Pasture Design
Grazing Management Guide

Initial design factors

When designing a pasture, the initial overview should consider the following:

- Vegetation types, such as grass, shrubs, forbs (for example legumes), and trees
- Riparian areas, sensitive habitats, and watercourses
- Topography
- Overall size of the pasture area

Key points

A well-designed and managed pasture can:

- Improve productivity and soil health
- Support the development or maintenance of native rangeland plant communities
- Maintain or improve Potential Natural Community
- Extend the grazing season
- Increase pasture longevity
- Distribute manure and urine more evenly
- Improve animal performance

After completing an assessment of existing physical characteristics of the site, the design also needs to consider:

- Results from pasture and/or rangeland assessments
- Size and number of paddocks to meet management objectives
- Fencing options for paddocks - whether temporary (electric or virtual) or permanent fences
- Sources and location of stock watering and delivery systems
- Conservation of sensitive areas, such as riparian vegetation, watercourses, domestic water sources, wildlife habitat, silvopastures, cultural sites, and treed areas.
- Historical grazing patterns, including pasture access points or routes and watering sites.

Other considerations may include identifying resting areas, managing manure distribution, the season of use (e.g., growing season and/or dormant season grazing), and the number and type of livestock that will be grazing, such as beef, dairy, sheep, yearlings, cow-calf, or horses.

Vegetation considerations

The vegetation in the pasture will affect how the pasture is grazed. If the vegetation is primarily comprised of pasture forage species, then achieving uniform grazing should not be too difficult. However, pastures frequently contain a number of different vegetation types, often related to soil, climate, moisture differences, history of use, and pasture age. Given time and opportunity, livestock will select or preferentially use some vegetation areas. Trees are often advantageous to have in a pasture, as they provide shade and shelter, but may require additional management to protect them and avoid manure buildup in this area. The location of your paddock fences need to consider the different vegetation types. For example, if the pasture contains both forested areas and tame forages, you may want to consider fencing them as separate paddocks, thus increasing management flexibility and reducing the livestock's ability to be selective.

Riparian areas

If the pasture contains a riparian area and a watercourse, pond, or lake, the same principle of fencing areas of similar vegetation applies. Riparian areas typically have more diverse, greener, and more palatable vegetation, which is attractive to most classes and types of livestock. This can result in overuse of these areas, especially if they are part of a larger pasture that consists of drier and less palatable upland vegetation. To manage the riparian area effectively and to make productive use of the vegetation, it is often advisable to fence this area separately from the upland area of the pasture. Refer to *Factsheet #6 - Riparian Pasture Design*.

Topography

Level or gently sloping pastures generally do not have topographical restrictions. Pastures with steep slopes or a mix of rolling and level terrain present challenges, making it important to understand livestock movement patterns and preferences. Typically, most species of livestock prefer the easiest access to forage, which requires the least expenditure of energy, and therefore they often congregate on the flattest land.

Attracting livestock up steep slopes may require the use of both fences and other attractants, such as water and salt/supplements. Depending on weather and insect conditions, stock may show a preference for either exposed hilltops to capture a breeze and escape insects or valley bottoms in search of shelter. Fence location needs to ensure that stock will not be trapped at the bottom of steep slopes. This is accomplished by allowing some level terrain at the bottom of slopes when designing a pasture.

Topography and aspect can also affect the type of vegetation (e.g., shrubs and trees on north-facing slopes) and the timing of forage growth, with south-facing slopes starting growth earlier in the spring but drying up sooner than north-facing slopes. Independent of or within these topographic features, forage shaded by a canopy may also experience later forage development which may also influence livestock preferences and grazing patterns. Pasture design and management need to consider these effects when developing a grazing system.

Grazing system intensity

The intensity of the grazing management plan often determines how many grazing cells or paddocks are required. The lowest management intensity is one-pasture, *continuous grazing*; next is a rotational grazing system that may have a few paddocks (e.g., 4-6), with livestock moves largely based on a calendar schedule, *slow rotational grazing*. This is typical of many range-use grazing plans. More *intensive grazing systems* employ multiple paddocks or cells that facilitate short-duration, high-stock density and/or adaptive high-stock density grazing strategies.

Grazing rotation terms

Continuous grazing: single pasture, livestock not being moved

Slow rotational grazing: livestock moved every 2 to 10 weeks

Planned rotational grazing: livestock moved every 3 to 10 days

Management intensive grazing: livestock moved every 1 to 4 days

MOB grazing: 75 to 300+ (Animal Units) AU per hectare, livestock moved 2 to 10 times daily

Adaptive high-stock density grazing: livestock moved every 3 days to 10 times daily, adjusts for conditions and/or nutritional needs

Source: maiagrazing and Colorado State University

Large pasture management

Large pastures (e.g., 50 or more hectares) are likely to have variations in vegetation, topography, and other factors as discussed above. In *slow rotational grazing* systems, it is best, where feasible, to arrange paddocks to separate the different vegetation types and/or topographic features to decrease forage and spatial selectivity, thereby improving livestock distribution and use through the pasture. As more paddocks are added and grazing duration is shortened to a few days or less, increased livestock density improves livestock distribution and reduces forage selectivity. Often this results in more animal units of grazing being obtained from the large pasture.

In very large pastures or range areas, improving livestock distribution and the length of time animals stay in preferred areas can be addressed through the strategic use of topographical features, herding, moving livestock to less mature (greener) forage, salting, and water access management. Consider removing salt from the grazed areas, closing off access to water (e.g., dugout, trough, or trail), moving livestock over a slope or to younger, more palatable forage (often to higher elevations) or more moist environments. Practicality is the guide here; getting the majority of livestock to distribute or move through the pasture, prior to them running out of forage, may be as successful as it gets. In those instances, take stock of the pasture and ensure the plants get a good opportunity to grow or regrow (rest) prior to grazing the area again. If possible, try grazing the pasture at a different time of year or shorten the grazing period in the next season.

Consider the following points regarding watering livestock:

- Try to keep travel distances to water under 400 meters, but this will vary depending on the terrain. Rougher terrain will be a shorter distance than level terrain.
- Clean water in troughs has improved animal performance compared to water from earthen dugouts.
- Ensure troughs and water flow are adequate for the number of livestock.
- Gravel or similar material should be placed around troughs in order to reduce mud.

- Placing a frame around gravel and depending upon the soils, for example clay soils, using a geotextile fibre under gravel may be warranted. Designing access points to natural water sources that minimize impacts to the soils and vegetation around streams, wetlands, and lakes reducing the need for livestock to slog through mud is highly recommended. For more details, refer to the *BC Livestock Watering Handbook* found here.

In some situations, lanes may be needed to move livestock to water, holding areas and so forth. Lanes should be 5 – 8 meters wide for cattle or large flocks/herds. Wider lanes are not necessary and generally remove more land from production. Gates from paddocks into lanes should be in the corners of paddocks. This allows animals to move more naturally and facilitates safer stock movement. Gravel or other materials (e.g. geo textile cloth) should be considered in wetter areas in order to reduce mud. Consider winter watering needs when designing your summer system.

Sensitive area management

Surface watercourses, including streams, lakes, and wetlands, and stands of trees may need protection from livestock impacts regardless of the intensity of the grazing management system. While exclusion fencing is one option, and may be required in some cases, it is not practical in most situations, and other options exist. Attractants such as alternate water sources, back scratchers, salt/mineral blocks, and shade or shelter can also draw livestock to other areas of pasture. These may reduce effects on sensitive areas to more acceptable levels.

Stocking rate and forage calculations

If your entire grazing area has historically supported your livestock at a reasonable level, when calculating **stocking rates,** you can generally expect it to continue doing so - even under a more intensive grazing system. If you are not sure how much forage is available and/or how many animals your site could support, there are some resources available to assist you in determining a reasonable stocking level to start with. In some instances, it may be a good idea to ensure you have a buffer built in or another location to move livestock to if there is a shortfall or stored hay that can be fed if needed.

Some ways or tools that may assist are:

- Reviewing current or historic stocking rates against operational objectives. For example, is there a need to address under or over utilization, livestock distribution, livestock performance, or plant species composition?
- Beef Cattle Research Council Carrying Capacity Calculator site found here.
- Information on BC's various range types, including productivity estimates can be found at BC Government's Rangeland Ecology web page found here.
- Stocking rate (Animal days/ac.) = $\frac{\text{Total forage (lb./ac) x level of use (50\%/100\%)}}{\text{Animal intake (lb./day)}}$

> **Note:** make sure to use the same weight measurement type (dry matter or air dry) for both forage and animal intake. Dry matter is the most common and consistent measurement type, especially regarding animal intake. The total utilization may vary and be less than 50% (closer to 35% on Crown Land range).

There are several formulas available that consider the unconsumed forage or losses associated with the grazing activity, such as trampling, spoilage from waste (manure), senesced (aged, weathered, dried up) forage, and forage consumed by wildlife and invertebrates. Those refinements to the equation above are intended to reflect the site's reality and enable a stocking rate that leaves an appropriate volume of forage left to sustain forage and plant community vigour. The "take half, leave half" rule of thumb is commonly employed, but there may be variations or circumstances or health of the pasture which may result in a lower utilization.

These further adjustments are typically added to the formula above in two ways:

1. Estimating the losses due to trampling etc. e.g., 20%. In the above formula you would subtract 20% of the total forage intake from the 50% use calculation then divide by the animal intake (lb/ac). Example:

   1500 lb/ac of total forage, level of use 50%, trampling etc. losses at 20%:

   (1500 x 0.5) – (1500 x 0.20) = 450 lb/ac of forage consumable by livestock

2. Or employ a harvest or grazing efficiency factor that combines the level of use with trampling etc. losses. Harvest efficiency is the portion of the current year's forage production that is consumed by the grazing animals. It includes a 50% leave rate for plant health and forage production. Example:

   1500 lb/ac total forage, harvest efficiency of 30% (i.e. 100% - 50% - 20%) = 30%): 1500 x 0.3 = 450 lb/ac of forage consumable by livestock.

   Animal days per acre for both would be: 450 lb/ac / 26 lb/day = 17.3 days per acre. In this example the animal equates to one animal unit or AU.

When considering what harvest efficiency rate or what additional trampling etc. losses to use there are general guidance points. The more intensive the rotation is the lower those losses tend to be so higher harvest efficiency factors and lower loss factors can be used. In continuous grazing systems the harvest efficiency is considered to be 25%. In wet meadow communities the harvest efficiency is lower still often at 12.5% due their lower palatability, e.g., mature reed canary grass.

North Dakota State University's "Determining Carrying Capacity and Stocking Rates, R1810", provides further insight and calculation examples.

Iowa State University Extension and Outreach Metric Conversions factsheet may be useful to convert to units to metric.

When grazing for only a part of the growing season (e.g., spring, post-hay harvest, or fall use of a pasture), assess the pasture's productivity for that period of time and stock accordingly. When employing management intensive systems, it will be important to keep the timing of use in mind. Adjusting duration of grazing or livestock numbers is likely to be necessary particularly in the spring or post-harvest as plants start to grow or regrow. In the spring, forage volume will start out low and increase quite rapidly. It may mean that the duration in the first several paddocks will be shorter than those grazed later in the spring or that the paddock size starts out larger and gets smaller as forage volume accumulates or livestock numbers are added into the rotation as forage volume increases.

These calculations act as a good starting point that can be refined over time. Stocking levels matched to your environment and forage stands provide assurance that your livestock can be supported for the timeframes you require. Even so, it's a good idea to have a backup plan for those unusual years when things don't go as expected. It is important to recognize that in biological systems there are variations in productivity and livestock intake year to year and through the season. **Candid observation and/or monitoring** will provide guidance for refinements or changes and ensure objectives are met.

FIO principles

Remember to employ the FIO principles. The *Frequency* (duration or length of stay), *Intensity* (degree of defoliation), and *Opportunity* (amount of time for forages within a paddock to rest, i.e., grow or regrow) are just as important, if not more so, than stocking levels. Success in this context refers to vigorous stands and healthy soils. In well-designed and implemented Management Intensive Grazing systems, plant vigour and soil health commonly improves, particularly versus continuous or slow rotation systems. Those improvements often result in higher stocking rates and/or an extended or lengthened grazing season.

For reference the table below provides Animal Unit equivalencies for different livestock types and classes.

Animal unit equivalency table

The **standard animal unit** is a 1,000-pound cow with a calf at side (<6 months old). With an intake of 2.6% of body weight, that equates to 26 pounds of dry matter (dm) per day or 780 lbs dm per month. Below are some typical animal unit equivalents.

Kinds/classes of Animals	Animal Unit Equivalent (AUE)	Number of Animals per AU	Dry Matter per Day (lb)	Dry Matter per Month (lb)
1,000 lb cow dry	0.92	1.1	24	727
1,000 lb cow with calf	1.00	1.0	26	780
1,300 lb cow with calf	1.30	0.8	34	1014

Mature bull	1.40	0.7	36.5	1095
Weaned calves to yearling	0.60	1.7	16	470
Yearlings (600-800 lb)	0.70	1.4	18	545
Dairy cow (<1000 lb)	1.00	1.0	26	780
Dairy cow (>1000 lb)	1.4	0.7	36.5	1095
Bison cow, mature	1.00	1.0	26	780
Bison, bull mature	1.5	0.7	39	1170
Sheep, Ewe (dry)	0.15	6.7	4.0	120
Sheep Ewe (with lamb)	0.20	5.0	5.2	156
Lamb (weaned to yearling)	0.12	8.3	3.1	94
Lamb (yearling)	0.15	6.7	4.0	120
Ram	0.25	4.0	6.5	195
Goat (mature)	0.15	6.7	4.0	120
Goat (yearling kid)	0.10	10	2.6	78
Horse (mature 1,000 lb)**	1.00	1.0	26	780
Chickens (layers or > 5 lb)	0.005	200	0.13	4
Chickens (< 5 lb)	0.003	330	0.08	2.3
Turkeys (> 5 lb)	0.018	55	0.47	14

Turkeys (<5 lb)	0.005	200	0.13	4
Ducks	0.01	100	0,3	9
Hogs/Pigs (sows), boars	0.4	2.5	10.4	312
Hogs/Pigs (55 – 300 lb)	0.3	3.3	7.8	234
Hogs/Pigs (< 55 lb)	0.1	10	2.6	78

Table 1. Kind and class of livestock with the equivalent AUE, AU, Dry Matter per Day and Month

** Animal Unit equivalent for horses varies according to body weight. A mature horse is often expressed as being 1.25 without a corresponding body weight – adjusting for body weight is important.

Note: this table amalgamates information from: NRCS, Montana State, North Dakota State, Minnesota Department of Agriculture. Feeds and Feeding, University of Wyoming and National Air Quality Assessment Tool (NAQSAT).

Grazing system layout options

When designing a rotational grazing system, the challenge is to determine what works or fits well with the landscape and operational realities. No one system is inherently better than another. All systems are set up to move livestock through the resources in a manner that can support the operational objectives and have the potential to improve soil health and plant stand vigour. Some of the attributes when designing this system are vigorous plants promoting active root growth, well-aggregated soils, microbial health (bacteria, fungi, etc.), rhizosphere organisms, and well-functioning ecosystem processes. Below are some basic design styles that can be considered.

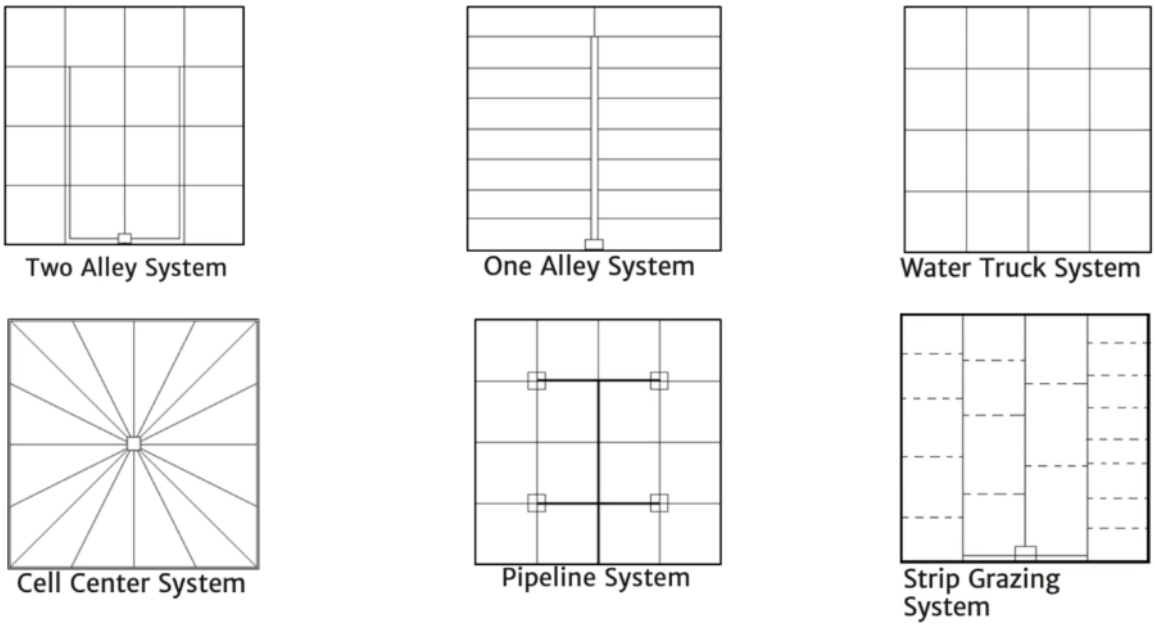


Figure 1: In these system descriptions, paddock refers to each individual grazing area within the pasture (Canadian Forage Grasslands Association).

1. The Two Alley System uses two alleyways to allow livestock to go to and from each paddock to a single water source. It allows the paddocks to be square, which affords better livestock distribution throughout the paddock.
2. The One Alley System uses one alleyway or laneway to provide access to water from each paddock. Livestock distribution is typically less uniform than in square or shorter rectangular paddocks.
3. The Water Truck System uses a portable water delivery system, commonly a truck and/or trailer and water trough, which is moved from paddock to paddock with the livestock.
4. The Center (centre) Cell System has the paddocks radiating out from the single water source, doesn't require a specific alleyway, and livestock move from paddock to paddock from the water source. Livestock distribution is often less uniform than other systems that are shorter in length or square.
5. The Pipeline System has the water piped or delivered to water troughs in each paddock or, as in this diagram, to an area that services four paddocks.

6. Strip Grazing typically refers to grazing a long strip starting at the end of the area/paddock closest to the water source and moving down that strip by progressively moving the fence (dotted line in diagram) further down the strip. There is no back fence; hence, livestock continue to have access to the initial grazing area. If the fence is moved every two days, that means the initial grazing area is grazed for the whole time the livestock are in the strip or larger area (e.g., four moves equal eight grazing days).

Each of these systems has its pros and cons. Select the system or combination of systems that best fits your landscape, infrastructure, budget, and/or personal preference.

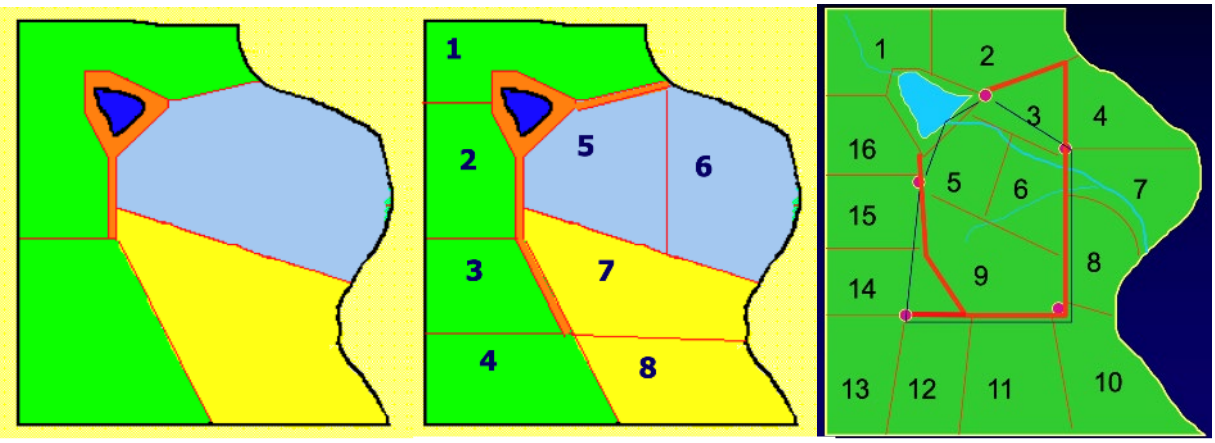
Grazing design considerations

Most sites almost assuredly do not have nice squares to work with, but all can be adapted to fit a specific site. Things to consider when designing a system are:

- Vegetation types, e.g., native species, domestic stands, shrubs, trees, etc. — especially in less intense systems managing similar vegetation types can reduce plant species selectivity or be a good fit for specific livestock types e.g., goats, sheep.
- Topography, e.g., slope, aspect, access — south facing slopes (aspect) may initiate growth and mature earlier in the year, if access is limited animals may not enter or depart an area readily.
- Riparian areas and watercourses, i.e., do they require any special considerations, such as seasonal adjustments (*timing*), off-site watering, crossing or laneway development to avoid site degradation, vegetation or browse use considerations, etc.?
- Paddock size and number: there is a huge array of options and considerations; key aspects to address are duration or length of stay and days of rest (regrowth).
- Stock water sources and how to provide water to all paddocks in the rotation.
- How will livestock move through the paddocks or system throughout the year, i.e., can they move from your first paddock and through the other paddocks with relative ease?

- Fencing
  - Where and what type of permanent fencing is desirable or required?
  - Types of temporary fencing examples:
    - electric fencing, lots of options; select ones that are suitable for your livestock type and geography
    - virtual fencing
    - mobile poultry units
- Fencing companies and/or their representatives are also good sources of information.
- Fencing information: *BC Agricultural Fencing Handbook* found here.

Examples of intensive rotational grazing systems



4 cells, short alleyway | 8 cells, longer alleyway | 16 cells, water system, alleyway

Figure 2: The above shows a progression from four large pastures through to 16 cells or paddocks. The first two (4 and 8 cells) use alleyways to take livestock to the pond, the third (16 cells) pumps water to five water troughs and extends the alley way. Reference: Kennedy, Missouri Grazing School Program.

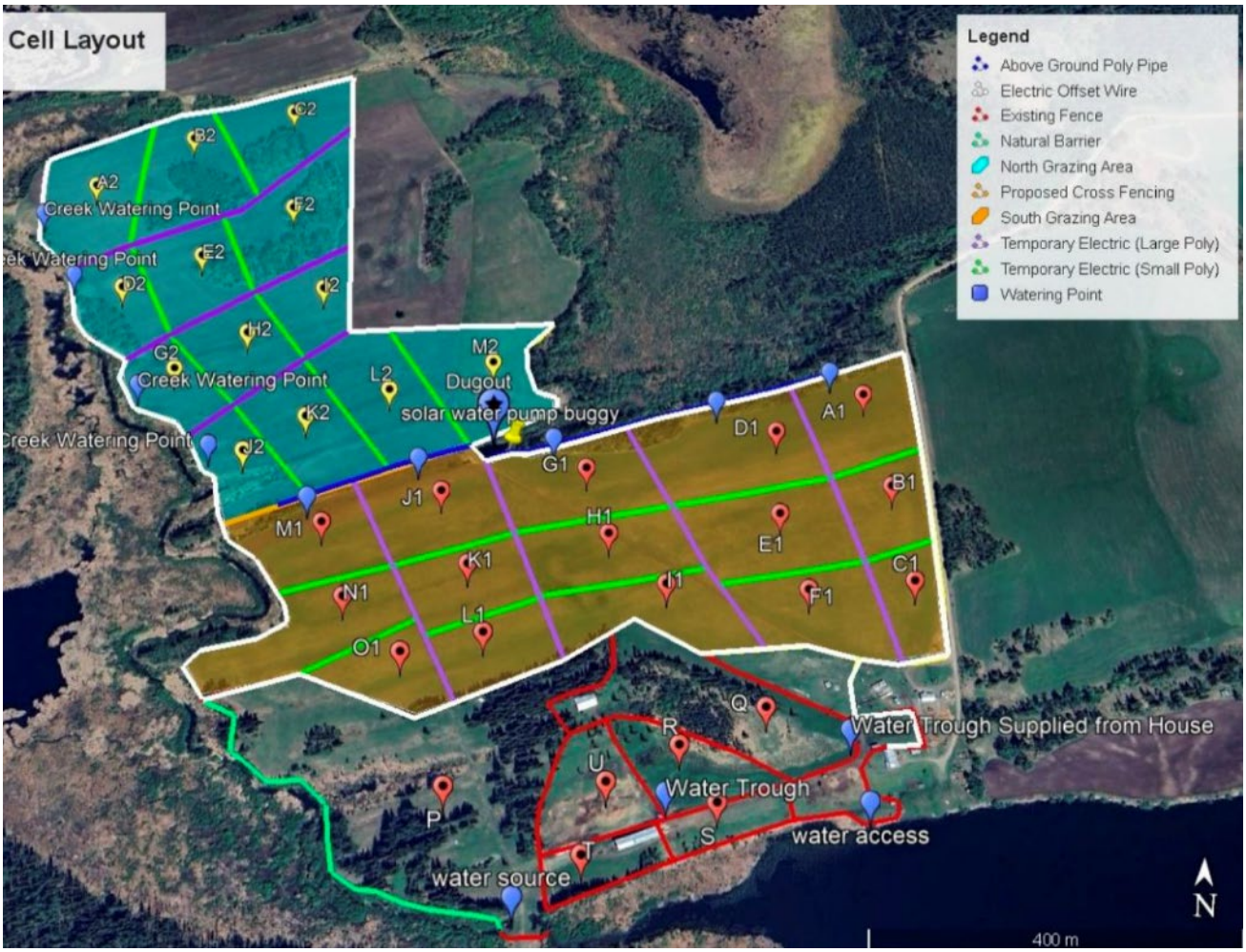


Figure 3. This plan has two rotations and herds (shaded areas), has an offset electric wire on the perimeter fences to facilitate the use of temporary electric fencing which are the purple and green lines. Water is provided at the blue balloons, and some strip grazing is used e.g., G1, H1 and I1to ensure access to water. Although some back grazing occurs the total duration is between 4 & 6 days in strip grazed paddocks. Grazing starts in Mid-May, one pass livestock moved elsewhere, rest period is >90 days livestock return to rotations after October 15.

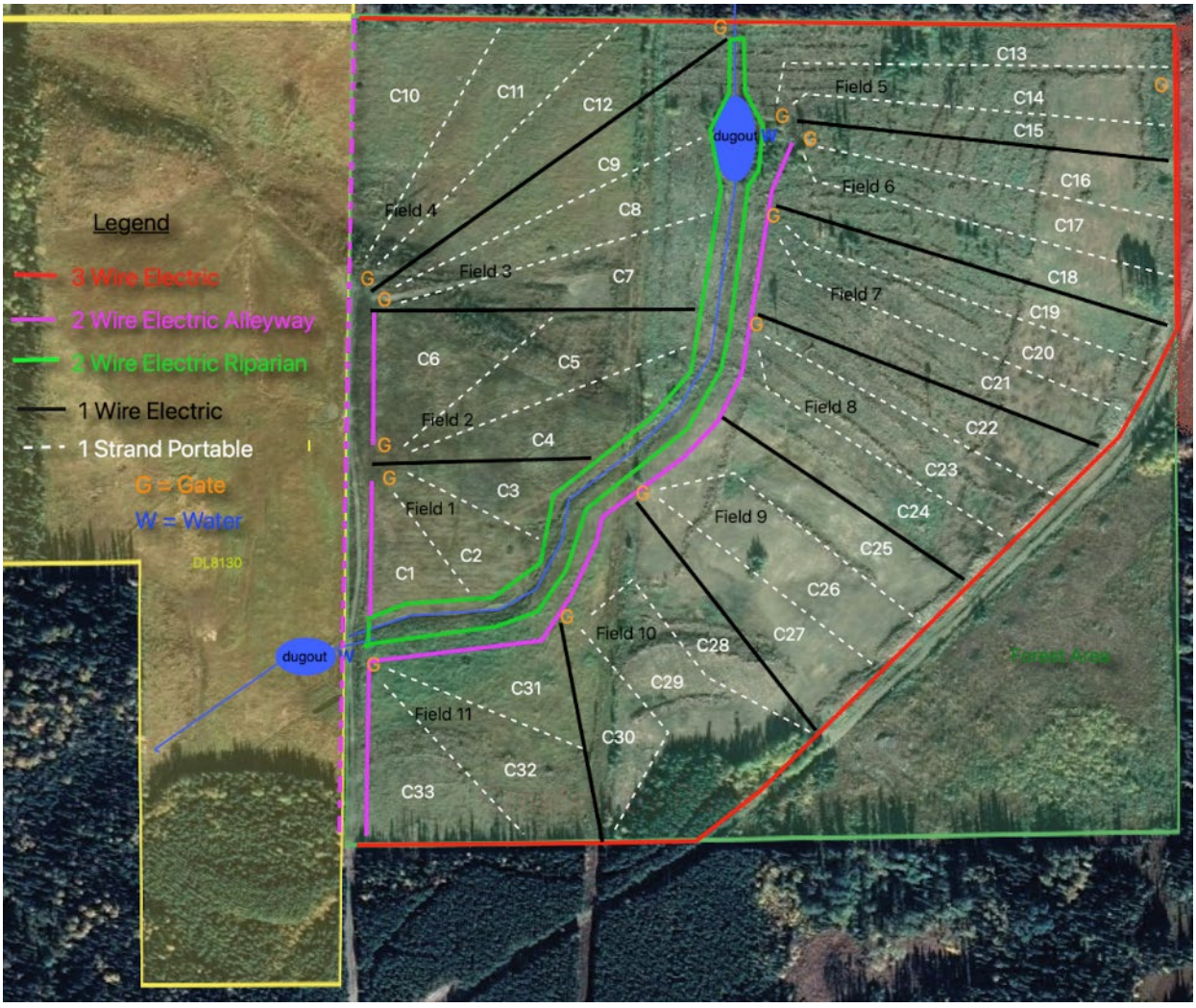


Figure 4. This plan protects the riparian area (green 2 strand electric fence) and uses an alleyway (purple, 2 wire electric) to access watering sites (dugouts in blue). Temporary electric fencing (white doted lines) for internal paddocks that connect to the alleyway gates. Grazing duration ranges from 2 to 4 days in a one pass system.

Figure 5. This plan uses alleyways to provide access to water (blue balloons) using high tensile (yellow) with temporary electric fencing (green). Rotation duration is 1 day on the first pass and 2 days on the second pass with 45 days of rest between pass one and pass two. Purple shading indicates the area that will be rejuvenated via the seeding of legumes.

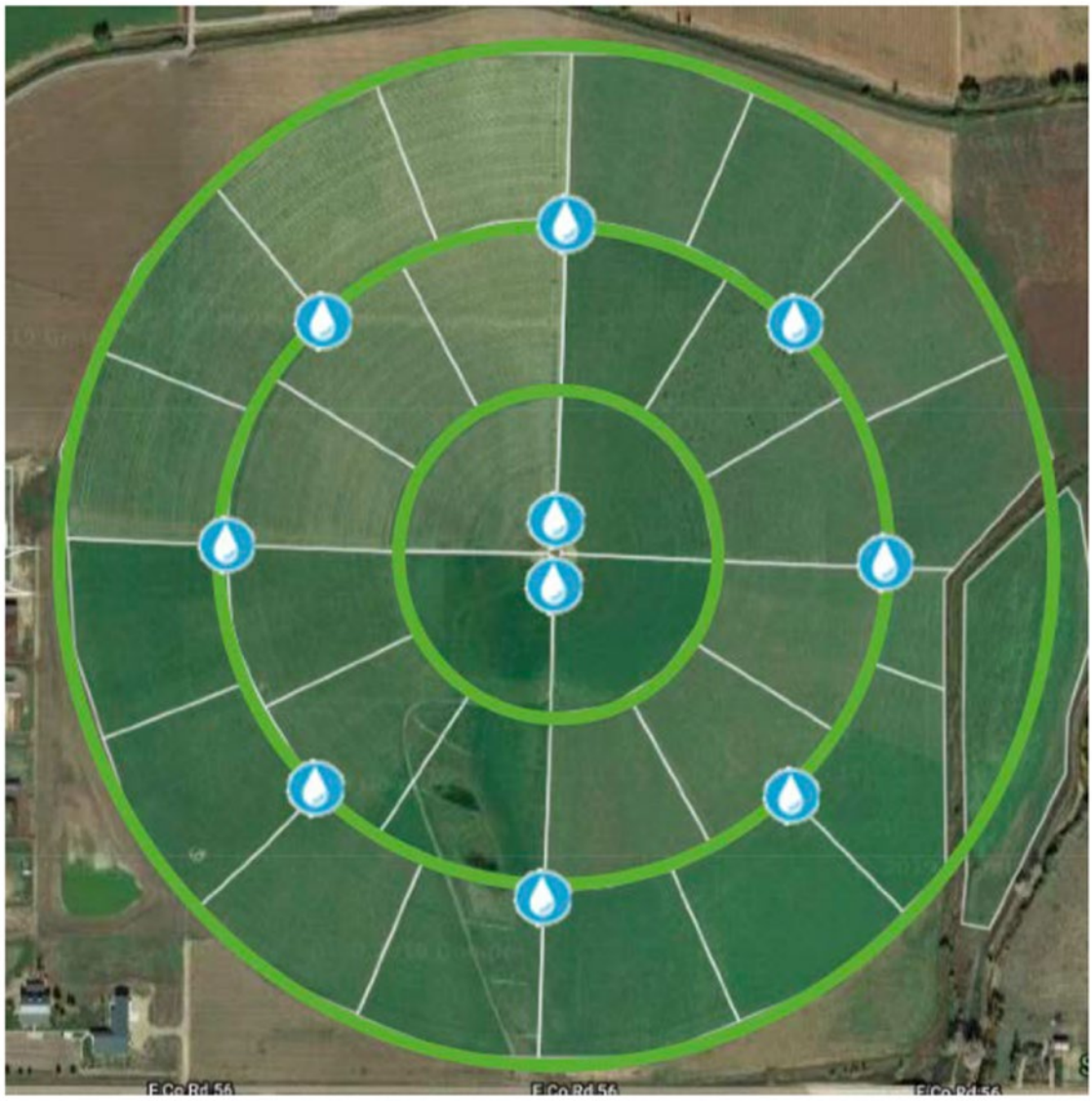


Figure 6. MiG system design on a 200-acre pivot including high-tensile concentric fences (green), moveable polywire paddock fencing (white), and watering locations at Colorado State University. Polywire locations represent areas associated with the given water points and are often further subdivided into 2 or 3 smaller paddocks depending on animal numbers and current forage supply (Figure by Casey Shawver, retrieved from PastureMap mobile application).

Figure 7. This plan splits the pasture into two large sections then uses temporary e-fencing for the paddocks. Water is supplied to three locations, and each location provides water to four paddocks. If you want about 25 days of rest after the first round of grazing, you can spend around 3 days in each paddock. For example, with 10 paddocks, after grazing the first one, you have 9 left. Grazing each of those for 3 days gives 27 days of rest for the first paddock. This plan assumes there's enough grass available to feed the animals during the rotation.

Legend: Dark blue: water course Light blue: water line Gold: permanent fence

Red: temporary e-fence Blue balloons: watering sights

Find more information:

Contact AgriServiceBC:

Email: AgriServiceBC@gov.bc.ca
Phone: 1 888 221-7141

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