Mulch Makeover

ENGR-215, Spring 2017

Team ‘Work’

Thomas Premo

Bryce Scriven

Matthew Wardynski

Tyler Wilkins

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1. Problem Formulation

1.1 Introduction

The purpose of the section one is to establish the basis and the general information about the project and the client. Another purpose of the first section is to go over what the problem is and show our solutions to the problem as well as what the effect our solution would have on the world.

1.2 Background

Team Work, consisting of Thomas Premo, Bryce Scriven, Matt Wardynski, and Tyler Wilkins, has been given the project is to landscape a patch outside the front of the school. The project will be carried out at Zane Middle School under the direction of Mr. Trevor Hammons. Grounds work was started on February 9th 2017, and will be expected to be completed in the spring semester of 2017. The school has a large patch of ground that they desire to have some sorts of paths and a nicer touch to it to make it seem more inviting as well as educational.

1.3 The Black Box Model

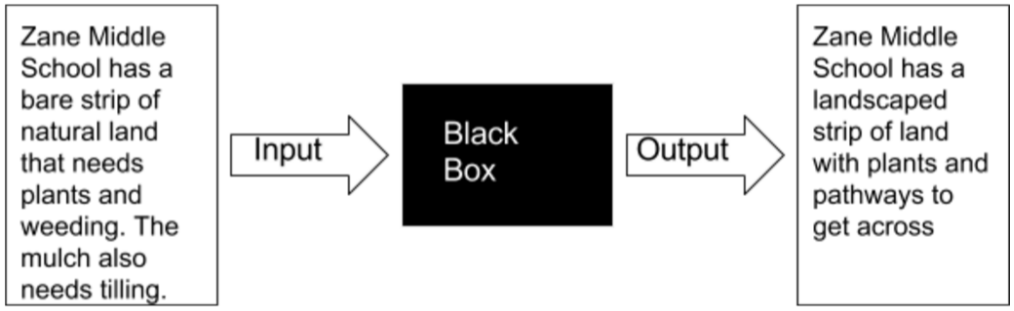

Figure 1-1: The Black Box Model demonstrates the problem that needs a solution. The Black Box has the problem as an input and the output is the solution and the result the solution has on the world.

2.1 Problem Analysis

The purpose of the problem analysis is to look at the specifications, considerations, and criteria of the Zane Middle School Grounds Work Project. The specifications will show what needs to be done in order to be successful. The considerations help focus on tailoring the project to the client. The criteria will be used to indicate when the project is finished and how the final product can be judged. Additionally, this section will show the expected usage and production volume, to ensure a lasting and satisfactory project.

2.1.1 Specifications and Considerations

2.1.1.1 Specifications

Specifications are parts of the project that have to be a part of the project by request of the client. Specifications are also needs that the client has to have achieved as a part of the project.

- Plants must not exceed a specified height (around 4 to 4.5 feet).
- There cannot be grass; the original mulch must be used to cover the surface of the rectangle.

2.1.1.2 Considerations

Considerations are parts of the project that the client would like to see but don't necessarily have to be a part of the project. Considerations are also things to keep in mind while designing the project, but if it can't work as part of the project the project is still successful.

- incorporating the school colors, red and gold, in the design

2.1.2 Criteria

The criteria help define what is required for the Zane Grounds Work Project to successfully meet the client's needs. The criteria are as follows:

1. **Durability**: The ability to endure use from middle school students is crucial to this project's usability at the school.
2. **Ease of Maintenance**: In order to have a functioning grounds work project, the space must be able to be easily maintained so it can stay in optimal shape and be manageable work for the grounds people.
3. **Safety**: Because some students are more rambunctious than others, the project must be as safe as possible so the kids do not injure themselves.
4. **Eco-friendliness**: For the positive educational value for the students and in the context of our Environmental Engineering course, it is of principal importance that the project materials are as eco-friendly as possible. The eco-friendlier the project is, the better it affects the environment, and the better it influences the students.
5. **Cost**: Since the project uses the client's money, minimizing cost is necessary for the client's satisfaction.

6. **Accessibility**: One of the primary reasons for this project to be built is so the students can easily walk through the space and have places to wait to be picked up by their parents, so it is imperative that the space is easily accessible for all students.
7. **Visual Aesthetics**: Many students will be using the project every day and it will be very noticeable from the front of the school, so the project must be visually appealing in order to make the school a more pleasing environment in general.

2.1.3 Usage

The project will transform the lifeless and barren rectangle in front of Zane Middle School into a visually appealing feature that will act as a centerpiece for the school. Fresh looking mulch and new plants will give the rectangle a cleaner look that will improve the overall look of the front of the school. Benches that will be installed by the school will be used by students waiting to be picked up.

2.1.4 Production Volume

A single rectangle in front of the school will be redesigned.

2.2 Literature Review

Construction materials vary greatly to meet different characteristics and requirements. Wood, adobe, and concrete are cost effective, reliable, and can be found in most parts of the world.

2.3 Wood

Wood is produced by woody plants and is an organic material, which makes it vary greatly due to environmental factors as well as genetics. Wood performance is based on many different facts such as how old the wood is, the axis it was cut on, and if the wood was treated with preservatives (Wood: Detailing For Performance). The following are widely used characteristics to classify wood:

- Strength
- Stiffness
- Hardness
- Finish Retention
- Treatability with Preservatives
- Resistance Capabilities

All types of wood are subject to decay and rotting overtime. Choosing a certain wood for its qualities will ensure efficiency as well as durability for any project (Beating the Elements, 2006).

2.3.1 Types of Wood

Outdoor woods easily found in the United States can be categorized into three different categories. American softwoods, hardwoods, and composites are three well known classifications for wood (Beating the Elements, 2006).

2.3.2 American Softwoods

American softwoods include Western red cedar, redwood, cypress, and pine. Softwoods are common and inexpensive compared to hardwoods. Softwoods are used in 80% of construction projects due to their low cost and accessibility, however they cannot withstand heavy daily use (Properties of Wood and Structural Wood Products).

Figure 2-1: Redwood planks
(https://www.timbertown.com/blog/wood-profiles/redwood-lumber-comes-in-many-grades)

2.3.3 Hardwoods

Hardwoods include white oak, ipe, teak, and mahogany are all examples of hardwood. Hardwood is denser than softwood making it a strong, durable building material. The process for wood to grow more densely is time consuming, this makes hardwood less common and more expensive than softwoods (International Timber, 2015).

Figure 2-2: Teak planks
(http://www.floridateak.com/)

2.3.4 Composites

Composites, unlike organic wood, have no defects, do not compress like wood, and are commonly made with recycled material. They are constructed with thermoplastic resins, wood flour, and wood fiber (Beating the Elements, 2006).

Figure 2-3: Composite planks
(http://resbuildmag.com/content/product-review-new-generation-composite-decking)

2.4 Adobe

Adobe is a worldwide building material made primarily of earth, clay, and straw. The ease of access and cheap cost of building supplies makes adobe very popular. The four commonly seen types of adobe are solid blocks, hollow blocks, perforated blocks, and interlocking blocks. These blocks differ in their production process, shape, and final characteristics. Any form of adobe brick building requires the use of bricks and mortar. (The Adobe Brick Technique, 2017).

Figure 2-4: Solid adobe bricks
(http://www.survivalistboards.com/showthread.php?t=113353)

2.4.1 The Brick

Adobe bricks are initially a mixture of clay, sand, and water with a consistency similar to plastic. A binder, composed of straw or grass, is then added to the bricks to help them set more uniformly during the drying process. The mud-like mixture is then poured into a form to solidify in the desired shape. Once solid, the bricks are "turned-out" and then dried during a two-step process. The first step is to lay the solid bricks on a level bed of straw or grass for several days. The next and final step is to stand the bricks on end in a dry, warm area for at least 28 days (Technical Preservation Services, 1978).

2.4.2 The Mortar

The mortar is the glue-like substance to hold the finished adobe bricks together. Mortar is commonly made out of mud. A different form of mortar can be created with cement and lime. The cement and lime mortar can only be used with stabilized adobe bricks. Unstabilized adobe bricks have different thermal expansion and contraction rates then the cement mortar, causing the adobe bricks to deteriorate faster (Technical Preservation Services, 1978).

2.5 Concrete

Concrete is a composite material made up of fine and coarse aggregate, cement, and water. This composite is adaptable and can be formed to many different shapes and sizes. Concrete has a very high compression strength, unlike its tensile strength which is very low. Due to this low tensile strength, most concrete is formed around patterns of rebar, then referred to as reinforced concrete (Meyer, 2003).

Figure 2-5: Concrete slab
(http://surfcivil.blogspot.com/2014/11/advantages-and-disadvantages-of.html)

2.5.1 Asbestos Testing

Testing of concrete for VOC's (Volatile Organic Compounds) is done by drilling out core sample of concrete and then submitting to a lab for analysis.

2.6 Similar Projects

2.6.1 Parklets

A parklet is a small seating area or green space created as a public space on the pavement in the place of a parking space. Partnering with the City of San Francisco, the Pavement to Parks organization created the Parklets Project to give people a place to relax off of the sidewalk. Since the San Francisco streets are often crowded, a creatively designed parklet is an inviting different atmosphere. These parklets come in many different styles and can include benches, tables, umbrellas, planters, and art (Birdsall 2013). The environmental themes from the Parklet Project lend themselves well to the Zane Middle School Project because the Zane project aims to create an environmentally-friendly space where the students can wait for their parents to pick them up.

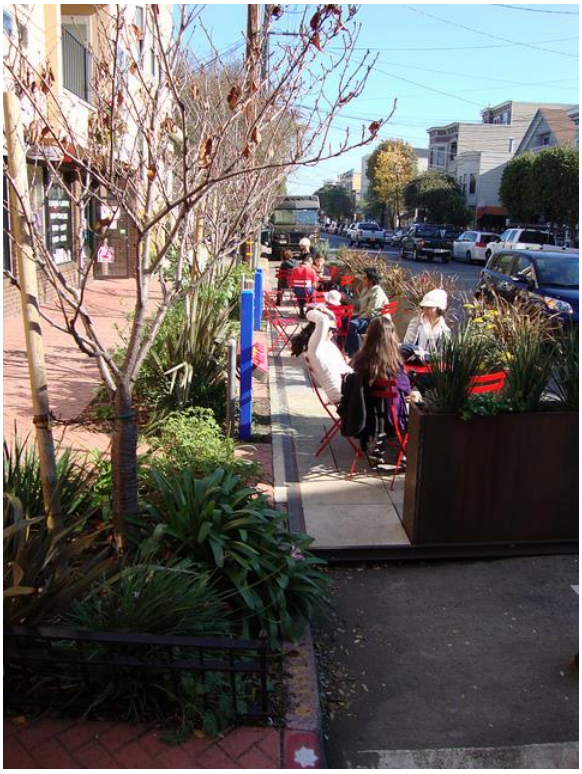

Figure 2-6: Noe Valley, San Francisco Parklet
http://pavementtoparks.org/parklets/featured-parklet-projects/noe-valley-parklets/

2.6.2 Eureka City Parklets

Four parklets were built in Old Town, Eureka after being approved by the Eureka City Council in August of 2015. There are now parklets at Ramone's Bakery (209 E Street), Humboldt Bay Tourism Center (2nd and G Streets), A Taste of Bim (613 3rd Street), and The Siren's Song Tavern (352 2nd Street). The project was pushed Rob Holmlund, the Economic Development Division Director, and information on the building process of these parklets was published by Michelle Birdsall (Birdsall 2016).

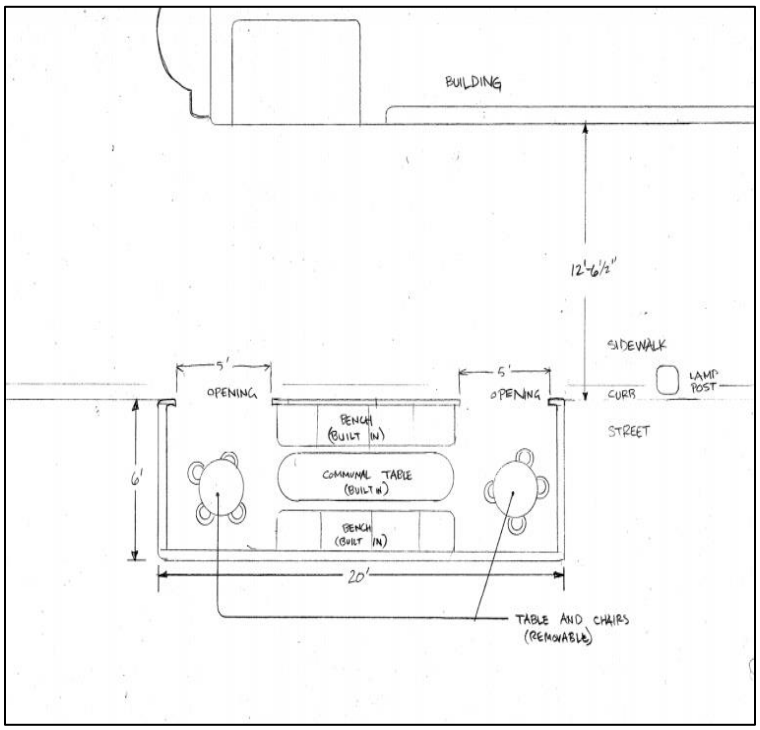

Figure 2-7: The plan for the Siren's Song Tavern parklet, sent in an email from Lisa Savage, a project/property manager of the City of Eureka

2.6.3 The Triangle of Life

The Triangle of Life project was a grounds work project that Engineering 215 students created in 2015 that renovated a triangle of land with pathways and plants. Like Mulch Makeover, The Triangle of Life was built at Zane on top of a patch of mulch, and it had implemented durable and maintainable paths and vegetation that could withstand constant use by the students (Adams, Fuentes, Charco, Caminti 2015).

Figure 2-8: The Triangle of Life at Zane Middle School
http://www.appropedia.org/Zane_Middle_School_triangle_of_life

2.6.4 Edible Landscape

The Edible Landscape project was developed in 2014 by Engineering 215 students, and it was designed to be an enjoyable, eco-friendly landscape that could be enjoyed by anyone visiting the school. Like Mulch Makeover, the Edible Landscape was constructed in a place that Zane students, faculty, and community members notice frequently. By adding vegetation, benches, and other landscaping elements, the team was able to turn an initially dull space into an area of environmentally educational importance (Garcia, Gill, Goebel, Holter 2014).

Figure 2-9: The Edible Landscape at Zane Middle School
http://www.appropedia.org/Zane_Middle_School_edible_landscape

2.7 Plants

Research relating to plants includes information about the plants themselves, as well as research about soil types and irrigation systems, which are components that foster plant growth.

2.7.1 Soil

Soil composition determines the types of plants that can grow in it. There are six main types of soil; silty, sandy, clay, peaty, saline, and loamy. The type of soil can be determined by rolling a small, wet ball of it in your hands, and noting the soil particles present. (5 Different Soil Types)

2.7.2 Soil Types

This section describes the properties and makeup of the six main soil types as well as information on how to identify them.

2.7.3 Silty

Silty soil has smaller particles and is smooth to the touch, it feels slick when wet and leaves dirt on your fingers if you roll it. Silty soil retains water relatively well and is fairly workable but it doesn't contain a lot of nutrients. Due to its ability to retain moisture, silty soil is usually cold and drains poorly. It is also easy to compact if stepped on. (5 Different Soil Types)

2.7.4 Sandy

Sandy soil has the largest particles of all the soil types, causing it to feel dry and gritty. Sandy soil cannot retain water or nutrients as it drains rapidly. Sandy soil is light and dries quickly in the spring. Wet sandy soil will crumble easily in your fingers and not retain its shape if rolled into a ball. (5 Different Soil Types)

2.7.5 Clay

Clay soil has the smallest particles of all the soil types and has good water storage qualities. It is sticky to touch when wet and smooth when dry. Due to their tiny size, it's particles tend to settle together making it harder for air to pass through. This makes it retain nutrients longer and increases its water retention time drastically. Clay soil is usually cold in the spring and can become heavy and difficult to work with. When moistened it rolls easily into a ball. (5 Different Soil Types)

2.7.6 Peaty

Peaty soil is soft, compressible and black/dark brown in color. It has a high water content and is rich with organic matter. One of the benefits of peaty soil is that it's able to retain water during the dry months. Peaty soil feels spongy and will expel water if squeezed. (5 Different Soil Types)

2.7.7 Saline

Saline soil has a high salt content which makes it undesirable for planting. It is difficult to grow anything in this type of soil and it doesn't irrigate well. Saline soil can be identified by a white layer that covers its surface. (5 Different Soil Types)

2.7.8 Loamy

Loamy soil, also called loam, is the ideal soil for planting. It has a mixture of silt, sand, clay, and hummus, as well as a higher pH and Calcium levels. Loamy soil is soft, dry, and dark in color. It retains water and nutrients extremely well. Loamy soil is often created when organic material, typically compost, is added to one of the other soil types. (5 Different Soil Types)

2.8 Irrigation

2.8.1 Design

Drip irrigation systems are a type of low-cost irrigation system effective for watering multiple individual plants like shrubs or flowers that are commonly used in gardens and parks. They use a long network of hoses to water each plant individually with a mini sprinkler head that 'drips' water onto the plant. Drip irrigated plants often grow better as they receive more water and also have fewer diseases than plants that are overhead watered or left to nature. Drip irrigation systems can also be used to add liquid or soluble fertilizers. (Building and Operating a Home Container Irrigation System)

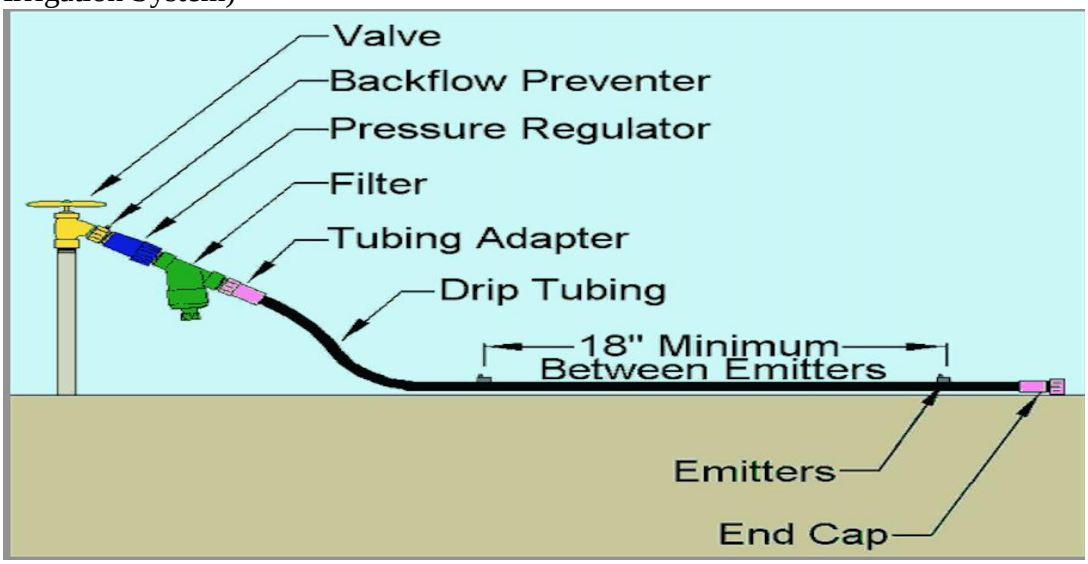

Figure 2-10: Drip Irrigation system components
http://www.irrigationtutorials.com/wp-content/uploads/2014/06/dripguide1.gif

2.8.2 Installation

Before installation, it's a good idea to plot out a design on a scale diagram of the area you want to irrigate in order to determine how much tubing, fittings, and emitters are needed for the system.

Drip irrigation systems begin with a water source, usually a hose nozzle attached to a wall. A particle filter and pressure regulator are added in order to regulate flow. Flow is a measure of how many meters the water will travel each second and pressure is measured in PSI (Pounds per Square Inch) Most systems run at 35 PSI but there are lower pressure systems on the market. If a municipal water source is used, a backflow preventer may need to be installed. A timer is added to control when the system is activated and a pressure reducer can also be installed. Some systems use a mainline tubing of hard plastic pipe connected to a series of flexible rubber tubes that are smaller in diameter. The tubing is running wherever the plants are, and is able to bend easily to reach each plant.

Figure 2-11: Drip Irrigation System
http://www.motherearthnews.com/organic-gardening/drip-irrigation-for-raised-bed-gardens-zbcz1406

2.8.2 Operation

Early in the season it is generally good to run the system twice a day for 10 minutes, then longer as the plants grow and begin to demand more water. The types of plants being watered will also determine how often the system is running. After heavy rains, it is good to turn off the water valve to prevent overwatering. The tubing can develop leaks or pop off and it is a good idea to keep spares of some of the smaller plastic parts in case they break.
(Building and Operating a Home Container Irrigation System)

2.9 Native Plant Species

2.9.1 Grass Seeds

The best grass seeds are NTEP rated, meaning that they are independently evaluated by the National Turf Evaluation Program and have been specifically bred for a greener color. They are also drought tolerant and resistant to disease and insects (How to Plant Grass Seed).

2.9.2 Preparing the soil

In order to begin planting, the soil will first need to be loosened at the top 2 or 3 inches and any debris like rocks and sticks will need to be removed. Any soil clumps larger than a half dollar will also need to be broken up, but it is also important to not use soil that is too fine. Next it is important to level areas where water might collect to prevent flooding (How to Plant Grass Seed).

2.9.3 Planting Grass Seeds

For small areas, the grass seed can be spread evenly by hand but a lawn spreader or mechanical seeder is necessary when planting in larger areas. There should be about 16 seeds every square inch. If the seeds are too close together, the seedlings will fight for room and nutrients which will cause the grass to be weak or thin in some areas. Once the seeds are in the ground, they are covered with about ¼ of an inch of soil. They should be watered often and kept moist to enhance germination, the process by which a plant grows from a seed. The seeds need to be watered lightly at least once daily until they've grown to at least 2 inches high. The Spring or the Fall are the best times to plant (How to Plant Grass Seed).

2.9.4 Bulb Plants

2.9.4.1 Tulips

Tulips are a bulbous plant of the lily family that blooms in the spring. They generally grow to be between 10 and 78 cm tall. Originally from The Iberian Peninsula and the area around the Mediterranean, tulips do well in mountainous areas with temperate climates and grow in long cool springs and dry summers. Tulip bulbs rot in wet soil so good drainage is necessary. Sunny sites work best for growing. Tulips are planted with the pointed end of the bulb facing up in a hole that is three times as deep as the bulb is long (Linnaeus).

2.9.4.2 Daffodils

The Daffodil, also known as Narcissus, is a bulbous plant with a lifespan of about 4 years. They regrow each year from an ovoid, dark-brown bulb and are 5-80 cm tall depending on the species. They bloom in the spring and in the summer their leaves die back. Non-Native to California, they grow well in many different climates but prefer acidic soil. Daffodil bulbs can either be round (single flower) or double nose (two or more flower stems). (Linnaeus)

It is best to plant Daffodils in September and early October in groups of ten or more. The bulbs must be planted pointed end up in a hole that is twice as deep as the bulb is tall. A reliable flower, Daffodils bloom year after year and don't require much care. They come in many different colors like white and yellow (Linnaeus).

Figure 2-12: A group of daffodils (http://www.petalmist.com/wp-content/uploads/2015/03/Daffodils_along_Whitwell_Ventnor_Road.jpg)

2.9.5 Shrubs

2.9.5.1 Harmony Manzanita

The Harmony Manzanita, native to the Northern California coast, requires a little more water than other Manzanitas found in Central and Southern California, but is still drought tolerant. The Harmony Manzanita is a tiny shrub with red bark, dark green leaves, and pink flowers that grows to be between 2-3 ft. high and 6 ft. wide. It's tolerant to most soil types and is good as large scale ground cover. The Harmony Manzanita is heat tolerant and stable, making it easy to manage. It's flowers also attract bees and hummingbirds, making it a valuable part of any garden ecosystem. (Las Pilitas Nursery, Harmony Manzanitas)

Figure 2-13: Harmony Manzanita (http://www.laspilitas.com/images/grid24_24/8628/pictures/Arctostaphylos_densiflora_Harmony_Manzanita-1.jpg)

2.10 Pedagogy

2.10.1 Visual Learning

Visual learning is one's preference to obtain new information through the use of visual examples. This would include the use of physical objects, virtual or pictorial examples to learn off of. Graphs and charts would be examples of pictorial learning visually. The use of having the objects presented to a visual learner is another example of having lessons stick to the student.

2.10.2 Upcycled Benches for Visual Learning

Benches made out of a plastic bottle brick is strong, ecological and great for a learning experience for kids to use. This is only one method on how to make benches out of recycled materials. Having a cutout in the bench itself would provide the children with a visual way to learn how to make benches out of recycled and ecological materials.

Figure 2-14: Plastic Bottle Brick
(http://sowhatelse.org/programs/bottle-brick-bench-building/)

2.10.3 Pathways Made from Different Material

Pathways made out of different materials provide the students with a visual method to show the different ways of designing walkways. Pathways made out of more sustainable and eco-friendly materials would have a more positive effect on the environment. This serves as both a functional and educational tool for the school and the students.

2.10.4 Learning Through Flora and Fauna

Having several different species of native plants planted in the planters can be a way to provide beauty and have students learn about the different plants out in the local area. Having signs to display the type and name of the plant near the species itself would help the students learn about them in a visual way. The students can see what the different types of flora are around the county and have the names of them as well as how to identify them. This provides the children with an educational benefit while also contributing to the aesthetic appeal of the newly refurbished grounds. Having native plants put into the planters will also be better for the environment because it would limit, to a degree, the use and spreading of invasive species in the local area.

3 Alternative Solutions

3.1 Introduction

Section 3 describes the alternative solutions created by Team Work as well as the processes used to evaluate them. The alternative solutions were determined by sitting down as a group and brainstorming. Brainstorming techniques were modeled by creating solutions that met our specifications and criteria to ensure that any of our alternative solutions can be used as a primary and final solution.

3.2 Brainstorming

Team Work held a brainstorming session during a meeting and came up with 12 different viable solutions for the project. From these 12 solutions, they were narrowed down and some were combined to make new alternative solutions for the project. These solutions were split up among the group members so they could take their own ideas and turn them into possibilities for a final design. The best of these ideas are considered to be the official alternative solutions.

3.3 Alternative Solutions

The alternative solutions outlined below were decided on in a series of group meetings. They are composed of different elements of the projects explored in past meetings to determine if they could be incorporated.

1. The Garden of Mulch
2. A Pass Through the Grass
3. Edible Garden
4. Xeriscaped Rectangle
5. Xeriscaped Planters
6. Irrigated Flower Bed Planters
7. Greenery Is Scenery
8. Rocky

3.3.1 The Garden of Mulch

Figure 3-1: The Garden of Mulch consists of mulch (A), sitting rocks (B), and cement pathways (C).

The Garden of Mulch is a simple and aesthetically pleasing design. The primary material would be the mulch (A), which is already in place**.** Mulch provides an extremely hardy and very low maintenance material to cover the open ground. Using the mulch is a very environmentally friendly and cost efficient alternative. In order to create more sitting space right next to the parking lot, large boulders (B) are placed along the edges of the mulch. This gives a 3D element to the site, which increases aesthetics. Additionally, the large boulders are conveniently placed for the students to sit on or lean against while awaiting their parents. A downside to placing boulders at Zane Middle School, would be the tendency for the students to want to jump on or off of the boulders, which is a safety issue. Figure 3.1 shows four cement pathways (C) spaced evenly on either side of the center square. This provides students with an easy pathway to the parking lot rather than walking around the site or on top of the mulch.

3.3.2 A Pass Through the Grass

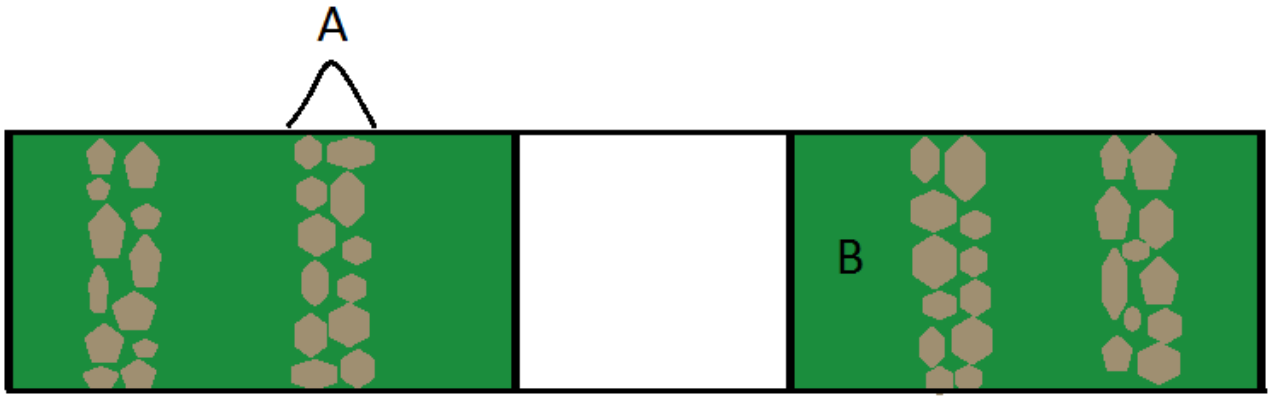

Figure 3-2: A Pass Through the Grass consists of two main elements. Reference (A) are flat stepping stones placed in line across the grass to form a pathway. The grass (B) covers the remaining open area.

A Pass Through the Grass provides a simple and minimalistic design with a focus on softening the look and feel of the front of the school. The grass (B) flows with the other grassy areas in front of the school. In order to maintain the new grass, the irrigation system running under this portion of the grounds is reinstalled. The grass is trimmed and mowed, done at the same time as the other lawns maintenance. The stepping stones (A) provide a simple path through the grass sections. The stone paths pose a problem if the students wander outside of the paths and start to damage the surrounding area. This solution poses no increased threat to safety other than an occasional stumble by tripping on the path.

3.3.3 Edible Garden

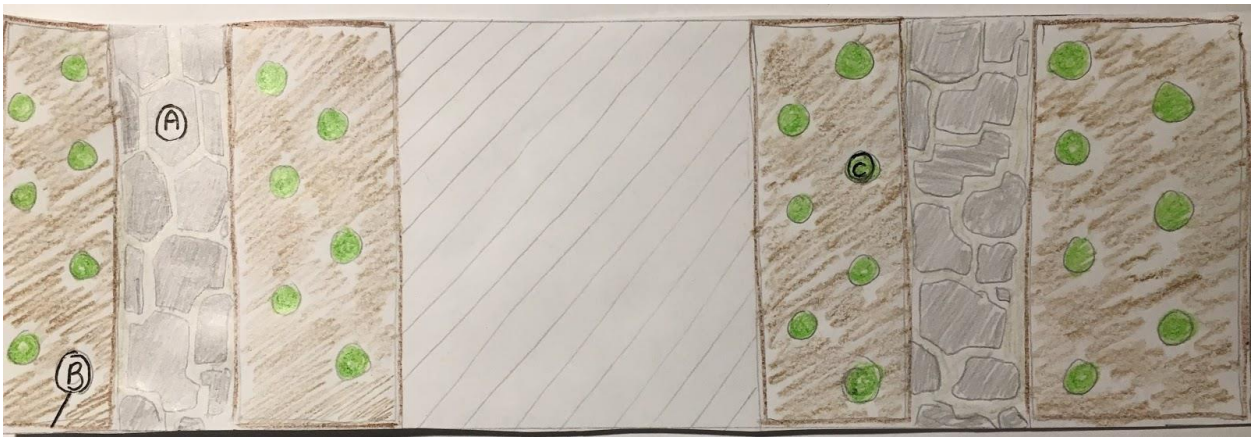

Figure 3-3: Edible Garden consists of three main elements. The walkways (A) are made out of large pieces of flagstone with and fine gravel or semi-permeable concrete used to fill the cracks. (B) shows a short and thin barrier, likely made out of wood, which will be used to contain the dirt in the garden. The plants (C) in the garden will be native plants that are edible.

The Edible Garden requires frequent irrigation. The existing sprinkler system already in place under the rectangle would be upgraded to meet the needs of the plants. The installation of a drip irrigation system, in which each plant is watered individually, would be ideal. The paths are filled with gravel or a semi permeable concrete to make them even and safe to walk on. If a gravel is used there would be the problem of it getting out from the path and onto the dirt. The barrier around the dirt is there to keep it in and could be expanded for a similar purpose with the gravel. As several different types of local edible plants will be used, they will have to be purchased and trimmed to maintain them. A student organization would ideally be responsible for maintaining the garden. Keeping raccoons and birds from eating the plants would also be an issue.

3.3.4 Xeriscaped Rectangle

Figure 3-4: Xeriscaped Rectangle is made up of semi permeable cement paths (C) like the ones used in front of the school. Drought tolerant plants shown by (D) would grow in soil or possibly mulch (B). A circular section, contained by a short wooden barrier (A) contains gravel and more drought tolerant plants to give the alternative a visual appeal.

The Xeriscaped Rectangle provides a visually-appealing and easy to maintain alternative. Using the xeriscaping method, landscapes in a style that requires little or no irrigation. The plants would be drought tolerant so no irrigation system would need to be implemented. Most xeriscaping uses rocks but due to the possibility of students throwing these rocks through windows, small pebbles would have to be used in the parts that require them. A small wooden barrier is used to keep them in place. The paths will use a semi-permeable cement like the paths at the front of the school from a previous year. This alternative would be easy to install and maintain and, with the circle and other features providing variety, would be visually appealing.

3.3.5 Xeriscaped Planters

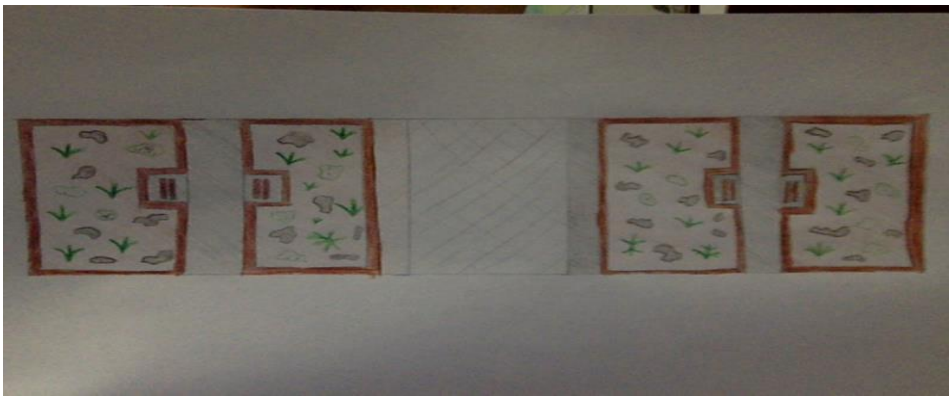

Figure 3-5: Xeriscaped Planters have three features to the design. The first being the planters themselves with zero-irrigation plants located in them. The second would be the benches that are embedded into the planter area. The third would be walkways in the middle and on the ends of the planters.

Xeriscaped Planters has the cost-effective use of zero-irrigation plants, as well as having the benefit of using California native plants. The planters would be made out of a wood material to have a nice aesthetic appeal. Benches would be placed within the planter area to make the pathways as clear as possible for busy traffic going through the schoolyard. The pathways will be made out of an eco-friendly material that changes from pathway to pathway to provide educational value to the students passing by or waiting to get picked up.

3.3.6 Irrigated Flower Bed Planters

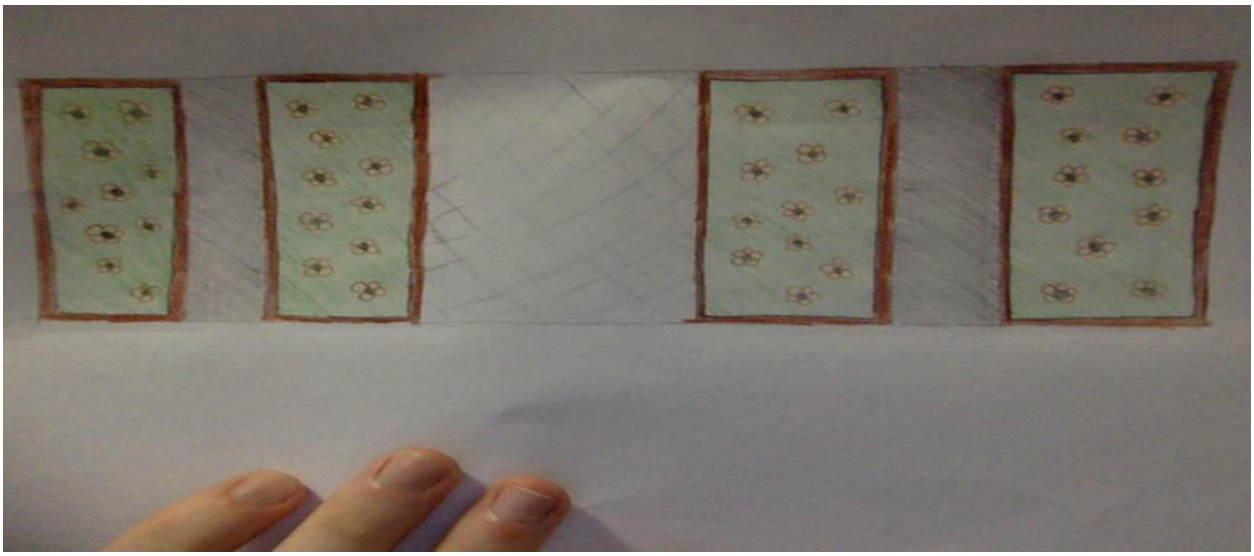

Figure 3-6: Irrigated Flower Bed Planters comes with multiple planters that contain flowers and grass to provide aesthetic appeal. The planters will be made to be sturdy because it will be used as seating itself. The pathways will cut through the planters as well as on the end of each planter.

Irrigated Flower Bed Planters contains more flowers than other zero-irrigation landscape designs, while using grass to fill in the other areas. The irrigation would keep these plants alive and well throughout the years. The planters will be made sturdier than that of other designs due to this designs necessity to use the planters as its own bench seating for students. The pathways will be made of eco-friendly materials that vary from pathway to pathway to ensure educational value for all students that walk in the planter areas.

3.3.7 Greenery Is Scenery

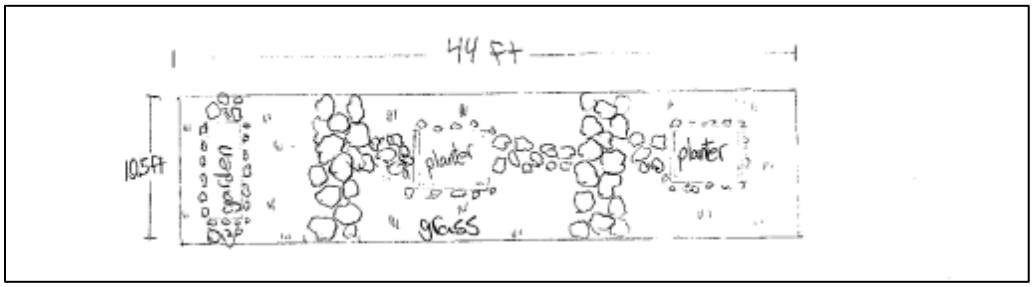

Figure 3-7-1: an aerial view of the right half of "Greenery is Scenery"

"Greenery is Scenery" is an irrigation system with grass, stepping stone paths, planters that are also used as benches, and garden beds containing edible plants and/or flowers. Figure 3-7-1 shows a general picture. In terms of durability, this alternative does well because each item will last a fairly long time. The stepping stones are unmovable, and the planters and garden beds are made of be made out of sturdy wood. Even though grass can get easily ruined if enough people walk through it, the Zane students know not to walk on grass, so that should not be a problem. The grass is easy to mow and there are already sprinklers installed in the space, so the grass could be easily maintained by the school grounds people, and the shrubs in the planters only need to be trimmed every once and awhile. The garden requires a bit more maintenance than the planters, but it is still manageable because it only requires basic gardening skills like watering and planting.

"Greenery is Scenery" is also safe, educational, and environmentally friendly. The irrigation system with grass and plants serves as a friendly environment where the students can wait after school, and there are also many local plants. All of the greenery also makes the space especially aesthetically pleasing. This space is also accessible to the students because they can move about freely with the paths and still have seating with the planters. Figure 3-7-2 shows an example of planter seating. None of these things are dangerous to students, so the safety criterion is well satisfied as well.

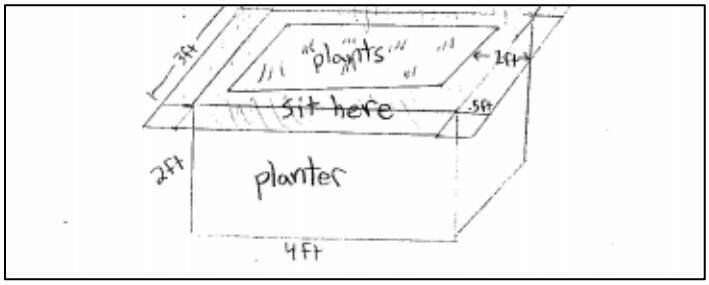

Figure 3-7-2: planter seating

3.3.8 Rocky

Figure 3-8-1: an aerial view of the right half of “Rocky”

“Rocky” is a zero-irrigation system with mulch, stepping stone paths, sitting rocks, and planters. Figure 3-7-1 shows a general picture. The zero-irrigation system with mulch provides a landscape that does not demand water or mowing like grass does, so less maintenance is required. The sitting rocks are very durable, and the planters, while they are not meant to sit on, are also be strong enough to withstand some miscellaneous use from the students.

“Rocky” also has environmentally friendly aspects to it. The zero-irrigation system with mulch requires much less water than grass would, so it conserves water. Also, there is no need for mowing, which reduces the use of fossil fuels. There are also local plants the planters. While there is not an excessive amount of greenery, this alternative is still aesthetically pleasing to the students because of how different it would be than the rest of the school. Instead of grass, there is mulch; instead of paved walkways, there are stepping stones; and instead of benches, there are sitting rocks. “Rocky” is also very accessible for the students because there are interesting paths and lots of seating. Unlike a normal bench, a sitting rock can seat students on every side, resulting in more space to sit. Figure 3-8-2 shows an example of a sitting rock.

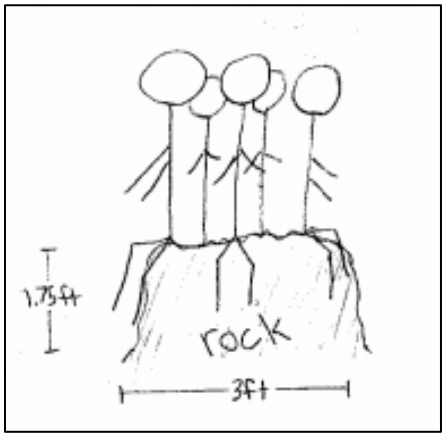

Figure 3-8-2: kids sitting on a small boulder

4. Final Decision

4.1 Introduction

Section 4 explains how the alternative solutions were evaluated and the decision for the final design was reached. The process used a Delphi matrix and weighed different criteria in terms of importance and compared it to each alternative. Once the process was completed, our final decision had the highest evaluation score.

4.2 Criteria Definitions

The criteria definitions elaborate on the criteria from Section 2 that were used in the decision-making process.

Durability: A durable project does not break or stop working after it gets older. It should be able to endure daily use and continue to function.

Ease of Maintenance: A project that is easy to maintain is accessible to anyone who wishes to sustain it. It should not be difficult to repair.

Safety: A safe project can be used without fear of injury. It should not have hazardous materials that could physically harm someone.

Eco-friendliness: An eco-friendly project uses environmentally-mindful approaches to solving the problem. It should not use any materials or methods that could harm the environment.

Cost: A cost-efficient project makes the best use of the client's and the engineers' budget. There should be no money that unnecessarily went to waste.

Accessibility: An accessible project is usable for everyone and can function well when a lot of people are using it.

Visual Aesthetics: An aesthetically pleasing project is both satisfying to the eye and inviting for the consumer. There should be no unappealing aspects of the project that turn consumers away.

4.3 Solutions

In the decision-making process, the following alternative solutions from Section III were considered:

- The Garden of Mulch

- A Pass Through the Grass
- Edible Garden
- Xeriscaped Rectangle
- Xeriscaped Planters
- Irrigated Flower Bed Planters
- Greenery Is Scenery
- Rocky

4.4 Decision Process

A Delphi Matrix, Table 4-1, was used to calculate the ideal solution based upon weighted criteria. Each criterion, shown in section II, was given a weight from 0-10, based upon the criteria's importance. The criteria weights were then evaluated by the client and adjusted to accommodate their thoughts and preferences. Each alternative solution was then evaluated on a scale of 0-30, as to how closely it met each criterion. All of the individual solution scores were then multiplied to the criteria weights to give an adjusted alternative solution score. The adjusted scores were summed for each solution to give us an adjusted total score. These adjusted total scores along with client input and approval, decided which solution is the best for the Zane Middle School Grounds Work project.

Table 4-1: The Delphi Matrix uses weighted criteria; each alternative solution is scored by its fulfillment of these criteria. The sums of each individual solution score multiplied by the criteria's weight allows us to see which solution fits the criteria the best.

	WEIGHT	ALTERNATIVE SOLUTIONS (0-30 HIGH)							
CRITERIA	0-10	THE GARDEN OF MULCH	A PASS THROUGH THE GRASS	EDIBLE GARDEN	XERISCAPED RECTANGLE	XERISCAPED PLANTERS	IR. FLOWER BED PLANTER	GREENERY IS SCENERY	ROCKY
COST	3	20 60	20 60	14.75 44.25	15.5 46.5	11.75 35.25	12 36	14 42	18.75 56.25
DURABILITY	8	27 216	22 176	15.5 124	20 160	20.75 166	15 120	18.75 150	21.5 172
EASE OF MAINTENANCE	6	30 180	20 120	13.25 79.5	21.5 129	20.75 124.5	12.25 73.5	14 84	22.25 133.5
SAFETY	9	25 225	20 180	19.5 175.5	21.5 193.5	20 180	19 171	20.5 184.5	14.25 128.25
ECO-FRIENDLY	8	15 120	15 120	21.25 170	26 208	23.75 190	20 160	18.25 146	21 168
ACCESIBILITY	6	20 120	10 60	17 102	17.25 103.5	21.25 127.5	21 126	18.75 112.5	19 114
VISUAL AESTHETICS	7	8 56	15 105	22.75 159.25	20.5 143.5	24.25 169.75	26 182	20 140	17 119
	TOTAL	977	821	854.5	984	993	868.5	869	891

4.5 Final Decision Justification

The final decision that was made was to adapt to a new solution in order to account for last minute criteria. This provided the client with great influence of what they wanted in the project with only minor changes. This solution had ideas that the client really liked, or could get through administration, such as drought tolerant plants, evergreen species, and not blocking any line of sight. The final solution will also include benches that provide the students with a great place to rest for the students. While the solution was not a part of our alternative solutions nor was it on the Delphi matrix, it proves to be the best solution for the project.

5. Design Specification

5.1 Introduction

Section 5 describes the solution that was finalized in section 4. This section will include specifics on a description of the solution with visuals, costs and hours spent on the project, instructions and implications of the project, and the final results of the project.

5.2 Description of Solution

The Mulch Makeover project meets the set criteria and provides the front of Zane Middle School with a safe, and visually appealing main feature. Fresh looking mulch and new plants that replaced the weeds and shrubs growing in the rectangle give it a developed, professional look. The project is safe for students and durable as the plants are hardy and require little maintenance.

5.2.1 Relative Location

The location of the project in relation to the school grounds can be seen in Figure 5-1. This is an imperative spot to be aesthetically pleasing as well as functional. Mulch makeover is located directly between the main parking lot and Zane Middle School's gymnasiums.

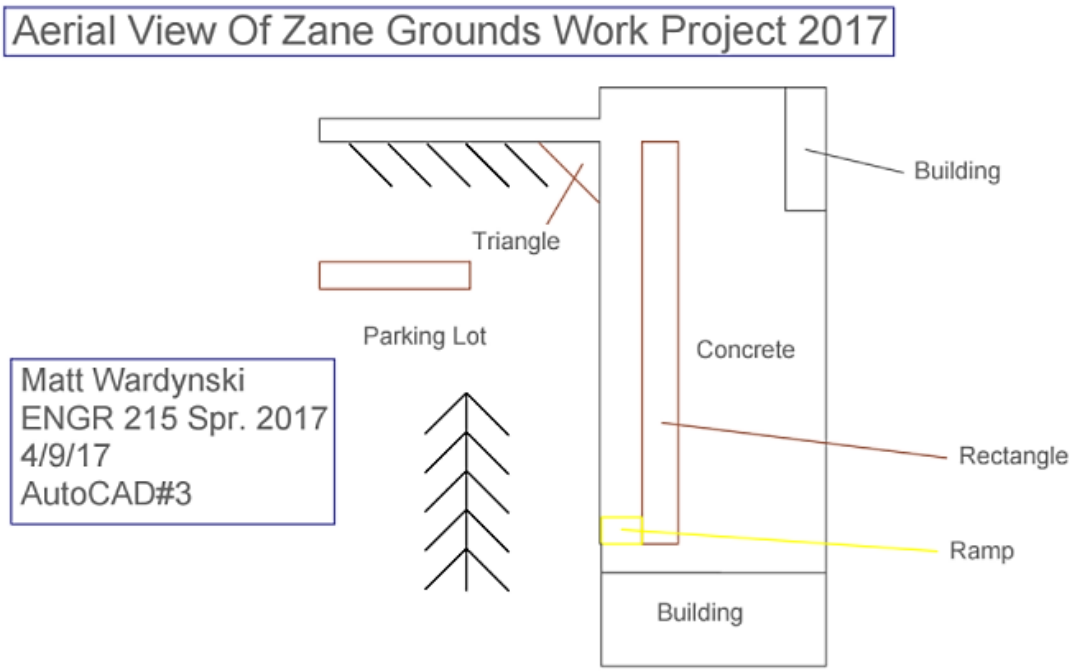

Figure 5-1: Overhead view of worksite in relation to school grounds

5.2.2 Area of Responsibility

Mulch Makeover was created on a strip of mulch roughly 104 feet long by 9 feet wide. Figure 5-2, shows four measurements at the top of the figure. These measurements correspond to our available work area. The three sections of the rectangle with no attached measurements show the areas designated to other
groups.

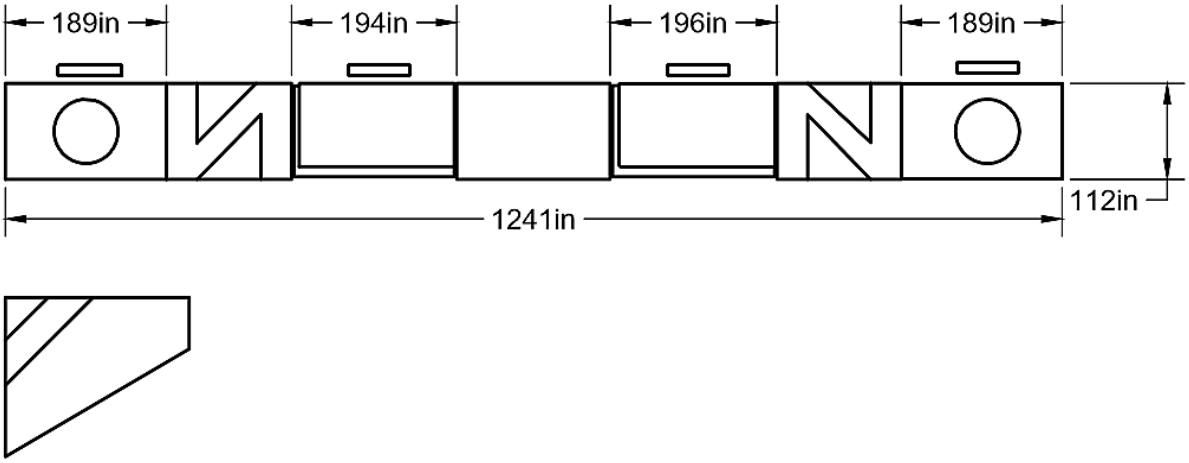

Figure 5-2: Overhead view of worksite (2)

5.2.3 Inner Elements

The two outside sections of Mulch Makeover incorporate two Hino Crimson azaleas in each. This species of plant was chosen due to its characteristics of drought tolerance, low growth, and ease of maintenance. The azalea bushes are planted deep enough into the soil to cover the roots and base. The inner sections are planted with ceanothus plants, which have similar characteristics to the azalea bushes. The plants were placed deep enough into the soil to just cover the root ball, then watered to help the plants settle.

5.3 Costs

The costs section includes a description of the total amount of hours Team Work put into designing this project as well as the costs associated with purchasing materials to implement to project and the costs to maintain it.

5.3.1 Design Costs

The design costs section outlines the total amount of hours Team Work put into this project. A total of 152.6 hours was spent on the project. Figure 5-3: shows a breakdown of this total by design section.

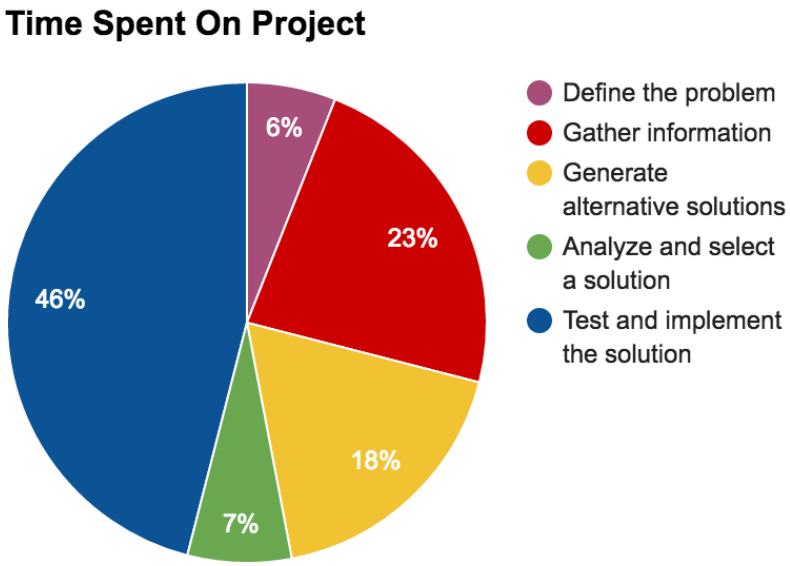

Figure 5-3: Breakdown of Labor (hours)

Total hours: 152.6

5.3.2 Implementation Cost ($)

Table 5-4: Total cost of materials used for the project. The total amount spent on the project was $142.28.

Table 5-4: Total cost (dollars)

Quantity	Material	Retail Cost ($ ea.)	Total ($)
1	Soil Test Kit	20.60	20.60
6	Ceanothus Plant	11.99	70.00
4	Crimson Hino Plant	11.99	51.68
Total Cost	$142.28		

5.3.3 Maintenance Cost ($)

The cost of maintenance will include the costs associated with watering the plants and replacing any parts the project requires.

Table 5-5: The expected maintenance frequency of the project

Maintenance Task	Frequency
Trimming plants	monthly
Watering	weekly
Cleaning up mulch	weekly

5.4 Instructions for Implementation and Use of Model

The design is rather easy to implement, the idea is to get several different, California native, plants and trees and plant them in designated sites on the rectangle outside of the school near the parking lot. The use of the design is the beautification of the campus and parking lot pick up area. Maintaining the model is rather easy because of the drought tolerance of the plants. These plants would not require much water but might need trimming to keep in the rectangle area.

5.5 Results

The area in the rectangle is well planted and will have new growth in the area. The weeds that were a part of the rectangle are now taken out to make the new growth more sustainable. Tilling the mulch has made the rectangle look like there is new mulch. The project came out to be a very great success with plants steadily growing.

6. Appendixes

6.1 Appendix A: References

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6.2 Appendix B: Brainstorming

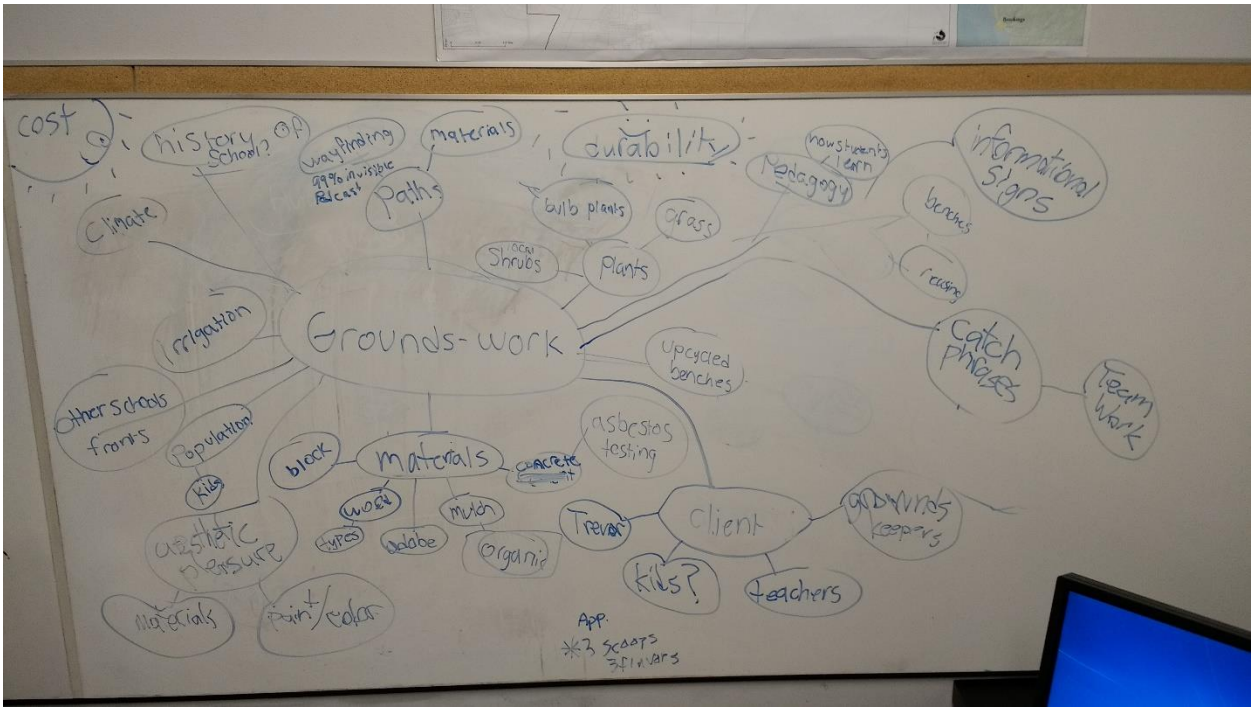

Figure 6-1: Project Inception

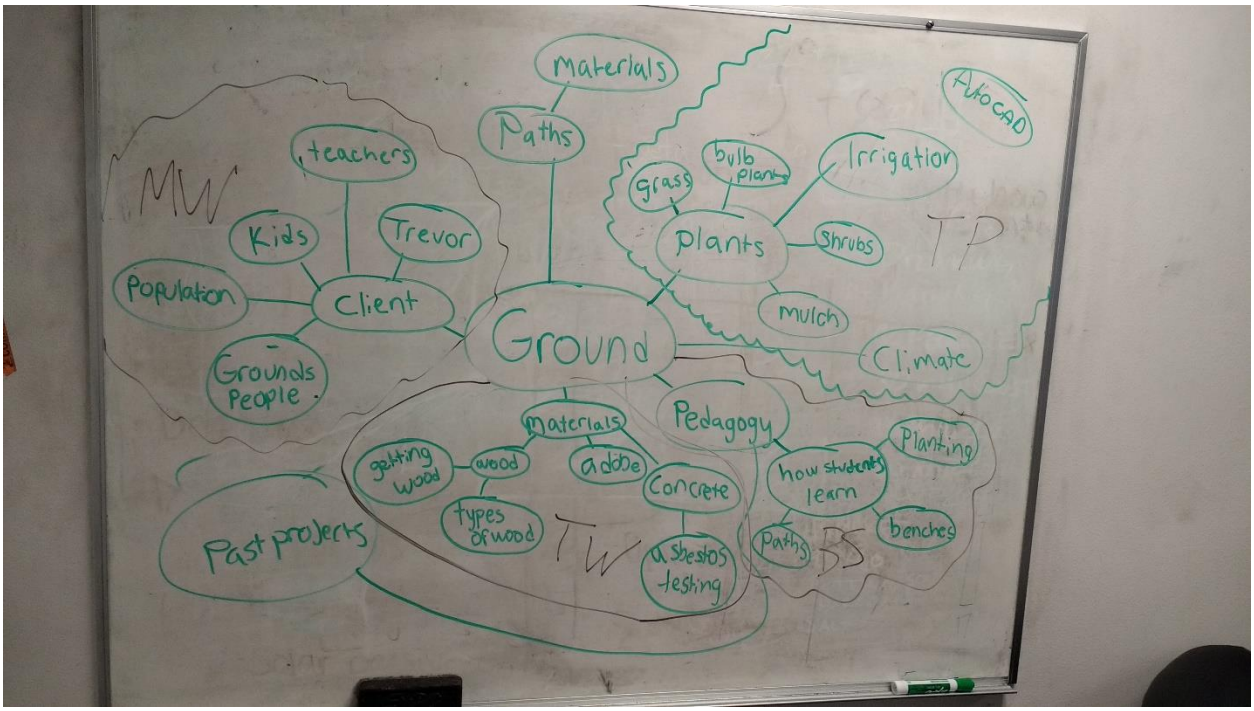

Figure 6-2: Literature review planning

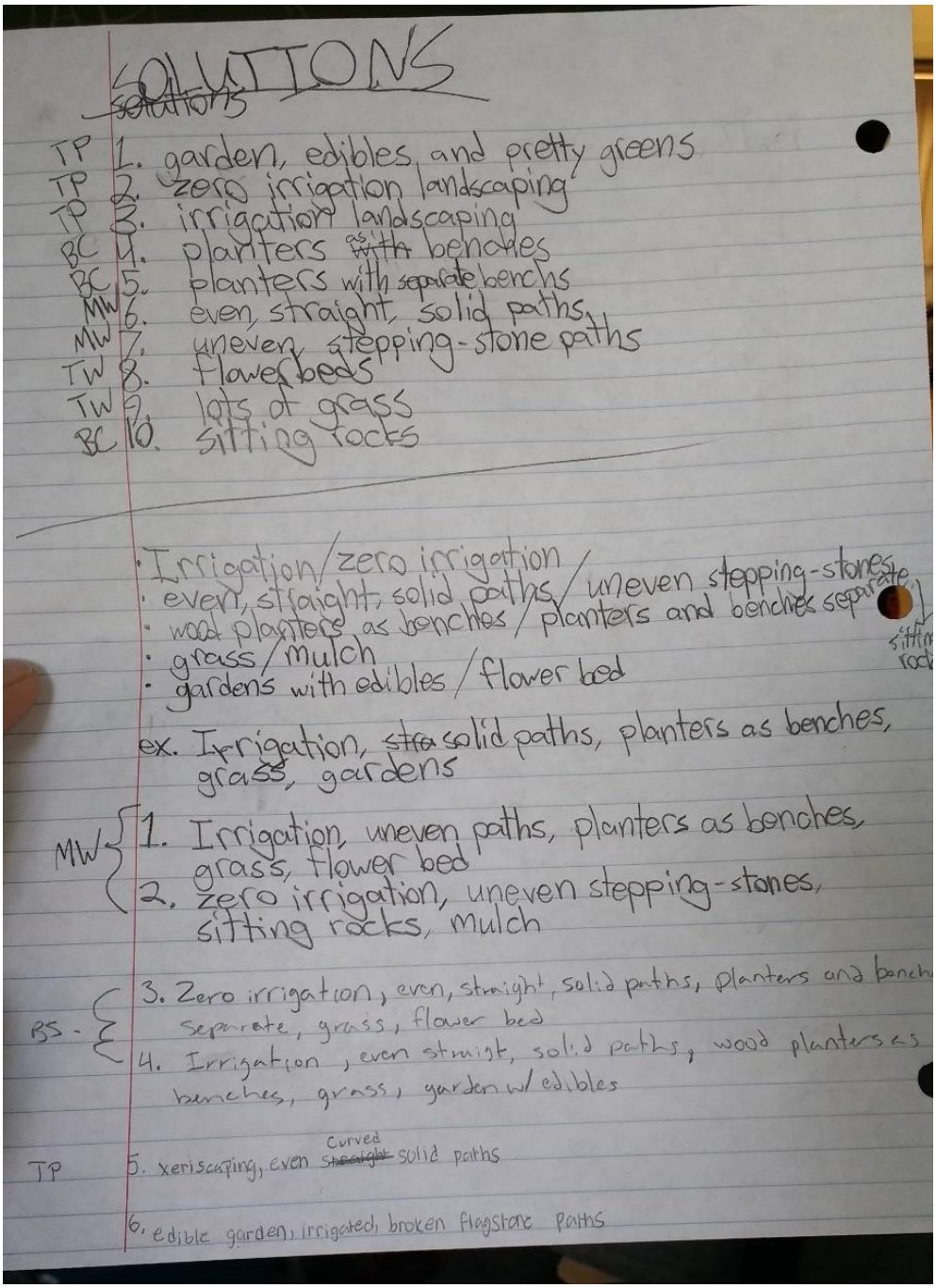

Figure 6-3: Alternative solutions

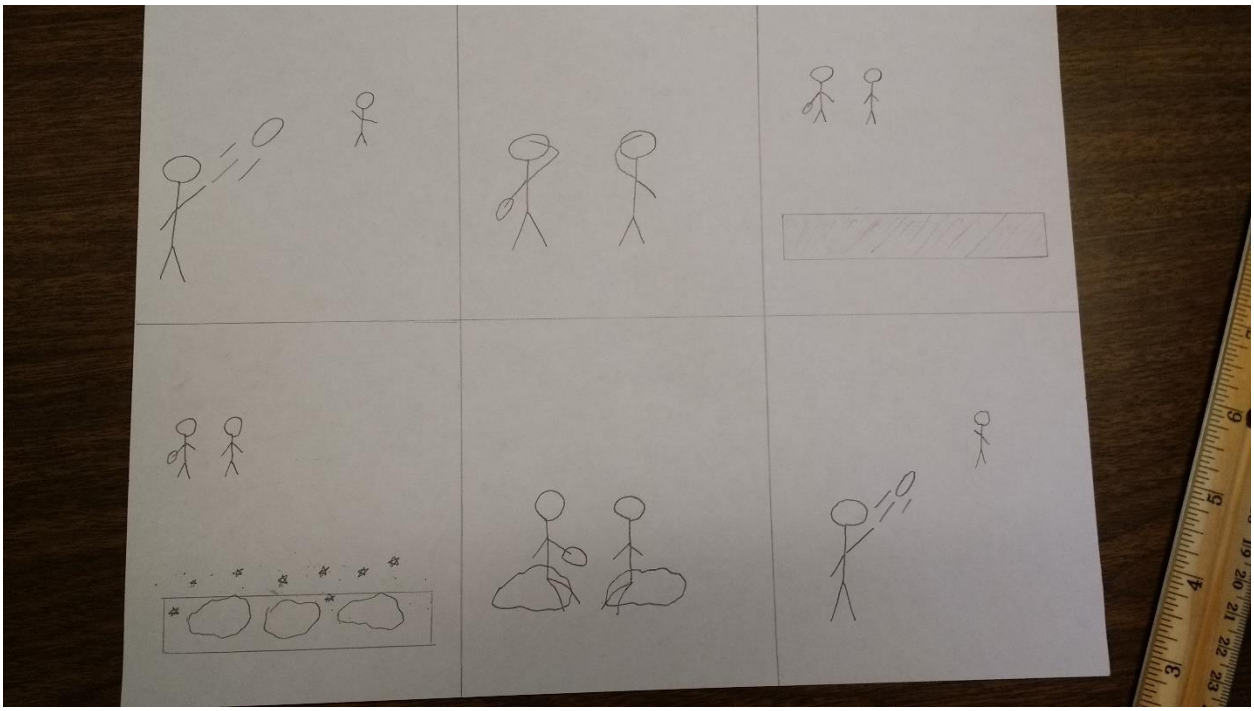

Figure 6-4: Video planning