MONOLITH RANCH MEADOWS CONSERVATION PLAN 1.0

DUCKS UNLIMITED

CITY OF LARAMIE

This conservation plan, and its appurtenant engineering, plansets and other data, was prepared by the Ducks Unlimited, Inc. Colorado-Wyoming Field Office in 2016-2017 in fulfillment of the requirements set forth in the Grant Agreement, managed by the City of Laramie. All inquiries regarding the contents of this report can be made to: Tom Peterson, Biologist, 1825 Sharp Point Drive, Suite 118, Fort Collins, Colorado 80525, tpeterson@ducks.org, (308)218-8160.

FOREWARD:

The purpose of this project is to determine the feasibility of improving irrigation and enhancing activities on the Monolith Ranch Meadows. The Monolith Ranch Meadows is part of the 11,788-acre Monolith Ranch owned by the City of Laramie (City). The Monolith Ranch is located three miles south of Laramie in Albany County, Wyoming and was purchased by the City in 1981, as a long-term investment to secure additional water supply for the future. To date, the City has not changed use for any of the water rights associated with the Monolith Ranch and their adjudicated use remains irrigation (Laramie Comprehensive Plan 2007). The focus of this project is to explore improving irrigation infrastructure to improve agricultural operations and thus also enhancing irrigated habitat for migratory birds on the western portion of the ranch associated with Harney Creek and Goforth Reservoir.

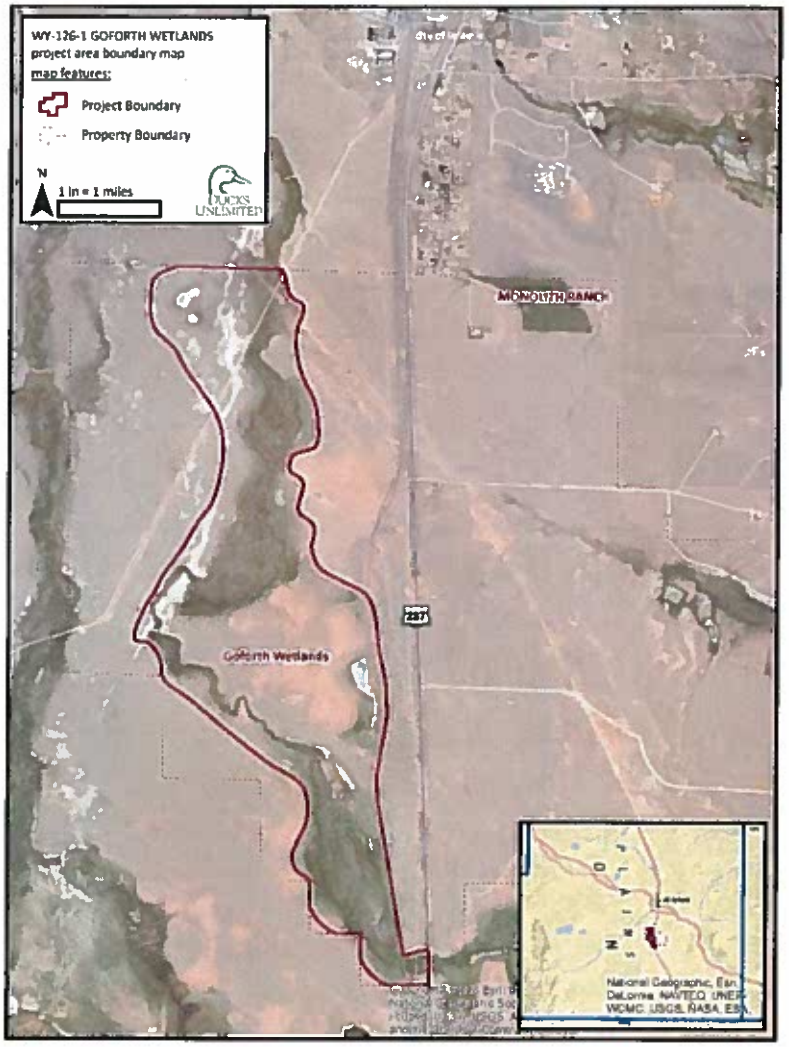


Figure 1. Map of Monolith Ranch Meadows project area.
Monolith Ranch, located south of Laramie by approximately 3 miles, encompasses 11,788 acres. The Monolith Ranch Meadows encompasses nearly 2,000 of these acres which have been used primarily for agriculture (i.e., irrigated meadows and livestock grazing).

In 2016, the Ranch Advisory Committee and the City of Laramie, approached Ducks Unlimited to assist them with exploring the feasibility of addressing several pending issues on the Monolith Ranch Meadows. The impending issues are listed below.

- The Goforth Reservoir Dam, which was breached in the early 1980s, and is no longer functioning
- Repairing the jurisdictional dam is cost prohibitive
- Available water rights for the ranch on Harney Creak are not efficiently utilized
- Infrastructure needed to improve efficacy and efficiency of irrigation water in the is lacking resulting in poor water distribution in Columbus Meadow Complex
- The water rights tied to the Columbus Meadow Complex, north of Goforth Reservoir, are unadjudicated
- Water control structures on the Goode Meadow Complex, south of Goforth Reservoir near HWY 287, are not functioning properly
- Water resources on the Goode Meadow Complex are being under utilized
- There is interest in developing high quality recreation opportunities with limited access
- There is interest in developing a small put and take fishery at Goforth Reservoir and improving wildlife viewing or hunting opportunities on the Monolith Ranch Meadows as a secondary benefit to improving agricultural grazing and irrigating practices

The Monolith Ranch Meadows are part of a larger landscape known as the Laramie Plain Wetland Complex that has been recognized for its importance in providing high-quality wetland habitats (Copeland et al. 2010, WGFD 2014, Tibbets et al. 2016). Conservation of wetland habitats in this region will provide benefits to not only waterfowl and other waterbirds, but to as many as 39 Species of Greatest Conservation Concern identified as using wetlands for part of their life cycle in the region (WGFD 2010). For more information on the context of the Monolith Ranch Meadows in the Laramie Plains Wetlands Complex please refer to the Laramie Plains Wetland Complex Regional Wetland Conservation Plan available on the WGFD website (https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Habitat%20Information/Wyoming%20Wetlands%20Conservation%20Strategy/Laramie-Plains-Wetlands-Complex.pdf).

Prior to settlement, natural wetlands covered about 3.2% of Wyoming (Dahl 1990) and were predominantly associated with riparian corridors and glaciated montane regions. By the mid-1980s, the total area of wetlands had been reduced to approximately 2% (Dahl 1990). Both the number and area of natural wetlands continue to decline, though this is offset to some extent by an increase in ponds and other human-created wetlands and water bodies.

Waterfowl management in North America is guided by the goals and objectives laid out in the North American Waterfowl Management Plan (NAWMP, NAWMPC 2012). These plans are particularly important to helping guide irrigated wet meadow habitat for waterfowl. Continental population objectives for ducks, geese and other waterbirds are achieved through the adoption of three overarching goals:

1.) Abundant and resilient waterfowl populations to support hunting and other uses without imperiling habitat;

2.) Wetlands and related habitats sufficient to sustain waterfowl populations at desired levels, while providing places to recreate and ecological services that benefit society; and,

3.) Growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation.

Achieving these goals depends upon identifying and delivering appropriate regional and local conservation activities. The success of the NAWMP is "predicated on the premise that cumulative effects of many targeted local-scale management actions will ultimately benefit continental waterfowl populations through improvements in recruitment and survival (IWJV 2013, p. 4.2)." The activities prescribed in this conservation plan target habitat conditions most likely to improve waterfowl populations and our enjoyment of those populations.

This plan presents a long-range vision to improve forage production and wildlife habitat in addition to improving the application and utilization of water associated with the Monolith Ranch Meadows. The basic purpose of this plan is to provide a biologically sound framework for improving the infrastructure and management of the Monolith Ranch Meadows. Although securing funding for all aspects of this plan may not be feasible all at once, each component of recommended infrastructure replacements and enhancements will incrementally increase options to apply principles of water and wetland management. As such, the components should be viewed as individual actions for funding purposes, with each action providing immediate benefits and ultimately contributing to a desired future condition.

MONOLITH RANCH MEADOWS SUMMARY:

The Monolith Ranch Meadows fall within a portion of the Monolith Ranch located between Highway 287 and County road 34 (Sand Creek Road). It is part of the Laramie Plains Wetland Complex which encompasses about 1,480 m^2. The Laramie Plains Wetland Complex contains approximately 100,000 acres of wetland habitat that is important to a variety of species including, Gadwall, Mallard, Franklin's Gull, Sandhill Crane, and White-faced Ibis (WGFD 2014). Restoration techniques outlined in this plan would substantially increase the agricultural productivity and value of the Monolith Ranch Meadows while also benefitting the aforementioned species and other migratory waterbirds that annually migrate through the Laramie Plains.

On a broad scale, infrastructure improvements are needed to improve irrigation, conserve water, increase seasonal availability of water supplies, and improve water conveyance among proposed irrigation cells. Selected irrigation cells would be managed seasonally as foraging sites to sustain larger, more diverse populations of migratory waterfowl, shorebirds, and other waterbirds. Goforth Reservoir will store water for irrigation, but will also provide other essential habitat functions such as brood rearing and migration habitat for waterfowl. Improved water management capabilities will not only improve forage for livestock but will also improve the composition and distribution of plants species that will benefit migratory waterbirds. The associated benefits of increasing functionality of irrigated hay meadows will not only improve abundance and diversity of wildlife on Monolith Ranch, but it may also present opportunities to improve agriculture income and recreational opportunities such as, waterfowl hunting, bird watching, hiking, and fishing. The future uses of the Monolith Ranch Meadows will be determined by the Ranch Advisory Committee and the City of Laramie.

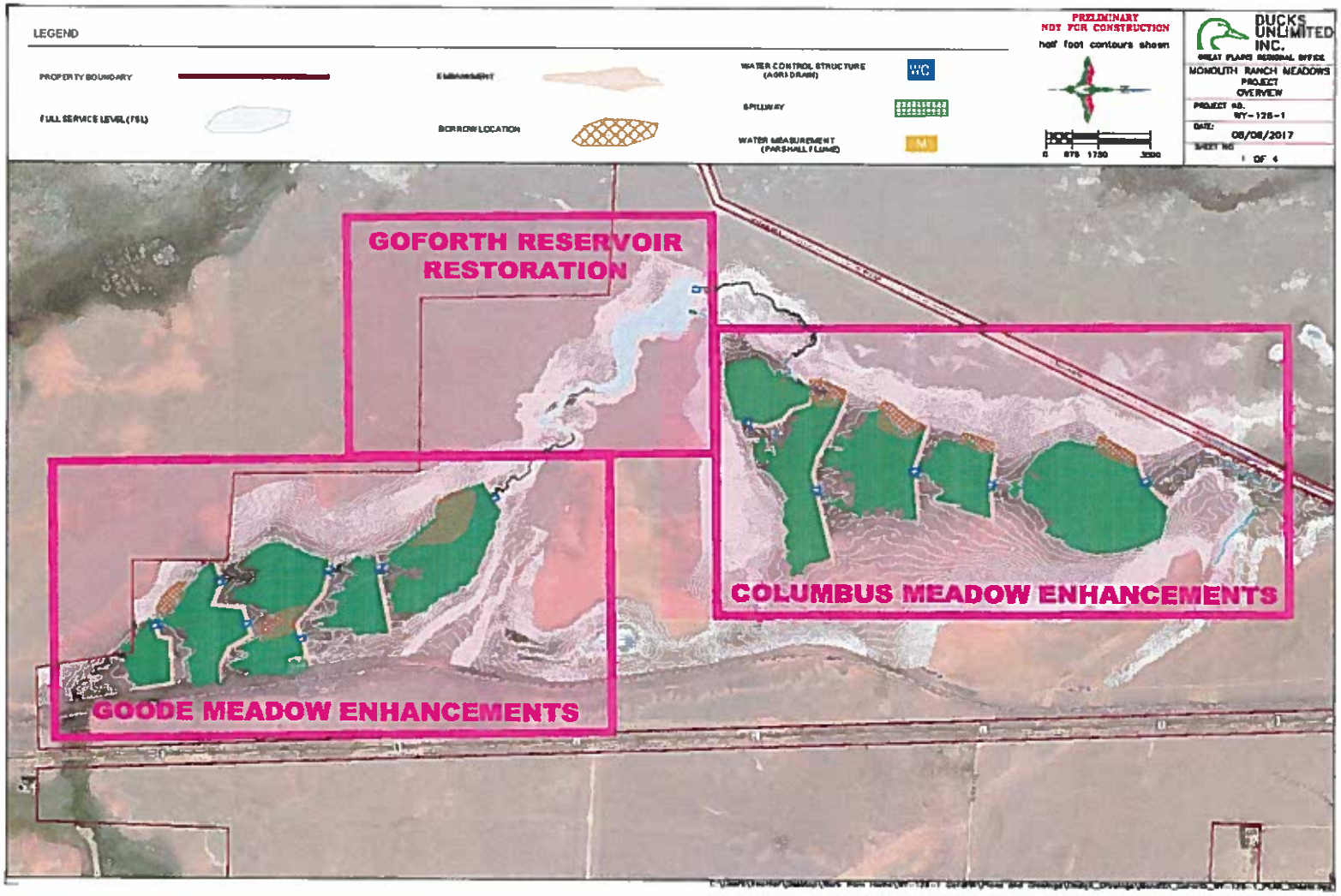


Figure 2. Map of the Monolith Ranch Meadows identifying different irrigation complexes (i.e., Goode Meadow, Goforth Reservoir, Columbus Meadow).

GENERAL CONSERVATION PLAN:

The Ranch Advisory Committee and the City of Laramie have several objectives identified that would improve irrigation management activities on Monolith Ranch. This plan provides a series of conservation actions required to achieve desired outcomes and administrative objectives required for successful implementation of the plan. Generally, these actions correspond to four interrelated objectives that, when completed, will assure attainment of our goals. Those objectives are:

1.) Hydrologic control throughout the Goode and Columbus Meadows Complexes, as well as Goforth Reservoir;

2.) Appropriate plant community composition and structure in both meadows and Goforth Reservoir;

3.) Expansion of the abundance and diversity of irrigated wet meadow habitat on the property; and,

4.) Installation of infrastructure that improves efficiency of management without impeding livestock use.

Photo. Looking north at section of Goforth Reservoir dam that was compromised in the early 1980's.

Waterfowl use of the wetland complexes is a function of plant community composition and structure. Both resident and transient populations of waterfowl and other waterbirds will utilize irrigated hay meadows as wetlands to the extent that those water bodies provide appropriate

resources to the birds given the particular phase of their life cycle. The primary focus of our restoration efforts on the Monolith Ranch Meadows is to improve irrigation infrastructure to increase the productivity of the ranch. This object can be accomplished in conjunction with improving migration habitat to waterfowl and other waterbirds as they move between breeding and wintering grounds. In addition to improving agricultural operations, breeding birds will benefit from the ability to maintain semi-permanent to permanent in the Goforth Reservoir between irrigation seasons. Appropriate foraging, loafing and roosting habitats are required elements of any plan. Plant communities should, therefore, be managed to provide both cover and high quality food resources at optimal times of the targeted birds' life cycles

Because hydrology is the principal ecological driver of plant community dynamics, wetland habitat condition, recreational opportunity, and management cost, its control is of utmost concern to effective management on the Monolith Ranch Meadows. This plan calls for the attainment of full hydrological control on managed irrigation cells on the property. While being primarily utilized to provide irrigated forage grasses for livestock there would also be a process of identifying and procuring enough water to supply irrigation cells during all critical periods of targeted vegetation communities. Procurement of water for irrigation cells will be accomplished through the rehabilitation of existing storage and irrigation infrastructure, as well as through the development of new water control devices on the property. Procurement of water will be accomplished within the legal and administrative boundaries presented by federal, state and local agencies.

To the extent possible given the physiography of the property and the pattern of temporal availability of water, the plan calls for a design that allows managers to spread water in each irrigation cell effectively and efficiently. This will allow maximum flexibility in the scheduled drawdowns and inundations for each managed irrigation cell. Having the ability to control hydrology will optimize plant community response, maintain the potential to control problem vegetation, and make food resources available for livestock, as well as wildlife (Frederickson 1991).

While adding this capacity to the system is expensive and does increase its complexity, it also provides managers with long-term efficiencies because a management action in one basin does not necessarily impact the management of another basin. Modernization of the irrigation infrastructure includes the installation of modern water-control devices, spreader dikes, and emergency spillways to pass high flow events. These improvements will allow managers to move water throughout the complex in the most effective way possible to maximize agricultural production and wildlife habitat while potentially improving recreational opportunity.

Two distinct wetland types are proposed to be restored at the Monolith Ranch Meadows and will call for different management strategies to achieve desired plant community characteristics:

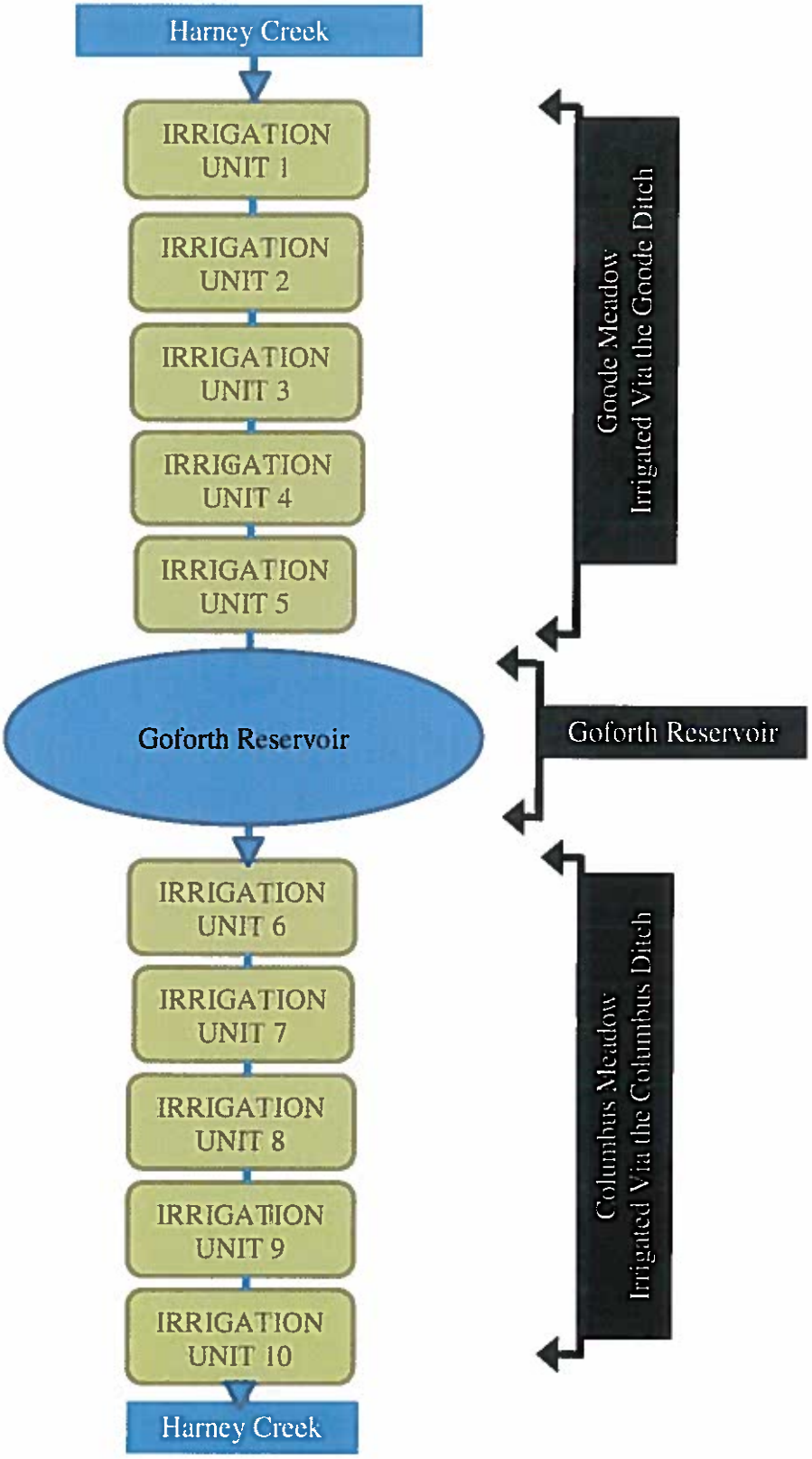
1.) **Goforth Reservoir (Semi-persistent wetland) .** Upon being restored to some capacity, Goforth Reservoir will serve a multitude of purposes for this complex. Goforth Reservoir will likely serve as a semi-permanent to permanent wetland. This low productivity wetland will be important to sustain the variety of avian, mammalian, and herpetofauna communities found on the property and provide a source of water for the Columbus

Meadow Complex. In addition to serving as a water storage site during dry times that could be used to fill irrigation cells of the Columbus Meadow, Goforth Reservoir will also provid roosting and loafing habitat for migratory waterfowl. If desired by the Ranch Advisory Committee and the City of Laramie, Goforth Reservoir could also provide suitable habitat for a small put-and-take fishery. However, in all cases the Goforth Reservoir will continue to function as an irrigation reservoir while providing ancillary wildlife benefits.

2.) **Irrigation Cells (Non-persistent wetlands).** The second strategy is to achieve targeted plant community composition and structure via moist-soil like management in the Irrigation Cells that are to be developed on the property. Moist-soil management is the use of timed drawdowns and inundations to encourage specific plants that provide both high quality vegetative forage for livestock, and necessary forage and substrates for invertebrate foods required by wildlife. This irrigation management plan provides for a symbiotic relationship between agricultural production and wildlife management. These irrigation cells ought to be managed to promote propagation of naturally occurring annual plant species to provide forage for livestock and wildlife. The propagation of annual plant species can be accomplished by disrupting the ecological succession of plant communities; however, the promotion of specific annuals requires regular monitoring, quick response and application of the correct management technique. Techniques include mimicking natural disturbance (e.g., flooding, grazing, burning) as well as mechanical disturbance (e.g., mowing and disking) and utilizing chemical controls when needed.

The design, construction and management principles are applied to specific irrigation complexes found on the property in the sections that follow. The first section provides general information on the proposed water supply and distribution systems on the 'Goode Meadow'. The second and third sections provide similar guidance for 'Goforth Reservoir,' and the 'Columbus Meadow', respectively. A detailed work plan with cost estimates for proposed solutions is provided in the next section. Finally, a preliminary management plan for all sections is provided to guide management activities on the ground once construction activities have been accomplished.

Figure 3. Monolith Ranch Meadows–Water Distribution Schematic.



GOODE MEADOW

The Goode Meadow extends north from the railroad and property boundary along Highway 287 concluding just south of Goforth Reservoir (see Figure 2, p. 6). Within this area, we propose the creation of five irrigation cells (see Figure 4, p. 13). The Goode Meadow has adjudicated water rights that are appropriated to irrigate 180 acres. The meadow is currently being irrigated and used for grazing livestock. However, poorly developed irrigation infrastructure has inefficiencies resulting in low quantity and quality of available forage. Water availability in Harney Creek often fluctuates between years, however inadequate and failing infrastructure make it difficult to utilize all the designated water effectively. The ranch advisory committee and the ranch lessee agree that irrigation infrastructure is lacking and deteriorated resulting in less than ideal coverage of irrigation water across the Goode Meadow.

Our investigation of the property revealed that there are very few wetlands on the site providing habitat for migratory and resident waterbirds. Ducks Unlimited and its partners have identified the need for irrigation infrastructure improvements as an opportunity to not only improve forage for livestock but also to improve habitat for wildlife. In addition to improving livestock forage, proper management of irrigation cells will greatly improve the production of forage plants and animals preferred by targeted bird species. These irrigation cells will be seasonally irrigated for agricultural grass hay production which will in turn act as shallow water wetland habitat that is critical for migratory waterbirds. Typically, these wetland types are shallow (less than 24 inches in depth), have varying hydrology (passing from wet to dry multiple times in an annual cycle), and are disturbed (both hydrologically and mechanically) more frequently than other wetland types. Desired conditions result in an aquatic environment that is highly productive and one that is easily accessed and utilized by livestock as well as most wetland-dependent bird species. Creating over a hundred acres of ephemeral wetland habitat will provide waterfowl and other wetland dependent species with much needed resources at critical times in their annual lifecycle.

The management objectives for the Goode Meadow are as follows:

1.) Improve and maintain irrigation infrastructure that will maximize forage production, improve carrying capacity of livestock on Monolith Ranch, and help utilize water more effectively;

2.) Provide seasonal shallow water wetland habitat for migratory waterbirds by utilizing the flood irrigated hay meadows;

3.) Increase the amount of forage available to all wetland-dependent wildlife species in the complex. Particularly increase annual moist-soil plant composition to produce an abundance of seed production and substrate for invertebrates; and,

4.) Increase the quality and quantity of waterfowl habitat that could provide quality recreational opportunity in the future.

The following onsite improvements are recommended to achieve the hydrologic and vegetative conditions preferred by livestock, waterfowl, and other wildlife species on the Goode Meadow:

1.) Spreader Dikes: The plan proposes the installation of 5 spreader dikes (7,829 linear feet) within the Goode Meadow to create 5 individual irrigation cells. These spreader dikes will have the ability to spread surface water to 165 acres and the remainder of the irrigated acres will be irrigated subsurface. The spreader dikes will produce seasonally available very shallow water depths optimal for moist-soil type plant production providing forage for livestock, most waterfowl, and other migratory bird species;

2.) Water Conveyance: The plan proposes to use Harney Creek and the Goode Ditch to convey water between irrigation cells and down to Goforth Reservoir; and,

3.) Water Control Structures: Seven new water-control structures are proposed in the Goode Meadow to allow for precise water and irrigation control. Water control structures will allow managers to inundate and remove water from different irrigation cells as deemed necessary.

4.) Emergency Spillways: Emergency spillways will be constructed on each of the five irrigation cells to pass high flow events without compromising the water control structures and spreader dikes. Emergency spillways will be constructed using Flexamat, a high strength geogrid of concrete blocks. The strength yet flexibility of this material makes this the best option for protecting spreader dikes and water control structures from high flow events.

Please consult the work plan that follows for details and estimated costs of these proposed tasks.

With these activities complete, management of the Goode Meadow should focus on mimicking the temporary and ephemeral wetland types that have intra-annual periods of inundation and drought. Annual drawdowns will ensure that appropriate seed-bearing, emergent plants are made available to migrating birds utilizing the complex. More frequent periods of disturbance are required to encourage the types of moist-soil plants desired by foraging migratory birds. Additionally, managers can experiment with longer inundation periods in certain cells if providing resident waterbirds and wildlife with year-round habitat as long as these activities are consistent with established direct flow flood irrigation agricultural management practices.

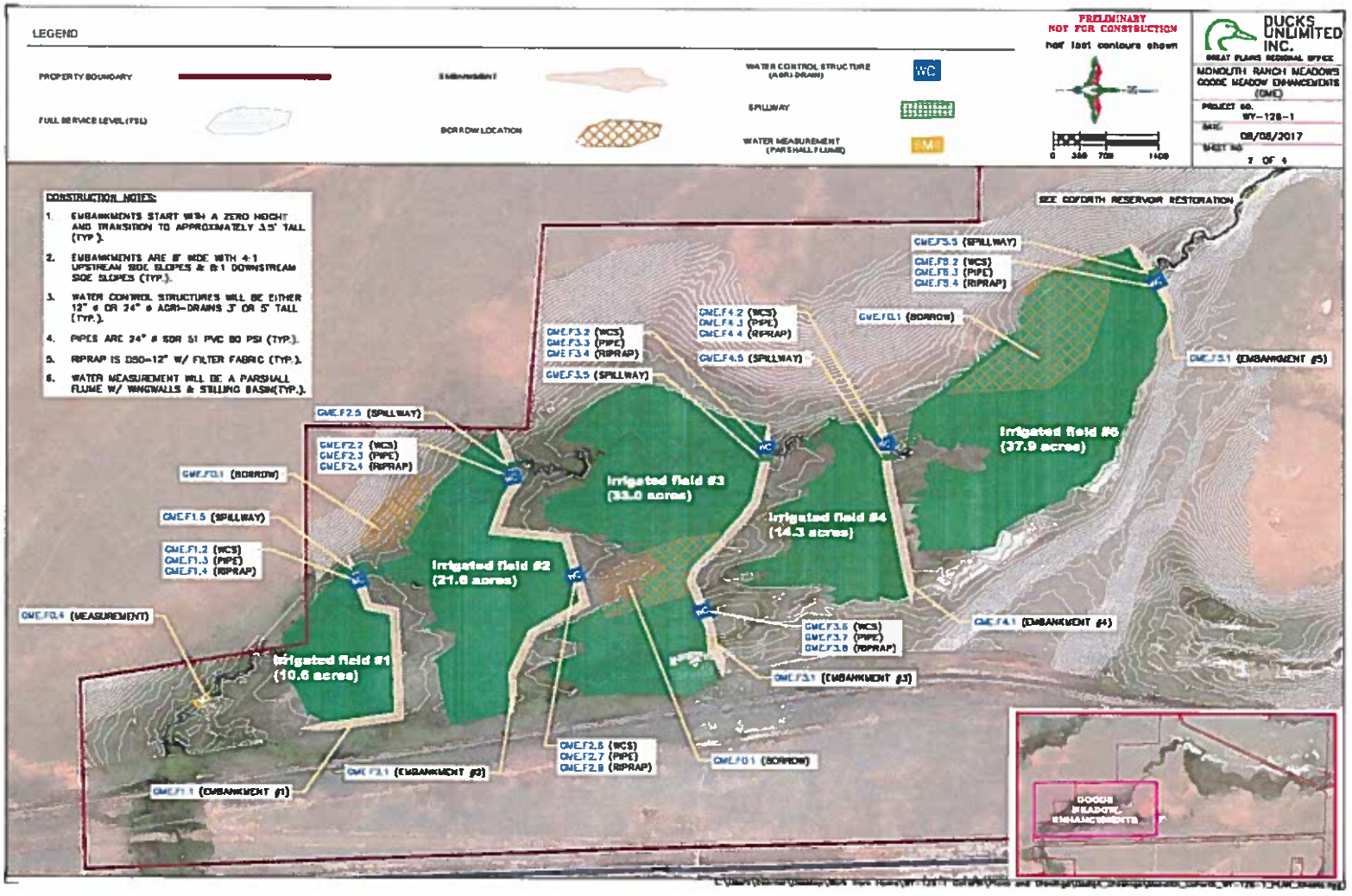


Figure 4. Map of Identified Tasks on the Goode Meadow of Monolith Ranch.

The following table summarizes the list of activities or tasks proposed for the Goode Meadow on the Monolith Ranch Meadows. Each task listed can be indexed using the Task Number on the plan (Figure 4, p. 13) preceding this table. Accompanying these activities is an estimate of the cost of the activity based on similar work performed by DU in the year 2016-2017.

Table 1. List of Tasks for Goode Meadow.

					Engineer's Estimate		
ZONE	TASK	PART	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL
			GOODE MEADOW ENHANCEMENTS				
GME	F0	1	MOBILIZATION	1	L.S.	$20,000	$20,000
GME	F0	2	SITE PREPARATION - BORROW	1	L.S.	$7,000	$7,000
GME	F0	3	SEEDING (SORGHUM)	1	L.S.	$7,500	$7,500
GME	F1	1	EMBANKMENT #1 (1756 LF)	5,586	C.Y.-P	$4.25	$23,741
GME	F1	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F1	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F1	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F1	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F2	1	EMBANKMENT #1 (2480 LF)	6,506	C.Y.-P	$4.25	$27,651
GME	F2	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F2	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F2	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F2	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F2	6	WCS (12" Agri-Drain 3' Tall)	1	EA.	$4,500	$4,500
GME	F2	7	PIPE (12" PVC SDR 51)	60	L.F.	$30	$1,800
GME	F2	8	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F3	1	EMBANKMENT #1 (1824 LF)	6,251	C.Y.-P	$4.25	$26,567
GME	F3	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F3	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F3	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F3	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F3	6	WCS (12" Agri-Drain 3' Tall)	1	EA.	$4,500	$4,500
GME	F3	7	PIPE (12" PVC SDR 51)	60	L.F.	$30	$1,800
GME	F3	8	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F4	1	EMBANKMENT #1 (1259 LF)	3,500	C.Y.-P	$4.25	$14,875
GME	F4	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F4	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F4	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F4	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F5	1	EMBANKMENT #1 (510 LF)	2,585	C.Y.-P	$4.25	$10,986
GME	F5	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F5	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F5	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F5	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F0	4	WATER MEASUREMENT (Parshall Flume w Stilling Basin)	1	L.S.	$12,500	$12,500
GME	F0	5	Contingency (%10)	1	L.S.	$26,852	$26,852
						SUBTOTAL	**$295,371**

GOFORTH RESEVOIR

The Goforth Reservoir is located between the Goode Meadow and Columbus Meadow of the Monolith Ranch Meadows (See Figure 2, p. 6). It was once composed of a single body of water held by a jurisdictional dam in Harney Creek. However, in the early 1980's a flood event comprised the dam breaching a gap in the dam compromising the dam's ability to impound water. Currently the reservoir has a water control structure and culvert with a screw gate the allows for minimal control of water moving through the system.

Photo. Goforth Reservoir as it appeared in 2017 prior to restoration effort on the Monolith Ranch. The photo is looking southeast towards Highway 287.

The Ranch Advisory Committee, City of Laramie, DU and partners have identified improving irrigation, forage production and wildlife habitat as the key components of restoration efforts on the Monolith Ranch Meadows. One key element of this restoration effort is to restore Goforth Reservoir to some capacity of water storage so it can act as a properly functioning irrigation reservoir while also secondarily being a permanent to semi-permanent wetland. This management strategy will not only provide increased hay production and livestock grazing capacity but also foraging habitat for waterfowl and other wetland-dependent birds, but will provide more permanent habitat used for roosting, loafing and brood rearing for resident waterbirds. Having a waterbody that is more permanent in nature will ensure that any resident birds and other wildlife will have resources available to them once irrigation cells are drawn down. Although the focus of Goforth Reservoir will not be food production for wildlife, it will

play a critical role in the overall Monolith Ranch Meadows system. Additionally, Goforth reservoir will be a critical component of this wetland system due to its ability to store water. By having the ability to store water in the reservoir will enable managers to control timely releases into the Columbus Meadow even during dryer periods when flow rates in Harney Creek are low. Managers will need to decide on the best use of available water, however having the capacity to store water in the middle of the system will increase management flexibility.

The following onsite improvements to Goforth Reservoir are recommended to achieve the hydrologic and vegetative goals outlined by the Monolith Ranch advisory committee and its partners. These improvements will benefit both the ranching operation and habitat conditions preferred by targeted waterfowl and other species addressed in this plan:

1.) Embankment: Rebuilding the Goforth Reservoir embankment is essential to returning functionality to the reservoir. Current design is to build a contour levee to a height that remains under the Safety of Dams size. At the proposed capacity, Goforth Reservoir will be able to store 49.23 acre/ft and 18.53 acres of surface water when at its full service level;

2.) Water Supply: Water will be supplied to the reservoir by Harney Creek, Bibee Spring and irrigation return flows from the Goode Meadow;

3.) Water Conveyance: Water will continue to flow into Goforth Reservoir via Harney Creek. Releasing and maintaining reservoir levels will be accomplished through the newly installed water control structure which will be placed at the current permitted low level outlet;

4.) Water Control Structure: One new water-control structure is proposed in this plan to control water level and outflow from Goforth Reservoir. The proposed structure will be an Agri-Drain water control structure that will give managers precise control of water levels in the reservoir.

5.) Emergency Spillway: An emergency spillway will be constructed on the levee of Goforth Reservoir to help prevent a future catastrophic blow out of the reservoir. The spillway will be sized to handle 1000 cfs, which is based off an analysis of the Harney Creek watershed. The emergency spillway will be constructed using Flexamat, a high strength geogrid of concrete blocks. The strength yet flexibility of this material makes this the best option for protecting the reservoir and water control structures during high flow events.

Please consult the work plan that follows for details and estimated costs of these proposed tasks.

With restoration activities completed management of Goforth Reservoir ought to focus on agricultural hay production which in turn by doing so will provide a wet-dry cycle meant to function like the natural, semi-permanent palustrine wetland. These bodies of water typically

follow five to ten year wet-dry cycles that provide ample opportunity for oxygenation of wetland substrate and re-setting plant seral stage development, resulting in much more dynamic and productive systems than wetland basins that maintain static water levels in perpetuity. The reservoir should experience periodic drawdowns to facilitate increased forage production around the fringe area. Additionally, managers could mimic drought conditions at least once, every 5 to 10 years to ensure that appropriate submerged aquatic vegetation, invertebrate communities and soil microorganisms are sustained for the long-term.

We have provided a more complete Preliminary Management Plan for the Goforth Reservoir appended as a section to follow (See page 31).

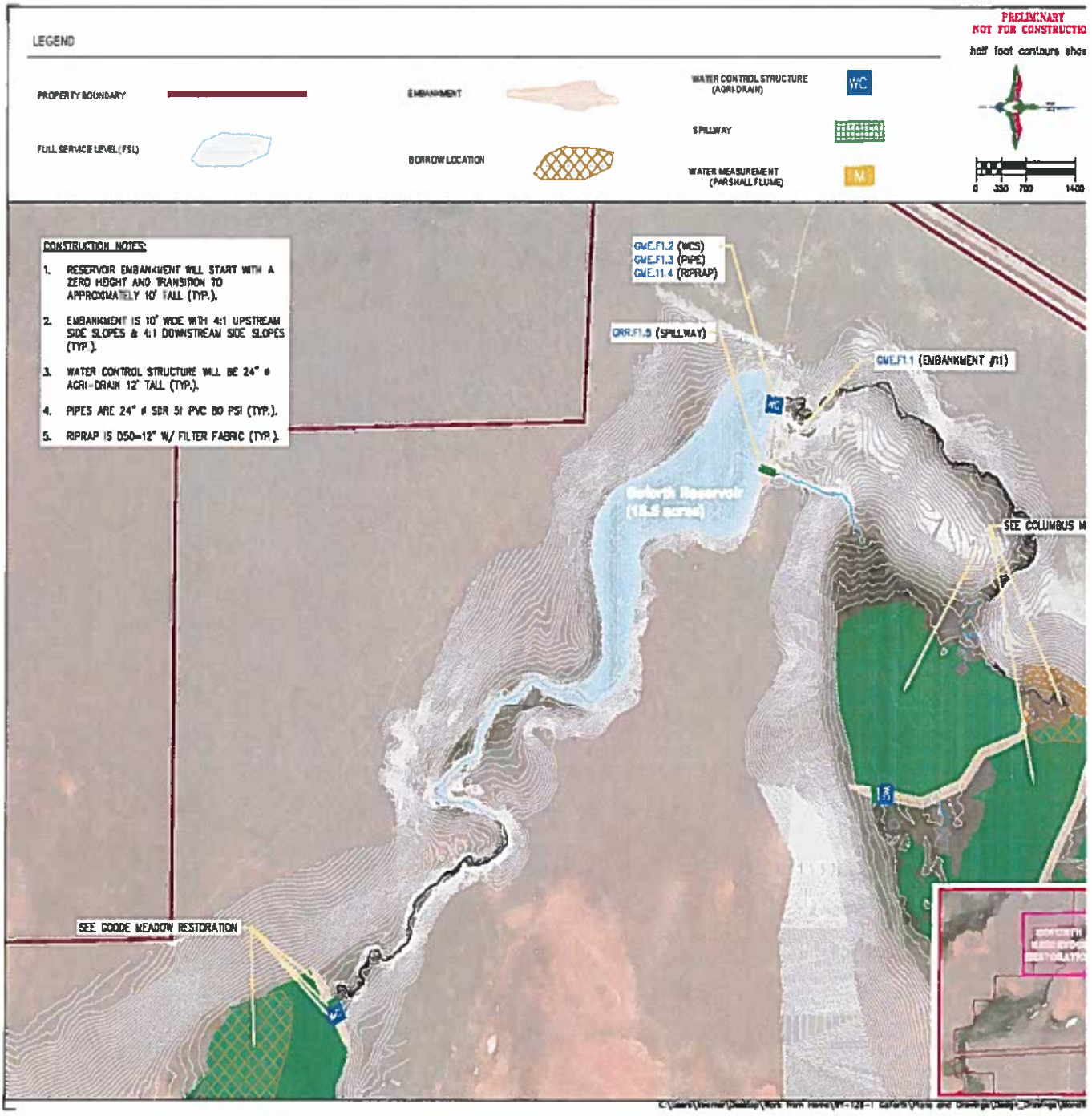


Figure 5. Map of Identified Tasks on Goforth Reservoir.

The following table presents the list of activities or tasks proposed for Goforth Reservoir on the Monolith Ranch. Each task listed can be indexed using the Task Number on the plan (Figure 5, p. 18) preceding this table. Accompanying these activities is an estimate of the cost of the activity based on similar work performed by Ducks Unlimited in the year 2016-2017.

Table 2. List of Tasks for Goforth Reservoir.

					Engineer's Estimate		
				ESTIMATED		UNIT	
ZONE	TASK	PART	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL
GOFORTH RESERVOIR RESTORATION							
GRR	F0	1	MOBILIZATION	1	L.S.	$5,000	$5,000
GRR	F0	2	SITE PREPARATION - BORROW	1	L.S.	$1,500	$1,500
GRR	F0	3	SEEDING (SORGHUM)	1	L.S.	$1,500	$1,500
GRR	F1	1	EMBANKMENT #1 (1756 LF)	3,864	C.Y.-P	$4.25	$16,422
GRR	F1	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GRR	F1	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GRR	F1	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GRR	F1	5	SPILLWAY (FLEX-A-MAT 16'x50' Roll)	4	EA.	$6,500	$26,000
GRR	F0	4	Contingency (%10)	1	L.S.	$6,072	$6,072
						SUBTOTAL	$66,794

COLUMBUS MEADOW

The Columbus Meadow is located to the north of Goforth Reservoir and extends north until reaching County road 34 (Sand Creek Road; see Figure 2, p. 6). Within this complex we propose the creation of five irrigation cells. This area has unadjudicated water rights which are intended to irrigate 282.98 acres for grazing livestock. However, poorly developed irrigation infrastructure has resulted in this area not being irrigated to its fullest potential thereby reducing the quantity and quality of forage for livestock. Water availability in Harney Creek often fluctuates between years, however the inefficiencies and failing infrastructure make it difficult to utilize all the designated water effectively. The ranch advisory committee and the ranch lessee agree that irrigation infrastructure is lacking and deteriorated resulting in less than ideal coverage of irrigation water across the Columbus Meadow.

Evaluation of the property revealed that there are very few wetlands on the site providing habitat to migratory and resident waterbirds. Ducks Unlimited and its partners have identified the need for irrigation infrastructure improvements as an opportunity to not only improve forage for livestock, but also an opportunity to manage these irrigation cells for wildlife. In addition to improving livestock forage, proper management of irrigation cells will greatly improve the production of forage plants and animals preferred by targeted bird species. These irrigation cells when flood irrigated to produce grass hay and livestock grazing opportunity will also provide seasonal shallow water wetland habitat that is critical for migratory waterbirds. Typically, these wetland types are shallow (less than 24 inches in depth), have transitory hydrology (passing from wet to dry multiple times in an annual cycle), and are disturbed (both hydrologically and mechanically) more frequently than other wetland types. Desired conditions result in an aquatic

environment that is highly productive and one that is easily accessed and utilized by most wetland-dependent bird species. Creating over a hundred acres of ephemeral wetland habitat will provide waterfowl and other wetland dependent species with much needed resources at critical times in their annual lifecycle.

The management objectives for the Columbus Meadow are as follows:

1.) Improve and maintain irrigation infrastructure that will maximize agricultural forage production, improve carrying capacity of livestock on Monolith Ranch, and help utilize water more effectively;

2.) Provide seasonal shallow water wetland habitat to migratory waterbird by utilizing the flood irrigated hay meadows;

3.) Increase the amount of forage available to all wetland-dependent wildlife species in the complex. Particularly increase annual moist-soil plant composition to produce an abundance of seed production and substrate for invertebrates; and,

4.) Increase the quality and quantity of waterfowl habitat that could provide quality recreational opportunity in the future.

The following onsite improvements are recommended to achieve the hydrologic and vegetative conditions preferred for livestock, waterfowl and other species on the Columbus Meadow addressed in this plan:

5.) Water Supply: Water supply in this portion of the complex it will be largely dependent on flows in Harney Creek and volume of water stored in Goforth Reservoir. Under ideal conditions, there will be enough water in Harney Creek to manage all three section of the Monolith Ranch Meadows as desired. However, during dry years if water has been stored in Goforth Reservoir, water can be conveyed out of the reservoir and used to irrigate the Columbus Meadow as needed;

6.) Spreader Dikes: The plan proposes the installation of 5 spreader dikes (9,792 linear feet) within the Columbus Meadow to create 5 distinct irrigation cells. These spreader dikes will have the ability to spread surface water to 153 acres and the remainder of the irrigated acres will be irrigated subsurface. The spreader dikes will produce seasonally available very shallow water depths optimal for moist-soil type plant production and foraging by most waterfowl and other migratory bird species;

7.) Water Conveyance: The plan proposes that Harney Creek and the Columbus Ditch will be the main conveyance of water between each cell within this system; and,

8.) Water Control Structures: Five new Agri-Drain water-control structures are proposed in this plan to allow for precise water and irrigation control within the entire Columbus

Meadow. Water control structures will allow managers to inundate and drain water from different irrigation cells as necessary. Although certain areas will be sub-irrigated from cells up gradient, cells will be able to be managed on an individual basis.

9.) Emergency Spillways: An emergency spillway will be constructed on each of the five irrigation cells to pass high flow events without compromising the water control structures and spreader dikes. Emergency spillways will be constructed using Flexamat, a high strength geogrid of concrete blocks. The strength yet flexibility of this material makes this the best option for protecting spreader dikes and water control structures from high flow events.

Please consult the work plan that follows for details and estimated costs of these proposed tasks.

With these activities complete, management of the Columbus Meadow should focus on mimicking the temporary and ephemeral wetland types that have intra-annual periods of inundation and drought. Annual drawdowns will ensure that appropriate seed-bearing, emergent plants are made available to migrating birds utilizing the complex. More frequent periods of disturbance are required to encourage the types of moist-soil plants desired by foraging migratory birds (i.e., grazing). Additionally, managers can experiment with longer inundation periods in certain cells if providing resident waterbirds and wildlife with year-round habitat is desired as long as these activities are consistent with established direct flow flood irrigation agricultural management practices.

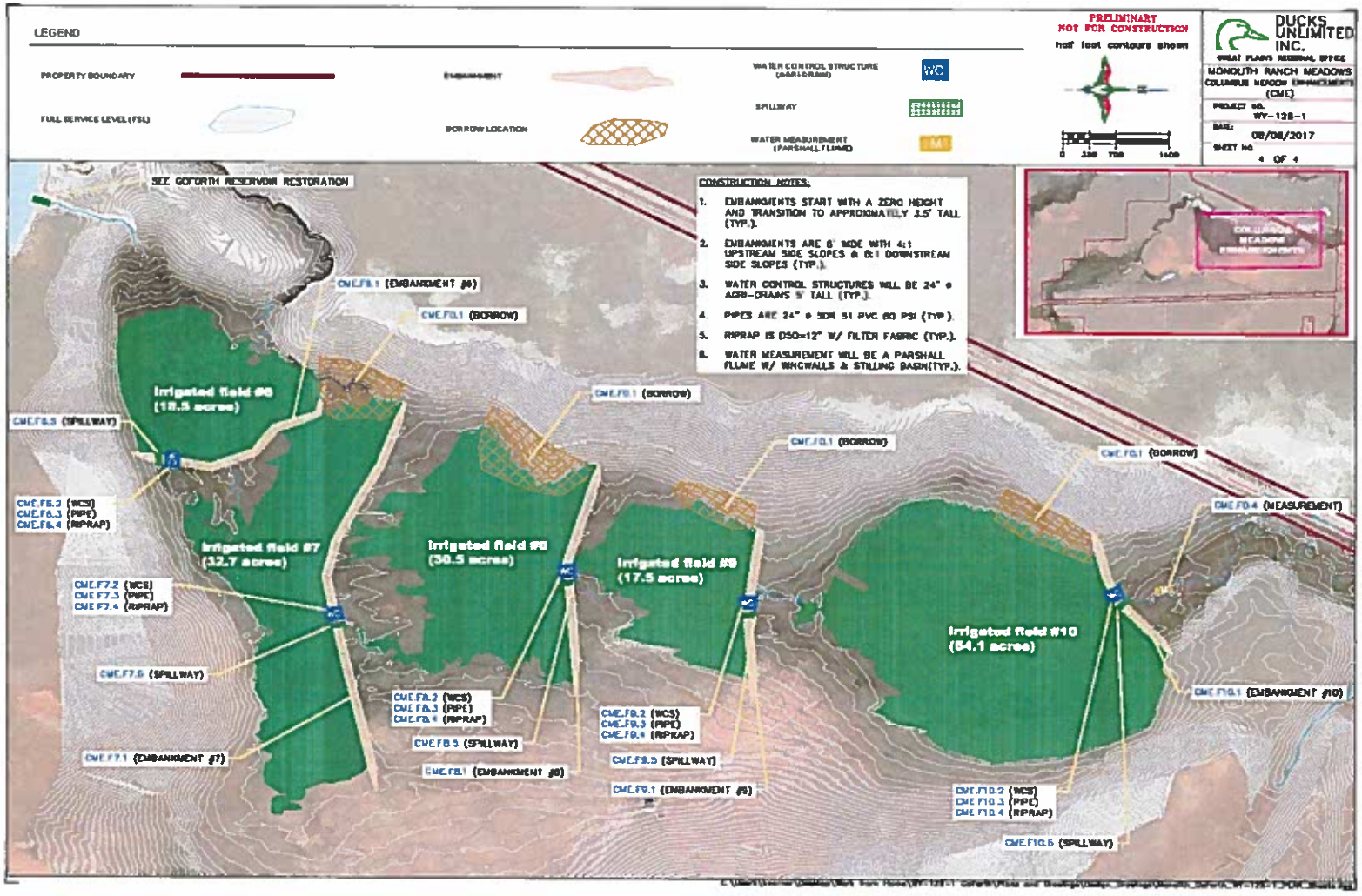


Figure 6. Map of Identified Tasks on the Columbus Meadow of Monolith Ranch.

The following table summarizes the list of activities or tasks proposed for the Columbus Meadow on the Monolith Ranch Meadows. Each task listed can be indexed using the Task Number on the plan (Figure 6, p. 22) preceding this table. Accompanying these activities is an estimate of the cost of the activity based on similar work performed by DU in the year 2016-2017.

Table 3. List of Tasks for Columbus Meadow.

					Engineer's Estimate		
				ESTIMATED		UNIT	
ZONE	TASK	PART	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL
COLUMBUS MEADOW ENHANCEMENTS							
CME	F0	1	MOBILIZATION	1	L.S.	$25,000	$25,000
CME	F0	2	SITE PREPARATION - BORROW	1	L.S.	$8,500	$8,500
CME	F0	3	SEEDING (SORGHUM)	1	L.S.	$7,500	$7,500
CME	F6	1	EMBANKMENT #6 (1430 LF)	5,511	C.Y.-P	$4.25	$23,422
CME	F6	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F6	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F6	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F6	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F7	1	EMBANKMENT #7 (2667 LF)	7,340	C.Y.-P	$4.25	$31,195
CME	F7	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F7	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F7	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F7	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F8	1	EMBANKMENT #8 (1547 LF)	4,425	C.Y.-P	$4.25	$18,806
CME	F8	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F8	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F8	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F8	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F9	1	EMBANKMENT #9 (3210 LF)	3,000	C.Y.-P	$4.25	$12,750
CME	F9	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F9	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F9	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F9	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F10	1	EMBANKMENT #10 (938 LF)	4,129	C.Y.-P	$4.25	$17,548
CME	F10	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F10	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F10	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F10	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F0	4	WATER MEASUREMENT (Parshall Flume w Stilling Basin)	1	L.S.	$12,500	$12,500
CME	F0	5	Contingency (%10)	1	L.S.	$26,072	$26,072
						SUBTOTAL	**$286,793**

MONOLITH RANCH MEADOWS WORK PLAN

We submit in this section the complete and uninterrupted task list and work plan with cost estimate for the activities identified in the first version of the Monolith Ranch Meadows Conservation Plan drafted by Ducks Unlimited, Inc. (DU) in June of 2017. ***This is the same information as that provided individually in each of the complex sections detailed above.*** This information provides the details of work proposed on the property and supplies those interested with the most up to date information we have regarding estimated costs for the prescribed conservation activities.

Costs estimates for each of these tasks, except those dealing with on-site management, which is the purview of the city of Laramie, were developed by DU Engineering staff. These estimates are based upon current rates experienced on other projects DU has delivered or is delivering in the region, as well as from quotes from local contractors and other sources.

Please note that these estimates are based on current going rates and DU does not make any guarantee as to their reliability in any given year. Many of the activities proposed in the plan are reliant upon earth-moving equipment. The cost rate for these activities is, therefore, extremely sensitive to gas prices, the season of project delivery, and the workload being experienced in a particular region. Any or all of these factors can cause a significant increase or decrease in going rates for work. Nevertheless, we provide here a present estimate of the cost of all the work planned in the wetland management plan.

We identified 72 tasks needed to achieve the goals stated in the conservation plan. **We estimate that the total cost to deliver all of these tasks alone will be $648,958.**

The following pages contain a map showing the approximate locations and types of activities planned on the property. These tasks are cross-referenced to their cost estimate in the subsequent work plan tables.

Note that these tables do not provide information on the funds to pay for any additional planning, design, and permitting of these activities. Also, on average, it costs DU $25K to provide these services for each phase of the project, although these prices are likely to diminish with each subsequent phase.

Table 4. Wetland conservation activity costs by Monolith Ranch Meadows complex.

Complex	Total ($)
Goode Meadow	$295,371
Goforth Reservoir	$66,794
Columbus Meadow	$286,793
Total	**$648,958**

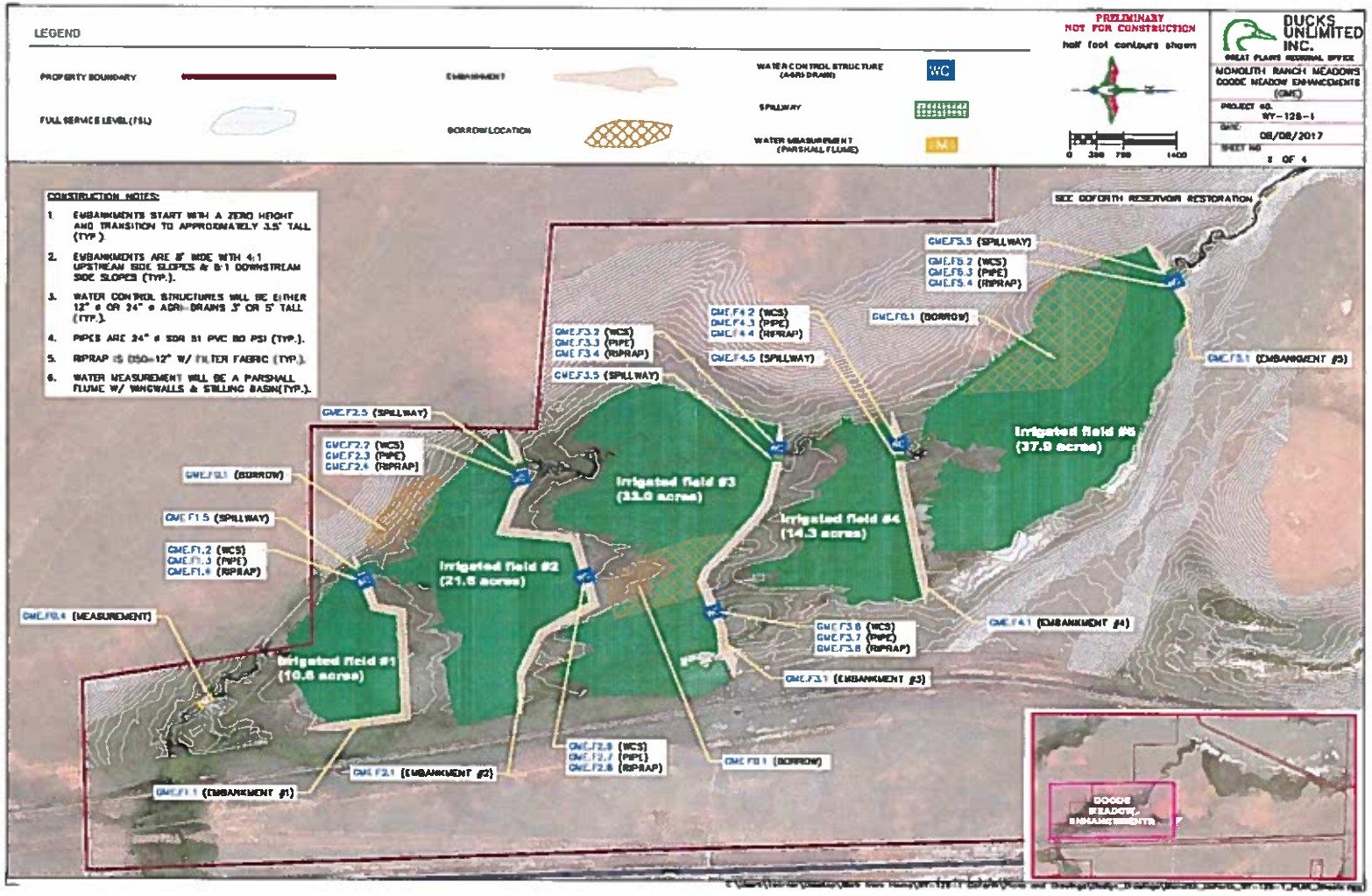


Figure 7. Map of Identified Tasks on the Goode Meadow of Monolith Ranch.

The following table presents the list of activities or tasks proposed for the Goode Meadow on the Monolith Ranch. Each task listed can be indexed using the Task Number on the plan (Figure 7, p. 25) preceding this table. Accompanying these activities is an estimate of the cost of the activity based on similar work performed by DU in the year 2016.

Table 5. List of Tasks for Goode Meadow.

					Engineer's Estimate		
				ESTIMATED		UNIT	
ZONE	TASK	PART	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL
GOODE MEADOW ENHANCEMENTS							
GME	F0	1	MOBILIZATION	1	L.S.	$20,000	$20,000
GME	F0	2	SITE PREPARATION - BORROW	1	L.S.	$7,000	$7,000
GME	F0	3	SEEDING (SORGHUM)	1	L.S.	$7,500	$7,500
GME	F1	1	EMBANKMENT #1 (1756 LF)	5,586	C.Y.-P	$4.25	$23,741
GME	F1	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F1	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F1	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F1	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F2	1	EMBANKMENT #1 (2480 LF)	6,506	C.Y.-P	$4.25	$27,651
GME	F2	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F2	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F2	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F2	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F2	6	WCS (12" Agri-Drain 3' Tall)	1	EA.	$4,500	$4,500
GME	F2	7	PIPE (12" PVC SDR 51)	60	L.F.	$30	$1,800
GME	F2	8	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F3	1	EMBANKMENT #1 (1824 LF)	6,251	C.Y.-P	$4.25	$26,567
GME	F3	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F3	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F3	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F3	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F3	6	WCS (12" Agri-Drain 3' Tall)	1	EA.	$4,500	$4,500
GME	F3	7	PIPE (12" PVC SDR 51)	60	L.F.	$30	$1,800
GME	F3	8	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F4	1	EMBANKMENT #1 (1259 LF)	3,500	C.Y.-P	$4.25	$14,875
GME	F4	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F4	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F4	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F4	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F5	1	EMBANKMENT #1 (510 LF)	2,585	C.Y.-P	$4.25	$10,986
GME	F5	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GME	F5	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GME	F5	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GME	F5	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
GME	F0	4	WATER MEASUREMENT (Parshall Flume w Stilling Basin)	1	L.S.	$12,500	$12,500
GME	F0	5	Contingency (%10)	1	L.S.	$26,852	$26,852
						SUBTOTAL	**$295,371**

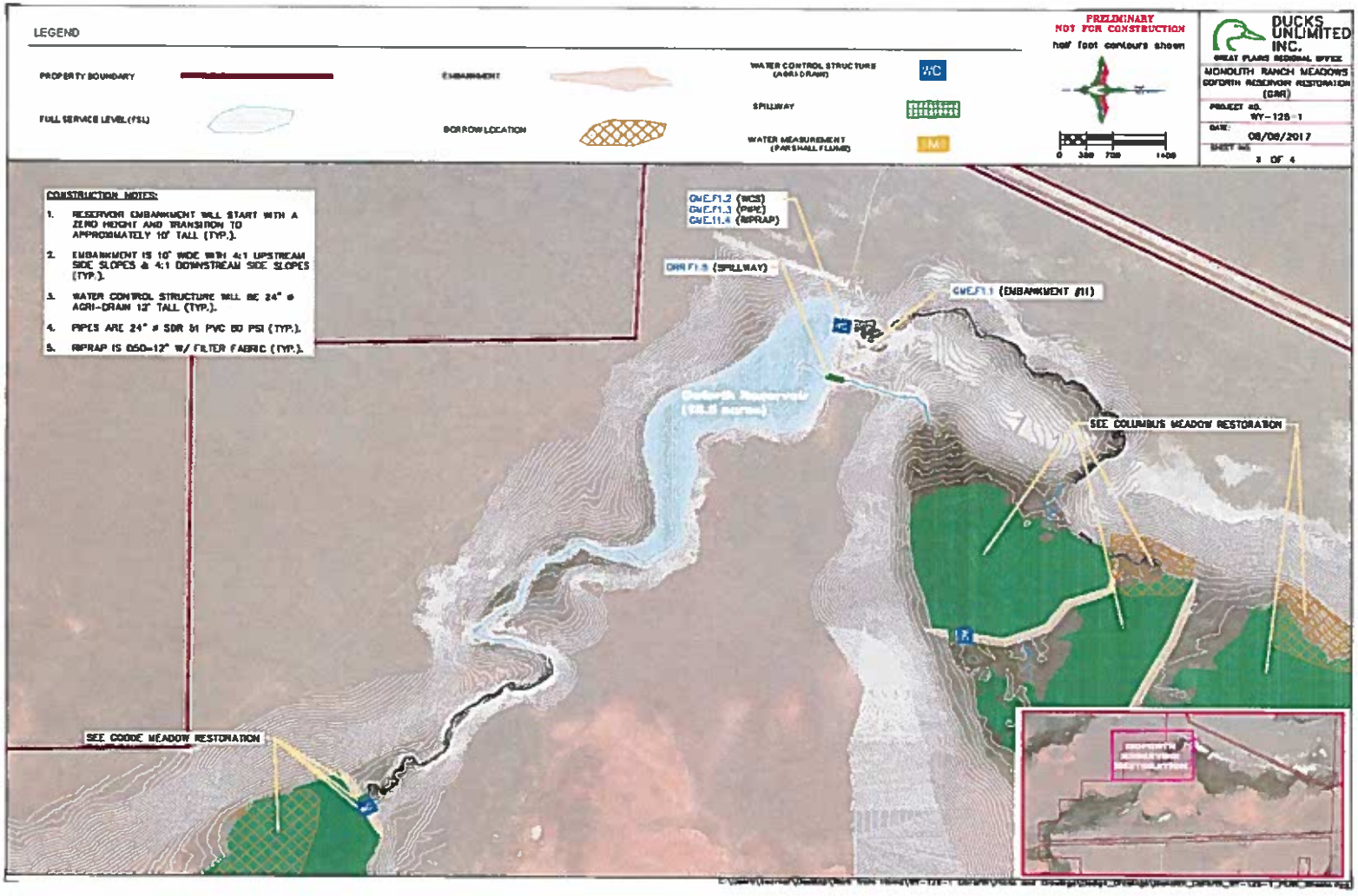


Figure 8. Map of Identified Tasks on the Goforth Reservoir of Monolith Ranch.

The following table presents the list of activities or tasks proposed for Goforth Reservoir on Monolith Ranch. Each task listed can be indexed using the Task Number on the plan (Figure 10, p. 33) preceding this table. Accompanying these activities is an estimate of the cost of the activity based on similar work performed by Ducks Unlimited in the year 2016

Table 6. List of Tasks for Goforth Reservoir.

					Engineer's Estimate	
				ESTIMATED		UNIT	
ZONE	TASK	PART	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL
GOFORTH RESERVOIR RESTORATION							
GRR	F0	1	MOBILIZATION	1	L.S.	$5,000	$5,000
GRR	F0	2	SITE PREPARATION - BORROW	1	L.S.	$1,500	$1,500
GRR	F0	3	SEEDING (SORGHUM)	1	L.S.	$1,500	$1,500
GRR	F1	1	EMBANKMENT #1 (1756 LF)	3,864	C.Y.-P	$4.25	$16,422
GRR	F1	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
GRR	F1	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
GRR	F1	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
GRR	F1	5	SPILLWAY (FLEX-A-MAT 16'x50' Roll)	4	EA.	$6,500	$26,000
GRR	F0	4	Contingency (%10)	1	L.S.	$6,072	$6,072
						SUBTOTAL	$66,794

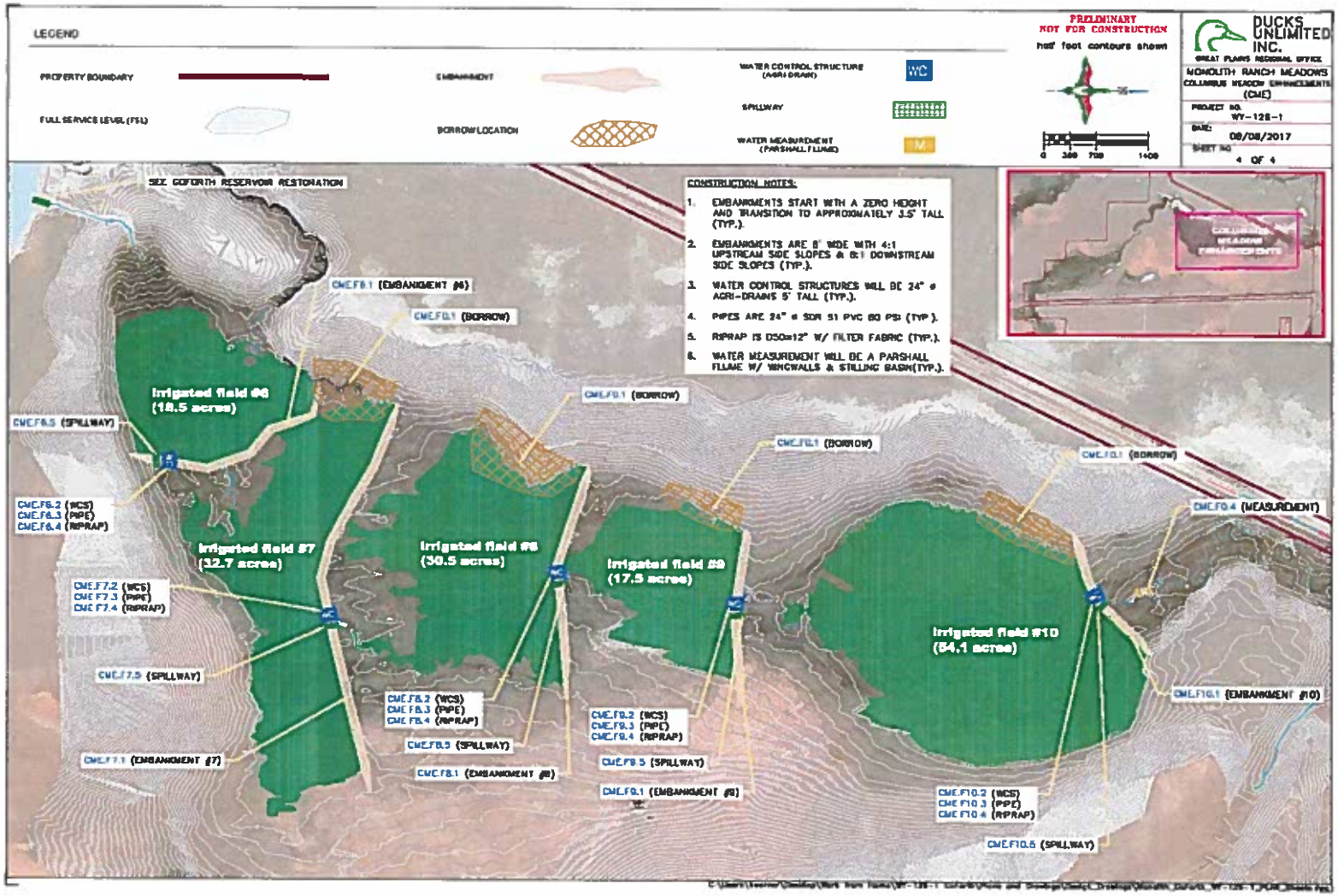


Figure 9. Map of Identified Tasks on the Columbus Meadow of Monolith Ranch.

The following table presents the list of activities or tasks proposed for the Columbus Meadow on the Monolith Ranch. Each task listed can be indexed using the Task Number on the plan (Figure 9, p. 29) preceding this table. Accompanying these activities is an estimate of the cost of the activity based on similar work performed by DU in the year 2016.

Table 7. List of Tasks for Columbus Meadow.

					Engineer's Estimate		
				ESTIMATED		UNIT	
ZONE	TASK	PART	DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL
COLUMBUS MEADOW ENHANCEMENTS							
CME	F0	1	MOBILIZATION	1	L.S.	$25,000	$25,000
CME	F0	2	SITE PREPARATION - BORROW	1	L.S.	$8,500	$8,500
CME	F0	3	SEEDING (SORGHUM)	1	L.S.	$7,500	$7,500
CME	F6	1	EMBANKMENT #6 (1430 LF)	5,511	C.Y.-P	$4.25	$23,422
CME	F6	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F6	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F6	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F6	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F7	1	EMBANKMENT #7 (2667 LF)	7,340	C.Y.-P	$4.25	$31,195
CME	F7	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F7	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F7	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F7	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F8	1	EMBANKMENT #8 (1547 LF)	4,425	C.Y.-P	$4.25	$18,806
CME	F8	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F8	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F8	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F8	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F9	1	EMBANKMENT #9 (3210 LF)	3,000	C.Y.-P	$4.25	$12,750
CME	F9	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F9	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F9	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F9	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F10	1	EMBANKMENT #10 (938 LF)	4,129	C.Y.-P	$4.25	$17,548
CME	F10	2	WCS (24" Agri-Drain 5' Tall)	1	EA.	$6,500	$6,500
CME	F10	3	PIPE (24" PVC SDR 51)	60	L.F.	$50	$3,000
CME	F10	4	RIPRAP (D_{50}=12" w/ Filter Fabric)	4	C.Y.-P	$200	$800
CME	F10	5	SPILLWAY (FLEX-A-MAT 16'x40' Roll)	2	EA.	$5,200	$10,400
CME	F0	4	WATER MEASUREMENT (Parshall Flume w Stilling Basin)	1	L.S.	$12,500	$12,500
CME	F0	5	Contingency (%10)	1	L.S.	$26,072	$26,072
						SUBTOTAL	**$286,793**

PRELIMINARY MANAGEMENT PLAN

This plan proposes that irrigation cell management activities on Monolith Ranch should focus on maximizing production of high-quality foods for both livestock and migrating waterbirds. By making preferred forage available to the resident and migratory populations of waterbirds that use the Laramie Plains, managers will be achieving the stated goals of this plan including increasing the efficient use of water, improving livestock forage, and increasing wildlife habitat. The most viable means of obtaining these food-providing habitats is through the use of moist-soil management techniques (modified for the unique hydrologic and climatic conditions presented by the locale). The management actions described below formulate a moist-soil management plan for use on the proposed irrigation cells on the property. Additionally, Goforth Reservoir will play an important role in providing year-round habitat, but will also increase the resilience and management capability of the irrigation cells themselves.

Moist-soil plants refer to species that grow on mudflats and soils that are saturated during at least some portion of the growing season (Frederickson and Taylor, 1982). In the Laramie Plains region, these are plants included in the *Polygonum* (Smartweed), *Chenopodium* (Lambsquarters), *Sporobolus airoides* (alkali sacaton), and *Panicum* (Panic grass) genera, amongst others. These plants provide forage in two ways: First, the plants produce large amounts of highly nutritious seeds that persist well in aquatic environments. These seeds provide amino acids, minerals and nutrients that are often lacking in cereal grains and other domestic crops. Moist-soil plants also provide excellent substrate for the invertebrates that are critical during many periods of waterfowl's life cycles. The protein, minerals and vitamins provided by gastropods, chironomids, and other aquatic insects are crucial to ensure nest success, brood survival and successful fledging/molting of waterfowl.

There is a rich literature regarding moist soil techniques available online, some of which is summarized here. While initial prescriptions can be made for irrigation on the property, it is crucial for long-term success of the plan that managers keep careful record of the plant response to any of activities called for here. Plant response will vary between basins and between years. Factors such as seed banks, soil types, soil temperatures, soil moisture levels, soil–water salinities, day length, and residual herbicides undoubtedly influence the composition of developing vegetation (Frederickson 1991, Strader and Stinson 2005, p.8).

However, we know that two important factors determine plant responses to moist-soil manipulations. They are: First, the timing of annual drawdowns and, second, the stage of succession (e.g., number of years since the area was disturbed by disking or plowing, grazing, fire, or the number of years since the impoundment was flooded continuously; Frederickson and Taylor 1991).

The following plan prescribes a series of activities to be performed within the Irrigation Cells once construction is complete and water delivery is made available. The plan calls for a mix of disturbance, inundation and drawdowns such that plant response can be monitored and a diversity of habitat conditions can be obtained. Future year's efforts can then be prescribed based on the response to the set of activities prescribed here.

Table 8. Proposed Inundation, Drawdown and Grazing Schedule for Monolith Ranch Meadows with Sufficient Water Available.

Unit	J		F		M		A		M		J		J		A		S		O		N		D	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Cell 1				I	M	M	M G	M G	D G	D G	G	G	G	G	G	G	I G	I	M	M	M	M		
Cell 2				I	M	M	M G	M G	D G	D G	G	G	G	G	G	G	I G	I	M	M	M	M		
Cell 3				I	M	M	M G	M G	D G	D G	G	G	G	G	G	G	I G	I	M	M	M	M		
Cell 4				I	M	M	M G	M G	M G	D G	D G	G	G	G	G	G	G	I	I	M	M	M		
Cell 5				I	M	M	M G	M G	M G	M G	D G	D G	G	G	G	G	G	I	I	M	M	M		
Goforth Reservoir				I	M	M	M	M	M	M	M	M	M	M	M	D	D	D	D	I	I	I		
Cell 6				I	M	M	M G	M G	D G	D G	G	G	G	G	G	I G	I G	M	M	M	M	M		
Cell 7				I	M	M	M G	M G	D G	D G	G	G	G	G	G	I G	I G	M	M	M	M	M		
Cell 8				I	M	M	M G	M G	D G	D G	G	G	G	G	G	G	G	I	I	M	M	M		
Cell 9				I	M	M	M G	M G	M G	D G	D G	G	G	G	G	G	G	I	I	M	M	M		
Cell 10				I	M	M	M G	M G	M G	D G	D G	G	G	G	G	G	G	I	I	M	M	M		

I = Inundation or placing boards in water control structures (WCS); M = Maintain, desired water level is sustained, leaving boards in WCS; D = Drawdown or pulling boards from WCS; G = Grazing or other management tool used for disturbance during this timeframe.

Table 9. Proposed Inundation, Drawdown, and Grazing Schedule for Monolith Ranch Meadows During Dryer Years.

Unit	J		F		M		A		M		J		J		A		S		O		N		D	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Cell 1				I	I	M	M G	M G	D G	D G	G	G	G	G	G	G	G	I	I	I	I	I		
Cell 2				I	I	M	M G	M G	D G	D G	G	G	G	G	G	G	G	I	I	I	I	I		
Cell 3				I	I	M	M G	M G	D G	D G	G	G	G	G	G	G	G	I	I	I	I	I		
Cell 4				I	I	M	M G	M G	M G	D G	D G	G	G	G	G	G	G	I	I	I	I	I		
Cell 5				I	I	M	M G	M G	M G	M G	D G	D G	G	G	G	G	G	I	I	I	I	I		
Goforth Reservoir				I	I	M	M	M	M	M	M	M	M	M	M	D	D	D	D	D	D	I		
Cell 6				I	I	M	M G	M G	D G	D G	G	G	G	G	G	I G	I G	M	M	M	M	M		
Cell 7				I	I	M	M G	M G	D G	D G	G	G	G	G	G	I G	I G	M	M	M	M	M		
Cell 8				I	I	M	M G	M G	D G	D G	G	G	G	G	G	G	G	I	I	M	M	M		
Cell 9				I	I	M	M G	M G	D G	D G	G	G	G	G	G	G	G	I	I	M	M	M		
Cell 10				I	I	M	M G	M G	D G	D G	G	G	G	G	G	G	G	I	I	M	M	M		

I = Inundation or placing boards in water control structures (WCS); M = Maintained, desired water level is sustained by leaving boards in WCS; D = Drawdown or pulling boards from WCS; G = Grazing or other management tool used for disturbance during this timeframe.

Tables 8 and 9, above, propose an initial schedule of moist-soil management for the ten irrigation cells located in the Goode and Columbus Meadows. Table 8 represents a management schedule for when water is readily available, and Table 9 depicts a schedule when water is more limited in the system. Additionally, each table has an initial schedule for water storage and use in Goforth Reservoir that corresponds with the two hydrological scenarios. Managers will have to adjust management techniques in response to availability of water and vegetative response to different management actions. These schedules prompt a series of management activities in the wetlands such that appropriate, food-providing plant communities are encouraged, water levels conducive to foraging for a broad range of birds are maintained and agricultural and wildlife forage production is maximized.

Rows in the figure represent different Irrigation Cells and Goforth Reservoir itself. The columns represent two-week time periods for each month. Inundation or placing boards in a water control structure to begin filling a certain cell is identified by an 'I' in the table. Time periods when desired irrigation level is reached is identified with an 'M' identifying that desired water level is met and should be maintained. Initiation of drawdowns in a given two-week period is indicated by a 'D' in a particular cell. The main disturbance regime that will occur on the Monolith Ranch Meadows that will sustain the optimal vegetation successional stage will be grazing of livestock. Time periods when this action is recommended is identified with a 'G' in the tables above.

Typical moist-soil management prescriptions, proposed for units in warm climates with long growing season, have three periods: early season drawdowns, mid-season drawdowns, and late season drawdowns. Different moist-soil plant species respond differently in these periods (See Table 10 below). Note that few of the listed species are found in the Monolith Ranch Meadows area. Functional replacements should be identified and managed for as we proceed.

The high latitude and elevation of the Monolith Ranch Meadows, however, does not allow managers this many options. The pattern suggested here has all meadows reaching their full-service level by the first of March whenever possible. This can be water held over the winter in Goforth Reservoir or filled with early runoff. From a habitat stand point this is the most critical timeframe of the year. Providing quality habitat during the spring migration period is essential in allowing waterbirds that are moving through the Laramie Plains landscape to rest and refuel. Providing natural seeds and invertebrate resources is critical at this part of the annual cycle to maintain and store essential amino acids and minerals needed for reproduction. Birds arriving on the breeding grounds in better body condition will be able to initiate nests earlier, lay larger clutches, and have increased nest success. All lending to increased recruitment.

Table 10. Moist-soil plant species response to drawdown date. USFWS *Waterfowl Management Handbook* (Fredrickson 1991).

Family	Species		Drawdown date		
	Common name	Scientific name	Early[a]	Midseason[b]	Late[c]
Grass	Swamp timothy	*Heleochloa schoenoides*	+[d]	+++	+
	Rice cutgrass	*Leersia oryzoides*	+++	+	
	Sprangletop	*Leptochloa* sp.		+	+++
	Crabgrass	*Digitaria* sp.		+++	+++
	Panic grass	*Panicum* sp.		+++	++
	Wild millet	*Echinochloa crusgalli* var. *frumentacea*	+++	+	+
	Wild millet	*Echinochloa walteri*	+	+++	++
	Wild millet	*Echinochloa muricata*	+	+++	+
Sedge	Red-rooted sedge	*Cyperus erythrorhizos*		++	
	Chufa	*Cyperus esculentus*	+++	+	
	Spikerush	*Eleocharis* spp.	+++	+	+
Buckwheat	Pennsylvania smartweed	*Polygonum pensylvanicum*	+++		
	Curltop ladysthumb	*Polygonum lapathifolium*	+++		
	Dock	*Rumex* spp.		+++	+
Pea	Sweetclover	*Melilotus* sp.	+++		
	Sesbania	*Sesbania exalta*	+	++	
Composite	Cocklebur	*Xanthium strumarium*	++	+++	++
	Beggarticks	*Bidens* spp.	+	+++	+++
	Aster	*Aster* spp.	+++	++	+
Loosestrife	Purple loosestrife	*Lythrum salicaria*	++	++	+
	Toothcup	*Ammania coccinea*	+	++	++
Morning glory	Morning glory	*Ipomoea* spp.	++	++	
Goosefoot	Fat hen	*Atriplex* spp.	+++	++	

[a] Drawdown completed within the first 45 days of the growing season.
[b] Drawdown after first 45 days of growing season and before 1 July.
[c] Drawdown after 1 July.
[d] + = fair response; ++ = moderate response; +++ = excellent response.

Irrigation cells should reach their desired levels in early March. Irrigation water is then continuously applied in some irrigation cells for four weeks before a drawdown is initiated. This early-season drawdown schedule will usually commence in early May. Another set of irrigation cells will have irrigation water applied for a couple of more weeks, commencing a late-season drawdown in late May to early June. These two general periods are all the growing season in this landscape will allow. The key aspect of the proposed draw down schedule is that all drawdowns happen gradually over a three to four week time period. A slow drawdown is beneficial for waterbirds because it allows additional resources to become available as water levels recede. Additionally, slow drawdowns will result in improved water quality of released water and a more preferred vegetation response. In most landscapes, fast drawdowns result in undesirable plant species and a loss in nutrients. This management strategy is also conducive to maximizing the agricultural grazing potential of the irrigated hay meadows by cattle.

A fall fill for all the units is scheduled to allow for habitat to be available for fall migrants on the Monolith Ranch Meadows when water is available. Two methods of inundation can occur. If water is available in Harney Creek for a late pulse to put some water in all or some of the irrigation cells should be taken advantage of. Additionally, if minimal flows exist in Harney Creek another fall fill option is to use water stored in Goforth Reservoir to spread water within the cells in the Columbus Meadow. Managers should adjust the number of cells and depths of

each cell depending on seasonal variation in available water. Besides secondary wildlife benefits this will also jump start spring green-up.

Flooding and drawdowns in all cells occurs over a four-week period. This allows different depth-bands of water to travel across flooded portions of the cell at different points in time during the spring migration of waterfowl and other waterbirds facilitating ideal foraging depths over a longer timeframe. A couple cells like irrigation cell 4 and 5 in this case, is shown with irrigation water being applied later into summer, this will provide shallower foraging habitat throughout the season for resident breeding ducks, geese and other waterbirds. Realistically, cells receiving irrigation water longer through most or all the summer months should be rotated between years so that vegetation isn't degraded over time.

Similarly, drawdowns of irrigation water in spring and early summer are paced to allow for optimal germination of targeted plant species over different depth bands in the units. Careful note must be taken of plant response to initiation dates and rates of both flooding and drawdowns. These notes will provide the basis for future year's water schedule. While we cannot predict exactly which species will respond in a given year, the presented schedule should allow managers to identify how different rates of drawdown at different times prompt a given moist-soil plant response on the Monolith Ranch Meadows.

A 'G' in a particular cell in Table 10 indicates that this is the time period in which grazing could be initiated on the Monolith Ranch Meadows. It is vital to the City that the improvements to flood irrigation infrastructure and management techniques provide livestock grazing opportunities over the current conditions. Annual grazing of the irrigation cells will maintain an early successional stage of vegetation within the cell that will benefit both wildlife and livestock. However, over grazing prior to annual plants dropping their seeds will reduce available forage for wildlife. Ideally grazing would occur when the seed heads on the moist-soil plants are mature and dehiscence (shattering) is probable. Grazing disturbance that has an impact of removing vegetation from certain areas but leaving some vegetation standing will create habitat once flooded that is ideal for waterfowl and other waterbirds. Waterfowl initially respond best to units with some open water or areas with short or sparse vegetation. After several days of use, ducks drop into or swim into dense vegetation (Frederickson and Taylor 1981.) Grazing is a great maintenance tool for maintaining a wetland in a certain successional stage that is desired to meet habitat objective. However, managers will need to adjust grazing pressure and keep tabs on plant composition to make sure that other disturbance regimes aren't necessary. If meadows dominated by annual plants transition towards a perennial dominated landscape additional disturbance techniques may be required. Disking, fire, burning, drying out, or continuous year-round flooding can be used to set back plant succession to the desired growth of annuals.

Plans for subsequent years should be developed based on observed response to the plan laid out here. Inundation, flood duration, flushing, drawdown, and disturbance can be planned for each irrigation cell as warranted. Managers should stagger management prescriptions across cells such that at least one cell in the series exhibits a particular moist-soil response. If the proposed infrastructure improvements in this plan are completed, DU believes that with property management the Monolith Ranch Meadows can meet the goals set forth in this plan and become

some of the most valuable migration habitat for waterfowl in the Laramie Plains while also supporting production agriculture.

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