Illinois is a leader in developing exotic weed legislation. In 1988, Illinois passed the "Illinois Exotic Weed Act." Through this legislation and the determination of the Illinois Department of Conservation, the usage of exotic plants for erosion control, wildlife food, landscaping, forage improvement, and wood and fiber production has been dramatically reduced (Harty 1997).

An abundance of resources is available for the control and management of invasive species. Methods for controlling the invasive species impacting the study area have been largely derived from several noteworthy references that provide the latest and most applicable information on the identification, control, and management of invasive species. These references include:

- *Vegetation Management Guidelines for Illinois Nature Preserves* (Illinois Nature Preserves Commission 1990).
- *Element Stewardship Abstracts* (The Nature Conservancy 1998).
- *Tennessee Exotic Plant Management Manual* (Tennessee Exotic Pest Plant Council and Great Smoky Mountains National Park 1997).

Additionally, several restoration efforts of similar scope are occurring in the immediate vicinity of NTC Great Lakes. Several knowledgeable people associated with these projects have offered their professional opinions during the course of this effort, and all have agreed to further consultation with officials of the Environmental Department, NTC Great Lakes. A list of these knowledgeable people is provided in Appendix B.

A number of invasive species occur within the boundaries of Pettibone Creek Ravine. Garlic mustard, bedstraw, multiflora rose, bush honeysuckle, teasel (*Dipsacus sylvestris*), and burdock (*Arctium minus*) are the most obvious non-native species, and each of these can, at times, be invasive. However, garlic mustard is the only species that severely threatens the natural integrity of the ravine. Bush honeysuckle and multiflora rose occur in low numbers of scattered individuals and certainly have the ability to become more invasive over time. Throughout their North American distribution, these species often competitively eliminate native species from the landscape.

Garlic mustard occurs throughout most of the ravine, although levels of concentration vary from place to place. The heaviest concentration is along the west- and south-facing slopes. These slopes are generally less steep and yield a greater diversity of herbaceous plants than the north- and east-facing slopes. Additionally, the condition of the west- and south-facing slopes was influenced by the dumping of

concrete debris during much of the base's earlier history. The south- and west-facing slopes exhibit an abundance of both first- and second-year plants. The north- and east-facing slopes essentially lack the abundance and diversity of herbaceous vegetation as compared to the south- and west-facing slopes. Although many of the same species do occur, they do so with far less frequency. From some distance, garlic mustard seems far less apparent except along the upper edges of these slopes. Upon closer examination, however, much of these north- and east-facing slopes are dominated by thousands of first-year seedlings. Multiflora rose and bush honeysuckle occur sporadically throughout the ravine, but are most often found on the south- and west-facing slopes.

The following treatments provide a synopsis of the description, natural history, and distribution of garlic mustard, bush honeysuckle, and multiflora rose. Additionally, management options are discussed in some detail.

4.3 Garlic Mustard [*Alliaria petiolata* (Bieb.) Cavara & Grande]

4.3.1 Description, Natural History, and Distribution

Garlic mustard is so named because of the garlic-like odor emitted after crushing or cutting any part of the plant. This herbaceous species can reach heights of over 3 feet. Its leaves are sharply toothed, triangular, and alternate. It flowers in May and June bearing numerous small flowers in a terminal and sometimes axillary raceme. Small black seeds are produced in long narrow capsules called siliques. Young plants overwinter as basal rosettes.

Garlic mustard is native to Europe but also occurs in northern Africa and India. In North America, it occurs from Quebec and Ontario south to Kentucky and North Carolina and west to Kansas. It is abundant and widespread throughout much of northern Illinois.

Garlic mustard typically occurs in shaded, disturbed woodlands. Seeds disperse in August and lie dormant approximately 20 months until germinating the second spring after ripening. An individual plant can produce up to 900+ seeds.

4.3.2 Management Options

As with bush honeysuckles, garlic mustard can be controlled by several different methods including prescribed burning, cutting, pulling, and chemical treatments. Some attempt is being made to find an adequate biological control option. Ongoing studies are occurring in Europe where garlic mustard is native. These studies are being conducted to identify insect species that are monophagous on garlic mustard. Although initial results have been promising, additional studies on the biology and phenology of potential biological control agents will be necessary before any agent is introduced into North America (Hinz 1998).

Prescribed burning of moderate to high intensity in fire-adapted communities can successfully control garlic mustard. Burns in the fall or early spring are recommended. Since ripened seeds lie dormant for approximately 20 months, several yearly burns are necessary to eliminate plants produced from the seed bank.

Cutting flowering stems at ground level can produce a 99 percent rate of mortality. Resprouting rarely occurs. Because viable seeds can be produced after stems are cut, cuttings should be removed from a site. Cutting is recommended for medium to large populations. Hand pulling while minimizing soil disturbance is recommended for small populations and individual plants.

Spot application of a 2 percent solution of glyphosate to the foliage of individual plants can be effective. This should be done in the spring or fall when most native vegetation is dormant. Glyphosate is a nonselective herbicide which kills all vegetation.

4.4 Bush Honeysuckles (*Lonicera tatarica* L.)

4.4.1 Description, Natural History, and Distribution

The most problematic bush honeysuckles in Illinois include tartarian (*L. tatarica* L.), Morrow's (*L. morrowii* Gray), amur (*L. maackii* (Rupr.) Maxim.), and belle (*L. x bella* Zakel). The latter is considered a hybrid between tartarian and Morrow's. Tartarian is the most abundant bush honeysuckle in the ravine.

These invasive shrubs grow up to heights of over 15 feet. They are deciduous with opposite entire leaves. Tartarian honeysuckle flowers in May and June; its flowers

are white to pink and its fruits are red. Flowers and fruits are borne in pairs in the leaf axils.

Tartarian honeysuckle is a Eurasian native imported for use as ornamentals and to improve wildlife habitat and now occurs throughout much of the eastern United States. In Illinois, the prime area of distribution centers around the Chicago area.

Bush honeysuckles have a broad tolerance and adapt readily to a wide variety of environmental parameters. They can impact both forested and open communities as well as wetlands. Some form of habitat disturbance is generally considered to be the key to the introduction of these species.

Avian seed dispersal provides a major mechanism for the spread of these invasive plants. Seedlings can tolerate moderate amounts of shade. Bush honeysuckles leaf out earlier and hold their foliage longer than many more-desirable native species and easily outcompete for habitat and niche. Additionally, they are suspected of limiting competition by allelopathy, a process of releasing chemicals into the soil that inhibit the growth of competitive species.

4.4.2 Management Options

A variety of measures are recommended for controlling bush honeysuckles. They include prescribed burning, hand pulling of seedlings, cutting, and chemical treatments.

Prescribed burning is recommended in fire-tolerant communities. Burning in the spring will kill seedlings and the tops of mature plants. Bush honeysuckles readily resprout, and several annual burns may be necessary for complete control.

Grubbing and/or pulling while providing an element of control can easily disturb the soil allowing for further introduction of it or other invasive species. If roots are not removed completely or if stems are cut without some form of chemical treatment, regeneration is inevitable.

Chemical control typically involves either a foliar treatment or treatment of the freshly cut stumps with a recommended herbicide. Either method when properly followed can yield up to a 90 percent rate of success. Foliar application is recommended for large thickets where risk to non-target species is minimal. The cut

stump method is recommended for individual bushes or in areas where non-target species are abundant. A 2 percent solution of Glyphosate (Roundup) is recommended for foliar treatment since it is non-selective and will also kill non-target species. A 20 percent solution is recommended for stump treatment. A 2 percent solution of Triclopyr (Garlon 3-A) with water plus a 0.5 percent non-ionic surfactant is also recommended for foliar treatment. Triclopyr is a selective broadleaf herbicide and will not harm grass and grass-like species.

Chemical control can also be administered by ejection. The EZJect Lance is a metal tube over 5 feet long fitted with premade plugs of herbicides encased in brass capsules. The lance is pushed against the target tree or shrub and the capsule is driven into the trunk.

4.5 Multiflora Rose (*Rosa multiflora* Thunb.)

4.5.1 Description, Natural History, and Distribution

Multiflora rose is a medium-height thorny shrub. Stems (canes) initially grow erect but quickly arch over, giving this invasive species its spreading habit. Leaves are alternate and further divided into 5 to 11 ovate serrate leaflets. Clusters of small white flowers appear in late spring. The small and firm red fruit may remain on the plant throughout the summer and well into the winter months. Multiflora rose spreads vegetatively from shallow roots or by layering when the tips of the arching canes touch the ground and form roots. Avian dispersal can rapidly spread the seeds.

This species was introduced from east Asia for wildlife food and cover, living fence rows, and windbreaks. It is well distributed throughout much of the United States except for the Rocky Mountains, southeastern coastal plain, and deserts of California and Nevada.

While growing best in deep fertile well-drained soils, multiflora rose easily adapts to a wide variety of environmental parameters. It can form inpenetrable thickets.

4.5.2 Management Options

Several options exist depending on individual circumstances. Mowing, cutting, or otherwise manually removing as much of the plant as possible may be used for small populations or in areas where chemical treatment is not an option. However, these methods often only limit the spread or contain this invasive species rather than eradicate it. Prescribed burning may be useful in fire-adapted communities.

Biological control such as the European Rose chalid, a phytophagous wasp, shows some promise but is still largely under study. Another possible biocontrol agent, the rose rosette disease, is not yet being considered due to the susceptibility of all roses to this disease.

Chemical treatment by either a foliar or cut-stump method is frequently recommended. Foliar spraying may be used in large thickets where impact to non-target species is minimal. Either a 2 percent solution of Glyphosate (Roundup) or a 2 percent solution of Fosamine (Krenite) with a 0.5 percent solution of a non-ionic surfactant works well. Of the two, however, Fosamine is preferred because of its selective non-volatile qualities. It will only kill woody species.

The cut-stump method is also effective and is especially useful where multiflora rose occurs with non-target species, making foliar treatment impractical. The stems are cut back to ground level in the late summer or even during dormancy. A 10 to 25 percent solution of Glyphosate or Triclopyr is applied to the stumps.

SECTION 5

RECOMMENDATIONS

5.1 Restoring Natural Vegetation

Pettibone Creek Ravine is in immediate need of active management to restore viable populations of native species. Although many desirable native species continue to exist, their numbers, in many instances, are decreasing rapidly. Opening up the canopy will allow the herbaceous layer to spread to desirable levels and ultimately assist in correcting the substrate stability problems. In most instances, the canopy is closing due to rapid growth of less-desirable woody pioneering species that include box elder and, to a lesser extent, sugar maple. Eliminating saplings of these two species 8 inches or less in diameter is recommended throughout the entire ravine. This may be accomplished by girdling. Girdling is a method used to kill the tree by severing or damaging the cambium layer by using a hatchet or special tool to cut through these layers. This action will provide the needed sunlight to the forest floor and generate additional growth of the herbaceous layer. Additionally, graminoids (grasses and grass-like plants) are noticeably absent throughout much of the ravine. Opening up the canopy should coincide with an aggressive program of planting and/or seeding native graminoid species such as bottlebrush grass (*Elymus hystrix)*, rice grass (*Oryzopsis racemosa)*, long-awned wood grass (*Brachyelytrum erectum)*, panic grasses (*Panicum* sp.), native bromes (*Bromus* sp.) and bluegrasses (*Poa* sp.), and a variety of woodland sedges (*Carex* sp.).

5.2 Controlling Invasive Plants

The following recommendations are based on the most current and acceptable practices available to land managers and stewards. Although several control methods typically are approved for each species, the choice is ultimately made based on best

professional judgement after careful analysis of existing conditions which include but may not necessarily be limited to the following characteristics:

- Degree and stability of slope
- Population dynamics and spatial distribution of invasive species
- Population dynamics and spatial distribution of desirable species
- Fire tolerance level of community

In addition to the following recommendations, the development of a "Master Control Plan for Alien Plant Species" is highly recommended. Such a plan would establish guidelines for inventory, control, monitoring, and any other management action deemed necessary as related to alien and, in particular, invasive plants. The NTC, Great Lakes, and its associated facilities cover a large area and although few natural communities occur within its boundaries, the native more-desirable plants occurring in them will continue to lose habitat and niche to the more invasive alien plants. Developing guidelines and establishing a zero tolerance for invasive plants for the entire base will allow for immediate and ongoing control and monitoring. This will inevitably enhance and/or restore the natural integrity of Pettibone Creek Ravine and all other remaining pockets of natural communities.

The recommended and preferred action for removing garlic mustard is by a low-intensity prescribed burn during the early spring for several successive years until garlic mustard's seed bank is exhausted. Fire effectively kills young seedlings, but has little or no effect on the second-year plants. Prescribed burning especially along the mid to upper slopes will minimize further damage to the substrate by excessive pedestrian movement across these slopes. Cutting and removing the stems of second-year plants is an acceptable option in those areas immediately adjacent to the access road that winds through the ravine. As is the case with prescibed burning, flowering stems must be cut over several years because of the longevity of a viable seed bank. Chemical control is not recommended because most of the garlic mustard does not occur in pure stands and chemical control could adversely impact other more-desirable species.

Although bush honeysuckle and multiflora rose have not yet reached detrimental proportions, both species should be removed due to their invasive nature. The recommended action for each is a combination of cutting and chemical treatment.

Stems should be cut at or close to ground level and the exposed stumps painted with a 20 percent solution of glyphosate. This method can yield up to a 90 percent rate of success when administered properly. Several years may be needed to ensure a high rate of success due to seed germination and seedling growth. Pulling of seedlings is not recommended because of the disturbance factor to the substrate.

5.3 Monitoring Needs

Although qualitative observations for monitoring purposes is adequate, additional quantitative monitoring is suggested. Establishing permanent plots (1-meter-square quadrants) within those areas where active management will occur can quantify the success of opening up the canopy, providing supplemental planting and/or seeding, and eradicating invasive species. To be successful, these sampling plots should be placed prior to active management with baseline sampling accomplished before any corrective measures are undertaken. The numbers of each species would be counted per plot and compared with each successive sampling effort to quantify the success of all restoration efforts. Monitoring efforts should be conducted for a minimum of five years. All corrective measures should be repeated as necessary on a yearly basis.

SECTION 6

SUMMARY

The recommendations presented in this report and Attachment 1 are based on approved and professionally accepted methodologies for improving substrate stability, controlling invasive species, and restoring the natural integrity of impacted natural communities. Pettibone Creek Ravine exhibits a graded patchwork of conditions with some areas exhibiting obvious degradation and other areas exhibiting relatively natural conditions. If the guidelines presented are followed, the natural integrity of the entire ravine can be restored to a lesser or greater extent depending on the occurrence of any additional impacts. Additional impacts will be minimized if pedestrian traffic is restricted to the access road except for those individuals charged with the actual restoration efforts. A buffer zone of native vegetation, especially native shrubbery around the entire upper perimeter of the ravine, will reduce the likelihood of impacts from above and outside of the ravine.

Environmental Quality Management, Inc., developed this restoration and maintenance plan in a professional manner on the basis of sound professional judgement. Any additional impact to the ravine can potentially alter any progress made to restore the ravine's natural integrity.

SECTION 7

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APPENDIX A

CORRESPONDENCE

Illinois
Department of
Natural Resources

524 South Second Street • Springfield, Illinois 62701-1787

Code 00-01877

http://dnr.state.il.us

George H. Ryan, Governor • Brent Manning, Director

April 28, 2000

Mr. Landon McKinney, Botanist
Environmental Quality Management, Inc.
1310 Kemper Meadow Drive, Suite 100
Cincinnati, OH 45240

RE: **Great Lakes NTC Biological Survey, Lake County**
Endangered Species Consultation Program
Natural Heritage Database Review #00-01877

Dear Mr. McKinney:

Thank you for requesting information regarding this area in Sections 4 and 9, Township 44 North, Range 12 East. Several records of State-listed endangered or threatened plants exist for Pettibone Creek Ravine and its vicinity within the Great Lakes Naval Training Center. All the species whose records are listed below were last observed in August 1995.

Within the Ravine itself, two large colonies and scattered single plants of the State-listed threatened **Forked Aster**, *Aster furcatus*, have been observed downstream of the principal internal road crossing, between it and the Lake.

The point which forms the northern arm of the harbor contains three State-listed species: a three-meter wide colony and scattered bunches of the State-listed endangered **Marram (Beach) Grass**, *Ammophila breviligulata*; more than 100 plants of the State-listed endangered **Seaside Spurge**, *Chamaesyce polygonifolia*; and more than 200 plants of the State-listed threatened **Little Green Sedge**, *Carex viridula*.

All of these listed species, or others, may be found elsewhere within the Training Center. The Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of significant natural features in any specific location; our records cannot replace detailed site surveys. The Department is unable to exclude the possibility that listed species other than those mentioned exist in the vicinity.

Prior to authorizing, funding, or performing any action which alters environmental conditions, State agencies and units of local government are required to consult the Department of Natural Resources in accordance with the *Illinois Endangered Species Protection Act* [520 ILCS 10/11], the *Illinois Natural Areas Preservation Act* [525 ILCS 30/17], and Title 17 *Illinois*

Administrative Code Part 1075. This requirement does not apply to federal agencies or facilities. However, the Department is pleased to coordinate with the Department of the Navy regarding any State-listed species and efforts to conserve and protect them.

Should you need additional information regarding the consultation process, or should you have any questions, please do not hesitate to contact me.

Sincerely,

Keith M. Shank

Keith M. Shank, Program Manager
Endangered Species Consultation Program
Division of Natural Resource Review and Coordination
Ph. (217) 785-5500
Fax (217) 557-0728

cc: Brad Semel, IDNR/ORC/Natural Heritage

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Within the Ravine itself, two large colonies and scattered single plants of the State-listed threatened **Forked Aster**, *Aster furcatus*, have been observed downstream of the principal internal road crossing, between it and the Lake.

The point which forms the northern arm of the harbor contains three State-listed species: a three-meter wide colony and scattered bunches of the State-listed endangered **Marram (Beach) Grass**, *Ammophila breviligulata*; more than 100 plants of the State-listed endangered **Seaside Spurge**, *Chamaesyce polygonifolia*; and more than 200 plants of the State-listed threatened **Little Green Sedge**, *Carex viridula.*

All of these listed species, or others, may be found elsewhere within the Training Center. The Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of significant natural features in any specific location; our records cannot replace detailed site surveys. The Department is unable to exclude the possibility that listed species other than those mentioned exist in the vicinity.

Prior to authorizing, funding, or performing any action which alters environmental conditions, State agencies and units of local government are required to consult the Department of Natural Resources in accordance with the *Illinois Endangered Species Protection Act* [520 ILCS 10/11], the *Illinois Natural Areas Preservation Act* [525 ILCS 30/17], and Title 17 *Illinois*

Administrative Code Part 1075. This requirement does not apply to federal agencies or facilities. However, the Department is pleased to coordinate with the Department of the Navy regarding any State-listed species and efforts to conserve and protect them.

Should you need additional information regarding the consultation process, or should you have any questions, please do not hesitate to contact me.

Sincerely,

Keith M Shank

Keith M. Shank, Program Manager
Endangered Species Consultation Program
Division of Natural Resource Review and Coordination
Ph. (217) 785-5500
Fax (217) 557-0728

cc: Brad Semel, IDNR/ORC/Natural Heritage

APPENDIX B

CONTACTS

Contacts for Pettibone Creek Ravine:

Steven M. Byers
Field Representative
Illinois Nature Preserves Commission
914 S. River Road
McHenry, IL 60050
(815) 385-9074

Steve Christy
Lake Forest Land Trust
Lake Forest, IL 60045-1866
(847) 234-3880. ext. 13

Jim Anderson
Ken Klick
Lake Forest Preserve District
32492 North Almond Road
Grayslake, IL 60030
(847) 968-3282 -JA

(847) 968-3284 -KK

APPENDIX C

REPRESENTATIVE PHOTOGRAPHS

1. Garlic Mustard (2nd year plants)

2. Garlic Mustard (2nd year plants)

3. Garlic mustard (1st year plants)

4. Garlic mustard (1st year plants)

5. Bush Honeysuckle

6. Multiflora Rose

7. Examples of garlic mustard's abundance

8. Examples of garlic mustard's abundance

ATTACHMENT 1
ANALYSIS AND RECOMMENDATIONS
FOR SUBSTRATE INSTABILITY

PETTIBONE CREEK RAVINE SLOPE EVALUATIONS

GREAT LAKES NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

PREPARED FOR:

Environmental Quality Management, Inc.
1310 Kemper Meadow Drive
Cincinnati, Ohio 45240

PREPARED BY:

GZA GeoEnvironmental, Inc.
N4140 Duplainville Road
Pewaukee, Wisconsin 53072

June 26, 2000
GZA File No. 150434.00

GZA
GeoEnvironmental, Inc.

Engineers and Scientists

June 26, 2000
File No. 150434.00

Environmental Quality Management, Inc.
1310 Kemper Meadow Drive
Cincinnati, Ohio 45240

Attention: Mr. Landon McKinney

Subject: Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

N4140 Duplainville Road
Pewaukee
Wisconsin 53072
262-691-2662
FAX 262-691-9279
http://www.gza.net

Dear Mr. McKinney:

GZA GeoEnvironmental, Inc. (GZA) is pleased to present this letter report to Environmental Quality Management, Inc. (EQM) summarizing our evaluation of the slopes along the Pettibone Creek Ravine ("Ravine") at the Great Lakes Naval Training Center (GLNTC) in Great Lakes, Illinois ("Site").

INTRODUCTION

The purpose of GZA's services is to provide a preliminary understanding of current slope stability conditions within the Ravine and to develop conceptual recommendations for use in future, more detailed evaluations. Our evaluation was performed in conjunction with evaluations by EQM of slope vegetation. We understand our evaluation will be combined with EQM's report into a restoration and maintenance plan and presented to the Navy. Therefore, as you requested, our evaluation is presented in a format provided by EQM. Please note that this letter report is subject to the Limitations presented in Appendix A.

A Subsidiary of GZA GeoEnvironmental Technologies, Inc.

The Ravine is located on the Main Side of GLNTC between Sheridan Road and the western shoreline of Lake Michigan. Pettibone Creek originates in North Chicago and enters the main branch of the Ravine at the northwestern corner of GLNTC, meandering through Main Side and terminating at Lake Michigan. The depth of the Ravine ranges from approximately 50 to 100 feet with 30 to 70 degree slopes. The areas of interest are along a 1-mile section of the Ravine. Ravine slopes and bluffs are in various stages of instability.

METHOD

Prior to visiting the Site, GZA conducted a brief literature search to obtain available information on existing subsurface conditions in the general vicinity of the Site. To supplement this subsurface information, we reviewed a previous study[1] for the Site performed by others, which was provided to GZA by EQM.

[1] STS Consultants Ltd, 1988, "Comprehensive Slope Stability and Erosion Study for the Naval Training Center, Great Lakes, Illinois."

GZA accompanied EQM on a 1-day Site reconnaissance of the Ravine on May 3, 2000, to observe conditions at the top of slope, toe of slope, and on the face of the slopes. As requested by EQM, our evaluation along the Ravine extended from the overhead steamline at the western end of the Marina to the timber walkway trestle over the Ravine north of Farragut Avenue. As requested, our evaluation did not include the southward-trending ravine which branches off the Pettibone Creek Ravine near the Sampson Road bridge, nor the westward-trending ravine which branches off the Pettibone Creek Ravine near the Farragut Avenue bridge (with the exception of the north slope behind Building No. 76). Refer to the attached Site Plan (Figure No. 1) for Ravine alignment and Navy building designations.

During our visit, we also met with Messrs. Mark Schultz and Bob VanBendegom from the Navy's Environmental Department to discuss the Navy's concerns along the Ravine and our preliminary conclusions from our Site observations. Based on our Site meeting, particular concern was expressed by the Navy for slope stability in several locations along the Ravine. These include: the slope below Building No. 42; the slopes adjacent to the steamline, which parallels the Creek and crosses it at several locations; the slope below Building Nos. 142 and 143; and the slope below the parking area at Building No. 26. GZA observed conditions at these locations during our evaluations along the Ravine alignment.

In addition to areas which had clearly experienced a degree of instability, other factors which we used to summarize current slope conditions with respect to stability and to assist in categorizing the importance of each included: slope angle, slope erosion, the presence of cracks in the ground surface, presence of groundwater seepage from the slope, lack of vegetation, tilting of trees downslope, and proximity of adjacent structures.

STUDY AREA

Based on available information[2, 3, 4] the subsurface conditions at the Site consist of man-made fill underlain by glacial lacustrine deposits underlain by glacial till. The lacustrine deposits are of the Equality Formation and generally consist of sand, silt and clay. The glacial till is part of the Wadsworth Till Member of the Wedron Formation and generally consists of a silty clay till with lenses of silt and sand.

Based on our Site observations, the slopes generally appear somewhat higher and steeper on the south side of the Ravine. The Ravine slopes generally contain brush and trees up to about 3 feet in diameter. Concrete rubble and construction debris exists at numerous locations along the slopes and creek banks. A dirt access road parallels the creek along the north side for the entire length observed by GZA.

---

[2] Ibid.

[3] Jibson, Randall W., Odum, Jackson, K. and Staude, John-Mark, 1994, Rates and Process of Bluff Recession Along the Lake Michigan Shoreline in Illinois, International Association of Great Lakes Resources, Journal of Great Lakes Resoureces, 20(1): 135-152.

[4] United States Department of Agriculture Soil Conservation Service in Cooperation with Illinois Agricultural Experiment Station, 1970, Soil Survey in Lake County, Illinois.

RESULTS

Slope conditions along the Ravine were observed to vary considerably. In order to summarize the various slope conditions, our preliminary observations are presented in two general categories. Each category represents a different level of concern considering current slope instability, if any, and the potential impact any slope instability would have on adjacent structures. The term "structures," as used herein, includes buildings, utilities and parking area pavement. Each category is further subdivided into two subcategories. Table 1 (attached) presents a summary of slope locations, associated conditions and designated categories. Photographs of each location presented in Table 1 are included in Appendix B. The conditions associated with each category are as follows.

Category 1

Category 1A - Slopes where visible instability has occurred and is either impacting adjacent structures or has the potential to impact adjacent structures in the near future.

Category 1B - Slopes where visible instability has occurred and this instability may impact adjacent structures in the future if conditions are not monitored and eventually repaired.

Category 2

Category 2A - Slopes where no visible instability was observed during our Site visit. However, structures exist adjacent to the slope and any future instability which may develop could impact the structures. Also included in this category are current deteriorated conditions which, if not eventually repaired, could contribute to slope instability.

Category 2B - Slopes where visible instability has occurred, however, there are not structures adjacent to the slope.

Areas where visible instability was not observed, or other existing conditions have not deteriorated, and adjacent structures do not exist are not included in the above categories.

RECOMMENDATIONS

Our conceptual recommendations to address the Ravine slopes vary depending upon the relative level of concern of current conditions as indicated by the Category designation. In general, the areas included in Category 1 should be addressed first with investigations and repairs. Category 2 areas should be monitored and eventual repairs planned, as needed. We recommend the following level of effort and conceptual scope of services for areas included in Categories 1 and 2. Table 1 includes comments related to recommended actions for each slope location.

Category 1

Each Category area should be addressed by a detailed investigation of current conditions leading to the design of slope repairs. This may include performing subsurface explorations to characterize the soil, such as at failed areas (e.g. Location No. 3), or a survey of existing ground surface elevations and drainage patterns, such as at Location No. 7.

In areas of slope failure, such as Location No. 3, laboratory testing of soil samples obtained from the explorations would typically be required to obtain soil parameters for use in the design of slope repairs.

During design, various repair alternatives should be evaluated. The alternatives will vary depending upon the current surface and subsurface conditions, the type of failure, slope accessibility and cost. For example, several areas of observed instability are along the outside of a bend in the Creek where bank erosion is concentrated. This appears to be a contributing factor to the failure at Location No. 3. At these locations, bank erosion protection may include: appropriately-sized and placed stone riprap; gabion walls placed to a sufficient depth to preclude undermining during a flood; and steel sheet pile walls. Some form of permanent lateral support for the toe of slope may also be necessary. The method of providing this would normally be incorporated into the means of providing the creek bank erosion protection.

Where groundwater and surface runoff are a contributing factor in slope instability, design alternatives may include: interceptor trenches to lower groundwater levels and intercept seepage from exiting the slope face; video survey of existing utility pipes for damage and subsequent repair/replacement of the pipes to avoid the introduction of water into the slope subsurface; regrading above the slopes to direct surface runoff away from the slope and reduce slope erosion; and slope protection in the form of properly-sized stone and/or maintenance of vegetation. We understand residents periodically report trees falling on the slope at Location No. 14. Based on our observations, this slope appears to be stable at this time. Concentrated surface runoff and the formation of gullies may be the cause of the reported trees falling; repairs should be designed to control this surface runoff.

Areas included in Category 1A should be addressed first by further investigations and design of repairs. Areas in Category 1B should be addressed with a similar scope of work, however, these areas may possibly be done over a longer schedule as compared to that for Category 1A. We recommend designs be prepared by a qualified geotechnical engineer, particularly the designs for repair of failed slopes.

Category 2

We recommend that a monitoring program be established for the areas included in Category 2. At a minimum, visual observations of slope conditions should be made and documented on a semi-annual basis. The most appropriate time for these observations are during or after periods of increased precipitation such as in the spring and fall. Field observations should also be made at other times of extended rainfall during the year or when residents

report any changed conditions. Optical surveys to measure slope surface elevations and horizontal location could also be considered, however, this would be at an additional cost. An optical survey would be appropriate for monitoring the steamline, such as at Location No. 10.

Areas in Category 2B do not have existing structures adjacent to the slope, however, some form of instability was usually observed and therefore, in addition to monitoring, eventual repairs should be planned. We anticipate these repairs will be similar to the conceptual repair methods discussed above for Category 1.

As the Navy proceeds with more detailed evaluations, design and a final constructed repair, this may be obtained through a design-build process or through the more traditional design-bid-build process. The former may address Category 1 concerns more expeditiously, whereas the latter may provide a more competitive cost for the work but would typically take longer.

We appreciate the opportunity to prepare this evaluation for EQM and look forward to continued involvement on the project. Please feel free to call with any questions.

Very truly yours,

GZA GeoEnvironmental, Inc.

Steven W. Nicoson, P.E.
Senior Project Manager

John C. Osborne, P.G.
Associate Principal
District Office Manager

Attachments: Table 1 - Summary of Slope Observations
Figure No. 1 - Site Plan
Appendix A - Limitations
Appendix B - Photographs

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GZA

TABLES

TABLE 1
SUMMARY OF SLOPE OBSERVATIONS
Great Lakes Naval Training Center
Great Lakes, Illinois

Location Designation No.	Location	Condition	Category	Conceptual Recommendation
1	South slope of ravine near timber walkway trestle.	Erosion gulley containing rubble fill. Top of slope being undercut.	2B	Monitor. Control runoff.
2	South slope of ravine near timber walkway trestle.	Steep, narrow erosion gulley at storm drain pipe.	2B	Monitor. Control runoff
3	South slope of ravine (east-facing slope) below Building No. 42.	Failed slope. Additional failure up slope appears probable. Fence near top of slope significantly leaning downslope.	1A	Investigate, design and construct repair.
4	North slope of branch creek below Building No. 76.	Slope appears stable, however, some trees leaning downslope. Top of slope very close to building (less than 10 feet).	2A	Monitor.
5	South slope where branch creek meets main creek.	Old, small failure at toe.	2B	Monitor. Consider future repairs.
6	South slope where branch creek meets main creek.	Old failure at toe. Slope is steep.	2B	Monitor. Consider future repairs.
7	North slope of ravine adjacent to parking for Building No. 26.	Slope erosion and loss of support for parking pavement.	1A	Investigate, design and construct repair.
8	South slope of ravine adjacent to west side of Barry Road Bridge.	Surface sloughing extending to almost top of slope.	2B	Monitor.
9	South slope of ravine adjacent to east side of Barry Road Bridge.	Failed slope. Slope repairs in progress. Additional failure appears possible immediately east.	1A	Repair in progress.
10	South slope of ravine about 150 feet east of Location No. 9 and below steamline.	Failure at toe of slope.	1B	Monitor, investigate, design and construct repair.
11	North slope of ravine below Building No. 73.	Large "bowl"-shaped slope may be old failure. Currently appears stable.	2A	Monitor.

TABLE 1
SUMMARY OF SLOPE OBSERVATIONS
Great Lakes Naval Training Center
Great Lakes, Illinois

Location Designation No.	Location	Condition	Category	Conceptual Recommendation
12	South edge of creek in front of Sampson Road Bridge pier.	Gabion slope protection has failed.	1A	Investigate, design and construct repair.
13	South slope of ravine adjacent to west side of Sampson Road Bridge.	Fairly steep slope appears stable at this time.	2A	Monitor.
14	North slope of ravine below Building Nos. 142 and 143.	Erosion gullies formed.	1B	Monitor.
15	South slope of ravine below Building No. 14H.	Storm drain on slope has connection separated. No damage to bell and spigot; separation possibly due to general downslope movement.	2A	Repair drain pipe.

Notes:
1. Representative photographs of each location are included in Appendix B.
2. Refer to report text for a discussion of categories and recommendations.

GZA

FIGURES

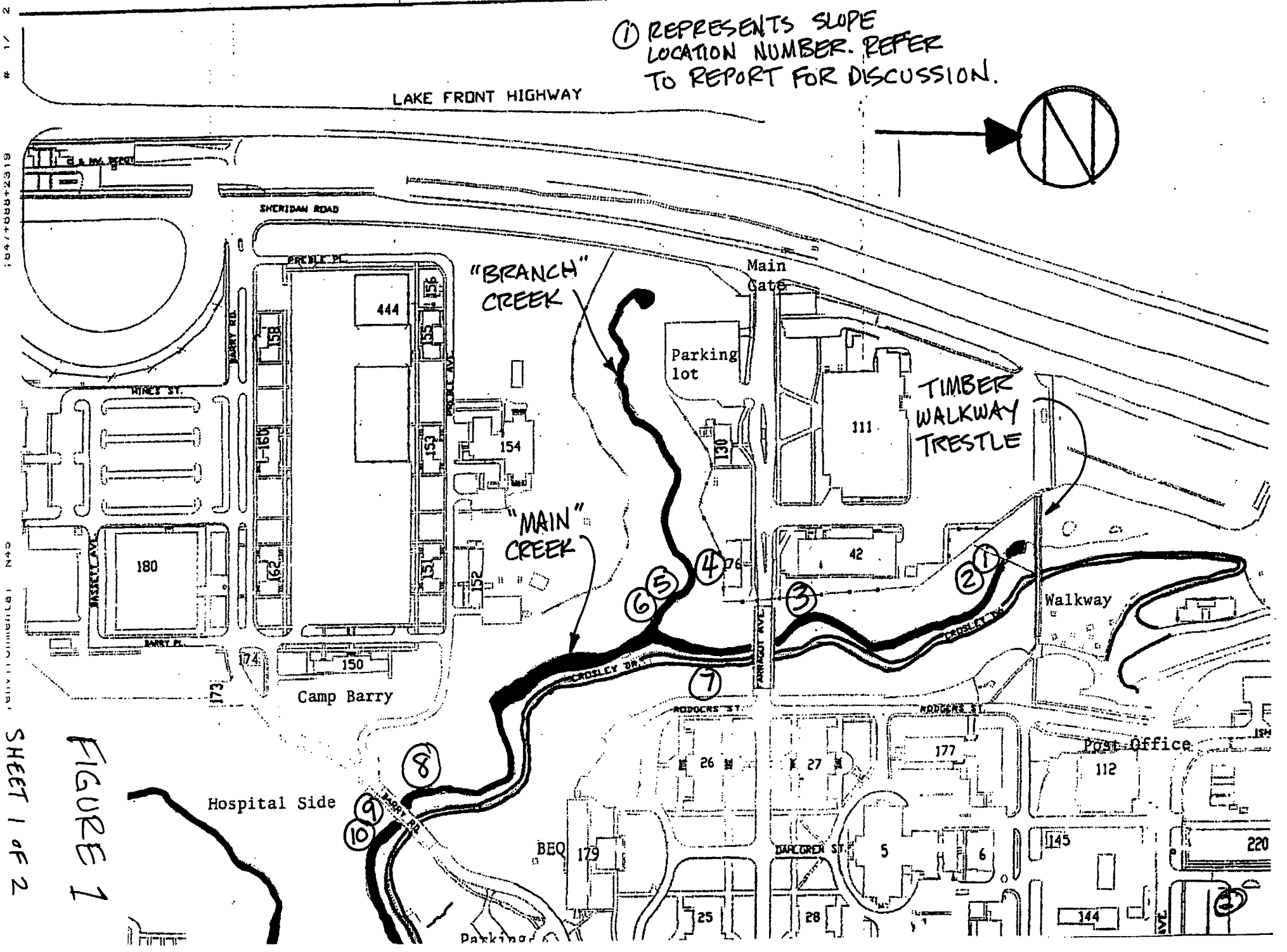
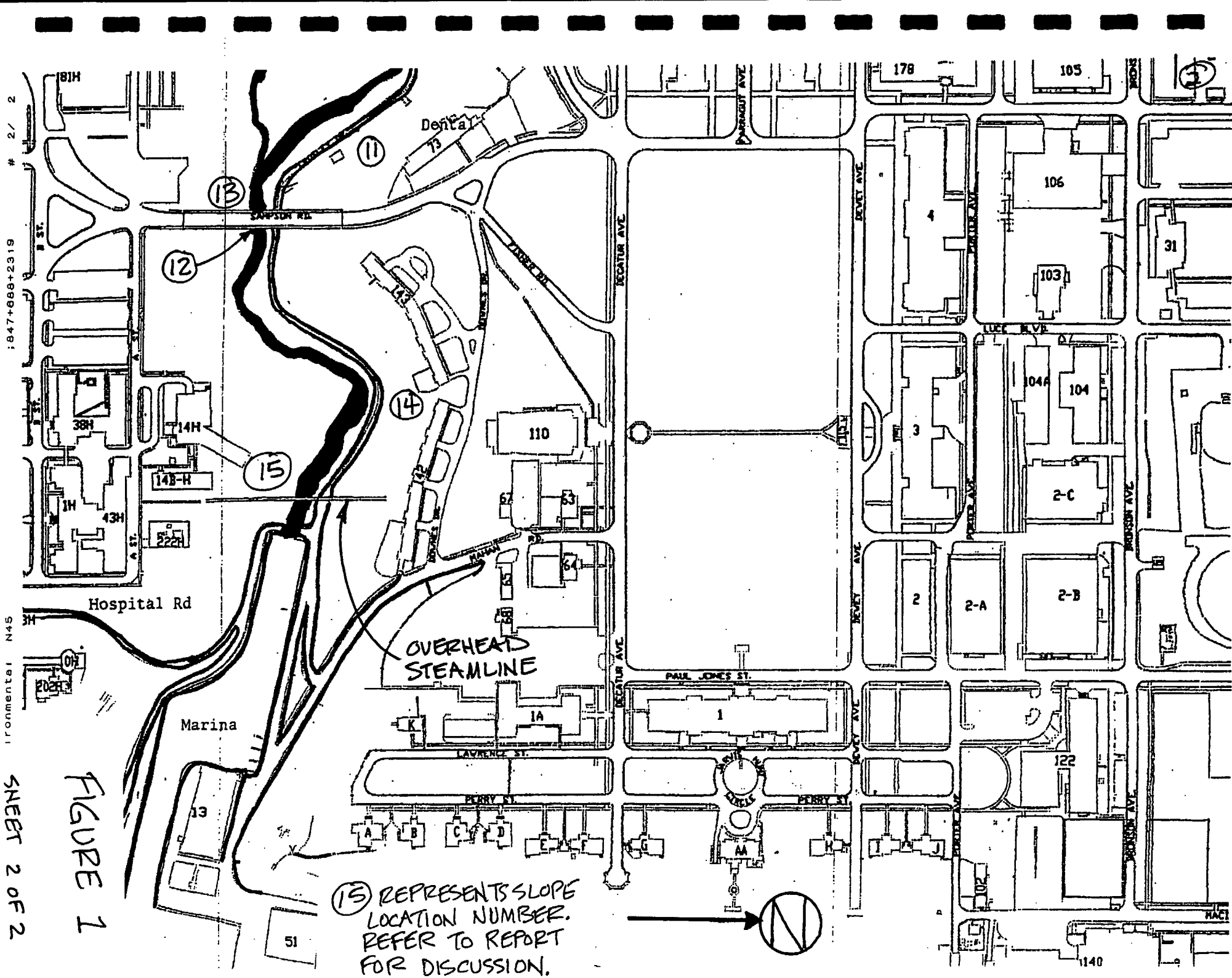


FIGURE 1

SHEET 1 OF 2



(15) REPRESENTS SLOPE LOCATION NUMBER. REFER TO REPORT FOR DISCUSSION.

FIGURE 1

SHEET 2 OF 2

GZA

APPENDIX A

Limitations

GEOTECHNICAL LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

3. Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design or location of the proposed building are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by GZA GeoEnvironmental, Inc. (GZA). It is recommended that this firm be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Construction

5. It is recommended that this firm be retained to provide soil engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Use of Report

6. This report has been prepared for the exclusive use of Environmental Quality Management, Inc. for specific application to the Great Lakes Naval Training Center located in Great Lakes, Illinois in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

GZA

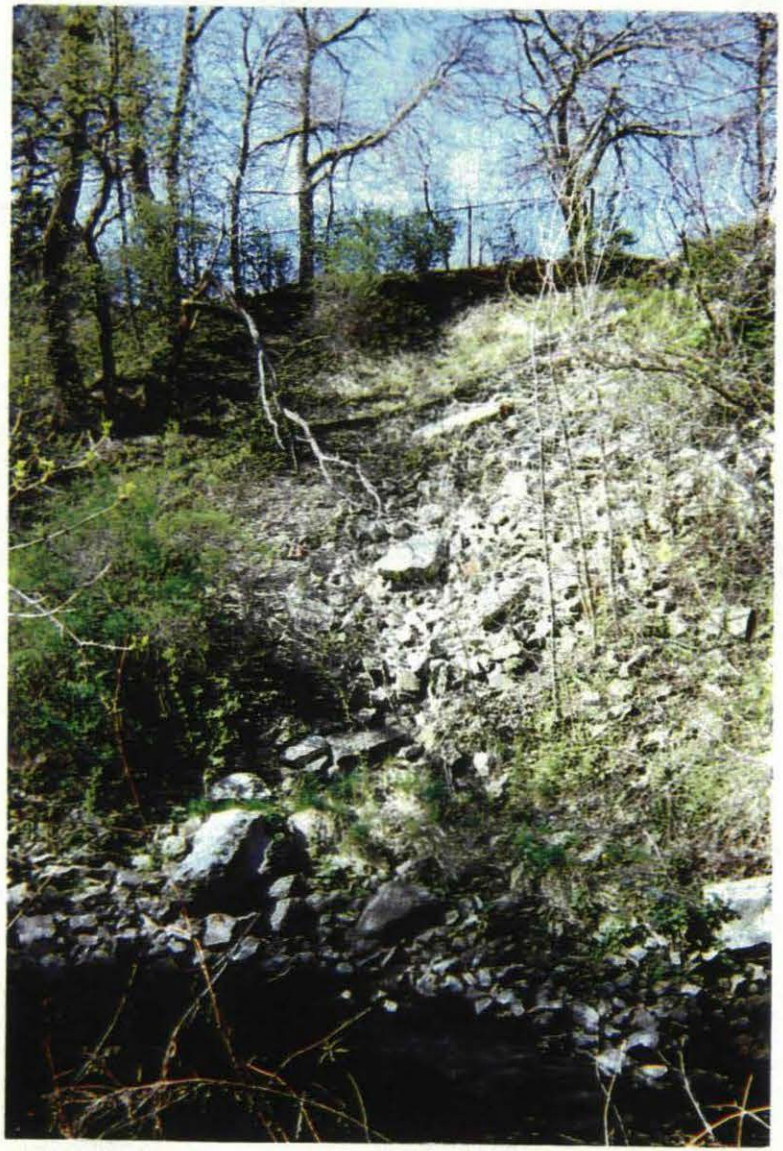
7. This soil and foundation engineering report has been prepared for this project by GZA. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

8. This report may contain comparative cost estimates for the purpose of evaluating alternative foundation schemes. These estimates may also involve approximate quantity evaluations. It should be noted that quantity estimates may not be accurate enough for construction bids. Since GZA has no control over labor and materials cost and design, the estimates of construction costs have been made on the basis of experience. GZA does not guarantee the accuracy of cost estimates as compared to contractor's bids for construction costs.

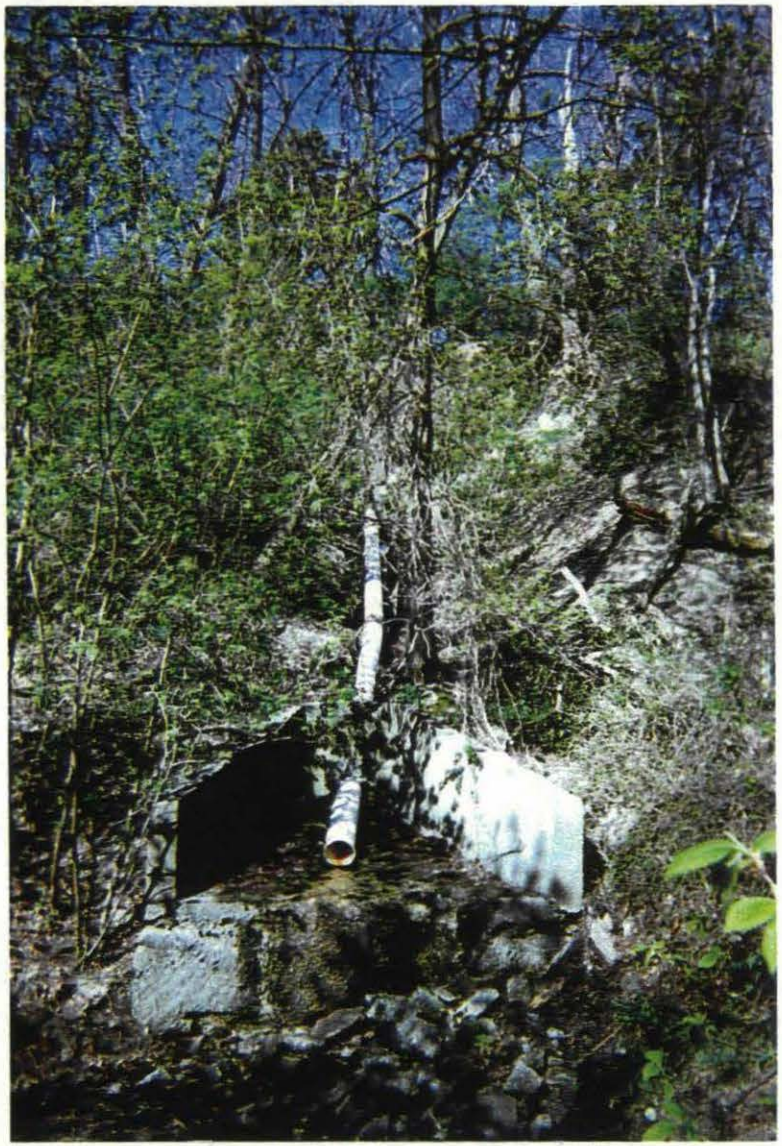
APPENDIX B

Photographs

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois



Location No. 1; Erosion gulley.

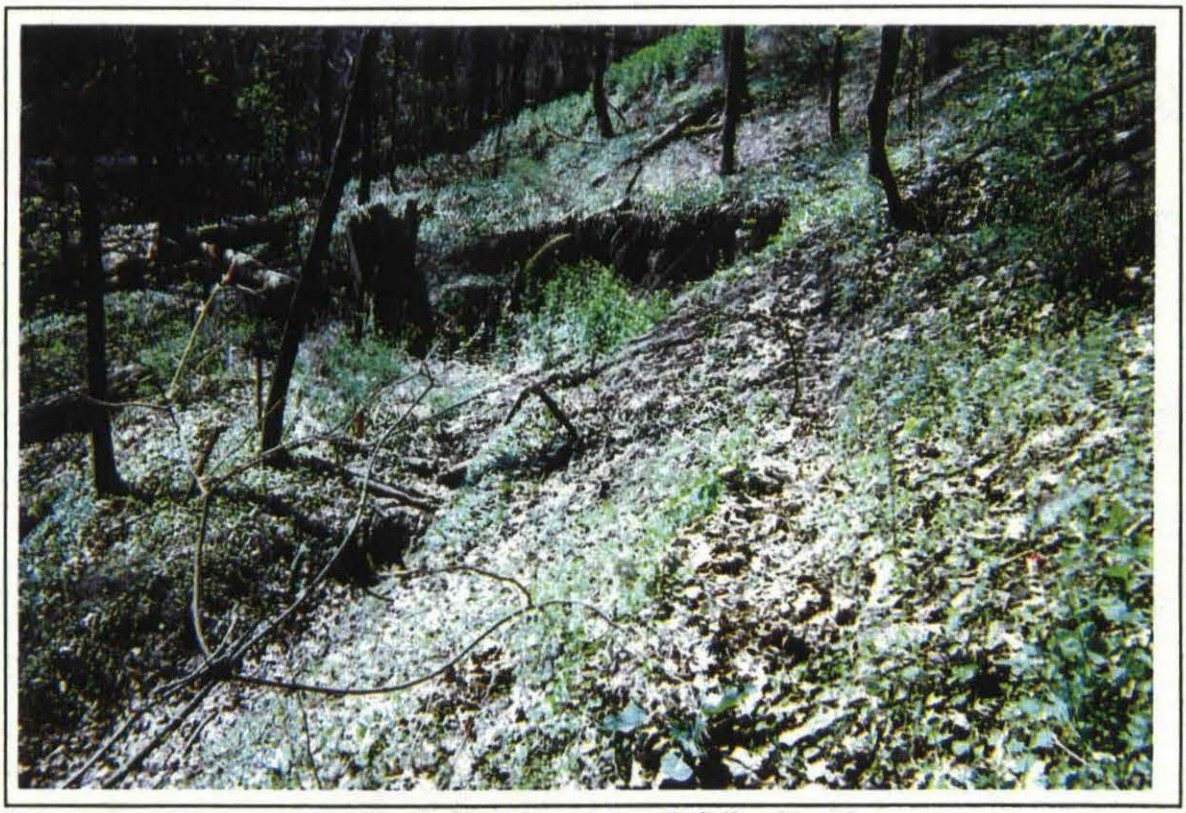


Location No. 2; Erosion gulley.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

Location No. 3; Failure below Building No. 42.



Location No. 3; Failure below Building No. 42.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

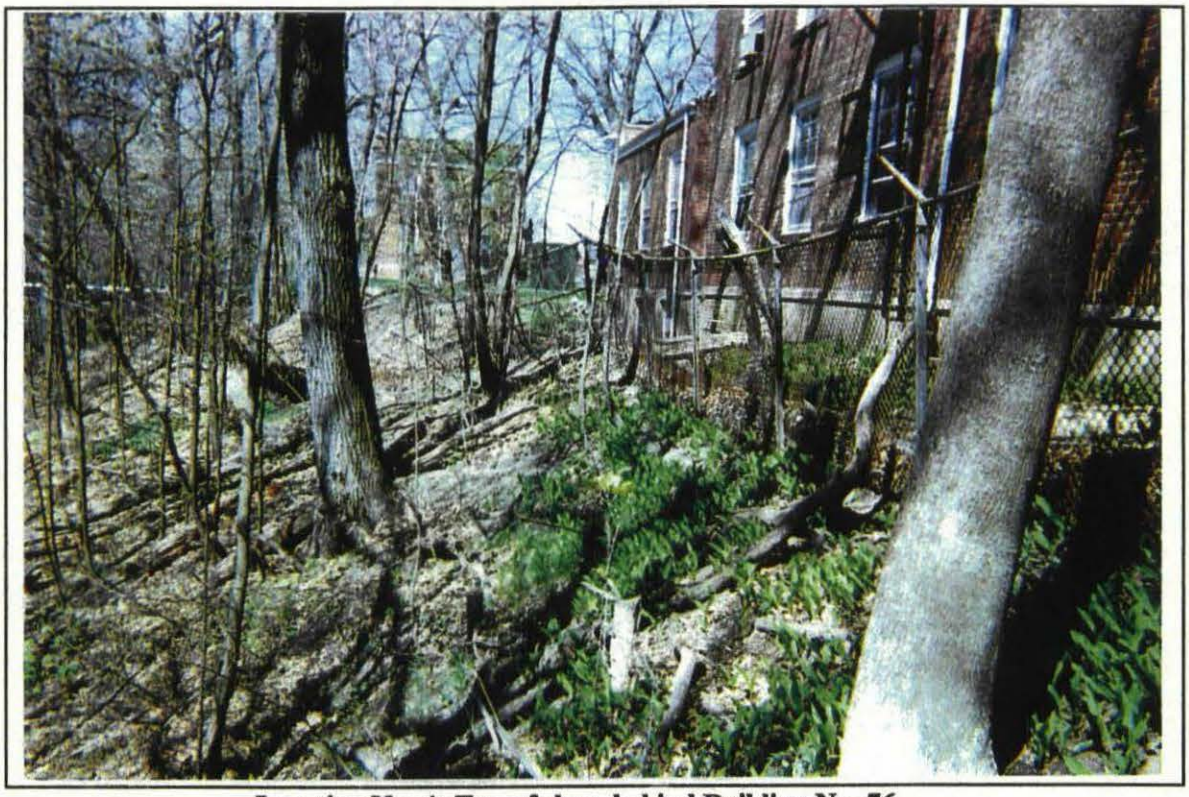
Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

Location No. 3; Building No. 42 above failure.

Location No. 3; Top of slope above failure at Building No. 42.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois



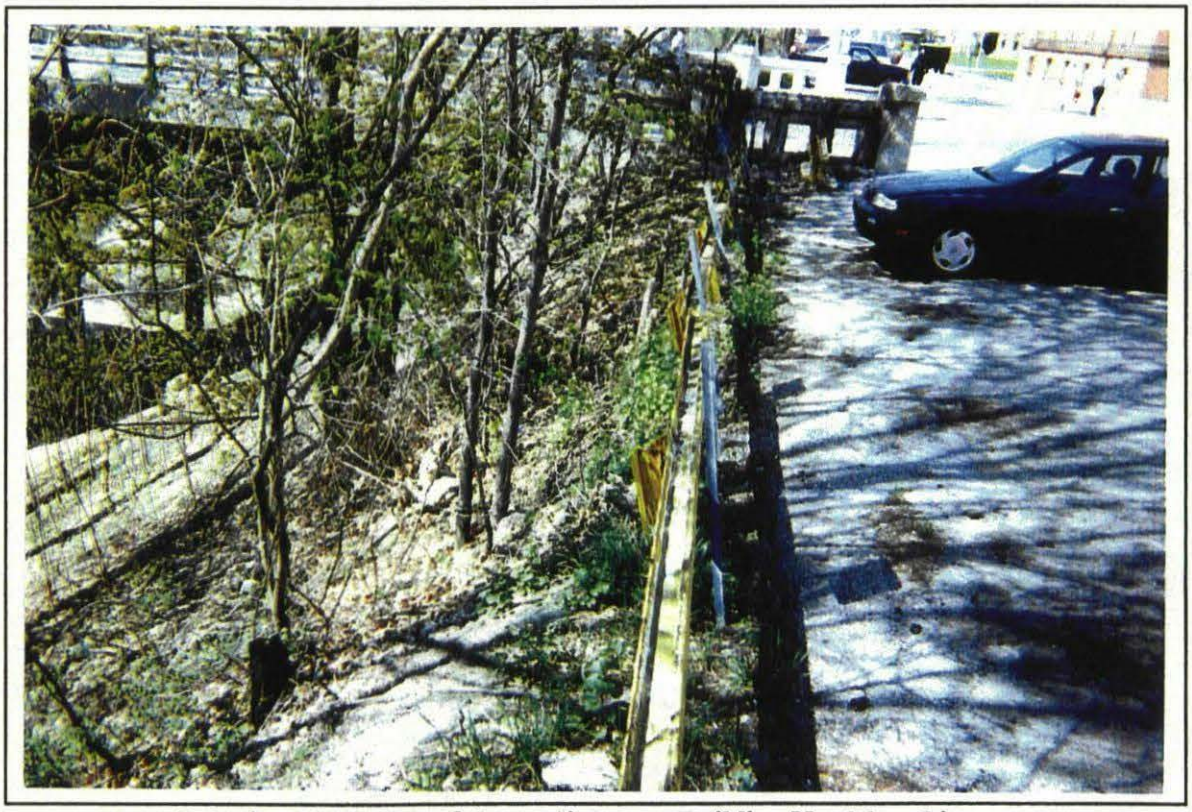
Location No. 4; Top of slope behind Building No. 76.

Location No. 5; Small failure.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

Location No. 6; Small failure.



Location No. 7; Top of slope adjacent to Building No. 26 parking.

File No.	Reviewed by:	Prepared by:	
150434.00	JCO	SWN	GZA GeoEnvironmental, Inc.

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

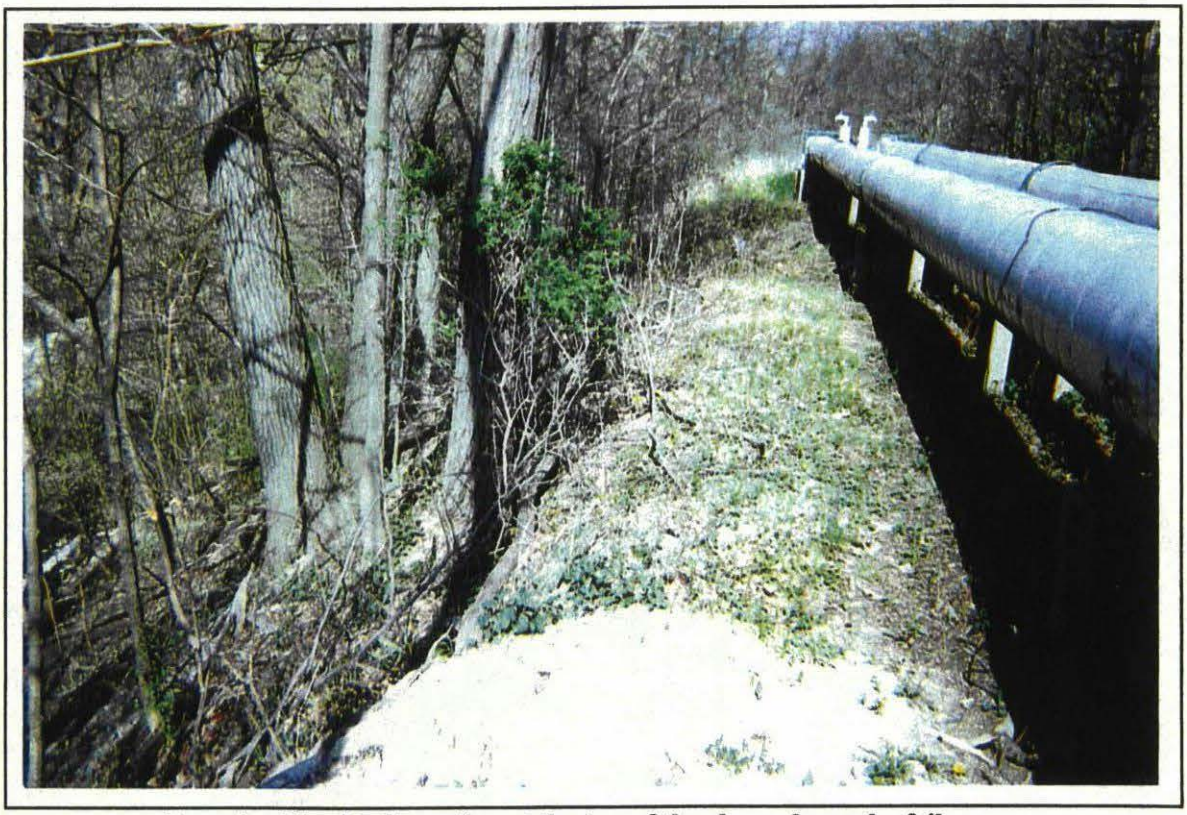
Location No. 8; Surface sloughing.

Location No. 9; Repairs in progress.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

Location No. 10; Small failure.



Location No. 10; Steamline at the top of the slope above the failure.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

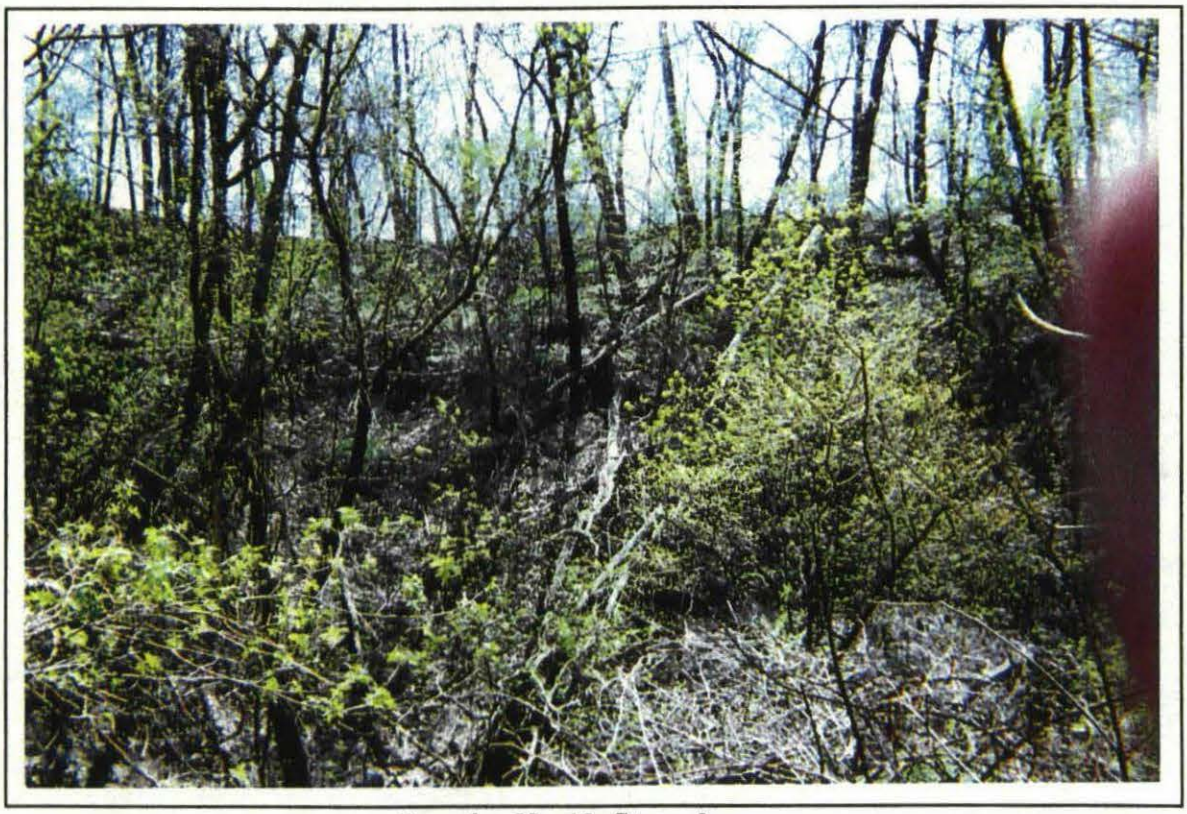
Location No. 11; Possible old failure.

Location No. 11; Proximity of Building No. 73 to top of the slope.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

Location No. 12; Gabion wall failure.



Location No. 13; Steep slope.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	

Pettibone Creek Ravine Slope Evaluations
Great Lakes Naval Training Center
Great Lakes, Illinois

Location No. 14; Erosion gulley.

Location No. 15; Storm drain pipe separated on the slope.

File No.	Reviewed by:	Prepared by:	GZA GeoEnvironmental, Inc.
150434.00	JCO	SWN	