June 2006

28th Bomb Wing

Final Golf Course Environmental Management Plan
Prairie Ridge Golf Course
Ellsworth Air Force Base
South Dakota

United States Air Force
Ellsworth Air Force Base
Air Combat Command

Global Power for America

Prairie Ridge Golf Course has adopted the following US Air Force Golf Course Environmental Management Policy statement:

"In concert with the mission of the United States Air Force,
we pledge to employ only those management practices that
minimize or eliminate the potential for negative impacts to
the environment and the surrounding community,
ensure compliance with all appropriate regulations, and to
constantly reevaluate our processes to
achieve the highest standards of environmental excellence."

This policy has been prominently displayed in the clubhouse foyer.

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Thanks to William H. Bushman; AFCEE, Air Force Golf course Environmental Management

Executive Summary

The Golf course Environmental Management (GEM) program was developed by the Air Force Center for Environmental Excellence (AFCEE), in cooperation with Air Force Services and the golf program. The expectation of the GEM program is to ensure that golf course management activities comply with the land management goals of the installation Integrated Natural Resources Management Plan. The primary goal of the program is to provide assistance in the management of Prairie Ridge Golf Course based on the reality that every action will have impacts on other elements of the course, including maintenance, aesthetic appeal, and playability. The main objective of the GEM program is to simplify environmental issues for the course manager, satisfy the commander's concerns, and keep the ultimate customer, golfers, high on the manager's list of priorities.

This GEM Plan addresses environmental challenges and management concerns borne from initial GEM program activities and represents the golf staff's preferred management approach. The plan is the result of a collaborative effort between Prairie Ridge and 28th CES Environmental Flight personnel and the first of its kind in the Air Force. The Prairie Ridge plan will be used to focus on topics of concern, develop long-term goals, and recommend activities and projects for the future. The essential elements of a GEM Plan include the following:

- Environmental Management Policy Statement
- Golf Course Environmental Baseline Assessment (GCEBA) report
- Environmental challenges (issues that require guidance, effort, or funding beyond the purview of golf staff)
- The golf course's management practices for the identified environmental challenges
- A detailed map of the depicting facilities, features, and the environmental challenges
- A description of the mapped environmental challenges
- Goals and objectives for future years
- Compilation of best management practices

Chapter 1 of the Prairie Ridge plan introduces the GEM program; Chapter 2 includes the Prairie Ridge environmental baseline assessment; Chapter 3 addresses environmental challenges;

Chapter 4 addresses future goals and objectives; and Chapter 5 discusses Best Management Practices. The Appendix section contains the maps and tabled data used to support the plan. Revisions to the plan will integrate adaptations to these undertakings, refine environmental goals, and maximize use of information resources and education programs.

The AFCEE Environmental Compatibility Quotient (ECQ) criteria (2006 version) were used to indicate the maturity of Prairie Ridge's management practices, in relation to GEM program goals and objectives. The initial rating, determined by AFCEE in 2004, was 60 out of 100 (60 percent indicated a lack of program maturity). Golf course and environmental personnel have worked to increase the course rating to the current 83 percent. Some objectives are partially completed, signaling a potential to reach 92 percent (an advanced state of program maturity).

Prairie Ridge has seven identified environmental challenges, a list of which follows this summary; the mission impacts range from critical (BASH implementation) to none (OU-6 reclamation). The costs to remedy these situations range from minimal (BASH implementation) to over $2 million (Clear Zone encroachment). A common thread is the relationship of water to each of these challenges: managing flora and fauna, maintenance of irrigation systems, implementation of spill control plans, prevention of erosion and flood damage, and wetlands management. As a result, the fix for each problem must be compatible with elements of related environmental quality management plans.

Our golf course is unique in both design and maintainability. Sited in a small but well-sheltered valley, Prairie Ridge offers exceptional access to patrons in terms of physical proximity and cost. Designers tapped a previously unused resource (treated wastewater) for irrigation, eliminating a substantial expense and demand. The course has been exceptionally well-maintained despite the severity of the local environment. Our GEM Plan will help preserve the inherent qualities of our course and advance greater aspirations in golf course management. The men and women of the 28th Bomb Wing stand to benefit substantially from this effort.

ALFRED M. LEWIS, Colonel, USAF
Commander, 28th Mission Support Group

Prioritized List of Environmental Challenges

Challenge	Aspect/Impact	Resolution
Bird/Aircraft Strike Hazard (BASH) Plan	Golf course manager (GCM) not notified of BASH/Bird Hazard Working Group meetings; needs help to coordinate control of bird populations. **Impact:** Potential increase for BASH incidents Reference EAFB OI 91-212	GCM to activate membership, attend meetings, and take part in mitigation planning. Perform waterway maintenance to reduce affinity to waterfowl. --Minimal Cost --Est. Comply Date (ECD) June 06
Airfield Clear Zone Encroachment	Approx. 35 acres of course (portions of Holes 2, 3, 4, 5, and 6) are within the designated airfield Clear Zone. **Impact:** Violates a compatible use policy for airfield land Reference AFI 32-7063; AFH 32-7084	Relocate holes per recommended design Concept C. --Est. cost: $2.25 million (CY2007) --ECD not established
Stormwater and Wastewater Outfalls Mgmt	Maintain watercourse as functional element of the installation spill plan (Facility Response Plan). **Impact:** Potential for pollutant spill to migrate off-base Reference 40 CFR 112.20; 21	Dredge small pond and clear of waterways of silt and overgrowth to maintain control volume. --Cost not established --ECD not established
Invasive Species Mgmt	Establish aesthetic/functional thresholds of invasive species to effectively manage pests; control/eradicate weeds. **Impact:** Damage to greens/fairways; loss of use/revenue Reference EO 13112	Develop and incorporate GC management plan into installation management plans --Cost not established --ECD not established
Water Resources Mgmt	Maintain waterway to ensure irrigation system availability (approx 250K gal/day). Approximately 5 acres of PRGC land is jurisdictional wetland. **Impact:** Damage to greens/fairways; loss of use/revenue Reference AFI 32-7064 (INRMP)	Dredge small pond to retain and settle solids from upstream discharge areas; manage WWTP discharge as necessary --Cost not established --ECD not established
Flood Hazard Mgmt	Approx. 22 acres of PRGC are located in 100-year floodplain; 100-yr event will likely damage Holes 7, 8, 9, and all practice areas. **Impact:** Damage to greens/fairways; loss of use/revenue Reference EO 11988	Reduce risks and minimize exposure as appropriate --Cost not established --ECD not established
Installation Restoration Program (Operable Unit 6)	Allow compatible reuse of approx. 2-acres of OU-6 as appropriate **Impact:** None identified Ref: Record of Decision; Oct 1995	Allow reuse as a riparian (undisturbed) buffer --Cost not established --ECD not established

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According to Air Force Instruction (AFI) 32-7064 (Integrated Natural Resources Management), golf course management activities must comply with the land management goals of the Integrated Natural Resources Management Plan (INRMP) and the golf course environmental management (GEM) plan. This chapter will discuss the goals and objectives, components, and processes of the GEM program. The last section of the chapter is a course-specific analysis for the Prairie Ridge Golf Course.

1.1 GEM Program Overview

The U. S. Air Force Golf course Environmental Management (GEM) program is a proactive Air Force Center for Environmental Excellence (AFCEE) initiative to foster a better understanding of the environmental challenges facing Air Force golf courses worldwide. The GEM program was created, with the support and approval of the Air Force Services Agency golf program, to serve installation golf course managers and superintendents in creating an environmentally sensitive approach to managing their facilities. The program goals and objectives, Air Force environmental principles, and benefits of successful GEM programs describe the Air Force commitment to successful stewardship of the lands in their trust.

1.1.1 Goals of the GEM Program

The primary goal of the GEM program is to provide assistance in the day-to-day management of the installation golf course and surrounding land based on the reality that every action taken will have impacts on other elements of the course, its maintenance, aesthetic appeal, and playability. Other goals of the GEM program are as follows:

1.1.1.1 Provide a unique approach to melding sound ecosystem-based environmental practices into a comprehensive and holistic approach to golf course management

1.1.1.2 Implement a systematic, process-oriented approach which will allow for the use of each idea or theory of management as it applies or doesn't apply at each course. The free interchange of ideas is paramount for this concept to succeed

1.1.1.3 Facilitate the creation of an environmentally friendly golf course facility for its customers

1.1.1.4 The main objective of the GEM program is to simplify the maze of environmental issues for the golf course manager while satisfying the concerns of commanders in addition to keeping the ultimate customer, the golfers, high on the manager's list of priorities. Ultimately, the program provides a comprehensive approach to ease the process of golf course operation while protecting, preserving, and furthering the game of golf

The U.S. Air Force Center for Environmental Excellence is dedicated to helping provide a way that more rounds can be played on better conditioned courses that minimize or eliminate negative impacts to the environment. In many cases, our golf courses are being managed compatibly with the environment. The GEM program is the vehicle to document and communicate successes to patrons, commanders, and the local community.

1.1.2 Air Force Golf Course Environmental Principles

The GEM program has slightly modified and adapted the "Environmental Principles for Golf Courses in the United States" (GCSAA, 2005) for their use to compile a logical and comprehensive approach to golf course management for installation commanders, directors or managers of golf facilities, and superintendents.

1.1.2.1 To enhance installations ecologically and economically

1.1.2.2 To develop environmentally responsible golf courses that are economically viable

1.1.2.3 To improve, create, and protect habitat for wildlife and plant species in concert with the U.S. Air Force mission

1.1.2.4 To recognize that every golf course must be developed and managed with consideration for the unique conditions of the ecosystem of which it is a part

1.1.2.5 To provide important green-space benefits

1.1.2.6 To use natural resources efficiently

1.1.2.7 To respect adjacent land use when planning, constructing, maintaining, or operating golf courses

1.1.2.8 To create desirable playing conditions through practices that preserve environmental quality

1.1.2.9 To support ongoing research to scientifically establish new and better ways to develop and manage U.S. Air Force golf courses in harmony with the environment

1.1.2.10 To document outstanding development and management practices to promote more widespread implementation of environmentally sound golf

1.1.2.11 To educate golfers, managers, commanders, and the local community about the principles of environmental responsibility and to promote the understanding that environmentally sound golf courses are quality golf courses

1.1.3 Benefits of Successful GEM Programs

This ecosystem-based environmental management philosophy is expected to benefit the U.S. Air Force in the following ways:

1.1.3.1 Increase overall environmental awareness

1.1.3.2 Decrease pesticide and nutrient inputs

1.1.3.3 Minimize or eliminate negative environmental impacts

1.1.3.4 Ensure compliance with environmental regulations

1.1.3.5 Keep course manager and superintendents up-to-date on environmental information, policies, and practices

1.1.3.6 Demonstrate proactive environmental stewardship

1.1.3.7 Involve installation residents and our neighbors in the surrounding community

1.1.3.8 Reduce operation costs

1.1.3.9 Increase overall safety, enjoyment, and participation by the customer

1.1.3.10 Protect U.S. Air Force interests

1.1.3.11 Preserve the great game of golf

1.2 Components of the GEM Program

The GEM Plan consists of the following components (AFCEE, 2005):

1.2.1 Environmental Management Policy Statement

1.2.2 Golf Course Environmental Baseline Assessment (GCEBA) report

The GCEBA is comprised of the following components:

Site visit, interviews, and data collection

Course specific analysis

Miscellaneous facility review

Environmental compatibility quotient checklists

Identification of environmental management challenges

Summary report

1.2.3 Environmental challenges (issues that require guidance, effort, or funding beyond the purview of golf staff)

1.2.4 The golf course's management practices for the identified environmental challenges

1.2.5 A detailed map of the entire golf course grounds depicting all of the facilities, natural features, and the identified environmental challenges

1.2.6 A description of the mapped environmental challenges

1.2.7 Goals and objectives for future years

1.2.8 Compilation of the best management practices employed in their implementation of the GEM program recommendations to manage the golf course

The GEM planning process includes an initial analysis, or golf course environmental baseline assessment (GCEBA), of all aspects of the golf course facility in order to provide a summary of the identified environmental issues facing the golf course manager and staff. From these issues, a GEM Plan is compiled that satisfies the specialized needs of the golf course manager with AF goals and objectives for environmental management. The *U. S. Air Force Golf Course Environmental Management Program* web site includes technical guidance on GEM program requirements (AFCEE, 2005).

One of the important results of the GCEBA process is the identification of the significant environmental challenges that should be addressed in the long term GEM planning process. Ideally, the golf staff will address each issue from the best way to satisfy the goals of the golf facility and acceptable levels of course playability and customer satisfaction. The golf staff's preferred management approach for these issues must be provided to the installation's environmental staff for coordination and approval. Ideally, the GEM Plan will be shared with the course's customers. Appropriate plan components should be made available for viewing by the course's customers in a highly visible location (pro shop or clubhouse).

1.3 GEM Program Processes

The five steps in the GEM program process are Assessment, Documentation, Implementation, Evaluation, and Revision.

1.3.1. Assessment

Experienced environmental managers realize the importance of assembling all of the data relevant to a problem prior to determining its best solution. Assessment is the first and most important task of the golf course environmental baseline assessment (GCEBA). Proper completion of the GCEBA is important to the long-term compatibility of an installation's golf course management practices with the GEM program, and more importantly, the U. S. Air Force's natural resource and environmental management goals and objectives. The Prairie Ridge GCEBA was completed in September 2004 (Bushman, 2004).

When environmental challenges are identified, the golf course staff should determine the preferred management approach in the context of their ongoing, long-term goal of providing the best golfing experience. By developing a well-conceived, golf facility-based management approach, the golf staff should then coordinate with the environmental staff to ensure a consistency and compatibility with installation-wide natural resource and environmental management goals and objectives.

1.3.2. Documentation

It is not enough just to know how to create a successful golf course environmental management program. There must be a written record documenting existing site data, maintenance practices, pesticide applications, and other historical golf course activities. By documenting what we know, we will be able to determine how to make better decisions in the future. The completed GEM Plan will assist in the daily management of the course while providing a convenient vehicle to communicate to commanders and customers alike the environmental issues that challenge us on our golf course as well as our plans to deal with them. In order to reach the environmental stewardship goals set by the U. S. Air Force, we must consistently employ only those management practices that minimize or eliminate potential negative impacts to the environment.

1.3.3. Implementation

Positive and decisive action is the only true measure of the success of a GEM program. The Prairie Ridge staff has adopted the GEM program Environmental Policy and worked to find ways to minimize or eliminate negative impacts to the environment.

1.3.4. Evaluation

In order to ensure the highest quality of customer service and environmental stewardship, there must be continual self-evaluation and improvement. There also should be consistent, on-going measurement of the reduction or elimination of environmental impacts the newly implemented practices have on the course. For example, documenting the reduced use of inputs such as fertilizers, pesticides, and irrigation can be used to demonstrate the increased environmental stewardship of the golf course management practices as well as the overall value of the GEM Program. It is important for U. S. Air Force golf courses to show improvement over time. This can be easily accomplished by regularly evaluating golf course maintenance methods, practices, and management approaches to day-to-day issues and changing when appropriate.

1.3.5. Revision

The very nature of a superior GEM program implies that all documents be regularly maintained to represent the most current conditions. U. S. Air Force golf course managers and superintendents should be constantly looking for ways to improve their environmental stewardship. Acting on lessons learned is right behind initial implementation as the most important aspect of a successful GEM Program. The GEM Plan should be kept as current as possible at all times. Ideally, it should be completely updated at least every five years (when the Integrated Natural Resources Management Plan is updated).

1.4 Course-Specific Analysis

The course-specific analysis includes a general overall description of the course, details of the course, facilities, and various observations on the way the course plays, looks, and is managed.

1.4.1 Course Description

Prairie Ridge GC is located just north of Interstate 90 approximately 9 miles east of Rapid City, South Dakota, and adjacent to Ellsworth AFB (EAFB). The course is bounded by several important installation functions, but is not within the secured perimeter: to the west most importantly by the southern runway approach, the Bismarck Gate access road, Operable Unit 6, and the wastewater treatment plant; to the east by Ellsworth Road; to the north by a mobile home park, Davis Drive and Gateway Lake; to the south by open, treeless pasture land. For reference use, a location map for EAFB is shown in Appendix 1; a map showing the relative location of the course within EAFB boundaries is shown at Appendix 2.

The 97-acre parcel is located in a small but well-sheltered valley within the southeast portion of the EAFB installation boundary. The maximum geographic relief of the course is 74 feet. Two converging perennial streams, one from the base of Gateway Lake and the other from the wastewater treatment plant, split the course into wetlands, wooded lowlands, and short-grass prairie. The golf course drainage is approximately one mile long, is crossed by seven golf cart bridges, and flows through six culverts, one holding pond, and one aeration pond. Jurisdictional wetlands, along with groves of conifer and cottonwood, are located along the drainage. Wooded and grassy areas are located throughout the course. Geologically, the golf course soil is classified as Nunn- and Kyle-Clay loams (NRCS, 2004), with Onita-Clay (USAF, 1994) over the Pierre Shale Formation; the Onita clay layer is approximately 13 feet thick near the clubhouse and maintenance building (FMG, 2002).

Sixty-four years of climate data for EAFB were obtained from the Operational Climactic Data Summary (EAFB, 2005a). The data showed that Prairie Ridge golfers are challenged with average daily maximum temperatures between 32^{o}F and 87^{o}F, an average of 46

thunderstorm days between May and October, and maximum wind speeds between 66 and 112 knots. The summary of climactic data is shown at Table 1.

Table 1. Summary of EAFB climactic data; Feb 1939 to Feb 2003 (EAFB, 2005a).

Month	Temp Max (F)	Temp Min (F)	Temp Max Ave (F)	Temp Monthly Ave (F)	Temp Ave Min (F)	Liquid Precip Ave (In)
Jan	75	-25	32	23	13	0.5
Feb	75	-27	37	26	17	0.6
Mar	84	-18	44	33	23	1.0
Apr	91	5	58	45	34	1.8
May	98	20	68	56	45	2.9
Jun	108	31	77	65	54	3.0
Jul	111	42	87	73	61	2.0
Aug	108	37	87	72	59	1.5
Sep	106	19	76	62	49	1.1
Oct	94	0	62	49	38	1.0
Nov	84	-22	45	35	25	0.7
Dec	74	-30	36	27	17	0.4
Annual	111	-30	59	48	36	16.5

1.4.2 Course Details

The nine-hole Prairie Ridge course, constructed in 1989, is one of the more recent additions to the Air Force inventory. The designer, Patrick Wyss of Wyss Associates (FMG, 2000), designed the course around the highly variable relief of the site and several other natural and man-made obstacles. The natural terrain has been gently shaped and manicured to allow use of hand or electric carts. The course is open to all active duty, retired, National Guard, Department of Defense and civilian personnel (active duty personnel have priority). The course is open daily from 0700 to dusk, as long as the air temperature is above 40^{o}F and ground conditions permit. A layout of the course is shown in Figure 1.

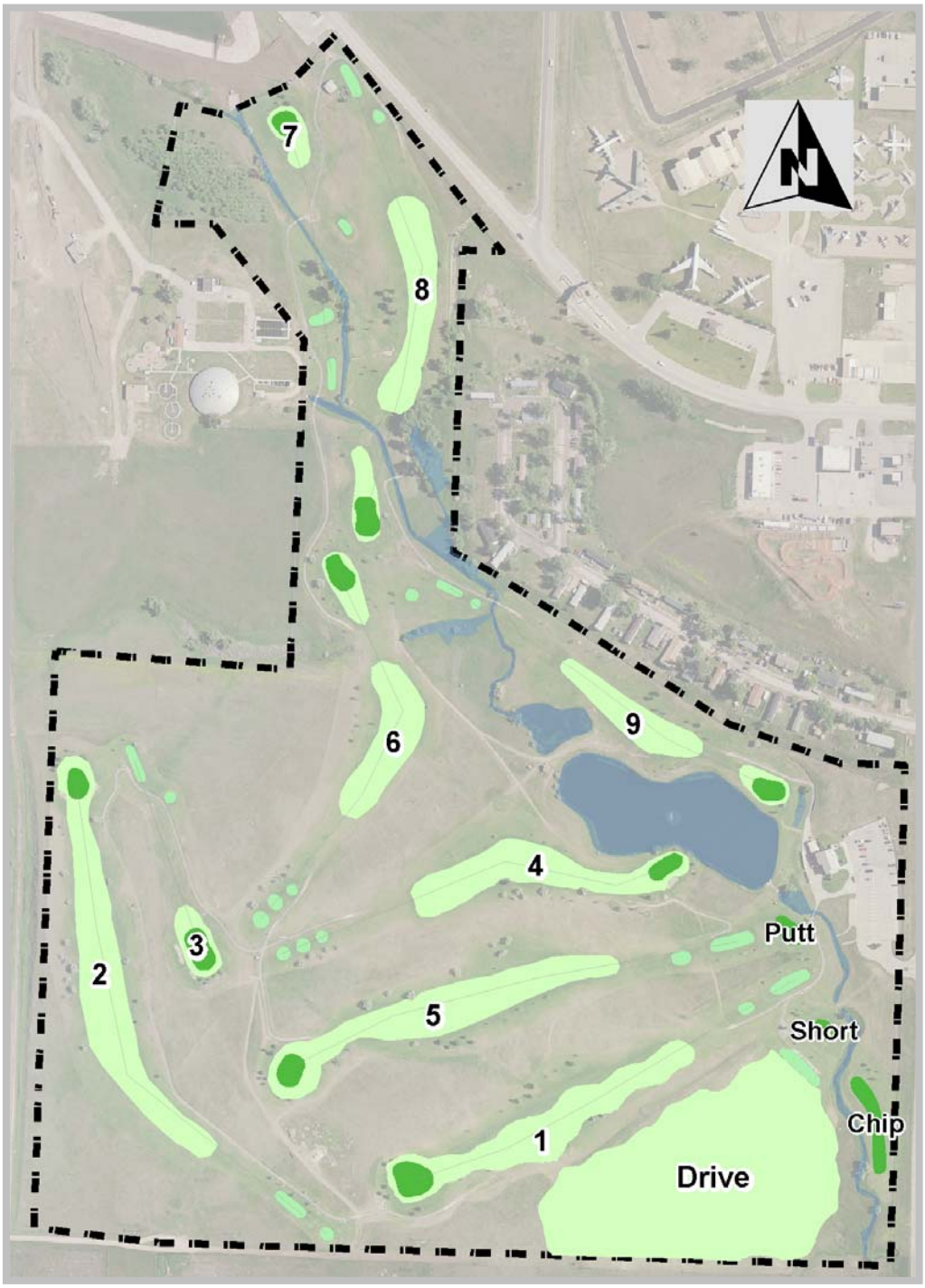

Figure 1. Prairie Ridge Golf Course Layout (Geobase 2006).

The course is fairly wide open so golfers never have to fear that errant play will result in damage to the property of others; the rough makes course play difficult if the fairways are missed. Holes 1, 4, and 5 are played alternatively up and down an exciting 25-percent slope (FMG, 2000). Holes 2 and 3 are played up and back along a windswept crest. The two creeks weave through the Hole 7 and 8 fairways, and Holes 4 and 9 embrace the two course ponds. In the hilly sections, fairways are fast; however, the lowland fairways are lush. Overall, the undulating greens make for a wonderful golf outing. Additional details about the course are shown in Table 2.

Table 2. Details of the Prairie Ridge Golf Course (Bushman, 2004).

Architect	Patrick Wyss
Year constructed	1989
Climate	Temperate & dry
Average annual rainfall	16.5 inches (EAFB, 2005a)
Average growing season	Mar- Oct (215 days)
Total Facility Acreage	97 acres
Par	36-36-72 (Nine holes only)
Yardage/Rating/Slope	Blue- 6,456/71.9/116
	White- 6,034/67.8/112
	Red- 5,176/70.4/116
Golf course manager	Jim Holec
Superintendent	Jim Holec
Turfgrass:	
Tees	Perennial Rye/Kentucky Bluegrass
Fairways	Perennial Rye/Kentucky Bluegrass
Greens	Creeping Bent/Penncross
Roughs	Perennial Rye/Kentucky Bluegrass

1.4.3 Facilities

Although the course is primary to the enjoyment and eventual return of most customers, the support facilities play a huge role is the overall success of the operation. This section of the GCEBA will examine the following facilities for their aesthetic, functional, and environmental values:

- **Clubhouse/pro shop/snack bar**
- **Maintenance complex**
- **Practice areas**
- **Pesticide mixing and storage**
- **Cart storage facility**
- **Infrastructure**

1.4.3.1 Clubhouse

Constructed in 1989, the Prairie Ridge Golf Course clubhouse is 4,164 square feet on two floors. The structure houses the staff offices, pro-shop, patron rest and break areas, and also has an attached deck and covered pavilion. The clubhouse, shown in Figure 2, is the first stop for all patrons and visitors. The pro shop, staff offices, and rest areas are located at street level; the tournament room, patron lockers, restrooms, ice machine, and a storage area are all located on the bottom floor. There are 40 power carts and pull carts for rent. Additionally, there is a PGA teaching professional and a full service Pro Shop including club fitting, club repair and custom club making.

The clubhouse has a well-stocked Pro Shop (Figure 3) with several types of clubs for sale. They have a full line of accessories, including bags, grips, shirts, wind shirts, head covers, pull carts, umbrellas, shoes, hats, and gloves. Refreshments (both with and without alcohol) and snacks (crackers, chips, candy bars, cookies, pizza, and hot dogs) are available in the Pro Shop as well. The offices of the course manager and assistant course manager are located in the clubhouse.

Figure 2. Golf Course Clubhouse (2006).

Figure 3. Prairie Ridge golf course Pro Shop (2006).

1.4.3.2 Maintenance Complex

Ellsworth AFB civil engineer and contracting staff designed a new maintenance complex (shown in Figure 4 and Figure 5) in 2003. Construction on the 6,310 square foot building began in 2004; the building was built into the side of a hill adjacent to the clubhouse and out of the 100-year floodplain. The maintenance building has two large maintenance bays, a large five-door cart storage area, a restroom, shower room, and a large employee break area. The building was completed in August 2005 at a cost of approximately $930,000.

Soon after the building was accepted, cracks developed in the floor along the base of a supporting wall. The building is still under warranty and Services, Contracting, and Civil Engineer personnel are working to remedy this problem.

Figure 4. Golf Course Maintenance Building (front, 2005).

Before the building was constructed, maintenance personnel had to drive equipment out to a temporary shelter at Gateway Lake to retrieve or perform maintenance on other equipment. The new maintenance building has room to store all course equipment, i.e. golf carts, maintenance equipment, tool boxes, supplies, etc. The building also provides sheltered areas in which to perform periodic and unscheduled maintenance of this

equipment. A photograph of one of the large bays while in use is shown at Figure 6. Golf course personnel are satisfied that the building supports their needs.

Figure 5. Golf Course Maintenance Building (rear, 2006).

Figure 6. Bay use is maximized during the off-season for storage/maintenance (2006).

1.4.3.3 Practice Areas

Prairie Ridge is outfitted with 15,700 square feet (0.36 acres) of practice green and nearly 6.7 acres of driving range. The putting green has nine moveable cups to offer the entire range of putting challenges golfers face while playing; the putting lengths range from one to fifty feet. A unique short-game practice area allows golfers the opportunity to practice pitch shots, chip and run shots, lob- and sand-wedge shots from up to 70 yards to a green with a pin placement. A chipping green (with a sand bunker) is available to practice short chips shots and numerous sand bunker shots; the sand bunker enables players to practice short and medium bunker shots from up to 15 yards. The driving range is over 250 yards long and 200 yards wide. Yardage markers are set every fifty yards to allow players to practice the full range of wood and iron shots. A portion of the practice area is shown in Figure 7.

Figure 7. The Chipping hole is near the short-game green and driving range (2005).

1.4.3.4 Pesticide Mixing and Storage

All of the pesticides utilized by golf course personnel are stored at the Ellsworth AFB entomology shop. No wettable powders are used. When applications are needed, the course manager (licensed applier) uses an injection system pesticide applicator equipped with a boom sprayer. This device actually mixes the chemical as it sprays so there is no tank and no rinsate to deal with after the application. He also uses portable back-pack sprayers, filled from the injection system unit, to treat areas not accessible by the boom sprayer.

1.4.3.5 Hole 7 Pavilion

Before the maintenance/cart storage facility was constructed in 2005, the only equipment shelter available on the course was a small covered pavilion (Figure 8). This pavilion formerly accommodated Gateway Lake visitors until security fence, installed in late 2001, separated the pavilion from the lake; as a result, the pavilion became part of the golf course. Because the maintenance facility can accommodate the storage of all carts and equipment, the pavilion will revert to its former use as a shelter; this will allow golf patrons to escape the elements, or allow others to play through, before moving to the Hole 8 teebox.

Figure 8. An old equipment shelter will again be used as a shelter for patrons (2005).

1.4.3.6 Infrastructure

This section examines important elements of a quality golf course that are difficult to group into another category. The asphalt cart paths are in fair condition; construction to interconnect the paths has been planned and designed, but not funded (see diagram at Appendix 4). The parking lot is in good condition although may not be large enough as the new maintenance facility has encroached upon of the parking area.

There are site amenity groups (trash can, recycle bin, etc.) near most teeing areas. Plans to improve the signage are being considered. A portable relief station has been set up near the Hole 3 green, which provides excellent proximity to Holes 3, 4, 5, and 6.

The functional operability of the irrigation system has been affected by the age of the pumping system and the positioning of the intake relative to water level. The two pumps in the system have nearly reached the end of their life cycles, but are expected to operate effectively until replacements can be funded. The replacement design will include installation of a third smaller pump, to be used to maintain adequate pressure in the line and reduce the operating costs of the larger pumps.

The availability of water will always be an important consideration at most golf courses, especially in areas where water is apportioned according to an established water right. Fortunately, Prairie Ridge Golf Course was designed to use a water resource for which the installation owns (treatment plant discharge). Prairie Ridge personnel currently use approximately 250,000 gallons of treated wastewater each day (during the irrigation season) to irrigate the course. Although most of the $350 per month in electricity costs for the Prairie Ridge operation can be attributed to the irrigation system, no costs are incurred for the cost of the irrigation water. The installation manages the treatment plant discharge as needed. A discussion of how to maintain the availability of this resource is found in the Water Resources Protection section of this report.

2. Prairie Ridge Environmental Compatibility Quotient Checklists

The Golf Course Environmental Compatibility Quotient (ECQ) checklists are a systematic and convenient method of assessing the overall performance, implementation, and completeness of an installation's golf course environmental management planning and environmental stewardship. The checklists can be used in several ways:

- As an analytical tool while compiling a GCEBA to determine the Environmental Compatibility Quotient (ECQ)
- As a self-assessment tool for the golf course manager or superintendent dedicated to improving their environmental stewardship
- As an award nomination evaluation by a Golf Course Assessment Team (GCAT)

The ECQ checklists cover the following ten topics or categories:

- Overall Management Philosophy & Documentation
- Safety, Training, & Awareness
- Compliance
- Pesticide Use, Storage, & Handling
- Pollution Prevention
- Conservation Practices
- Water Resources
- Maintenance Practices
- Customer Relations & Education
- Miscellaneous Special Projects & Activities
- ECQ Summary

2.1 Determining the Prairie Ridge 2006 ECQ

The purpose of the Environmental Compatibility Quotient (ECQ) is to indicate the maturity of an installation's golf course management practices in relation to GEM program goals and objectives. It may also be used by a golf course assessment team to evaluate the course for an award (AFCEE, 2005). The ECQ is a score, from 1 to 100 points, determined by survey results for ten ECQ checklists (ten surveyed areas each). The quality of the respective golf course manager's environmental management program is then indicated by determination of the actual and potential environmental compatibility survey results. The ECQ is simply derived—there are 100 questions requiring 100 responses, all weighted equally—as a percentage of responses of "Yes" and "Partial" responses.

Key to checklist survey responses:

Yes – Response indicates the practice is complete or ongoing and can be verified.

Partial – Response indicates the practice has been initiated but needs further attention and improvement.

No – Response indicates the practice is not yet in place.

Condition Code – A red, yellow, or green color code is used to indicate maturity of the program "at a glance"

Actual ECQ - the percentage of "Yes" responses for all ten checklists.

Potential ECQ - the percentage of "Yes" responses plus the percentage of "Partial" responses for all ten checklists.

The surveyed ECQs (Actual and Potential) are then compared to the ECQ Scoring Level/Condition Code (shown in Table 3) and used to determine a comparative level of environmental program quality. Initially, the Prairie Ridge course was rated an actual ECQ of 60 ("Just Started") and a potential ECQ of 78 ("Showing Progress") during the GCEBA (Bushman, 2004). Prairie Ridge golf course personnel have made significant improvements from the previous ECQ determination. As a result, the overall ECQ determination has been

raised to an Actual ECQ of 83 percent ("Showing Progress") and a Potential ECQ of 92 percent ("Advanced"). Table 4 presents a summary of the revised ECQ determinations.

Table 3. ECQ Scoring Scale (Bushman, 2006).

Result of ECQ Determination	Level	Condition Code
90-100	Advanced	**GREEN**
70-80	Showing Progress	**YELLOW**
69-0	Just Started	**RED**

Table 4. Prairie Ridge Golf Course 2006 ECQ Summary (Bushman, 2006).

SUMMARY: Prairie Ridge GC 2006 Environmental Baseline Assessment				
No.	**Environmental Compatibility Indicator**	**Yes**	**Partial**	**No**
1	Overall Management Philosophy & Documentation	8	2	0
2	Safety, Training, & Awareness	10	0	0
3	Compliance	10	0	0
4	Pesticide Use, Storage, & Handling	7	3	0
5	Pollution Prevention	10	0	0
6	Conservation Practices	8	1	1
7	Water Resources	8	1	1
8	Maintenance Practices	7	1	2
9	Customer Relations and Education	7	1	2
10	Miscellaneous Special Projects & Activities	8	0	2
	Composite point total/response percentage	**83**	**9**	**8**
	Results for Prairie Ridge Golf Course; Ellsworth AFB, SD			
	Actual ECQ (Number of "Yes" responses)	**83**		
	Potential ECQ (Actual ECQ plus number of "Partial")	**92**		

The following sections list the Prairie Ridge golf course manager responses to the ECQ checklists and often include a rationale or explanation supporting the response. The supporting comments will serve to indicate the type of resolution intended, the status of the issue, and other helpful information. The statements may also include comments on resource shortfalls, challenges, criteria for success, or special needs, as appropriately determined.

2.2 Overall Management Philosophy & Documentation

2.2.1. Has management demonstrated that the environment is an important part of their responsibilities by initiating the GEM Planning process?

Yes. Golf course management has set up monthly environmental meetings, discussions on pest management activities, and become involved in project planning meetings with Civil Engineer Squadron functions.

2.2.2. Has the golf course adopted and posted an Environmental Policy?

Yes. The Prairie Ridge Golf Course has adopted the following US Air Force Golf Course Management Policy statement: "In concert with the mission of the United States Air Force, we pledge to employ only those management practices that minimize or eliminate the potential for negative impacts to the environment and the surrounding community, ensure compliance with all appropriate regulations, and to constantly reevaluate our processes to achieve the highest standards of environmental excellence." This policy has been prominently displayed in the clubhouse foyer.

2.2.3. Is the GEM Plan underway or completed, available, and updated regularly?

Yes. The initial Prairie Ridge GEM Plan has been completed and available.

2.2.4. Is a map of the property highlighting identified environmental challenges such as landfills, threatened or endangered species habitat, restoration sites, floodplains, etc. used in the environmental management decision-making process and is it posted for customers?

Yes. A map of the Prairie Ridge Golf Course is used to support environmental decision-making. The map and legend (posted at the Prairie Ridge GC clubhouse) is used to help explain environmental decision-making to patrons.

2.2.5. Are environmental goals, objectives, challenges, projects, and progress are evaluated at least annually and are regularly communicated to employees, customers, management, and the local community?

Partial. Environmental goals are evaluated annually and incorporated into the Prairie Ridge Maintenance Plan. Goals are communicated generally to employees at staff meetings; customers and local citizens will have access to the environmental information tri-fold.

2.2.6. Are written records of water quality monitoring activities, results, and control measures readily available?

Yes. Water quality monitoring is performed by the contracted operator of the Ellsworth wastewater treatment plant, which is located adjacent to the golf course (Hole 6); the Bioenvironmental Engineer Flight maintains copies of the analytical analyses performed by the contractor. Environmental Flight compiles these analytical results into a monthly Discharge Monitoring Report (DMR) to DENR; these reports characterize the monthly effluent discharge, including necessary control measures, are available for review.

EAFB personnel do not perform water quality sampling of the unnamed tributary or ponds on the golf course; DMR sampling results show that the discharged water meets EPA guidelines for reuse of treated wastewater and state standards for irrigation use. Golf course personnel need only perform visual, qualitative assessments of the streams and ponds located on the golf course and report unusual events where the water has become discolored, excessively turbid, or carries a sheen or odor.

2.2.7. Is there an inventory of bird and mammal species documented, maintained, and readily available?

Partial. The most recent base-wide inventory was completed in 1996; a project has been proposed for an updated inventory.

2.2.8. Is there a general understanding of how course management practices may positively enhance or adversely impact the environment?

Yes. Golf course personnel have spent a great deal of effort to become knowledgeable in the management of environmental compliance, environmental planning, and pollution prevention issues. Good environmental management will help to maintain the environmental quality and diversity of the golf course as a habitat and conserve resources (time, money, chemicals, etc.). A poorly managed golf course may require unnecessary additional resources to restore a habitat, resolve a repeat finding, or to pay fines.

2.2.9. Are the environmental impacts of pest control measures such as leaching and runoff potential, toxicity to non-target organisms, soil absorption capacity, pesticide persistence, water solubility, and effects on soil microorganisms and non-target species considered as part of the course management planning process?

Yes. Soil tests are performed annually to facilitate fertilizer selection and application rates. These test records are kept in a binder at the golf course maintenance building.

2.2.10. Are records of pest treatments employed and their effectiveness maintained and used to guide future pest control decisions?

Yes. All application records are stored in the golf course maintenance building.

2.3 Safety, Training & Awareness

2.3.1. Are all employees are familiar with the GEM program and are they trained on the importance of environmental compliance with the goals and objectives of the program as it applies to their duties?

Yes.

2.3.2. All appropriate employees are trained to be familiar with U. S. Air Force, federal, state, and OSHA regulations that apply to storage, handling, and disposal of chemicals used on the property?

Yes.

2.3.3. Are all employees are aware that chemical use, storage, and disposal and their potential risks to human health and the environment?

Yes.

2.3.4. Have all employees received documented training on avoiding management practices that may adversely impact worker health, on- and off-site water quality, local soil health, and wildlife species and their habitats?

Yes.

2.3.5. Is a current copy of all Material Safety Data Sheets (MSDS) for all chemicals used anywhere on the golf course property maintained and readily available for use by employees?

Yes.

2.3.6. Have all employees received documented, regular training on all potential OSHA issues associated with their duties?

Yes.

2.3.7. Are all golf course pesticide applicators active participants in a local respiratory and pulmonary testing program?

Yes. The golf course manager is the only applicator.

2.3.8. Are pesticides, fertilizers, and other chemicals stored on appropriate shelving in an approved storage facility?

Yes. Pesticides are stored at the Pest Management facility, which is managed by the installation Pest Manager; fertilizers are stored at the maintenance building.

2.3.9. Are golfers notified in the pro shop and on the first and tenth tees about the day's planned or recently completed spraying of any chemical or fertilizer that may be hazardous to human health or public safety?

Yes. A temporary sign is posted.

2.3.10. Are key staff members trained regarding water quality and conservation issues pertinent to the course and their particular duties?

Yes. The golf course manager and superintendent have been integrally involved in the development of plans vital to the protection of water quality, such as the Hazardous Waste, Spill Prevention, Pest Management plans. They have also worked with the BEE to ensure that personnel and patrons remain safe from exposure to potential health threats presented through use of the treated

wastewater. They have also worked diligently to maintain the condition of the course while attempting to reduce operational and maintenance costs of the irrigation system.

2.4 Compliance

2.4.1 Are fuel storage/delivery area and equipment managed in accordance with federal, state, and local regulations?

Yes. Gasoline and diesel fuel are stored in a combined double wall fuel tank (500 gal. each). Golf course personnel have worked with the AST/UST manager to ensure that all tank requirements are being met.

2.4.2 Are installation environmental staff members included in pertinent, on-going course management discussions and plans at scheduled meetings?

Yes. The Environmental Flight is invited to discussions on golf course issues and meets once monthly with golf course personnel.

2.4.3 Are there golf course staff meetings where environmental management issues are regularly discussed?

Yes. Discussions on topics such as training, critiques on procedures, priorities, etc. are conducted when warranted.

2.4.4 Does the director of golf and the superintendent attend all internal and external ESOHCAMP in-briefings and out-briefings?

Yes.

2.4.5 Does the director of golf and/or the superintendent coordinate with installation environmental staff on the various management plans that affect or include the golf course?

Yes.

2.4.6 Have all necessary permits been secured and/or updated and their requirements satisfied in a timely manner?

Yes. No permits are required to operate the golf course. The depredation permits required to control migratory birds and deer are current and are maintained by the Natural Resources manager. Permits for air and water discharge are being rewritten at this time.

2.4.7 Has appropriate impact analysis (NEPA) been performed on all proposed actions on or affecting the golf course property?

Yes. National Environmental Policy Act (NEPA) project proposals are coordinated through the Work Request Review Panel (WRRP), of which the NEPA program manager is a member. The last major project (Golf Cart Path) required an AF813, Request for Environmental Impact Analysis. An EIAP action (Environmental Assessment) was performed to retain real property for the golf course redesign (EAFB, 1999).

2.4.8 Are used oil containers in good condition, not leaking, and clearly labeled?

Yes. The ten-gallon used-oil tank is taken to the Auto Skills Center regularly to transfer the oil to the contractor pick-up point.

2.4.9 Has the golf course staff submitted their proposed management approach to the identified environmental challenges to the installation environmental staff for coordination and review?

Yes. The Environmental Flight has worked closely with the GCM to identify/resolve these challenges.

2.4.10 Were there less than two major golf course facility-related findings during the last official ESOHCAMP visit?

Yes. There were no Major findings for the Prairie Ridge activity during the June 2004 ESOHCAMP; however, there were two Minor findings (Natural Resources – no GEM in place--and Hearing Conservation protocols).

2.5 Pesticide Use, Storage, & Handling

2.5.1 Are there trained scouts on staff, other than the superintendent, to monitor turf and plant health and pest populations regularly using a process to notify management of pest problems and organized into a report or guide so that they can be used for future pest control solutions?

Partial. Golf course personnel have been trained to identify common turf and pest problems; for instance, personnel have been shown that flocks of birds begin to gather in areas that may have cutworm or other insect infestations. These training aids have not been yet been organized into a report or guide.

2.5.2 Are there written pest profiles of common pest species with a variety of potential control measures pre-evaluated including alterations in cultural management, biological, physical, and mechanical controls prior to treating the problem on the course?

Yes. Pest management maintains profiles for common turf disease and insect infestations, but does not maintain profiles on all topics of concern; instead, the golf course manager consults with a private firm (Warne Chemical) on these advanced topics.

2.5.3 Are there established and documented aesthetic and functional thresholds for all managed areas to effectively manage pest populations and reduce chemical use?

Partial. It is first helpful to point out that the term pest is referred to, in this instance, as either flora or fauna. Pest management thresholds for some species have already been established, either by the state and Federal government or locally. These and others are in the process of being considered for inclusion into the Pest Management and Invasive Species Management Plans.

2.5.4 Is there a specially designed pesticide mixing area where all mixing is performed by appropriately trained personnel?

Yes. No mixing is performed. The sprayer uses a pesticide injection system that eliminates the need for pesticide mixing. Wettable powders are not used.

2.5.5 Has a current list of pesticides and other chemicals stored or used at the golf facility been provided to the appropriate Fire Department(s)?

Yes.

2.5.6 Is there a written Integrated Pest Management Plan readily available and updated in use at the facility?

Yes. It is in the process of being updated and reviewed by Environmental Flight.

2.5.7 If personal protective equipment is required for pesticide use, storage, or handling, is it available for use by trained individuals?

Yes.

2.5.8 Are written and readily available records maintained of all applications of pesticides made by certified applicators, including the following?

2.5.8.1 The quantity of each pesticide used

Yes.

2.5.8.2 The chemical or common name of the active pesticidal ingredient(s)

Yes.

2.5.8.3 The pest or purpose for which the pesticide was applied

Yes

2.5.8.4 The date and place of application.

Yes.

2.5.9 Is the chemical storage structure/area locked, well ventilated, fire proof, and is access limited to select personnel?

Yes.

2.5.10 Are there designated and documented "no spray" areas around pond, river, stream, or lake edges and have they been communicated to pesticide applicators?

Partial. The "no spray" areas are designated and known to the applicator; however, these areas have not been mapped.

2.6 Pollution Prevention

2.6.1 Are there designated and documented "minimally-maintained" or natural vegetative buffer areas around pond, river, stream, or lake edges and have they been communicated to mower operators and pesticide applicators?

Yes. Planning has also begun to map these areas, the details of which are explained in the section on Water Resources challenges.

2.6.2 Has the Installation Spill Plan been amended to include the golf course facility and is there a spill containment kit at each required location and are there spill containment procedures in place?

Yes. Details of the Prairie Ridge plan have been included within the Mission Support Group and Other (Annex VII Site-Specific Spill Plans) web page accessible from the installation intranet.

2.6.3 Does the chemical storage area have a sealed metal or concrete floor and are all liquid pesticides handled over an impermeable surface?

Yes. The golf course maintenance building has a sealed floor, as does the Pest Management building (golf course pesticide storage area).

2.6.4 Does the chemical storage area have a lip along the edges to contain spills?

Yes. The bottom portion of the storage locker has a containment area.

2.6.5 Are liquid products stored below dry products and are dry materials stored on pallets or shelves to keep them off the floor?

Yes.

2.6.6 Have all the golf facility employees regularly received documented and approved HAZCOM and safety and health training?

Yes.

2.6.7 Are grass clippings blown off equipment with compressed air instead of or prior to washing?

Yes.

2.6.8 Are gasoline, motor oil, brake and transmission fluid, solvents, and other chemicals used to operate or maintain equipment and vehicles prevented from directly or indirectly entering water bodies?

Yes. These methods are addressed in the site-specific spill plan.

2.6.9 Has the watershed in which the course resides and contributes runoff to been identified and documented on a readily available map to aid the golf course staff in the management of their facility?

Yes. The natural drainages (watersheds) have been somewhat altered by stormwater conveyances and are mapped as stormwater drainages; these maps are available from the Water Quality program manager. Maps of the topographic, or natural drainages, are available within the Floodplain Delineation Study Report (USACE, 1996b).

2.6.10 Are appropriate quantities of fertilizers applied during weather conducive to reducing the potential for leaching and runoff?

Yes.

2.7 Conservation Practices

2.7.1 Are recycling containers conveniently provided for customer and employee use throughout the golf course facility?

Yes. There are recycling containers and trash bins at every hole.

2.7.2 Are there officially and appropriately designated minimally maintained areas on the golf course facility grounds?

Yes. Designated minimally maintained areas exist between nearly every hole. Figure 9 indicates the varying levels of maintenance for course turf.

2.7.3 Has the irrigation system or its components recently been upgraded to reduce inefficiency, malfunction, and overall water use?

Yes. A study was performed to upgrade the pumps, which have currently exceeded their useful life, to more efficient units (approximately $50K). Golf course personnel are continually vigilant in preventing/detecting leaks.

2.7.4 Has all "non-target" irrigation (ponds, natural, or out of play areas, etc.) been eliminated or minimized?

Yes.

2.7.5 Have flow meters been installed to monitor water use and detect potential waste?

Partial. Meters have been installed at the pump house and readings are recorded monthly; however, these meters may require periodic calibration.

2.7.6 Has the entire golf course facility property been examined for critical habitats, threatened or endangered species, wetlands, floodplains, and historical/cultural resources?

Yes. There are no critical habitats, no threatened/endangered species, and no historic/cultural resources. The property is part of a critical installation floodplain (USACE, 1996b) and contains most of the installation wetland property.

2.7.7 Are employees encouraged to minimize their trips around the course to conserve on the use of fossil fuels?

Yes. Golf carts are all electric; the mowing machines are gas-powered.

2.7.8 Does the restaurant and/or snack bar utilize reusable plates and silverware for use by customers throughout the facility's operating hours?

Yes.

2.7.9 Have all potential maintenance practices for designated "minimally-maintained" or natural areas been coordinated with the installation Bird/Wildlife Aircraft Strike Hazard (BASH) officer and environmental management personnel?

No. These areal extents and activities were established with help from Dr. Dan Friese (AFCEE) and Ellsworth Environmental Flight; however, little to no coordination has occurred between the golf course and BASH manager.

2.7.10 Are all motorized golf course equipment checked regularly for excessive air polluting emissions?

Yes. When a mower or other gas-powered machine begins to malfunction, it is either fixed or replaced.

Figure 9. Variability in turf condition is the result of flexible management (Holec, 2006).

2.8 Water Resources

2.8.1 Are water features regularly monitored for algae, erosion, excessive aquatic plant growth, fish kills, and sedimentation?

Yes. Visual monitoring consists of determining whether these indicators point to a specific cause and effect: algae growth caused by high nutrient availability may result in irrigation pump fouling or fish kills; excessive turbidity may lead to reduced irrigation capacity or aquatic vegetative growth. Occasionally, an irrigation system specialist is used to inspect subsurface portions of the system.

2.8.2 Are wash and wastewater kept from making direct contact with surface water and are they recycled or allowed to filter through a vegetative area when cleaning and maintaining equipment?

Yes. All facility sanitary sewer/floor drains lead to the Box Elder sewer system.

2.8.3 Outdoor irrigation of non-golf course landscape areas are regularly monitored and maintained for leaks and efficient performance?

Yes.

2.8.4 Has the golf course staff coordinated with stormwater management planning requirements from the installation's environmental staff?

Yes. The environmental staff performs an annual review at the golf course, placing particular emphasis on golf course maintenance practices, potential for exposed hazardous materials, and a review of best management practices (BMP). BMPs have not been developed for practices within the new maintenance areas.

2.8.5 Have part circle irrigation heads been installed where possible to preserve water resources and reduce maintenance while minimizing potential negative impacts to surrounding minimally maintained areas?

Yes.

2.8.6 Are all water feature maintenance tasks coordinated with the installation natural resource manager and bird/wildlife aircraft strike hazard officer?

Partial. These maintenance tasks, such as dredging the ponds, have been coordinated with the Natural Resources manager, but not the BASH manager.

2.8.7 Has the irrigation system been completely checked for proper water distribution in all irrigated areas and are water leaks fixed in a timely manner?

Yes.

2.8.8 Are moving water bodies such as streams or creeks that pass through the golf course regularly monitored for water quality both upstream and downstream of the course?

Yes. The water moving through the course is mostly wastewater treatment plant (WWTP) effluent; effluent is tested by the WWTP contractor to ensure the effluent water quality adheres to the National Pollutant Discharge Elimination System (NPDES) permit. Golf course personnel perform visual checks for turbidity, algal growth, and solids (including trash) to the point of discharge from the course; this discharge point (Outfall 006) is located on the EAFB property boundary and less than one mile from the WWTP outfall.

2.8.9 Does the facility have a Drought Management Plan written, ready, and available if, or when, irrigation restrictions may be instituted and required by the community or the installation?

No. The golf course manager has informal plans on how to pump water from the ponds into truck-mounted tanks, either with electric or hand pumps, if the irrigation system becomes inoperable. The discharge rate of the treatment plant is unlikely to affect the availability of water; however, if the ponds become too heavily silted, the irrigation system may be rendered inoperable.

2.8.10 Are water quality problems immediately reported to supervisors and appropriate installation environmental staff members for instruction and direction?

Yes. Infrastructure problems (plumbing, electrical, etc.) are called in to CE customer service. Water quality problems are reported to the Environmental or BEE Flights.

2.9 Maintenance Practices

2.9.1 Is there a written, regularly updated, and readily available Golf Course Maintenance Plan?

Yes. The Golf Course Maintenance Plan is updated annually, though is not yet available from a web link.

2.9.2 Does the Maintenance Plan include individual plans such as Integrated Pest Management, Tree Management, Hazard Communication, Drought Management, and Water Feature Management?

Partial. The Pest Management and Hazard Communication Plans are updated annually, though are not yet available from a web link. No Tree, Water Feature, or Drought Management Plans have been written.

2.9.3 Are green, tee, and fairway mowing heights maintained at reasonable levels without unduly stressing turf or requiring additional chemical inputs?

Yes.

2.9.4 Are there regular procedures in place to continually improve soil health such as topdressing, organic amendments, aeration, and drainage?

Yes. These procedures are included in the Maintenance Plan.

2.9.5 Is there a regularly-updated and readily-available map of the course's "hot spots" requiring special care or regular attention?

No. However, the golf course manager knows where the 'hot spots' are located.

2.9.6 Is all maintenance equipment maintained and cleaned in a manner that eliminates the potential for spreading of pest or disease contamination?

Yes. The equipment is washed regularly.

2.9.7 Has there been a complete examination for potential negative environmental impacts of all aspects of the golf course facility operation including the snack bar and grill, clubhouse, pro shop, and maintenance complex?

Yes. An inventory of all shop activities was performed to support the shop hazardous waste management plan. The golf course expected to complete a revised inventory as part of its inclusion into the EAFB Environmental Management System (EMS). For now, the HWMP is available from the Environmental Flight Environmental Plans intranet web site.

2.9.8 Is contour mowing used to conserve fuel and increase playability and aesthetics?

Yes.

2.9.9 Have all playing surfaces been inventoried and mapped for soil types including soil structure, nutrient levels, organic content, compaction, and water infiltration?

No. Information will be incorporated into the Golf Course Maintenance Plan.

2.9.10 Are soil tests and plant tissue analysis used to determine nutritional requirements?

Yes. Soil and plant tissue analysis is performed every three to four years.

2.10 Customer Relations and Education

2.10.1 Are the course manager and superintendent involved in a regularly updated, documented, and on-going customer educational program?

Yes.

2.10.2 Is there a conveniently located and highly visible place at the course or clubhouse where golf course environmental management notices and informational messages are regularly posted for customers?

No. The golf course manager plans to install an environmental notice board.

2.10.3 Do the course manager and superintendent actively communicate with customers to determine and document their points of view?

Yes.

2.10.4 Is there active and regular communication with the golf management staff, civil engineering, environmental management, the Services manager, and commanders by course management?

Yes.

2.10.5 Does the golf staff regularly survey their customers on how they rate the various elements of the golf course facility?

Yes. Marketing surveys are analyzed to determine needs and satisfaction levels.

2.10.6 Is there consistent and attractive signage around the course and grounds that would increase the awareness of the average golfer to the environmental management practices employed?

Partial. Signage is used to warn patrons/personnel of the health hazards associated with the treated wastewater. Other signs warn not to trespass in area of Operable Unit 6. The main signage is a bit cluttered with information, but a new sign is being crafted to replace the old one.

2.10.7 Are there signs appropriately located to warn golfers of hazards around or near recycled or otherwise non-potable water?

Yes.

2.10.8 If applicable, have areas of the course been designated "Environmentally Sensitive Zones" per USGA rules?

No.

2.10.9 Are course staff members trained regularly on how to improve their dealings with customers?

Yes.

2.10.10 Are there clinics provided to teach beginning golfers the basics of the game and to teach all levels of golfers the rules of the game?

Yes.

2.11 Miscellaneous Special Projects and Activities

2.11.1 Are there projects planned and funded for the near future that would demonstrate the compatibility of the course's management methods with protection of the environment?

Yes. Golf cart path installation planning is complete and awaiting funding.

2.11.2 Are there projects planned and funded to reduce the course's potential negative environmental impacts?

Yes. A redesign of the golf course was made to move portions of five holes from the airfield's southern clear zone. Funding was not approved because the base was initially listed for closure under the Base Realignment and Closure (BRAC)

commission (EAFB since removed from the BRAC list). The redesign is discussed in detail in the Airfield Clear Zone Challenge section.

The Natural Resources manager may consider controlling the turtle population in the course ponds to reduce depredation of fish populations in base lakes.

2.11.3 Are there tournaments or other events planned that may educate customers on the environmental challenges faced by the golf staff at this installation?

Yes. Earth Day golf tournaments are planned, but the local March-April weather is typically unpopular with golfers. These plans included offering commemorative Earth Day golf balls for patrons, with tournament activities or prizes that generate a focus on environmental aspects (trees from nurseries; cleaning supplies from HAZMART, commissary; 'made from recycled items').

2.11.4 Are there regular field trips for local students or other local community groups hosted at the course?

Yes. The golf course manager allows the local middle and high school to use portions of the golf course as a cross-country training area.

2.11.5 Are there projects planned to eliminate or minimize a potential erosion problem?

Yes. Completion of the golf cart path is expected to eliminate erosion in several areas.

2.11.6 Does the course have a native tree installation program complete with planting plan and maintenance schedule?

No.

2.11.7 Are any of the local schools or universities involved in educational or research activities at your course?

Yes. Annually, engineering students from the South Dakota School of Mines visit EAFB as part of the Fall semester Environmental Chemical and Physical Processes class (Figure 10). During this visit, they tour the wastewater treatment plant and are briefed on the golf course's treated wastewater reuse. As part of a project on water reuse, students helped develop the water quality monitoring guidelines discussed in the Water Resources Challenge section.

2.11.8 Are there special facility-wide recycling programs underway?

Yes. The installation maintains a bulk recycling collection service.

2.11.9 Is your course an active participant in the USAF Golf Environmental Management Program?

Yes.

2.11.10 Has your facility been nominated by your MAJCOM for the golf course environmental management award in the last 3 years?

No.

Figure 10. Students tour the wastewater plant and discuss golf course water reuse (2005).

3. Specific Environmental Challenges

3.1 Introduction

In the GEM program, environmental challenges are issues that require guidance, effort, or funding beyond the purview of golf staff. In this section, each Prairie Ridge challenge will be discussed; topics addressed include the regulatory driver, management approach, target resolution date, and project programming information.

3.2 Bird and Wildlife Aircraft Strike Hazard (BASH) Plan

The EAFB BASH Plan (EAFB Operational Instruction (OI) 91-212) does not list the golf course manager as a member of the Bird Hazard Working Group (BHWG), but requires golf course personnel to attend BASH/BHWG meetings. Unfortunately, the golf course manager has not been informed of scheduled meetings. According to EAFB OI 91-212, golf course personnel have been assigned the following tasks (EAFB, 2005c):

- Attend the BHWG meetings
- Report all hazardous bird activity and large gathering flocks of geese and ducks on the golf course to Flight safety (5-2389/2599)
- Work with 28th Bomb Wing BASH Program Manager and installation Natural Resources Program manager / Wildlife Biologist to control bird and wildlife activity on the golf course, which creates or has a potential to create a hazard to aircraft flight operations and or aircraft in the flight pattern.

Air Force Pamphlet 91-212, Bird/Wildlife Aircraft Strike Hazard (BASH) Management Techniques, states that other representatives (including the golf course manager) may be included on BHWG issues. The primary reason to ensure attendance by the golf course manager is to prevent BASH incidents due to lack of communication or coordination with golf course personnel. For example, golf course and airfield management personnel must coordinate activities designed to drive off large gatherings of birds to ensure that aircraft will not be operating in the area at the same time. The BASH manager should therefore

ensure that Prairie Ridge personnel are available at future BASH/BHWG meetings to fully represent potential golf course concerns.

Activating the BASH membership of golf course personnel is of particular importance due to the extent of wetlands and their proximity to the airfield. As shown in the course Challenge Areas Map (Appendix 3), approximately 5 acres of wetland habitat are located less than 400 feet from the airfield Clear Zone. A perennial stream flows through this area, warmed by discharges from the installation wastewater treatment system. This area attracts large flocks of migratory waterfowl, which has resulted in an increased potential for a BASH incident.

3.3 Airfield Clear Zone Encroachment

The installation Air Installation Compatibility Use Zone (AICUZ) Program Manager has determined that 35 acres (portions of Holes 2, 3, 4, 5, and 6) at Prairie Ridge Golf Course are within areas delineated by the Clear Zone (CZ) surfaces. Specifically, the Clear Zone is defined as the limits of the obstruction clearance requirements in the vicinity contiguous to the end of the Primary Surface. The length and width of a clear zone surface for a single runway is 3,000 feet by 3,000 feet (AFCEE, 1999). The Clear Zones are safety areas located immediately off both ends of active runways. The encroachment of the golf course within the Clear Zones is depicted in the Challenge Areas Map at Appendix 3; at Figure 11, a photograph shows the proximity of aircraft overflights to the golf course.

AFH 32-7084, The AICUZ Program Manager's Guide (AFCEE, 1999), Figure 4, Land Use Compatibility (page 79) indicates that Standard Land Use Coding Manual activity number 74 (Recreational Activities: including golf courses, horse stables, and water recreation) is not allowed in the Clear Zone. AFI 32-7063 (USAF, 2002), The AICUZ Program, further states that *"existing Air Force facilities and land uses may continue in the Clear Zone; however, replacement facilities will be programmed as part of the normal planning and programming process and must be sited outside the Clear Zone."* The MAJCOM Civil Engineer must approve alteration, minor additions, or improvements of

facilities in the clear zone (USAF, 2002). The AICUZ program manager has been consulted and has programmed a redesign of the golf course to resolve the Clear Zone encroachment.

Figure 11. Aircraft flyovers near Hole 2 can be both exciting and unnerving (Holec, 2006).

As a result, a land use study was performed (FMG, 2000) to consider options for a golf course redesign by using the former Renel Heights Military Housing property. The golf course and landscape design team submitted three concepts that moved play areas out of the Clear Zone: Concepts A and C both provide an 18-hole regulation course with Holes 7 through 18 constructed on the old Renel Heights housing land; Concept B provides a nine-hole executive-length course; Concept C provides an 18-hole regulation course. Golf course personnel favor the creation of Concept C, shown in Appendix 6.

Two projects were programmed in 1994: FXBM940004 was planned to construct nine new holes on the Renel Heights property; FXBM995004 was planned to relocate five holes

from the Clear Zone (three of which would be moved to Renel Heights). In calendar year (CY) 2000 dollars, the cost of the project ($1.7 million) was estimated to be approximately $138,000 per hole (FMG, 2000). In CY2007 dollars (4 percent annual rate of inflation), the cost was estimated to be $2.25 million, or $182,000 per hole. If these costs are projected to CY2016, the project will cost $3.2 million, or $258,000 per hole. The design requirements and computations for the course expansion are included at Appendix 7.

An environmental assessment has been completed; the study proposed that approximately 120 acres of the Renel Heights property be retained for possible future use as a golf course (EAFB, 1999). The Finding of No Significant Impact (FONSI) was signed by Col. Anthony Przybyslawski on 3 June 1999.

3.4 Storm and Wastewater Outfalls

According to the 1996 floodplain optimization study, the golf course is part of drainage area 006 (terminating at Outfall 006), which consists of about 1,474 acres (EAFB 1996a). The 3.5 mile drainage course receives runoff from Fuel Storage Areas C and D, the base golf course and riding stables, the RCRA Part B Hazardous Waste Storage area, OU-6, -7, and -9, intermittent storm water runoff from industrial areas due to rainfall and snow melt, and about 800,000 gal/day from outfall 005 from the base Waste Water Treatment Plant (WWTP) (ibid.). The runoff from these areas drains through Bandit Lake, Heritage Lake, and Gateway Lake, and eventually to the golf course ponds.

The EAFB Facility Response Plan (EAFB, 2006) identifies the lakes as part of larger structural control meant to prevent spills from the industrial area from leaving the base in accordance with 40 CFR 112. Although of limited detention capacity, these ponds have the potential to retain or dilute pollutants that might otherwise be transported off the installation; an effort to contain a spill by damming the culvert could have disastrous consequences to the facility and grounds. The areas served directly by this last line of defense are the wastewater treatment plant, south Clear Zone, Ellsworth Street north of Bismarck Gate, fuel offload terminals, and OU-6. As a result, it has become vitally important that the installation

maintain the retentive capacity of the ponds and interconnecting waterways by removing accumulated silt and overgrowth.

A large volume of sediment has built up in the small pond, generally referred to as the holding pond. Most of the sediment was generated during the renovation of the three base lakes (Bandit, Heritage, and Gateway) over the last ten years; however, discharge from the wastewater treatment plant also contributes to the solids influx. Sediment buildup has reduced the volume of the small pond, shown in Figure 12, and contributed to an increase in submergent vegetative growth.

Figure 12. The course holding pond harbors an undesirable amount of vegetation (2005).

The silt volume of the small pond has lowered the hydraulic residence time and depth of the pond. Both factors influence the settling rates of suspended solids within the pond, which results in a greater potential to convey the suspended solids to the larger pond. The large pond will eventually begin to lose capacity as well. The lower water depth in either pond will increase the potential for growth of submergent and emergent vegetation—habitat and food for wildlife (particularly waterfowl). A flyover photograph of the ponds is shown at Figure 13; note how the pond bottom is visible just a few inches from the water surface.

Figure 13. Shallowness of small pond has stimulated vegetative growth (Geobase, 2005).

Nutrient and solids loadings from these upstream discharge areas have also led to the heavy growth of algae, cattails, and other weedy growth in the wetlands stream channel. This vegetation has choked the channel section near the treatment plant discharge point, as well as other portions of the interconnecting waterways (Figure 14). This accumulated

vegetation may slow the flow of spilled pollutants and sediment, but will likely cause the dispersion of spilled contaminants over a wider area of stream channel.

Figure 14. The treatment plant discharge is heavily choked by algae and cattails (2005).

Personnel have proposed a project (Work Request Number 49078; 18 Nov 04) to have the silt dredged from the ponds and adjacent waterways. The purpose of this project is to restore pond volume. Work at this time may also be included to reduce the amount of weedy growth in the stream channels, particularly near the treatment plant outfall and the Hole 9 fairway (a section of upstream waterway is shown at Figure 15). To proceed with the project, the volume of silt should first be determined in order to provide a good cost estimate for the project.

As previously mentioned in the BASH section, 5 acres of wetland habitat are located less than 400 feet from the airfield Clear Zone. As shown in the Challenge Areas Map (Appendix 3), the wetlands area is composed primarily of ponds and waterways within the floodplain. These wetlands must be managed in accordance with Executive Order 11990, *Protection of Wetlands*, May 24, 1977; as a result, environmental personnel should secure the proper permits for potential wetlands maintenance.

Figure 15. Vegetative assessment of the waterway along the Hole 9 fairway (2005).

3.5 Invasive Plant Management

Executive Order 13112 (Invasive Species) directs EAFB to provide goals and objectives to detect, respond rapidly to, and control populations of invasive species in a cost-effective and environmentally sound manner. The installation Invasive Plant Management Plan (EAFB, 2005e) provides site-specific information on species to be controlled, the detection and monitoring program, action thresholds, and control techniques to be used. The plan includes a list of recommended management actions for the course, particularly with regard to control and eradication of thick infestations of Canadian Thistle (as shown in Figure 16).

Figure 16. Thick patches of thistle and bindweed are numerous over the course (2005).

A Noxious Weed Survey report has been prepared to support completion of the Invasive Species Management Plan. The report (EAFB, 2005d) delineates project areas, defines weed types, identifies weeds present, and maps densities and acreages of the weeds; a map of golf course weeds is shown at Appendix 5. There are two challenges for golf course, environmental, and pest management personnel. The first will be to integrate these findings into the respective pest management programs; the second will be to implement the recommended control techniques.

3.6 Water Resources Protection

The challenge in this case is to ensure protection of all water resources of the golf course, including but not limited to irrigation capacity and management of the resource. The regulatory driver for these actions is AFI 32-7064, Integrated Natural Resources Management, which authorizes Air Force activities to manage the protection of water resources. The two aspects that EAFB should address within this area are 1) ensuring availability of the resource, and 2) management of the resource, when necessary.

The source of water for the golf course is reclaimed wastewater effluent drawn from the large pond. The determination of water quality is discussed as a management objective in Chapter 4; yet, the availability of sufficient water remains to be a concern. According to golf course personnel, approximately 250,000 gallons of water are used daily to irrigate a little over 32 acres of fairway, fairway buffer, and greens (a depth of nearly one-third inch per night). Design Concept C for the course expansion is expected to increase the irrigable extent to approximately 72 acres, which will require over 560,000 gallons per night.

First, as indicated in the Storm and Wastewater Outfall Section, the golf course ponds have accumulated enough silt to reduce the capacity of the irrigation pond. For the last two years, the intakes of the irrigation pumps have frequently become clogged with silt; siltation has forced prolonged system shutdowns. The damage to greens and fairways currently seen may be an impact attributable to these shutdowns (an example of which can be seen in Figure 17).

Figure 17. Stress shown by Hole 1 green may be due to water availability/quality (2005).

As projects to restore the pond volumes move forward, project planners should work closely with the Environmental Flight Natural Resources Manager to identify objectives and extents of dredging operations, evaluate areas proposed for dredging, and to secure permits (when necessary) to dredge wetlands areas. Planners should determine the scope of the project with the understanding that the demand for irrigation water is highest (at night) when production (effluent discharge) is lowest. Information from the EAFB Environmental geodatabase (Geobase, 2006) states that the large pond has a 2.7 acre surface area; if the pond was maintained to a depth of 1 feet over the entire surface, the volume of the pond would be equal to the daily discharge of the treatment plant (800,000 gallons). The capacity

of the pond was calculated to be triple the daily volume required; the intake clogging problems would indicate that the large pond has less depth at the upper end than previously thought.

The second aspect of this challenge is to understand and face potential risks of managing the treatment plant discharge. For instance, the course currently uses about 30 percent of the daily treatment plant discharge during the irrigation season, which should result in 550,000 gallons being discharged downstream to whatever users and habitats exist. If the course is expanded, it will require 75 percent of the discharge and let 250,000 go downstream – a 45 percent reduction in downstream flow. EAFB personnel should manage the treatment plant discharge with awareness for the potential to affect downstream users.

3.7 Floodplains

Management of floodplains are conducted in accordance with Executive Order 11988, *Floodplain Management*, May 24, 1977, which requires all federal agencies to provide leadership and reduce the risk of flood loss; minimize the impacts of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values of floodplains when acquiring, managing, or disposing of federal lands.

According to the floodplain studies performed in 1996 (USACE, 1996a; 1996b), 262 acres of EAFB property have the potential for inundation during a 100-year event. As shown in the course Challenge Areas Map at Appendix 3, 22 acres of the golf course are within the 100-year floodplain. During a 100-year event, Holes 7, 8, and 9, all the practice areas, and approximately 2,300 feet of cart path are expected to be damaged (estimated replacement cost of $500,000). A photograph of the flooded practice green is shown at Figure 18.

The studies were not specific about the potential overtopping of Ellsworth Road in the vicinity of the golf course, the flow regime of the 6-foot culvert underneath, or of the flood hazards expected for the off-base trailer park in the vicinity of the culvert discharge. A recent agreement between Ellsworth AFB, the Cities of Rapid City and Box Elder, the Federal Emergency Management Agency, and the Omaha Corps of Engineers (study

contractor) will result in a revision of regional flood hazard data; a follow-on optimization study will be used to address effects of roadway overtopping and backwater.

Figure 18. Intense thunderstorms have caused flooding in practice areas (Holec, 2006).

3.8 Installation Restoration Program (IRP)

Operable Unit 6 (OU-6) is the designation for a 5-acre landfill situated just north and west of the 3rd and 6th holes at Prairie Ridge Golf Course. The landfill was used to dispose of demolition debris, hardfill materials, miscellaneous refuse and dried sewage sludge from 1960-80 (EAFB, 2004). The remedial objectives established by the Record of Decision were to provide protection against direct contact with or ingestion of landfill contents, minimize infiltration through the landfill, and control surface water runoff and erosion of the landfill cover. The Record of Decision required construction of a perennially-vegetated landfill cap and development of a long term monitoring plan for the site (ibid.).

The remedial measures did not impact the golf course activities, although environmental personnel have considered how this property might be reclaimed. The first consideration should be that Clear Zone constraints have reduced the potentially reusable area to that of a 2-acre triangularly-shaped parcel in the northeastern corner of OU-6. Secondly, the parcel happens to be a steeply graded slope--uphill from the adjacent fairways and greens. Perhaps the best reuse option may be to reclaim the parcel as a vegetated, though undisturbed, buffer for the golf course; removal of the fence would certainly enhance the visual appeal of this area. A depiction of the unconstrained OU-6 parcel is provided at Figure 19.

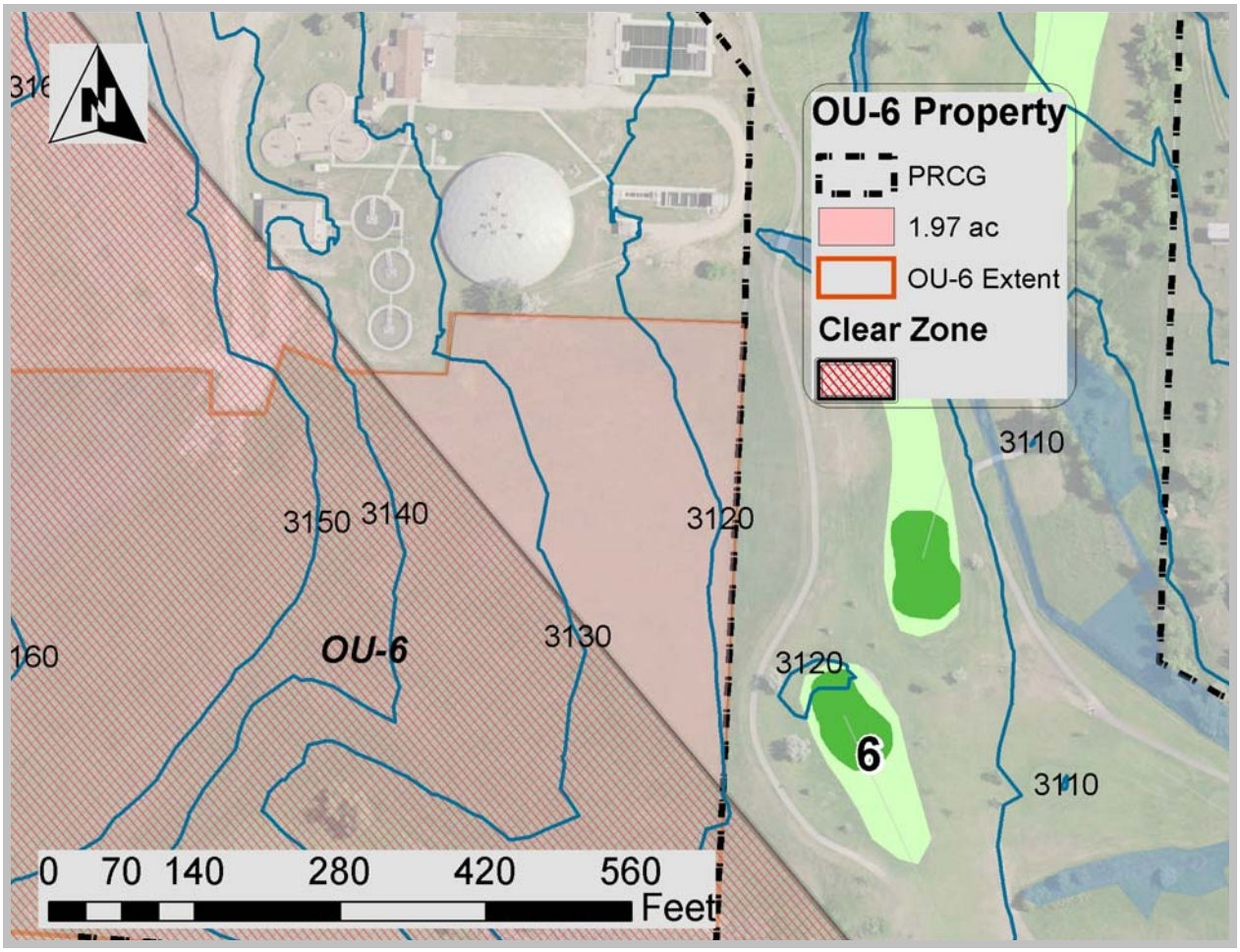

Figure 19. Only the northeast corner of OU-6 is outside the Clear Zone (Geobase, 2006).

3.9 Summary of Challenges

Prairie Ridge has seven identified environmental challenges; the mission impacts range from critical (BASH implementation) to none (OU-6 reclamation). The costs to remedy these situations range from minimal (BASH implementation) to over $2 million (Clear Zone encroachment). The common thread is the relationship of water to each of these challenges: managing flora and fauna, maintenance of irrigation systems, implementation of spill control plans, prevention of erosion and flood damage, and wetlands management. As a result, the fix for each problem must be compatible and integrated with elements of the appropriate environmental quality management plans (especially the installation Integrated Natural Resources Management Plan).

Resolution planning must involve the development of a reasonable range of alternatives and an assessment of potential effect of each alternative— every action taken will impact other elements of the course--the effect could be an adverse impact or a force multiplier. For example, consider the potential impacts taken to resolve the Water Resources Protection challenges upon Storm and Wastewater, Floodplain, and Wetlands challenges. In this case, the golf course irrigation capacity has been diminished by upstream lake restoration and WWTP sediment discharge. A construction project to restore this capacity has the potential to impact BASH, spill response, wetlands management, and flood mitigation objectives.

As a result, projects to resolve challenges will require a greater intensity of involvement by installation personnel and be planned and programmed, not *by* golf course personnel, but *with* golf course personnel. Additionally, personnel should expect that these projects may require funding from sources other than Non Appropriated Funds and proceed accordingly. In the end, the efforts to resolve golf course environmental challenges need to reflect and accommodate the higher priority operational needs and impacts--they are, in fact, installation projects, not golf course projects.

4. Future Goals and Objectives

4.1 Introduction

This section is intended to address environmental issues to be resolved by golf course personnel with minimal guidance, effort, or funding. A summary list of management and maintenance activities has been placed at the end of the following discussions.

4.2 Water Resources Management

4.2.1 Introduction

At Ellsworth AFB, the water resource management issues for golf course personnel include irrigation system maintenance, water quality and availability, pond and stream maintenance, and floodplain/wetlands management. Additionally, the golf course water bodies have the potential to receive inputs of pesticide, herbicide, and fertilizer from course maintenance activities, and to serve as habitat for waterfowl and West Nile virus vectors. The following management issues are being addressed by golf course personnel:

- Training of staff on appropriate water quality issues
- Creation of turf buffers, minimally-maintained, and no-spray zones
- Use of slow release fertilizers
- Assessment of past pesticide-use; incorporation of findings into practice
- Assessment of the need to dredge golf course ponds and waterways

4.2.2 Description of Water Resources

EAFB is situated on a gently sloping north-south upland plateau between Elk Creek to the north and Box Elder Creek to the south (EAFB, 2001). Storm water from the main base area is discharged by a series of drainage ditches which eventually exit the base through one of seven National Pollutant Discharge Elimination System (NPDES) permitted outfalls into Box Elder and Elk creeks, tributaries of the Cheyenne River.

The mapped drainage for the golf course begins at the spillway of Gateway Lake (to the north) and ends at the 6-foot diameter culvert passing under Ellsworth Road. Drainage

through the golf course is generally to the southeast through a network of fairly regular and open, but weedy and wooded, channels. The golf course drainage is approximately one mile long, is crossed by seven golf cart bridges, and flows through six culverts, one small pond, and one large (aerated) pond. The culverts are either round corrugated metal (under cart paths) or large concrete conduits (at pond inlets/outlets). The smaller pond (0.37 acres) flows into the larger (2.7 acres) aerated pond, which is used for watering the course. The perennial flow continues from the large pond to the culvert, also known as EAFB Outfall 6.

The water sources for the drainage are the installation wastewater treatment plant, seepage from Gateway Lake (not gauged), and ungauged local groundwater sources. The drainage maintains a perennially flow of 5 to 10 CFS, due largely to the effluent flow of the wastewater treatment plant, which was reported to have an average daily discharge of 0.6 MGD (Fitch, 2004). The plant was designed to process a 5.0 MGD maximum daily flow (ibid). The average daily discharge for September 2005 was 0.831 MGD (EAFB, 2005b).

4.2.3 Water Quality Issues

Wastewater treatment effluent is the source for a large portion of the water used for irrigation; as such, Prairie Ridge Golf Course personnel have always had an interest in water quality. Prairie Ridge Golf Course is the only facility in the Rapid City area that is known to irrigate exclusively with reclaimed treatment plant effluent. Course personnel use approximately 225,000 gallons of water daily to irrigate golf course greens and fairways (during the irrigation season). In their efforts to maintain the condition of the course, Prairie Ridge personnel have expressed the need to cultivate a greater level of confidence in the quality of the water source they rely upon. This objective can be attained through regular consultation with the Environmental and Bioenvironmental Engineering (BEE) Flights.

4.2.3.1 Assessment of Water Quality

The development of water quality objectives and water quality assessment was considered a best management practice, the discussion of which can be found in Chapter 5.

4.2.3.2 Turf Buffer, No-Spray, and Minimally-Maintained Areas

Turf Buffers and minimally-maintained areas. Turf buffers and minimally-maintained areas have been delineated, but not mapped. Turf buffers have been established as areas of irrigated rough used to protect greens and fairways from weedy growth and erosion. These buffers may also prevent errant play from encroaching upon adjacent play areas. Generally speaking, the two types of grass buffers found on the Prairie Ridge course are turf buffers and minimally-maintained buffers: turf buffers are irrigated but not mowed; minimally-maintained buffers are infrequently (if ever) irrigated and are mowed only when necessary to meet BASH requirements. The width of the buffers around water features was characterized, in the 2004 GCEBA, as minimal to non-existent (Bushman, 2004); the width and type of buffer to be established depends upon how the water feature is classified (simple riparian, wetland, etc.) A photograph contrasting the differently managed turf areas on the course is shown at Figure 20 .

Figure 20. Note contrast between irrigated and minimally-maintained areas (Holec, 2006).

No Spray or Pesticide-Free Buffer Zones. Management of pesticide drift, runoff or leaching into sensitive areas, such as water courses (including stormwater ditches), ponds, lakes and wetlands, may be reduced by establishing pesticide-free zones. The width of these zones may vary depending upon the agent used or, in other instances, by simply setting a standard width. The method employed must be able to accommodate the variability of terrain and the intensity of treatment. At Prairie Ridge Golf Course, a flexible approach was needed to complement the more infrequent use of pesticides.

Although this topic should be discussed to a greater level of detail in the golf course pest management plan, the width of the 'no spray' buffer was based upon the type of agent used and whether the area could be reached with application equipment. According to the installation pest manager, all the information needed by the applicator is on the agent label (Grimes, 2005). If an application restriction is indicated, some other control method must be implemented in protected areas: an alternate pesticide type may be used or, in the case of weeds, mowing equipment may be used to prevent weeds from forming seed (effectively preventing new growth).

4.2.3.3 Slow-Release Fertilizers

By admission, Prairie Ridge personnel have always exercised conservation in the application of turf conditioners; however, they expect that portions of the course will continue to require higher applications rates than most. Course personnel have procured approved types of slow-release fertilizers and are developing a plan for use and application. The plan will address how golf course personnel determine the appropriate fertilizer application types, times, rates, extent, and methods. The golf course manager is planning to arrange a visit by a turf specialist, last conducted in 1998, to discuss how to use these fertilizers to maximum benefit in an especially harsh environment (arid, severe climate; tight clay soils).

4.2.3.4 Incorporating Findings from Pesticide-use Assessments

Golf course personnel plan to incorporate findings from internal and external pesticide-use assessments into their Pest Management Plan. These findings will address how golf

course personnel optimize the appropriate pesticide application types, times, rates, extent, and methods. These assessment activities should include a cost-effectiveness comparison of prevention versus control/eradication methods and the effectiveness of chemical control/eradication to biocontrol or hand-removal methods.

4.2.3.5 Waterway Maintenance

A detailed discussion on how to maintain the golf course waterway, as part of the installation drainage system, is included in the Storm and Wastewater Outfall Challenge section.

4.3 Golf Cart Path Completion

Several hundred feet of asphalt golf cart path has already been constructed to preserve vital areas of the golf course. Appendix 4 shows a diagram of golf cart path that remains to be constructed; the cost to build the remaining sections was estimated to be approximately $40,000. The project has been approved, though funds are currently unavailable.

4.4 Facility Repair Activities

The cracks in the maintenance building bay floor are expected to be fixed in the summer of 2006, after an evaluation of the settling rate has been performed. Currently, the Services, Civil Engineer, and Contracting squadrons are managing the claims and fix-it process. No estimated completion date has yet been established.

The group of signs located at the entrance to the parking lot (shown in Figure 21) was characterized in the 2004 GCEBA as somewhat cluttered (Bushman, 2004). The golf course manager agreed and has scheduled this signage for replacement.

Figure 21. Course signage has been considered to be somewhat cluttered (Bushman, 2004).

4.5 Irrigation System Repair

The functional operability of the irrigation system has been affected by the age of the pumping system and the positioning of the pump intake relative to water level. The pump intake becomes occasionally clogged with silt, which must be cleared away by a scuba diver. The pumps have nearly reached the end of their life cycle, but are expected to operate effectively until replacements can be funded. The cost to upgrade the irrigation pump system to a 3-pump design is expected to cost nearly $50,000; the project has been approved, though funds are currently unavailable.

4.6 Debris Pile near Hole 2

A large pile of debris, including discarded wood, metal, and brush, has accumulated near the Hole 2 fairway; a photograph of the debris pile is shown at Figure 22. The golf course manager has planned to coordinate disposal of this debris by acquiring a roll-off dumpster; he estimated this task can be easily performed. The manager will need to coordinate the

waste cleanup with the Environmental Flight Planning Element Chief (Greg Johnson, 5-2692) to coordinate the delivery and pickup of a roll-off dumpster through the 28 CES Contract Management section. Once the Services Contract manager has arranged for provision of the dumpster, the golf course manager will be able to schedule and budget for the cleanup.

Figure 22. Debris accumulated near the Hole 2 fairway must be removed (2005).

4.7 Management Plans

The Integrated Natural Resources Management Plan (INRMP) requirements impose a need upon the golf course manager to write several management plans, including Priority Area (or 'Hot Spot') Map, Drought, Tree, and Water Feature management plans. The INRMP (AFCEE, 2004) states a requirement for the installation to manage trees according to an Urban Forestry Management Plan; this is the ideal vehicle in which to incorporate golf course tree management. A Drought Management Plan is essential for fulfilling the INRMP requirement to "irrigate grounds only when necessary to justify aesthetic or functional user

requirements." Since most of the Prairie Ridge water features are sited in wetland areas, the Water Feature Management Plan should augment the INRMP.

Informational resources to develop these plans are readily available in AFI 32-7064 and from leading golf course associations. For instance, implementation of a drought management plan usually relies upon site-specific data collected by regional weather sources: precipitation measurement; pan evaporation rates, historical records, etc.

4.8 Summary

Table 5 lists the management and maintenance activities to be undertaken by course personnel over the next GEM Plan cycle. As time and expertise will permit, more of these management actions could be posted on the CES Environmental or Services web links.

Table 5. Future goals and objectives to be addressed by PRGC personnel.

Challenge	Aspect/Impact	Resolution
Water Resources	Train golf course staff on water quality issues	Develop/train staff on WQ issues ECD Nov 06
Water Resources	Create turf buffers, minimally maintained, and no spray zones	Establish and map buffer zones ECD Dec 06
Water Resources	Slow release fertilizers should be used whenever possible	Plan use of and procure slow-release fertilizers ECD Jan 07
Water Resources	Examine and incorporate past pesticide-use patterns	Incorporate analysis into Pest Management Plan Update No ECD
'Hot Spot' Mgmt	Determine areas that require high priority effort ('hot spots')	Map 'hot spots' and develop resolution initiatives No ECD
Drought Mgmt	No drought management plan	Develop Plan No ECD
Tree Mgmt	No tree management plan	Develop Plan No ECD
Water Feature Mgmt	No water feature management plan Minimal to no buffers around water features	Develop Plan No ECD

5. Best Management Practices

5.1. Introduction

The Prairie Ridge staff supported the development of a best management practices document and recommended inclusion of the following water quality assessment practice.

5.2 Water Quality Assessment

The constituents of concern for the urban use of reclaimed water are salinity, sodium, trace elements (including metals), excessive chlorine residual, nutrients (EPA, 2004), and pathogens. For Prairie Ridge personnel to ensure the health of patrons and personnel, healthy plant growth, and maintain a reliable irrigation system, some reasonable measures were needed to ensure that reclaimed water is clear, odorless, and colorless for aesthetic purposes, and to assure minimum health risk. The objectives proposed were as follows: establish confidence in the course water quality; prevent degradation of course water quality; establish a response mechanism to potentially degraded course water quality.

In establishing confidence, two sets of constituent concentration limits were used to screen course water quality. The first set was developed by integrating the requirements of six states (AZ, CA, FL, HI, NV, TX, and WA) that regulate restricted urban water reuse. Restricted urban reuse is defined as irrigation in public areas where access can be controlled, such as golf courses and cemeteries (EPA, 2004). In general, these states require secondary or biological treatment followed by disinfection, and impose limits on biological oxygen demand (BOD), total suspended solids (TSS), turbidity (in nephelometric turbidity units; NTU), and fecal coliform (bacterial colony count).

The second set is used by the State of South Dakota (DENR, 2004) to determine the suitability of water for the irrigation beneficial use classification. These criteria are used to establish whether irrigation waters have acceptable concentrations of dissolved solids (conductivity). Conductivity is measured in units of micro-mho per centimeter (US customary unit). The Sodium Absorption Ratio (SAR) analysis is used to determine the potential for a particular dissolved solid (sodium) to affect the infiltration capacity of soil.

Discharge Monitoring Reports, or DMRs, are used by EAFB personnel to monitor and report the concentrations of constituents discharged from the treatment plant in accordance with the installation NPDES permit. The permit limits from the September 2005 DMR (EAFB, 2005b) were referenced and compared to the "six-state" and DENR beneficial use criteria; the compared values, shown in Table 6, were found to meet nearly all of the established criteria. Only two permit values (turbidity and fecal) exceeded the "six-state" criteria; these instances have been addressed in the following discussion.

Table 6. Constituent guidelines for reclaimed water for (Restricted Urban Reuse).

Constituent	Typical Range of Concentration Limits (EPA, 2004)	Beneficial Use Criteria (DENR, 2004)	EAFB Effluent NPDES Permit Limits (EAFB, 2005b)
BOD	20-30 mg/L (ave)		30 mg/L (ave.)
TSS	5-30 mg/L (ave)		30 mg/L (ave)
Turbidity	2 NTU* (ave)		13 NTU (ave) (calculated)
Fecal	0-200 col/100 mL		1000 col/100mL (ave.)
Chlorine			0.019 mg/L (max)
Conductivity		2,500 μmhos/cm (ave)	809 μmhos/cm (ave) (actual)
SAR		10	4

*State of Washington Only

EAFB has no permit limit for turbidity (NTU) or conductivity; the turbidity value shown was instead calculated by applying the relationship shown in Equation 1. The conductivity value shown was the actual sample result from the September DMR.

Equation 1. Estimating Turbidity from TSS concentrations (from Metcalf & Eddy, 2003).

$$\text{TSS, mg/L} = (TSS_f) * (T)$$

Where TSS, mg/L is regarded as total suspended solids in mg/L

T is the turbidity in nephelometric turbidity units (NTU)

TSS_f is the coefficient for unfiltered secondary treatment (2.3 mg/L TSS/NTU)

Washington is the only state that has imposed a maximum limit on turbidity (2 NTU average and 5 NTU maximum). Unfortunately, these turbidity limits do not correlate well with the TSS relationship described in Equation 1; neither the rationale nor the disparity was discussed. However, the state's TSS limit is the same as the EAFB NPDES permit limit (30 mg/L). In the end, the TSS results were considered to be a satisfactory measure of clarity.

The remaining task was for golf course and medical personnel to minimize the exposure of course patrons to pathogens which may be found in the irrigation ponds and in the aerosols formed during the irrigation process. The pathogens commonly found in wastewater include bacteria, protozoa, helminths (worms and eggs), and viruses; most of these pathogens can result in enteric infections, and/or ear, eye, and nose infections (Metcalf and Eddy, 2003). Typically, as in both the EAFB NPDES permit and EPA guidelines, the fecal coliform bacteria groups are used as a surrogate measure of the presence of pathogens. According to the water reuse guidelines (EPA, 2004), no risk-based analysis is currently available with regard to exposure to other pathogenic organisms and no states have set limits on other pathogenic organisms in waters used for restricted urban reuse.

EAFB's fecal coliform limit is substantially higher than the "six-state" limit; however, discharge records indicate that the typical coliform concentration is approximately 2 colonies per 100mL. As the general practice is to limit exposure to these waters, course personnel have restricted the use of irrigation systems to off-hours (when the public or employees might be subject to spray aerosols) and have installed signs around the course ponds warning others not to fish or swim in the water.

In examining the SAR, it was found that EAFB does not collect the sodium, calcium, and magnesium concentration data needed to calculate the ratio. Instead, the SAR input data from the City of Rapid City (RCWRF, 2005) was used, as a surrogate, to calculate the Sodium Absorption Ratio (SAR) for the EAFB effluent. The computation table used to calculate the SAR is included at Appendix 8. The results indicated an SAR of 3.96, which was well under the limit of 10 established by DENR to prevent damage to soils and plants.

The course manager, however, should carefully consider whether these findings support site-specific turf management methods and whether to perform an SAR analysis of EAFB effluent.

5.3 Conclusion

Since effluent makes up the majority of flow in the course waterways, use of the treated discharge will meet restricted urban reuse standards so long as NPDES permit limits are met. This finding has given the Prairie Ridge staff renewed confidence in the quality of their irrigation water and eliminated a perceived need to perform expensive water quality testing. Further, the operational measures used to minimize the potential health risks to patrons and personnel have been diligently implemented. As a result, course personnel have simplified their water quality management activities to the extent that only routine visual assessments are needed.

The response mechanism for reporting potential water quality degradation works very well. Environmental and BEE Flights have a good relationship with Prairie Ridge personnel and have repeatedly demonstrated their willingness to respond and provide support to the golf staff. For instance, if golf course personnel notice that course waterways have become discolored, excessively turbid, or carry a sheen or odor, they seek guidance from Environmental and BEE personnel. Course personnel have consulted with Environmental Flight and BEE personnel on treatment plant odors, fish kills, and irrigation problems.

If course water quality problems ever become a recurring problem (unrelated to treatment plant incidents), course personnel may consider direct monitoring. For instance, frequent measurements of pH, temperature, dissolved oxygen, conductivity, and oxygen-reduction potential could be collected by use of a hand-held multiprobe (YSI, 2006). Advanced water quality monitoring methods, such as in-lake sampling for dissolved and sediment-bound nutrients, secchi-depth (lake turbidity), and chlorophyll-*a*, could also be considered. However, direct and advanced monitoring methods are expensive and require extensive training; they should only be used to support specific water quality objectives.

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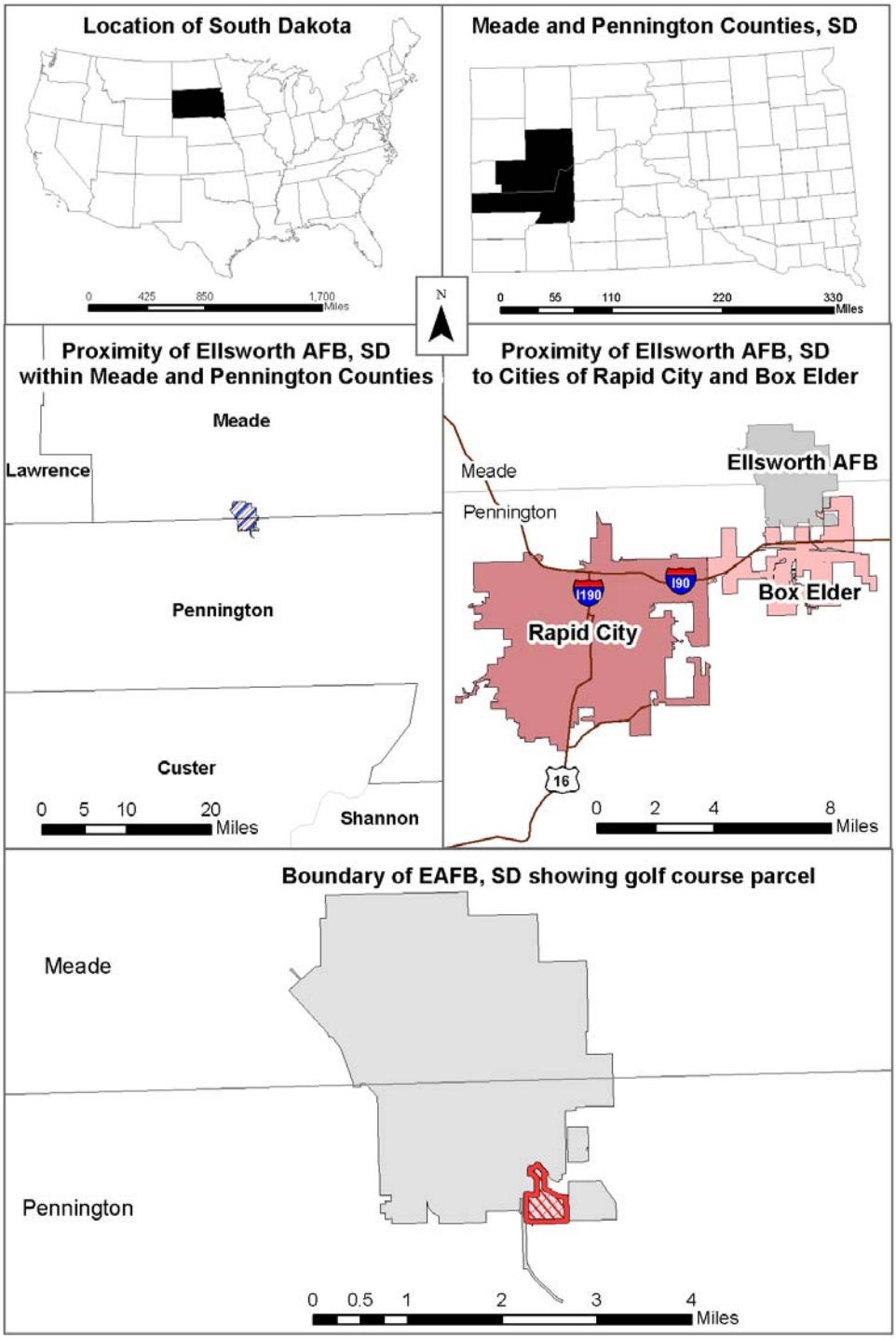
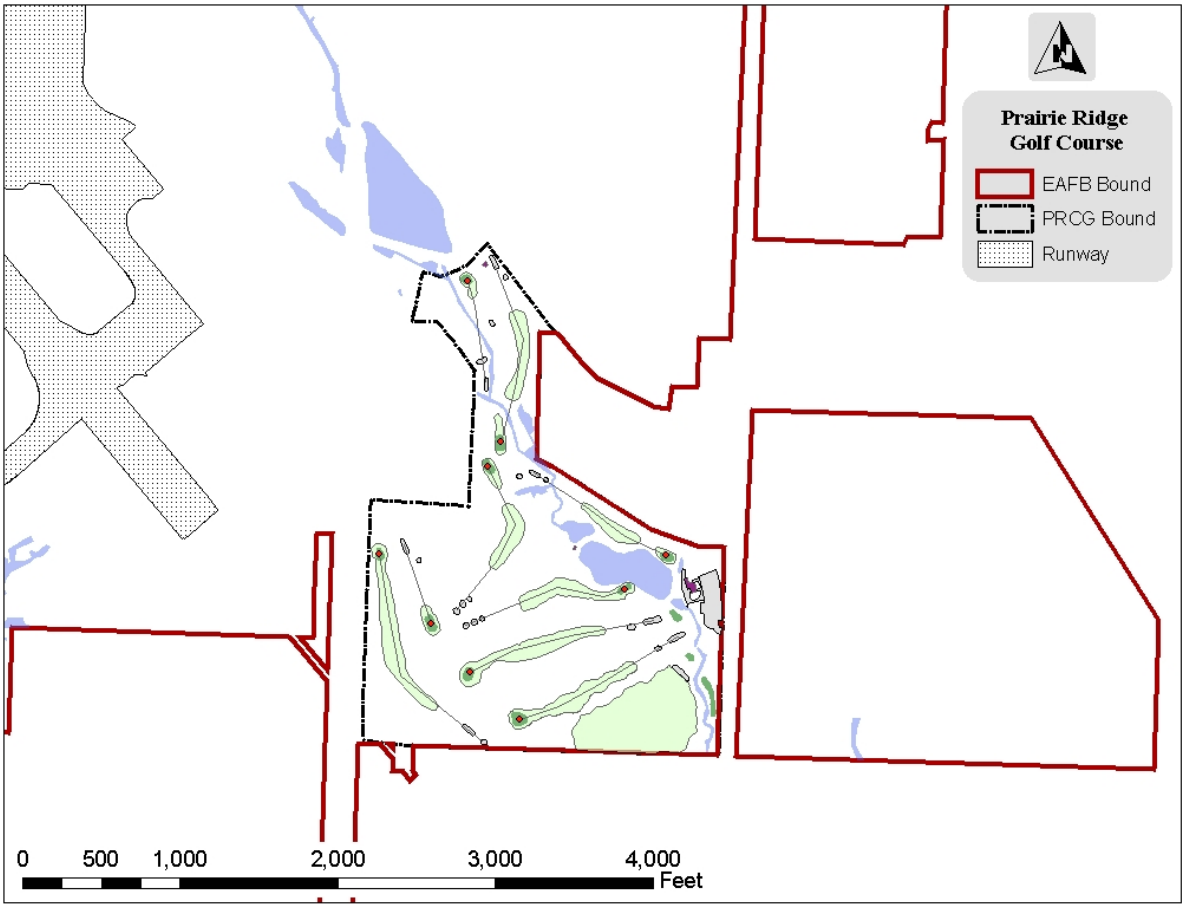
7. Appendices.

Appendix 1. Location Map for EAFB (Geobase, 2005).

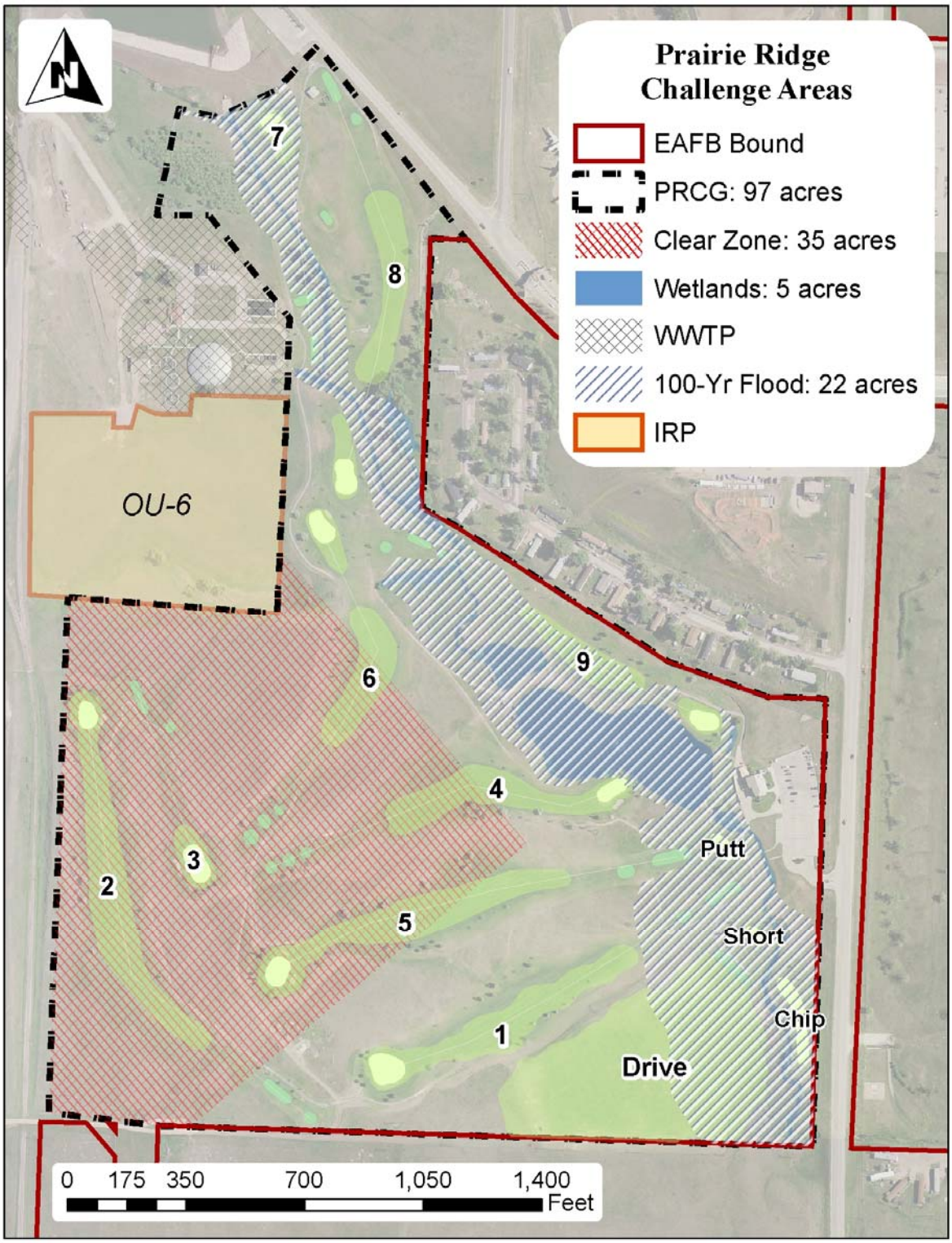


Appendix 2. Golf course location map (Geobase, 2005).

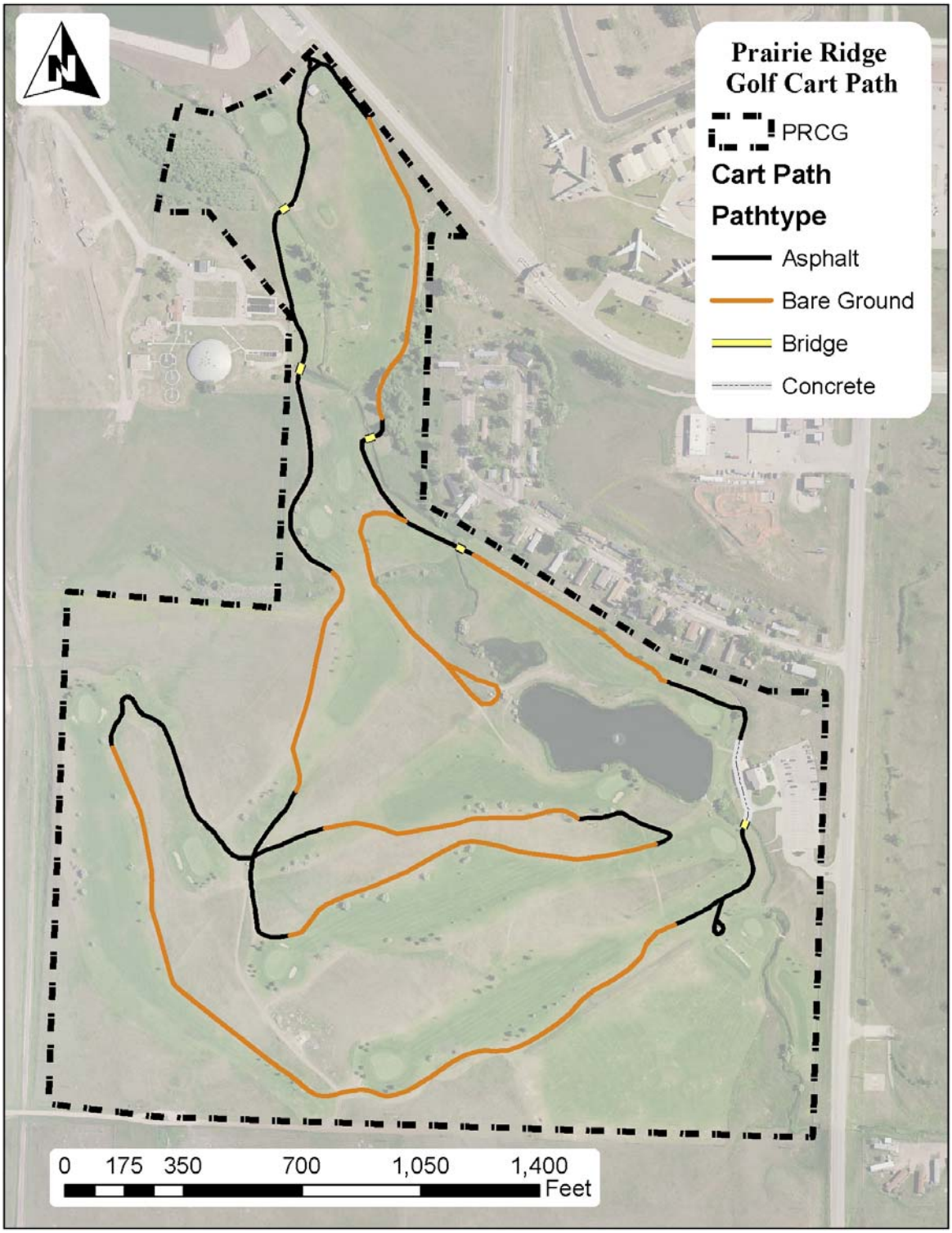
The course is located in the southeast corner of Ellsworth AFB. The large empty area across Ellsworth Road to the east is the old Renel Heights Housing area, a portion of which is planned for future course expansion.



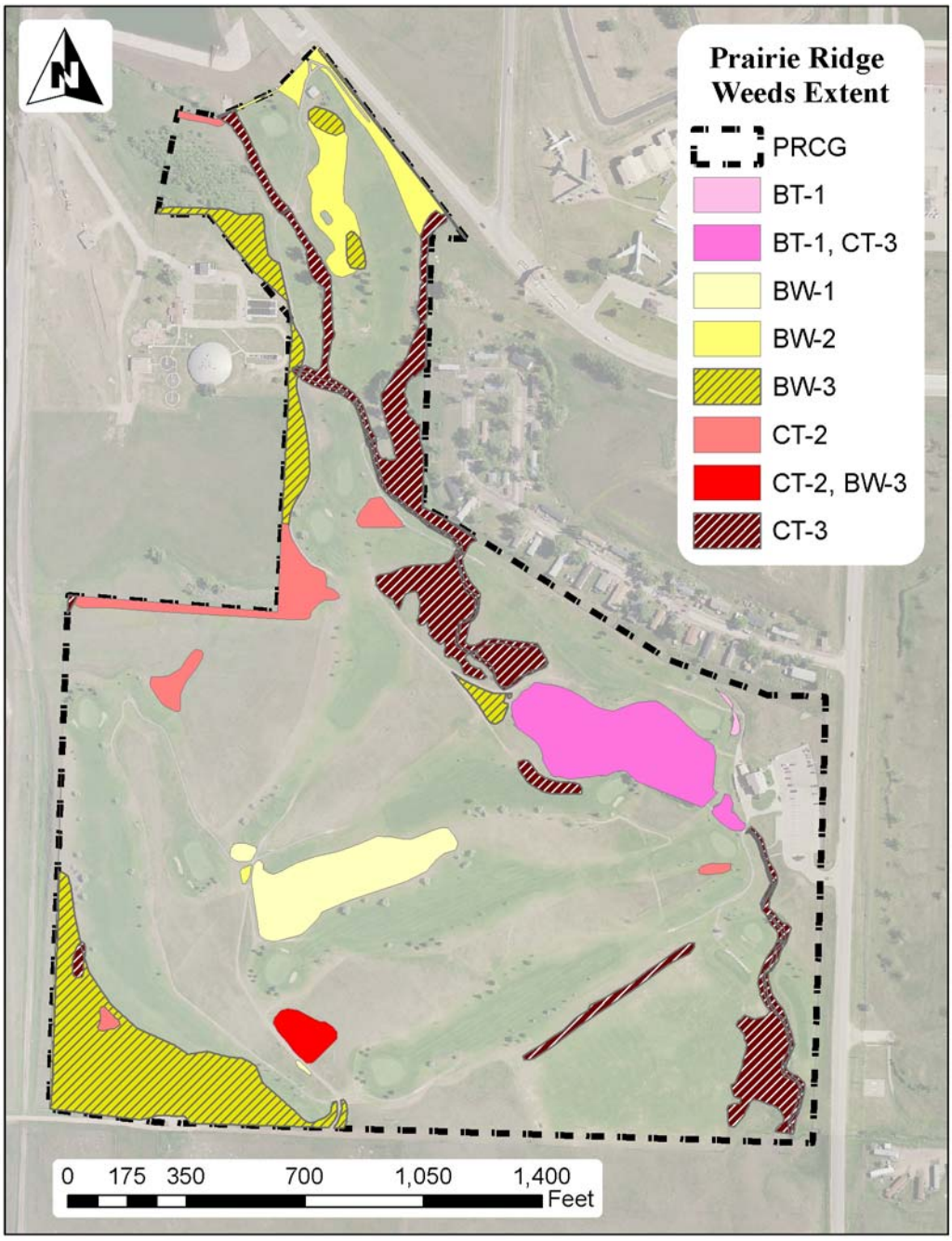
Appendix 3. Challenge Areas Map (Geobase, 2005).



Appendix 4. Cart Path Map (Geobase, 2004).

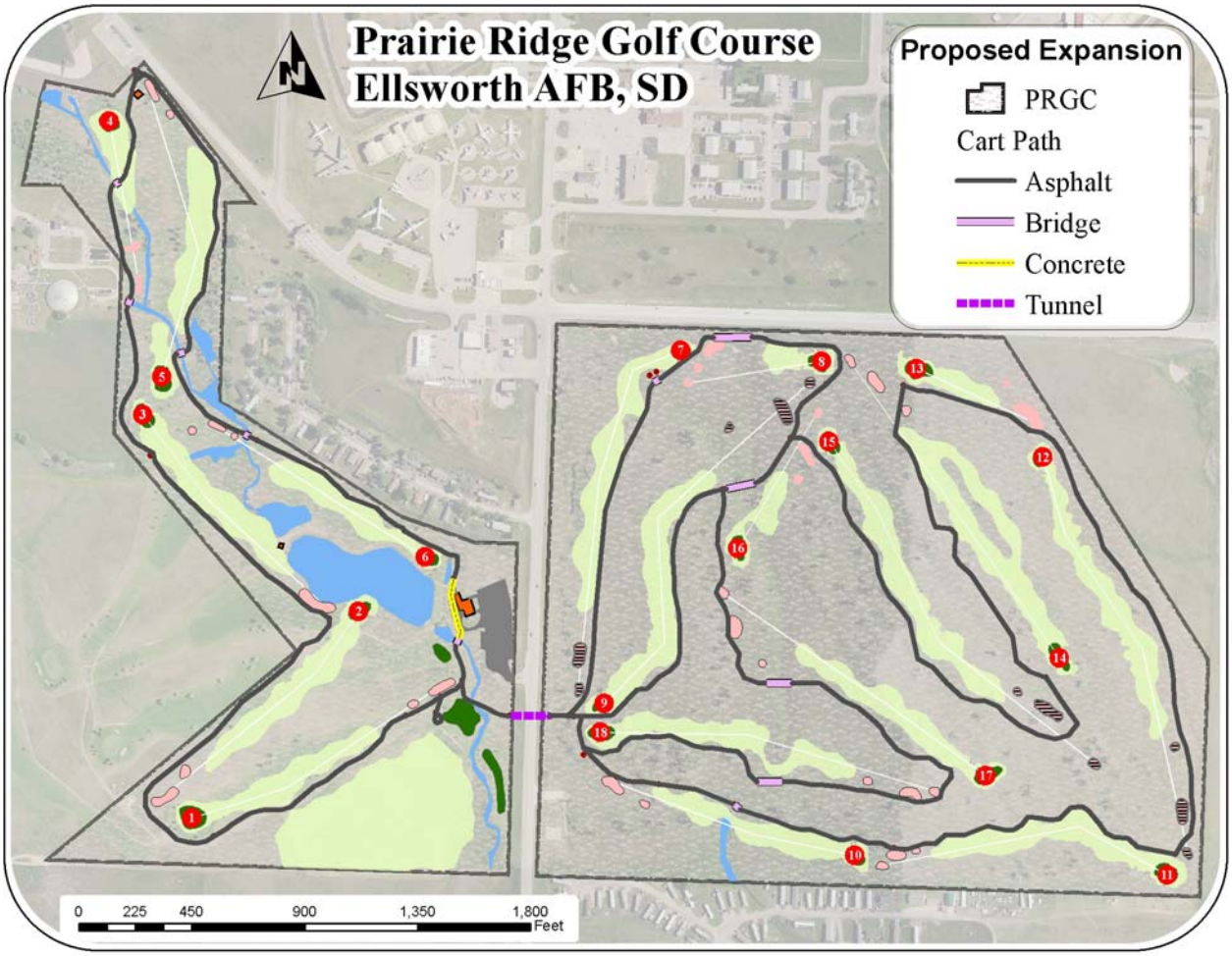


Appendix 5. Weeds Map (EAFB, 2005d).



Invasive plant species	Weed Density Code
BT: Bull Thistle (Cirsium vulgare)	1: Scattered individuals
BW: Field Bindweed (Convolvulus arvensis)	2: Scattered patches
CT: Canada Thistle (Cirsium arvense)	3: Medium-sized patches
	4: Numerous large patches

Appendix 6. Proposed Expansion Map (HMG, 2000).



Appendix 7. Expansion costs (FMG, 2000) (4 percent annual rate of growth).

Item	Quantity	Unit	Unit Cost (FY2000)	Subtotal (FY2000)	Subtotal (FY2007)	Subtotal (FY2016)
Golf Course Items:						
Mobilization	1.00	lump sum	$ 40,000.00	$ 40,000	$ 52,637	$ 74,919
Bonds and Insurance	1.00	lump sum	$ 35,000.00	$ 35,000	$ 46,058	$ 65,554
Surveying and Staking	1.00	lump sum	$ 25,000.00	$ 25,000	$ 32,898	$ 46,825
Rough and finish grading	100,000.00	cubic yards	$ 2.00	$ 200,000	$ 263,186	$ 374,596
Ellsworth Road Underpass	1.00	lump sum	$ 155,000.00	$ 155,000	$ 203,969	$ 290,312
Irrigation Pump Station	1.00	lump sum	$ 50,000.00	$ 50,000	$ 65,797	$ 93,649
Irrigation System, expanded	1.00	lump sum	$ 275,000.00	$ 275,000	$ 361,881	$ 515,070
Green Construction, including	75,000.00	square feet	$ 4.00	$ 300,000	$ 394,780	$ 561,894
Sand					$ -	$ -
Peat Moss					$ -	$ -
Topmix mixing					$ -	$ -
Topmix Hauling					$ -	$ -
Shaping					$ -	$ -
Gravel base					$ -	$ -
Seeding					$ -	$ -
Drainage allowance					$ -	$ -
Sod allowance					$ -	$ -
Topsoil preparation	50,000.00	cubic yards	$ 2.00	$ 100,000	$ 131,593	$ 187,298
Seedbed preparation and seeding	65.00	acres	$ 1,250.00	$ 81,250	$ 106,919	$ 152,180
Erosion control	1.00	lump sum	$ 25,000.00	$ 25,000	$ 32,898	$ 46,825
Bunker construction, including	50,000.00	square feet	$ 1.50	$ 75,000	$ 98,695	$ 140,474
Shaping and edging					$ -	$ -
Sand hauling and placement					$ -	$ -
Drainage					$ -	$ -
Sod allowance					$ -	$ -
Rocks/boulder retaining wall	1.00	lump sum	$ 25,000.00	$ 25,000	$ 32,898	$ 46,825
Asphalt cart paths	7,500.00	linear feet	$ 12.00	$ 90,000	$ 118,434	$ 168,568
Lake shaping	75,000.00	square feet	$ 2.00	$ 150,000	$ 197,390	$ 280,947
Soil polymer and injector	65.00	acres	$ 750.00	$ 48,750	$ 64,152	$ 91,308
Miscellaneous amenities	1.00	lump sum	$ 35,000.00	$ 35,000	$ 46,058	$ 65,554
Subtotal				**$ 1,710,000**	**$ 2,250,243**	**$ 3,202,798**
Design Services	1.00	lump sum	6%	$ 102,600	$ 135,015	$ 192,168
Contingency	1.00	lump sum	15%	$ 256,500	$ 337,537	$ 480,420
Total				**$ 2,069,100**	**$ 2,722,794**	**$ 3,875,385**
Cost per hole (15 holes)				$ 137,940	$ 181,520	$ 258,359
Project: Construct 9 Holes				$ 1,241,460	$ 1,633,677	$ 2,325,231
Project: Repair 6 Holes				$ 827,640	$ 1,089,118	$ 1,550,154

Appendix 8. Sodium Absorption Ratio (SAR) computations

The following computations show results of SAR determination (Metcalf and Eddy, 2001) for Rapid City Water Reclamation Facility 2005 effluent data (RCWRF, 2005); these computations used the maximum sodium concentration and the minimum magnesium and calcium concentrations. These results could be used comparatively to approximate the SAR for EAFB treatment plant effluent. An SAR of 10 or below is considered to be fully supporting of the irrigation beneficial use (DENR, 2004).

Computations for Constituent Milliequivalency and the Sodium Absorption Ratio (Gapon Equation)

Constituent Element of Interest	Molecular Weight (g/mol)	Mass Concentration per Unit Volume (mg/L) *	Convert to gram per Unit Volume (g/L)	Divide by Molecular Weight to find Molarity (mol/L)	Ion Valency (Absolute Value)	Multiply by Valency to find equivalency (Normality)	Convert to milliequivalency per unit volume (meq/L)
Sodium; Na^{+}	22.99	**141**	0.1410	0.00613	1	0.006	6.13
Calcium; Ca^{2+}	40.08	**93**	0.093	0.00232	2	0.005	4.64
Magnesium; Mg^{2+}	24.31	**2**	0.002	0.00008	2	0.000	0.16

Gapon Equation for Calculating the Sodium Absorption Ratio (SAR)

Sodium Absorption Ratio: The milliequivalency per unit volume of Na divided by the square root of half the summed milliequivalencies of Ca + Mg.

Gapon equation formula: G5/(SQRT((G7+G9)/2))

(Ayers and Wescot, Water Quality for Agriculture, 1985)

Use the total concentration value, not dissolved or recoverable concentration values

Sodium Absorption Ratio for sample = **3.96**

** User inputs ion concentration data into Mass Concentration column*