Department of Computer Science and Engineering
The University of Texas at Arlington

Project: Home Irrigation Control System

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1 General Organization

1.1 Project Manager

The Project Manager for team SmartGrass is Belachew Haile-Mariam. He was nominated to manage this project by Mr. Mike O'Dell, our course instructor and project supervisor. This nomination was unanimously agreed upon by all of the members of the team. His roles will include maintaining the project plan, scheduling meetings, delegating tasks, assigning roles to other members, and serving as the main point of contact for the team.

Belachew is a senior at the University of Texas at Arlington, majoring in Computer Engineering and minoring in Physics. He has a vast array of technical skills that include circuit and electronic design, control of embedded systems, web development, object oriented software engineering, and database management. He also possesses experience working with real world software projects, having previously held internships with Ayoka Systems and Fidelity Investments. This experience and his broad understanding of different technologies made him well suited for the Project Manager position.

1.2 Project Oversight

1.2.1 Internal Controls

The internal control of our project will be the main objective of the Project Manager. He will delegate tasks to other members and will be receive periodic updates on their progress. Additionally, a project plan will be updated and maintained by the project manager and will be used by the team to ensure that tasks are assigned and completed on schedule. Any alterations to the project plan will have to first be approved by the project manager.

The team will meet twice a week to discuss various aspects of the project, review previously completed work, plan work for the future, and update each other on the status of work in progress. In general, team meetings will not be used to complete tasks or other deliverables.

Documents will be shared across the group via Google Drive. Each member will keep a copy of all of the Google Drive's contents on their local machines in order to provide the team with a layer of redundancy. The creation and editing of all documents will be done with the participation of the entire group.

1.2.2 External Controls

External control of our project will come in many forms, outlined by Mr. O'Dell, our project's sponsor. They will serve as milestones and will be used to guide our group and keep us on track. They will consist mainly of:

Team Status Reports: Team status reports will be brief informal reports given throughout the course of the semester. Our team will work together to produce a presentation detailing our status and will present it to our peers.

Individual Status Reports: Individual Status Reports will be submitted by each member of Team SmartGrass periodically throughout the semester to show their individual status on their deliverables.

Document Submissions: Documents will be submitted periodically throughout the semester, including: Team and Individual Status Reports, SRS First and Final drafts, Project Charter, etc. These documents will highlight major points in our project and will collectively serve to keep us on track.

Gate Reviews: A Gate Review will be held towards the end of this semester and will serve to be a major unveiling and peer review session of the latest version of our SRS document.

1.3 Roles and Responsibilities

Team Member	Role	Responsibility
Belachew Haile-Mariam	Project Manager Hardware Lead	- Manage Project Plan - Delegate Tasks - Hardware Integration - Program low level code
Gautam Adhikari	Risk Manager Application Developer	- Notify team of possible risks - Aid in software tasks - Manage database queries
Jeremiah O'Connor	Document Master Software Lead	- Document Formatting - Lead web application development
Tung Vo	Quality Assurance Lead Application Developer	- Perform testing as needed - Aid in hardware tasks - Program low level code
Keith Aholt	Project Sponsor	- Provide feedback relating to project requirements
Mike O'Dell	Project Supervisor	- Oversee project and ensure that we are on track

1.4 Project Constraints

The following are a list of constraints that could potentially affect the outcome and/or quality of this project. We have deemed them to be unavoidable at the present time, and as such we will not go into detail about how to resolve them:

- **Limited Time:** We will have 2 semesters—roughly 8 months—to see this project through to completion. This means that we will have to plan accordingly and use our time effectively. However, we do not expect to be able to deliver every feature outlined in our System Requirement Specification in such a short amount of time, and will prioritize the most critical features over non critical features.
- **Limited Budget:** The budget set for this project is $800. We will be able to spend our budget on any and all necessary equipment, services, and resources. This constraint may limit our team's ability to purchase high quality materials and include proper packaging in our final product. Additionally, any service that we use which requires payment on a monthly basis (such as a server to host our website) will eventually be lost.
- **Limited Knowledge:** The scope of this project is broad, spanning electronic hardware design, web application development, plumbing, microcontroller control, etc. While our team possesses a vast set of skills, it does not contain any experts in any of the above listed fields. Our limited knowledge in one or several areas could potentially affect the outcome of this project.
- **Other Obligations:** Every member of this team has obligations outside of this project. These obligations include other classes, work, family, social/cultural clubs, personal relationships, and religious observations. As such, it is understood that team members will not be able to dedicate all of their focus at all times to this project. As a team, we will be flexible enough for occasional

1.5 Project Assumptions

The following are assumptions identified by the group. They may post a risk to the successful development of the project and will need further evaluation and validation during subsequent project process phases. They are listed below:

- **Team Effort:** All members of Team SmartGrass will put in as much effort as required in order to see the project through to completion.
- **Effective Leadership:** The project leader will be able to effectively lead the group and manage different scenarios that might come up.
- **Team Meetings:** All team members will do their best to arrive promptly for meetings and to be prepared to be productive in meetings once they have started.
- **Team Attitude:** The team members will try to maintain a positive attitude when dealing with each other, our sponsor, and our supervisor.
- **Communication:** Team members will communicate effectively and will respond to each other in a timely manner.

1.6 Preliminary Schedule and Cost Estimates

Preliminary Project Schedule (Phase I)		
Project Milestone	**Due Date**	**Cost (Hours)**
SRS First Draft	10/08/2014	20
Project Charter First Draft	10/15/2014	15
Project Plan First Draft	10/15/2014	20
Requirements Gate Review	11/05/2014	40
Architecture Design Specification Draft	12/01/2014	35
Baseline Project Charter	12/10/2014	20
Baseline Project Plan	12/10/2014	10
Architecture Design Gate Review	12/10/2014	5

Preliminary Project Schedule (Phase II)		
Project Milestone	**Due Date**	**Cost (Hours)**
Baseline Architecture Design	1/29/2015	25
Detailed Design Specification First Draft	2/23/2015	35
Detailed Design Specification Gate Review	2/26/2015	10
Baseline Detailed Design Specification	3/06/2015	25
System Test Plan First Draft	3/23/2015	30
Baseline System Test Plan	4/09/2015	25
Implementation	5/08/2015	530

2 Scope Statement

2.1 Purpose

The purpose of this project is to design, implement, and develop a system for users to monitor and control the watering of their home irrigation systems. Users will be able to view environmental information about their local watering environment, such as soil moisture content, temperature, and humidity. They will also be able to adjust their watering schedule, turn the device on or off, and view the device's health status via an online web interface.

2.2 Product Definition

The Home Irrigation Control System (HICS) will be a physical device that users will be able to connect to their home sprinkler system. It will wall mountable and intended for mounting in a customer's garage. The customer will be able to attach their existing sprinkler valve wires to the HICS system. Upon initial setup, the user will connect the device to the internet by plugging an Ethernet cable into the device. Once the device is connected to the internet, the user will be required to go online and register their product through our website. After this setup process is complete, the user will be able to view and interact with the irrigation system through an online dashboard at any time.

The device will have attachable sensors for environmental information that the user will be able to attach or remove as desired. These sensors will be able to collect metrics such as local temperature, soil moisture content, humidity, and whether it's raining or not. Once attached, the device will send information collected by these sensors to the website, which will display information the information for the user to view in a dashboard.

2.3 Intended Audience

The intended audience for our home irrigation control system will be homeowners who water their lawns on a regular basis. In particular, this device will be especially marketed towards homeowners in hot climates, such as the southern and southwestern United States.

3 Cost Management Plan

3.1 Purpose

The cost management plan will help ensure that the team will not exceed the allocated amount of $800 for the project budget. The plan will also help the team manage the time constraints for completion.

3.2 Project Budget

The team has been given approximately 6 to 8 months to complete this project. If each person allocates 10 to 15 hours per week, then this is about 240 to 480 man hours over the time span. As a collective 4 man team, this is about 960 to 1920 man hours over the 6 to 8 months period. The team has also been given a budget of $800 to spend on materials for the project. The cost management plan will ensure the team does not exceed the allotted budget.

3.3 Cost Breakdown

Our team's estimation of the initial cost of HICS has been determined based on the current scope of the necessary individual components. The primary cost will come from the hardware components. Each individual hardware component must be purchased separately. The web application server and hosting package can be purchased together as a bundle. We estimated a figure of around $540 for the hardware components. This will include a microcomputer, two microcontrollers, all necessary sensors, water valves, and plumbing equipment.

The cost for the web application will depend on the subscription prices for the hosting service. We have decided to use an online service for hosting to avoid any major costs of purchasing and maintaining a server. The estimated cost to host the web site is $20 a month, with a time span of approximately 5 months. As far as the components that will make up the web application we have decided to user ASP.NET which is a free application system. All other components necessary for the application will be free resources obtained through NuGet and other online venues.

Based on the team's initial research on material cost of items that will be needed, the team has found that the project will need an estimated amount of $640 for both hardware and software components. This is an approximation that we expect to vary over time, but it is close to the budget $800 of project. The initial breakdown of costs is shown below.

Part	Cost
Arduino Mega (x2)	$80.00
Arduino Case (x2)	$20.00
Raspberry Pi B+ Kit	$60.00
Soil Moisture Sensor (x6)	$25.00
Rain Sensor	$15.00
Temperature Sensor	$10.00
Water Valve(x2)	$30.00
Hosting Service(x5)	$100.00
Water Hose(x2)	$100.00
House & Grass Model	$100.00
Miscellaneous	$100.00
Total Cost:	**$640.00**

4 Earned Value Management

4.1 Purpose

The earned value management for HICS will be used for monitoring and measuring our project and defining our planned and actual progress. Earned value management is necessary to determine variance between present and future performance. Our team will evaluate each planned task in our project as it gets completed. This value can then be used to compare the different earned value components below.

4.2 Earned Value Components

Each earned value component is useful in determining comparable data for planned and actual work, as well cost value. Each individual component is broken down and explained in more detail in the following sections.

4.2.1 Budgeted Cost of Work Scheduled (BCWS)

BCWS is the budgeted cost in some value in terms of the projects baseline plan of the work accomplished at a given point in time. Each task in our Microsoft Project plan is assigned a BCWP based off its individual cost and value in the plan.

4.2.2 Actual Cost of Work Performed (ACWP)

ACWP is the actual amount of work that has been spent at a given point in time.

4.2.3 Budgeted Cost of Work Performed (BCWP)

BCWP is the budgeted cost in some value in terms of the base budget of the work accomplished at a given point in time.

4.3 Performance Analysis

Performance analysis is the measurement of cost and scheduled performance indices that is useful in evaluating team efficiency. An ideal performance index for either cost or schedule is one that follows a neutral curve for the index value as time progresses. As stated there are two difference types of performance indices: CPI and SPI.

4.3.1 Cost Performance Index

CPI is used to analyze the current state of the project in relation to the budget.

$$CPI = \frac{BCWP}{ACWP}$$

CPI > 1.0 → exceptional performance

CPI < 1.0 → poor performance

4.3.2 Schedule Performance Index

SPI is used to analyze the performance of the project in relation to the schedule.

$$SPI = \frac{BCWP}{BCWS}$$

CPI > 1.0 → exceptional performance

CPI < 1.0 → poor performance

5 Scope Management Plan

5.1 Introduction

This section will cover the scope management plan for HICS and outline how we plan to manage our project feature set. This plan is set in place to help avoid any classical mistakes in product development.

5.2 Definition

The project scope has been defined by a set of requirements established by the team and sponsor. These requirements cover each individual component that make up the project scope and cover, in great detail, the importance and priority of each. The requirements have been defined in our team's System Requirements Specification document to give the team and sponsor a clear feature set to use as a basis for future scope management.

5.3 Management

In order to maintain and manage scope effectively, each individual team member is responsible for monitoring each task as they are set forth and worked on. The Microsoft Project plan is a key tool in analyzing how each task is affecting the feature set. In addition to the plan, team tasks are to be evaluated at every team meeting and our team leader is responsible for monitoring these at a higher level. Changes to the feature set must be evaluated and agreed upon by each team member and signed off on by the sponsor. Upon milestone and major task completions the team will also analyze and review the scope management plan to search for improvements or positives to work on during the next phase.

6 Work Breakdown Structure

6.1 Purpose

The work breakdown structure is based on a hybrid waterfall method and serves to break down the work into its constituent pieces. Our project plan is broken up into two main pieces—Phase I and Phase II—which detail the project structure of the first and second semesters of this project, respectively. Phase I includes the Project Startup, the MS Project Plan itself, a System Requirements Phase, a System Architecture Phase, and a Recurring Tasks section.

6.2 MS Project Work Breakdown Structure

WBS	Task Name	% Complete	Duration	Start	Finish	Planned Value (BCWS)	Actual Cost (ACWP)	Earned Value (BCWP)
1	**Phase I (Fall Semester)**	**98%**	**72 days**	**Fri 9/5/14**	**Mon 12/8/14**	**227.5**	**253.5**	**222.5**
1.1	**Project Startup**	**100%**	**3.63 days**	**Fri 9/5/14**	**Wed 9/10/14**	**16**	**10**	**16**
1.2	**MS Project Plan**	**100%**	**69 days**	**Fri 9/5/14**	**Wed 12/3/14**	**25**	**24**	**25**
1.2.1	Project Plan First Draft	100%	29 days	Fri 9/5/14	Wed 10/15/14	20	18	20
1.2.2	Project Plan Baseline	100%	3 days	Mon 12/1/14	Wed 12/3/14	5	6	5
1.3	**System Requirements Phase**	**100%**	**63 days**	**Fri 9/12/14**	**Tue 12/2/14**	**113**	**168.5**	**113**
1.3.1	**Requirements Research**	**100%**	**5 days**	**Fri 9/12/14**	**Thu 9/18/14**	**20**	**20**	**20**
1.3.2	**System Requirements Specification**	**100%**	**30 days**	**Wed 10/1/14**	**Tue 11/4/14**	**61**	**118**	**61**
1.3.2.1	**SRS First Draft**	**100%**	**21 days**	**Wed 10/1/14**	**Sat 10/25/14**	**20**	**30**	**20**

1.3.2.2	SRS Baseline	100%	16 days	Sun 10/19/14	Tue 11/4/14	36	83	36
1.3.2.3	Team Real Peer Review	100%	0.13 days	Wed 10/29/14	Wed 10/29/14	5	5	5
1.3.3	Project Charter	100%	42 days	Mon 10/13/14	Tue 12/2/14	32	30.5	32
1.3.3.1	Project Charter First Draft	100%	3 days	Mon 10/13/14	Wed 10/15/14	14	20.5	14
1.3.3.2	Project Charter Baseline	100%	7 days	Mon 11/24/14	Tue 12/2/14	18	10	18
1.4	System Architecture Phase	96%	11 days	Mon 11/24/14	Mon 12/8/14	38.5	18.5	33.5
1.4.1	Architecture Design Specification	98%	11 days	Mon 11/24/14	Mon 12/8/14	33.5	18.5	33.5
1.4.1.1	ADS First Draft	98%	11 days	Mon 11/24/14	Mon 12/8/14	33.5	18.5	33.5
1.4.2	Team Patrol Crusaders Peer Review	0%	1 day	Fri 12/5/14	Fri 12/5/14	5	0	0
1.5	Recurring Tasks	100%	64.38 days	Thu 9/11/14	Wed 12/3/14	35	32.5	35
1.5.1	Sponsor Meetings	100%	35.06 days	Thu 9/11/14	Mon 10/27/14	3	1.25	3
1.5.2	Team Meetings	100%	55.38 days	Wed 9/24/14	Wed 12/3/14	32	31.25	32
2	Phase II (Spring Semester)	0%	82 days	Tue 1/20/15	Wed 5/13/15	693	0	0
2.1	System Architecture Phase	0%	9 days	Tue 1/20/15	Fri 1/30/15	25	0	0
2.1.1	Architecture Design Specification	0%	9 days	Tue 1/20/15	Fri 1/30/15	25	0	0
2.1.1.1	ADS Baseline	0%	9 days	Tue 1/20/15	Fri 1/30/15	25	0	0
2.2	Detailed Design Phase	0%	25 days	Mon 2/2/15	Fri 3/6/15	59.5	0	0

2.2.1	Detailed Design First Draft	0%	19 days	Mon 2/2/15	Thu 2/26/15	35.5	0	0
2.2.2	Detailed Design Baseline	0%	9 days	Tue 2/24/15	Fri 3/6/15	24	0	0
2.3	System Test Plan Phase	0%	5.6 wks	Tue 3/3/15	Thu 4/9/15	66.5	0	0
2.3.1	System Test Plan First Draft	0%	12 days	Mon 3/9/15	Tue 3/24/15	44.5	0	0
2.3.2	System Test Plan Baseline	0%	13 days	Tue 3/24/15	Thu 4/9/15	22	0	0
2.4	Implementation Phase	0%	79 days	Tue 1/20/15	Fri 5/8/15	530	0	0
2.5	Project Closeout	0%	3 days	Fri 5/8/15	Wed 5/13/15	12	0	0
2.6	Recurring Tasks	0%	82 days	Tue 1/20/15	Wed 5/13/15	0	0	0

7 Quality Management Plan

7.1 Introduction

The purpose of the quality management plan is to define a set of guidelines that can be followed to ensure that all requirements listed in the System Requirements Specification document are met.

7.2 Documentation

All written documents will be stored in a shared folder of Google drive. All written team deliverables will be divided up so that each member of the team to contribute its development. After each member finishes his portion of an assignment, the documents will be put together in a master copy, which will be stored in the same folder. Team members will review the master document before submitting it to the instructor for grading. The team's individual engineering notebooks will be used to record pertinent information related to the project as well.

7.3 Software

The software for this project will include the web application running on a remote server and the programs running locally on the microcomputer and microcontrollers. We plan to have a standardized process for creating methods and a proper template for documentation. To aid this, the team will be breaking the software up into modules for easier code reviewing and testing. A centralized location will be designated to hold all source code so that it can be accessed by all team members simultaneously, and a method of version control will be implemented to keep files in sync.

7.4 Hardware

The hardware components for the project will be researched carefully and discussed thoroughly within our team. When we decide to buy necessary components, we will submit an order request to Mr. O'Dell. When the components are delivered, they will be tested carefully to ensure that they are in proper working order and are the correct items requested. Finally, the components will be included in the development of the project.

7.5 Test Plan

A test plan will be developed for each individual hardware and software component of the project. Each component will be tested to match up requirements listed in the System Requirements Specification document. As each component is integrated into the prototype they will again be tested for functionality. The prototype will also undergo a rigorous set of tests to gauge its performance and reliability.

8 Communication Plan

8.1 Introduction

Communication will play a very important role for our team throughout the course of this project. A Communications Plan will help to ensure that our team is approaching internal and external communication in the most efficient way possible.

8.2 Internal Communication

8.2.1 Team Meetings

Our team will meet every Monday and Wednesday from 1:00pm to 3:00pm in the Senior Design Lab. Team members will share their individual progress with one another, discuss any outstanding issues that have to be resolved, and divide new work done amongst themselves. If a team member cannot attend a meeting, they will be updated by the project manager about what was covered.

8.2.2 GroupMe

GroupMe will be the main source of communication between all members of the team. This is a mobile application that allows group messages to be sent and received quickly. There is also a feature to access the group chat through a text messaging system which allows all of our members to be in constant communication with one another.

8.2.3 Facebook

Facebook will be used to post messages or updates to the group from team members. It will prove to be a very effective and convenient form of communication because every member in our team has a Facebook account. During our first meeting, we set up a private group on Facebook that will be used to share private messages and information with each other.

8.2.4 Email

Email will be used to share first draft and final copies of documents between team members, our project sponsor, and Mr. O'Dell. Email will also be the way that we will share documents with other teams for Peer Review Sessions.

8.2.5 Google Drive

Our team will use Google Drive to share document with one another. Google Drive can be accessed through a web browser interface or locally through a computer's document browser if the Google Drive program installed on the user's machine.

9 Change Management Plan

9.1 Purpose of Integrated Change Management Plan

In the process of developing a project of this size, a change management plan is essential. In the development process, several things will change due to the unexpected situations that develop. In order to get back to the main objective of the project, we may need to add a few features or consequently reduce features. The change management plan for our project is detailed below.

9.2 Roles and Responsibilities

- **Project Sponsor –** Our sponsor, Mr. Aholt, Owner and Manager of Nuts and Bolts Hardware Store, will be giving us constant feedback throughout the development process. He will inform our team if he sees thinks that any changes need to be made. Any changes that our team wishes to apply will first have to be approved by him as well.

- **Project Manager** – Our team will be constant on the lookout for any changes that have to be made. At the request to change a component of our project by our sponsor, instructor, or peer review group, our project manager Belachew will be the first person to address it. He will relay the request to the team and will ultimately decide whether or not the change to the project will be made.

- **Project Team -** Our team will carefully review the pros and cons of the changes that have been suggested before the changes are made. In order to keep a smooth and efficient schedule, the change will only be considered if they are productive and efficient to the outcome of the project.

- **Other Stakeholders** – Mr. O' Dell will be reviewing our progress and making suggestions to our team if we need to apply changes to the project. He will be guiding us so that we don't get off track.

9.3 Review and Approval Process

Anyone who wants change a component in the project will propose the change to the team. The person who proposes the change will provide reasons for the change(s) to be made. The team, along with the other stakeholders, will then discuss the pros and cons of the proposed change. Everyone will provide his or her opinion about the change. The customer and stakeholders will review the change(s) and will decide whether they meet their requirements. If everyone agrees that the change will increase the productivity and it

won't affect our scheduled goal, the change is then applied. If the proposed change is more than one, it will be prioritized and done according to its impact on the project. Lower priority changes may be compromised and ignored unless there is enough time remaining at the end of the project to apply them.

9.4 Change Identification, Documentation, Implementation and Reporting

Our team will have a change request form that will have name of all the stakeholders and the description of the change requested by the team member along with the pros and cons of the change. The person proposing the change will fill out their credentials on the form and it will be completed by the other team members, with Mr. O'Dell by signing off on it. The team, the sponsor, and Mr. O'Dell will have a copy of the signed change request form. This process will also be noted in our engineering notebook and signed by all of the members of the team. In case someone reports that the change applied was invalid, this form will be a proof that a valid change was made.

10 Risk Management Plan

10.1 Purpose of Risk Management Plan

For large-scale projects, there is always a chance that the project may fail or derail because of the risks that develop. However, in certain situations, some risks are not worth addressing. There might be legal issues or a potential hazardous behavior of the project, which no one ever thought of. To fix the problem related with the risks, there might be extra work necessary, which will most likely cause the project to not meet the pre-determined deadline.

The purpose of risk management plan is to deal with the potential risks and to meet the specifications on time. Using a risk management plan, our team will establish a standard way of managing possible risks. We will try to meet all the deadlines prior to when it's due so that we eliminate the risk of having a load of work to do at the end and under pressure. This section will help us plan, discuss, identify and control the possible risks.

10.2 Roles and Responsibilities

- **Project Sponsor** – Keith Aholt, Owner of Nuts and Bolts Hardware Store

  Our sponsor has a lot of experience working in the hardware sales environment and in management of various tools and equipment. He will share his prior experience with us to help us avoid risks. Any possible risk that we think is possible, we will let our sponsor know so that we can plan ahead on how to deal with it when necessary.

- **Project Manager – Belachew**

  He will be concerned with actively addressing the risks and organizing meetings so the team can make the most progress. He will be actively involved in updating the information about the measures we are taking to avoid the risks. For managing the risk, he will pass the work to the risk manager who will deal with the actual risk management plan.

- **Project Team – Smart Grass**

  Our team will meet twice a week. We will ensure that we are concerned about the current risks to the project and will discuss about possible future risks. Everyone's input will be taken seriously so that the no possible risk goes unnoticed.

- **Project Stakeholders** – Mike O' Dell

Mr. O'Dell will review our risks in the project and will give us an idea about how to eliminate or deal with the risks. Any risks he sees in our project, he will let us know so that we can take care of it immediately.

- **Risk Manager** – Gautam Adhikari

  Gautam Adhikari, our Risk manager, will be formally in charge of the risk management plan. He, with the help of all team members, will focus on identifying risks and figuring out effective plans to deal with them.

10.3 Risk Identification

Risk identification is the first step of risk management plan. If any member in the team sees a potential risk, he will report it to the risk manager. The risk manager will set up a meeting and the risk is then analyzed. The risk manager will assign work to all of the team members so that the risk can be avoided in a timely manner. He will also document the risk so that similar ones can be avoided in the future.

10.4 Risk Triggers

As a team, we will be concerned about the signs that are not supposed to be encountered according to our plan. The following are the signs which, if ignored, could lead to a delay in or even failure of the project.

- Behind on schedule
- Procrastination
- Lack of communication between stakeholders
- Dramatic change in requirements
- Integration issues on software and hardware
- Integration issues while documenting
- Lack of experience in specific task

10.5 Risk Analysis

The following risk analysis was done during a team discussion. The probability is calculated along with the cost (in weeks) that we need to deal with the risk. The risk analysis is calculated considering our experience in other projects and by guessing the workload added to the team.

Table 10.5 Risk Analysis

Risk Group	Risk	Probability (%)	Cost (weeks)	Risk Exposure (weeks)
Schedule	Behind on schedule and procrastination	30	2	.60
Document	Integrating everyone's documents	10	2	.20
Software	Integrating everyone's code work	40	4	1.6
Hardware	Integrating hardware together	50	4	2.0
Technical	Integrating hardware and software	40	2	.8
Technical	Networking using servers	40	2	.8
Budget	Lack of fund while purchasing right equipment	5	1	.5
Team	Availability of members for meeting and working to build project	40	2	.8
Miscommunication	Misunderstanding the idea or work	20	2	.4
Total Risk Exposure				7.7

10.6 Risk Severity

The following table describes the possible risks and their causes along with the risk criteria and action needed. These priorities are based upon the team discussions, prior knowledge and brainstorming.

Table 10.6 Risk Severity

Risk	Priority	Strategy	Response	Trigger
Bad reading by soil sensor	High	Control	Sensor will be placed where there is no	Team puts sensor where temperature and moisture fluctuates
Hardware failure	High	Avoid	Correct research before implementing	Team neglects to read instructions while assembly
Busy schedule	Medium	Avoid	Plan early	Team makes instant schedule
Insufficient programming knowledge	Medium	Prepare	Plan which programming language to use	Team has to use a new programming language.
Networking offline	Medium	Avoid	Hosting computer powered and installed properly	When power goes off or no internet connection
Unfriendly Application	Low	Mitigate	Make the app user friendly	App is hard to operate
Hardware unavailability	Low	Eliminate	Purchase early	A new device needed

10.7 Risk Response Planning

During team discussion, each risk is given priority and is prioritized. Based on our research and old experience, we give each risk a probability. If the risk is very small and has a negligible chance of affecting the project, the risk is rejected. High risks are handled promptly.

Project manager will plan all the steps for responding to the risks. Risks are managed according to their severity. All works are documented and divided among team members. Our team will already plan on how respond when a new risk is identified.

10.8 Risk Documentation and Reporting

The risk manager will be documenting all of the risks. We will have a log where any team member can add the risks they think might exist. When the risk is discussed the log will be updated. If the possible risk is not actual risk, it is taken out of the active risk log where if the risk is big, it will be highlighted and prioritized in the logbook. Other means

documenting would be google drive, email, and social networking sites. These will be accessed and used by all members so that documentation is easy and effective. Risk manager will monitor the documentation for integrity.

10.9 Risk Control

During group discussion, all team members will talk they found any possibility if risk. If there is a risk, the risk manager will research about it. Looking at the severity of the risk, risk manager will classify the work. All potential risks and its details are recorded in the logbook to maintain integrity of the risk management plan. The log will have all the details of the risks, risk triggers' and team response. This will be a good reference for dealing with new risks that evolve in future.

11 Procurement Management Plan

11.1 Purpose of the Procurement Management Plan

The purpose of the procurement management plan for HICS is to establish a set of guidelines to follow for the acquisition of the necessary equipment. Each member of our team, including the sponsor, will play some role in the procurement management plan and a description of the required acquisitions will also be detailed. In addition a scheduled is needed to establish necessary timings for each acquisition to ensure there is no time or money wasted during the development phase.

11.2 Roles and Responsibilities

11.2.1 Project Sponsor

The project sponsor is not responsible for providing any equipment to the team. The team will utilize our sponsor's expertise in the project field to determine which types of products to purchase. Since our sponsor owns a hardware store his input will be greatly valued when it comes to selection.

11.2.2 Project Manager

The project manager will be responsible for collecting and evaluating research gathered by the team and ultimately has the final say when it comes to product selection. Also since our project manager has the most experience with microcontrollers the team will be deferring to his recommendations on which product is best.

11.2.3 Project Team

The project team is primarily response for researching and gathering information for virtual all required products. Each individuals experience with a particular product will be evaluated into the purchasing decision.

11.2.4 Project Stakeholders

The project stakeholders may be required to evaluate the compatibility between each necessary product and determine if the components meet all water regulations and restrictions.

11.2.5 Contract Office Technical Representative (COTR)

The COTR will be responsible for maintaining necessary communications and requests between the team and Professor O'Dell.

11.3 Required Project Procurements and Timing

The procurement process for HICS is set to begin immediately after composing the final drafts for all required documentation. Since our sponsor owns a hardware store any product we need for the project that we can purchase at his store will be purchased there. All other products, once evaluated, will be purchased from the necessary vendors. The two major components that hold priority for purchase timing will be the web hosting service and the microcontroller since those two components are required to begin software development.

11.4 Description of Items/ Services to be acquired

The items below cover the necessary products that are current established for HICS.

- (1) Microcomputer (Raspberry Pi)
- (2) Microcontrollers (Arduino)
- (2) Water valves
- (6) Soil sensors
- (1) Web hosting service
- (2) Water hose
- (3) Waterproof cases computers

12 Project Closeout Report

12.1 Purpose

The purpose of the project closeout report is to provide insight into the final details of our project. This report will review any outstanding issues that have yet to be completed, will provide financial documentation for all project expenses, and will make sure that our sponsor is satisfied with the final product.

12.2 Administrative Closure

12.2.1 Were the objectives of the project met?

The evaluation of the project objectives will be produced after the product has been completed. These objectives will be analyzed by our team, sponsor, and classmates to ensure they were met with completion. Any deviations or discrepancies from the baseline will be listed and documented.

12.2.2 Archiving Project Artifacts

All project documents will be stored securely within our team's Google Drive account. Separate versions of each document will be archived on the drive as well in order to maintain easy version control and review. The documents stored will include:

- Systems Specification Requirement
- Project Charter
- Purchase Orders
- Architecture Design Specification
- MS Project Plan File
- Team Status Reports
- Team Presentations
- Detailed Design Document
- System Test Plan
- Prototype Diagrams
- Team and Sponsor Contact Info

12.2.3 Lessons Learned

This section of our Project Closeout Report will detail the lessons that we learn throughout the entire course of the project. We will record any mistakes we make and what solutions we devise to correct them. Any lessons listed here will be

carefully examined to determine if we listed them as a risk and if not what changes can we make to our risk assessment to account for similar future issues.

12.2.4 Plans for Post Implementation Review (PIR)

Upon completion of the project the team will review every component with our sponsor to evaluate completion success or failure. All risk and scope assessments will also be reviewed to determine if adequate evaluations were made and how they were addressed.

12.2.5 Final Customer Acceptance

After the project has been completed our team will setup a meeting with our sponsor to review the acceptance criteria we initially established. These results will be evaluated to determine the customer satisfaction with the product.

12.2.6 Financial Records

All records related to finance will be stored with our project artifacts. Final cost and purchase review will be done by the project manager.

12.2.7 Final Project Performance Report

Once the project has been completed the team will meet to evaluate our overall performance. All documentation will be reviewed to determine the proximity of our final project to our initial projections. We will record all of these evaluations in a final project performance report and include in it any performance feedback from our sponsor.