Evaluation and Proposals for M Trailhead Parking Lot Expansion

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Executive Summary

The current parking situation at the “M” and “Drinking Horse” trailheads can be both congested, and at times dangerous, as drivers are forced to park on the narrow shoulder of Bridger Drive. 54 vehicle accidents have occurred in the project corridor from 2004 to 2013, including three fatalities (Pecia). Reduced congestion and improved safety are of primary concern when evaluating proposed parking solutions.

Research into parking solutions implemented at other locations, typical setup of trailhead access points, and interviews with users of the trailheads, informed the decision making process while solutions were developed. Better designation of parking spaces, combined with wider entrances and exits, and better road visibility, were common solutions found at other parking and trailhead areas. The hiker survey revealed that most hikers were satisfied with parking at the “M,” although they acknowledged that parking becomes congested and it is necessary to park on the shoulder of Bridger Drive at times. Hikers also believed some sort of connection between the “Drinking Horse” and “M” trailhead would be useful.

Possible solutions to the parking issues include expanding the “Drinking Horse” parking area in the SE corner of the lot, along with providing a crossing between the “Drinking Horse” an “M” lots, such as the proposed underpass. Adding painted stalls to the parking areas and creating parking time limits on a portion of the parking stalls, will make parking at the trailheads more efficient. A community ride-share program would promote car-pooling and reduce traffic at the trailheads.

Based on ratings in areas consisting of total cost, implementation time, environmental impact, level of community effort required, maintenance, and safety, it is recommended that painted stalls be implemented at the “Drinking Horse” and “M” parking areas, along with time limits on a portion of the parking stalls. If the budget allows, an expansion of the “Drinking Horse” parking lot is also recommended.

Empathy Work

Problem Statement

Parking at the M and Drinking Horse trailheads can become crowded which prevents visitors from being able to safely park. Visiting hikers and the Gallatin Valley Land Trust require adequate parking at the trailhead in order to allow visitors to safely utilize the popular trails during peak hours. This project will propose three possible solutions in order to alleviate parking concerns at the M and Drinking Horse trailheads.

GVLT Project Goals and Vision

"What is your vision for this project?"

- "A functional parking space that is both safe and efficient (in terms of number of parking spaces)."

"What is the project goal?"

- "To safely accommodate people who wish to hike iconic Bozeman trails."

Pertinent Information from Robert Peccia and Associates Bike Trail Feasibility Assessment

- 7200 vehicles per day pass through trailhead area
- Possible bike trail will lead to "M" and "Drinking Horse" trailheads
- Underpass may be constructed, will eliminate some "Drinking Horse" parking spaces
- 54 vehicle accidents from 2004 to 2013, 4 fatalities

Pertinent Information from Western Transportation Institute 2012 Survey

- Number of hikers almost equally distributed throughout the week, with Friday being the most popular
- Large distribution of hiker age, 25-54 constitutes majority
- 89% of people used their own car to access trailhead
- Two or one the was the most common number of hikers in a group

Hiker Survey Information

Survey was conducted at the "M" trailhead, with a total of thirty hikers. Questions asked included;

1) "What is your overall opinion of parking at the "M" and drinking horse trailheads?"
2) "Have you ever had a problem parking at the "M" or drinking horse trailheads?"
3) "How many times have you had to park alongside the road?"
4) "What do you think of a pedestrian underpass connecting the "Drinking Horse" and "M" trailheads?"
5) "What amenities would you like at the trailheads?"
6) "What times of the day seem to be crowded at the trailheads?"

QUESTION 1:

Majority opinion was that parking could be better, but spending a large amount of money on improving the parking situation was not worth it.

QUESTION 2:

The majority of hikers said they seldom had a problem finding a parking spot at the “M” or “Drinking Horse” trailheads.

QUESTION 3:

Two hikers reported having to park alongside the road at some point.

QUESTION 4:

Opinion was split on a proposed pedestrian underpass at the “Drinking Horse” trailhead. Roughly half of the hikers thought an underpass was a good idea and would improve safety, while other hikers considered it an unnecessary and expensive addition to the trailhead. One hiker suggested implementing a crosswalk system he had observed in Vermont. The crosswalk system mentioned featured flashing lights roughly 1000 feet before the crossing area. These lights would light up when pedestrians were crossing the road.

QUESTION 5:

The majority of hikers felt the current amenities at the trailhead were sufficient. One hiker suggested implementing a water fountain at the “M” trailhead. Control of dog feces was considered important.

Question 6:

The general conclusion was that late mornings on weekends, and 2-3 hours after people finish work during the week were the busiest times at the trailhead.

Results of Parking Area Observation

The parking area and topography at the “M” trailhead, and the fact that suitable land nearby is privately owned, make it difficult to expand any of the parking at “M” trailhead. The “Drinking Horse” trailhead however has room for possible expansion on the SE end of the parking area, as shown in the picture below.

The layout of The M’s parking area consists of an oval paved road with parking along the edges. Most parking is located along the outside edge. Hikers also park around the inner edge where there is less space. This greatly reduces the amount of room that vehicles have to maneuver in and out of spaces. Parked vehicles along the inner edge also reduces visibility when attempting to back out of a spot. Figure 2 shows the amount of room that vehicles have when the inner edge starts to fill up.

One major observation made was that traffic coming in and leaving the trailhead was pretty consistent. As new hikers arrived, other hikers were returning to their vehicles to leave. Another observation made

is that the area does not have parking stalls, as seen in Figure 3. Establishing designated parking spots may aid drivers to better utilize the space. If angled, the parking may become less hazardous as it becomes full.

There are an estimated 40 parking spaces at the "M" trailhead and approximately 60 parking spaces at the "Drinking Horse" trailhead. An additional 20 parking spaces at the "Drinking Horse" parking area combines with a safe crossing area to the "M" trailhead would alleviate the relatively few parking issues hikers' experience.

Figure 1

Figure 2

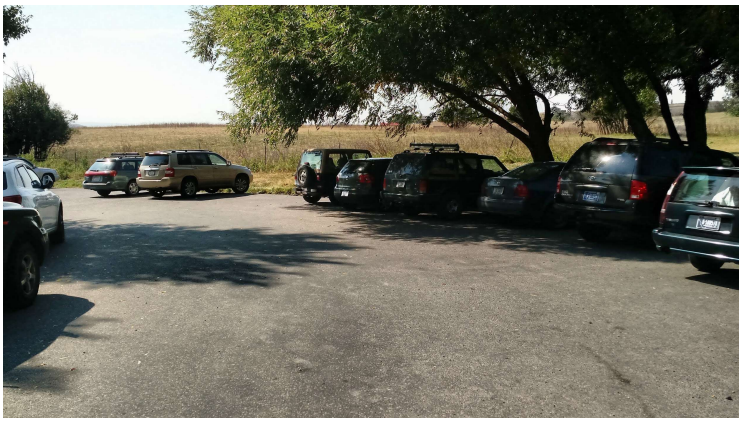

Figure 3

Other Trailhead Parking Descriptions

A) Billings Highlands Trailhead Parking

After visiting the Highland Trailheads in Billings, Montana, the parking areas consisted of a gravel foundation stretched along the entire border of the cliffs, shown in Figure 4. This parking setup allows quick and easy parking for all visitors. Highway 3 and East Interstate Road runs alongside the parking lot areas. This parking lot was difficult to leave because of the high speed incoming traffic from both directions.

Trail entry ways were placed all along the end of the entire parking lot, shown in Figure 5. This allowed visitors to have quick and easy access to any trail at their choice. The amenities offered throughout the trailhead included bathrooms, garbage cans, and dog waste dispensers.

Figure 4

Figure 5

B) Bear Canyon Trailhead Parking

The parking area for the trailhead located off of Bear Canyon Road is split by the gravel road. Parking is available in two rectangular spaces. The lot is gravel and dirt with space for about 20 vehicles. Trails are accessible straight from the parking area. Figure 6 shows how vehicles can park at this trailhead.

Accessing the lot is easy since the road has little traffic. Amenities were minimal consisting primarily of a trail sign. One area of concern with this lot is a ditch located between the road and where vehicles park. This can be a place where people can trip or a vehicle gets damaged. Figure 7 shows the ditch vehicles must drive across in order to leave the trailhead.

Figure 6

Figure 7

Objectives, Functional Requirements, and Constraints

Multiple goals were identified for the improvement of the “M” and “Drinking Horse” parking situations. An objectives tree is shown in figure 8. Metrics were developed to measure the relative success of all low level objectives as shown in table 1. Also, a functional diagram was created to illustrate the actions a parking lot must follow to increase parking area while ensuring pedestrian safety, shown in figure 9. Finally, constraints were identified which outline what a proposed solution must accomplish, see table 2.

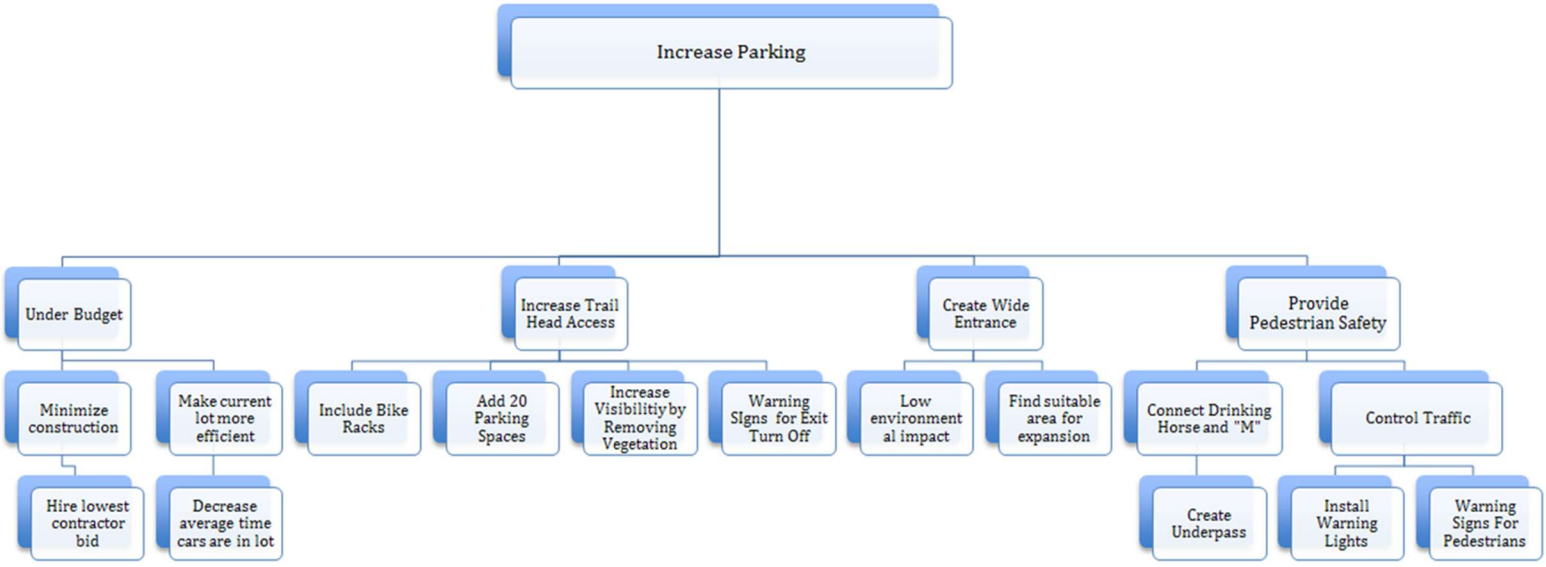

Figure 8

Table 1: Low level objectives with accompanying metric

Low Level Objectives	Metric
Hire lowest contractor bid	Under Budget Yes/No
Decrease average time cars are in lot	Decrease average time by %10
Include bike racks	Space for 20 bikes
Add 20 parking spaces	Yes/No
Increase visibility by removing vegetation	Pedestrians visible from 500ft
Install warning signs for exit turn off	1000ft from parking exit
Low environmental impact	Construction area under 2 acres
Find suitable area for expansion	Is area privately owned Yes/No
Create Underpass	Yes/No
Install Warning Lights	Lights visible from 1000 ft
Warning Signs for pedestrians	Signs visible from 1000 ft

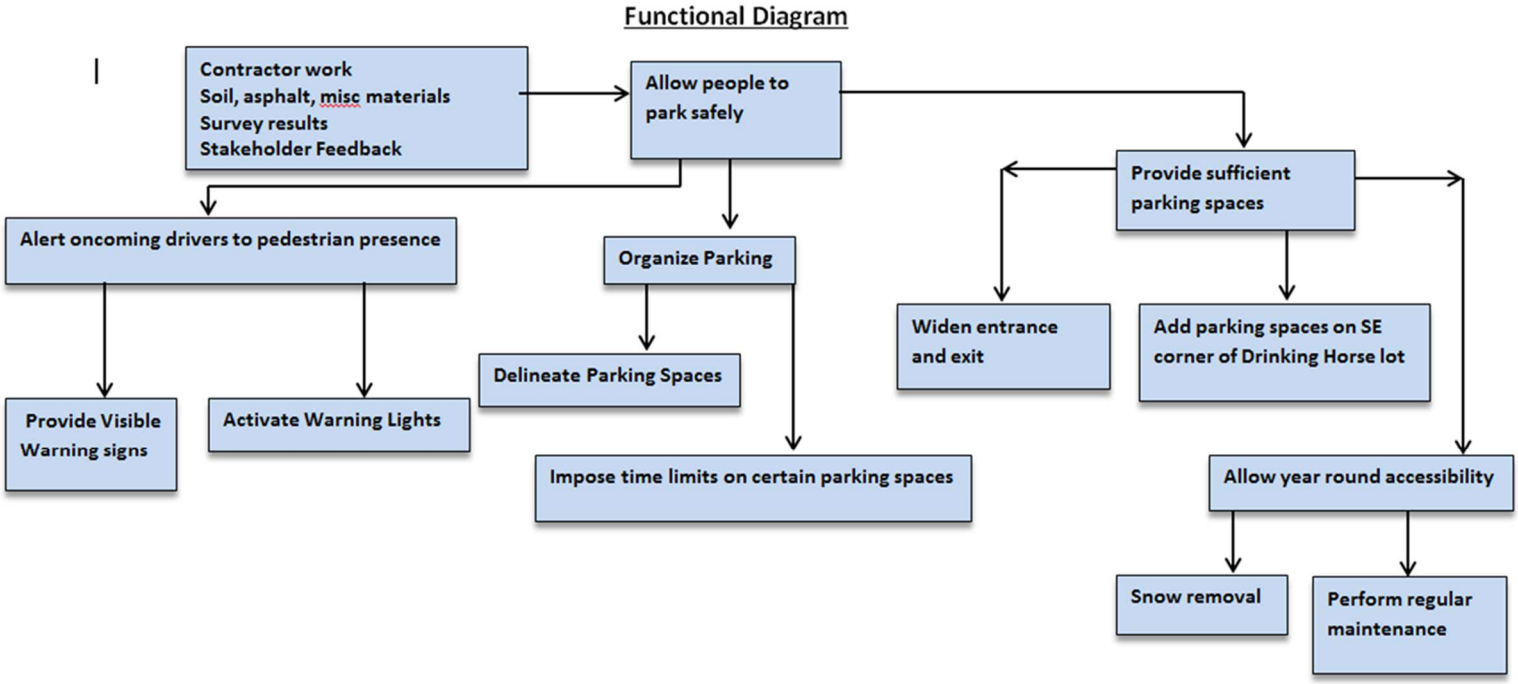

Figure 9

Table 2: List of Constraints

The proposal cannot exceed GVLT's budget.
The proposal must increase parking by 10 spaces between both lots to alleviate parking concerns
Total parking available cannot be reduced.
Pedestrian and vehicle safety must not be compromised according to data found in the Bozeman Trail Feasibility Memo
The environment cannot be damaged or harmed by additions or modifications.
The existing trees, shrubs, and amenities must not be damaged or removed.
Right of way must be obtained to use neighboring land or properties.
New construction must obey local laws and regulations.
Improvements must not be harmful to wildlife or pets.
Additions or changes must be able to survive harsh winter weather.
Materials in the proposal must be able to withstand the weight of a vehicle parking on it.
Construction materials must be environmentally friendly.
Additions must not be a hazard to hikers.

Ideation and Convergence

Our group used two ideation techniques to help boost our creative thinking and decision-making ability. The two techniques used for this process were the Empathy and Scamper techniques.

The empathy ideation technique focuses on attempting to view a problem from a different perspective; primarily the perspectives of stakeholders involved in a project. Stakeholders include clients, users, manufacturers, operators, owners, managers, and marketers among others.

While using the empathy ideation technique, it caused our group to try and think like a certain stakeholder. The two main questions asked during this process included: 1) what does that particular stakeholder desire, and/or care about 2) what concerns does this stakeholder have?

The SCAMPER ideation technique focuses on utilizing action verbs as stimuli. This technique is used to assist a person/group with ideas that can modify an existing product or to create new ones. The word "SCAMPER" is an acronym. Each letter stands for a method that helps people come up with creative ideas. ("Start Up Skills")

The letters and their meanings are as follows:

- S - Substitute
- C - Combine
- A - Adapt
- M - Modify
- P - Put to another use
- E - Eliminate
- R - Reverse

To effectively use the SCAMPER technique, a person/group has to identify the problem at hand, and then come up with a question for each action verb. The questions that involve the parking lot issue are:

- S - What to substitute in the parking lot design?
- C - How do we build our design with use for other activities?
- A - How to adapt our parking lot to surrounding activities?
- M - What do we change to the parking lot to make it better?
- P - How can changing the parking lot be used elsewhere?
- E - What to eliminate to help make design easier?
- R - How do we reverse the manner of the parking lot setup?

Overall, this technique was useful at engaging the group to think outside the box. Some of the ideas brought up in this technique were not useful, but those bad ideas helped create good ones. The original basis of this technique was to show that every new idea is a variation of something that already exists. By using the two-ideation techniques, our group was able to come up with 27 different options that could be used to help fix the parking lot issues at the “M” and “Drinking Horse” trailheads. The options are listed below.

Idea List:

1. Change where trail starts.
2. Move the parking lot to a new location.
3. Move the M.
4. Don’t allow pets on the trail.
5. Reconsider placement of road, move it.
6. Combine Drinking Horse and M parking lots.
7. Create an overpass for the road to cross parking areas.
8. Get rid of a trail head.
9. Connect the trails together.
10. Implement a ski lift to transport hikers.
11. Remove car access, only allow bicycles.
12. Build parking garage.
13. Add parking stalls/painted lines.
14. Add limits to the size of vehicles allowed.
15. Add parking time limits or meters.
16. Make the parking lot larger.
17. Add grocery store.
18. Add smoothie bar.
19. Add a bar.
20. Build a bike park.
21. Require hiking permits for alternating days.
22. Build picnic area.
23. Get rid of wooded areas to increase space.
24. Buy surrounding land to expand onto.
25. Direct how people park.
26. Implement community ride-share program
27. Expand Streamline bus service

Proposals

Proposal 1: Drinking Horse Parking lot Expansion

To fix the parking lot issue for the trailheads, expanding the Drinking Horse parking lot is the best option. Our objective during the project is to keep costs low, build on pre-owned land of GVLT, and allow a minimum of 20 extra parking spaces. The new size of the parking lot will be a total of 34,000 square feet, shown in Figure 10. To tackle this project, four things need to be done:

1) Find general contracting company.
2) Know what different parking lot options to use.
3) Figure out material/equipment costs and placements.
4) Know the entire parking lot building process.

By finding a general contractor, the key factor is the cost. Our goal is to keep the project to the lowest cost possible. To do this, the lowest bidder will be chosen unless other factors come into play. Material, time, and equipment costs are the main issues to oversee in the bidding process. Several excavation companies that are in the Bozeman area are TMC Inc., Central Excavation, Williams Civil Division, Mountain West Excavation, and Greater Gallatin Contractors.

Two different parking lot options can be constructed. First option is a gravel parking lot. This type of parking lot is cheap, easy to maintain, and permeable. The maintenance required for this parking lot entails weed control and top dressing. With proper maintenance, a gravel parking lot will last a lifetime. The average cost varies from $1 to $5 per square foot depending on the installation cost that will be at hand. Drawbacks to this parking lot are snow removal, eye appeal, and dust (Norris). If a gravel parking lot is placed, the average cost will be a minimum of $34,000 and/or maximum of $170,000.

The second parking lot option will be an asphalt parking lot. This type of parking lot offers a strong parking foundation, easy maintenance, eye appealing, and it is frost heave resistant. The maintenance required for asphalt is sealcoating and asphalt patching repair. The durability of asphalt depends on strength of subgrade material and volume of traffic. If kept properly, it should last a lifetime. The average cost for an asphalt parking lot varies from $2 to $9 per square foot, not including maintenance costs later on. Drawbacks to this option are costs, asphalt maintenance, and construction time. (Pros and Cons) If an asphalt parking lot is placed, the average overall cost will be a minimum of $68,000 and a maximum of $306,000.

The equipment used throughout the process includes: scrapers, excavators, skid steers, pay loaders, and compaction rollers. The materials used during the parking lot process include: sand, gravel, soils, and/or asphalt. During the building process, equipment and material storage placement is a key factor. Heavy equipment parking area will be placed on the west end of the new parking lot area. The soil and gravel piles will be placed outside of the new parking area on the east end. This will allow easy access to soil material, while causing no interfering with the building construction process.

To expand the Drinking Horse parking area, it will take minimal vegetation movement and cut/fill throughout the entire east end of new parking lot area. Sands and soils will be spread out and compacted to the appropriate subgrade given in site plans. Once subgrade has been reached, the excess

dirt has to be removed and compaction of the ground must reach a uniform density of 95% of the maximum density (“Chapter 9”). After the compaction density has been reached, either gravel or asphalt base course material will be placed directly on the subgrade in one or more lifts. The gravel will be finished within several lifts and the parking lot will then be complete. If asphalt is used, it will take multiple lifts to be laid out and compacted to the appropriate density on site plans. Once the asphalt has reached the appropriate thickness, the parking lot is complete.

Based on national standards for measuring parking spaces, in parking lot there’s going to be 4 base line and the parking lots will expand almost 125-130 available spaces to park. On weekends, “M” and “Drinking Horse” trailheads are visited almost 100-120 cars in peak busy hour. Our design creates enough space for the trailheads and makes more attractive/utilizable area for visitors and stakeholders (“Parking Angle Figurations”).

Figure 10

Proposal 2: Community Ride-Share Proposal

To reduce the need for an additional bus service with associated costs, and to decrease the number of vehicles at the "M" trailhead, a community ride-share program could be introduced.

Similar services such as "Uber" already exist within the United States. The basic idea is to connect drivers currently headed to the "M" with people planning on driving to the "M" trailhead, in order to allow these people to carpool, thereby decreasing the amount of traffic at the "M" trailhead.

In order to create a successful community ride-share program, several actions must be taken.

(i) The service would require advertisement and promotion. People are unlikely to use the service if they are unfamiliar with the ride-share premise, or do not know how to access the ride-share program. Informative advertisements in the Bozeman Daily Chronicle would be a useful way to increase awareness of the program along with radio advertisements and e-mails to MSU students.

(ii) A forum of some kind would be required to facilitate connections between people driving to the "M" and people looking for a ride to the "M." A dedicated website, or possibly a Facebook group could accomplish this task. A Facebook group would be much less expensive than a dedicated website although its functionality would be limited. A dedicated website would be much more customizable and useful, but the initial design, and continued maintenance would be more expensive.

(iii) Users would use their own discretion in accepting rides with other ride-share users. A program requiring drivers to be vetted though insurance checks, driver's license checks, and background checks would be expensive and cumbersome. While potential users may be more comfortable with a program that used vetted drivers, such a system would be prohibitively expensive and cumbersome considering the current budget and the fact that the scope of the program consists solely of transporting people to the "M" and no other locations.

(iv) Finally, a pick-up/drop-off area must be designated. Two or three common locations would be preferable. Recommended sites would be the MSU campus outside the Student Union Building, the fairgrounds, and a location on Main Street, possibly the parking area behind Pita Pit.

Advertisement

Item:	**Program Costs:**
• Bozeman Daily Chronicle	$20.34/column inch
• Radio Ad	$25.00/30 sec ad
• MSU e-mail	negligible

Online Forum

Item:	**Program Costs:**
• Facebook	$0.00
• Website	$2,000/year

Proposal 3: Parking Stalls

As a cost effective measure, we propose that parking stalls be painted onto paved surfaces located at the M trailhead. This solution utilizes the existing parking lot but increases parking capacity by insuring that visitors are parking in an efficient manner. During our research and visits, we noticed that many visitors parked their vehicles in a non-uniform manner. This is a low cost solution to easily manage parking at the M trailhead.

By utilizing standard parking stall sizes found in Bozeman City Ordinance No. 1905 ("Municode Library"), parking capacity can be increased by up to 23 spaces for a total capacity of 63 vehicles. This proposal divides the parking lot into 4 zones for different configurations. Refer to figure 11 to see how the lot is zoned. Zone A will have 8 spaces for parallel parking. Zone B will have 16 spaces for normal parking. Zone C will have 21 spaces for normal parking. Zone D will have 18 spaces for parallel parking.

Each stall is designed according to recommended sizes from Bozeman City Ordinance No. 1905. A simple stall has two measurements, length and width. Width is defined as the edge of the stall that's parallel with the outside edge of the pavement. Length is defined as the edge of the stall that is perpendicular to the outside edge of the pavement.

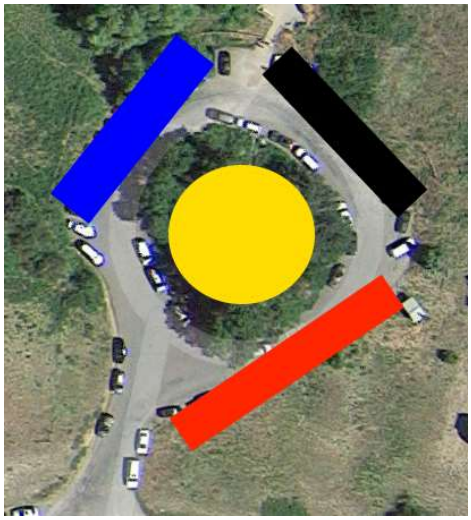

Figure 11

Zone A (Red)

Zone A is located along the southern edge of the parking area. The parking space is ideal for parallel parking along the edge of the pavement. This space allows for 170x9 feet of parking space. For parallel parking, each stall is recommended to be 20 feet wide and 9 feet long. This zone has adequate space for 8 20x9ft parking stalls.

Zone B (Black)

Zone B is located along the north-eastern edge of the parking area. The parking space allows for 150x18 feet of parking space at 90 degrees. For 90 degree parking, each stall is recommended to be 9 feet wide and 18 feet long. This zone has adequate space for 16 9x18ft parking stalls.

Zone C (Blue)

Zone C is located along the north-western edge of the parking area. This space allows for 190x18 feet of parking space at 90 degrees. For 90 degree parking, each stall is recommended to be 9 feet wide and 18 feet long. This zone has adequate space for 21 9x18ft parking stalls.

Zone D (Yellow)

Zone D is located along the inner radius of the parking area and is ideal for parallel parking. This zone allows for 375x9 feet of parking space. For parallel parking, each stall is recommended to be 20 feet wide and 9 feet long. This zone has adequate space for 18 20x9ft parking stalls.

Time Limits

It is also proposed that a small number of stalls be limited by time. On a timed hike, one team member was able to hike up to the "M" and back to the parking lot in under 2 hours at a leisurely pace. We believe this is a representative pace for individuals who want to complete the hike in a reasonable amount of time. Any 5 parking stalls being limited to 2 hour parking will reduce the total need of parking spaces for the M Trailhead.

Total Parking

After completion, this proposal will have a total of 63 parking stalls permanently added to the trailhead parking lot. This is an increase of 23 parking spots without hikers being forced to park on the side of Bridger Road or crossing the street from the Drinking Horse trailhead.

Materials, Time, and Cost

Material required for this proposal is a high visibility asphalt paint. Recommended colors are white or yellow for contrast with the existing asphalt. Paint can be obtained at a retail value of $25 per gallon of paint from local hardware stores such as Home Depot or Lowes. Estimated time to implement proposal is 16 man hours of work. The work can be implemented in stages during low traffic days to minimize impact on visitors. Cost can be estimated using prices found online at $5 per painted stall for a total of $315 ("What's the Average Cost to Line Stripe a Parking Lot").

Proposal Comparison

The three main metrics to compare the proposals are cost, environmental impact, and parking spots. Each proposal includes estimates for cost. For Proposal 2, an estimated $2,000/year advertising budget is used. Environmental impact is considered by the amount of construction or alteration needed to implement the plan. The total parking spots for Proposal 2 relies on the effectiveness of the program and reduces the parking need rather than increase the parking capacity for an equal net effect.

The "Cost Per Spot" is the primary metric we are considering for comparison.

	Proposal 1	**Proposal 2**	**Proposal 3**
Cost Per Spot	$544-$2448	N/A	$13.70
Cost	$68,000-$306,000	$4,000/year	$315
Parking Spots	125-130	Relies on Community	23
Environmental Impact	High	Very Low	Medium
Time to Implement	High	Low	Low
Safety	Not Affected	Not Affected	Not Affected

Proposal Conclusions

Each proposal has unique strengths and weaknesses. Proposal 1, expanding the Drinking Horse trailhead parking lot, has the highest estimated cost but increases parking the most. Proposal 2, the ride share program, does not require any additional construction but relies on community participation to be effective. Proposal 3, painting permanent parking stalls, has the lowest estimated cost but does not increase parking as much as Proposal 1. Additionally, each proposal can be combined with one another if the final budget allows.

The proposals meet all constraints and sufficiently solves the problem according to the background research we conducted. By comparing the individual strengths and weaknesses of each proposal, we conclude that Proposal 3 is ideal due to how many spaces it adds, it's low cost, and it's low environmental impact. It has the lowest "Cost Per Spot" of the proposals. If the final budget is not prohibitive, Proposal 2 is our second choice based on the amount of space it adds.

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