Redevelopment

Future land use analysis for Water Resources Inventory (WRIA) 9

[redacted] *Figure 1 WRIA 9*

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I. Background

WRIA 9, which is known as the Green/Duwamish River watershed encompasses a wide range of territory. From its origin in the Cascade Mountains northeast of Mount Rainier it flows downstream to where it meets Puget Sound at Elliot Bay (see Figure 1). According to the Puget Sound Regional Council, the population between 2000 and 2040 in WRIA 9 (excluding the city of Seattle and areas upstream of the Howard Hanson Dam) is projected to grow by a quarter of a million people (EPA Grant Application, 2010). It is well known that growth and development have a direct link with environmental impacts, sometimes these impacts being irreversible. Some examples of our impact on the environment include riparian development, habitat loss and fragmentation, expanding impervious surface coverage, polluted sediment and developed shorelines (Puget Sound Regional Council, 2008). The Chinook salmon, which inhabit the streams and rivers within this watershed, are impacted by growth and development. As of 1999, the Chinook salmon have become threatened under the Endangered Species Act (Washington State Conservation Commission, 2000).

Storm water runoff is a serious problem within this watershed which is linked to growth and development. According to the Washington State Department of Ecology storm water is the "most significant contributor to reduced water quality in the Puget Sound" (King County, 2008). In association with the federal Clean Water Act of 1972, the National Pollution Discharge Elimination System (NPDES) permit program was established that attempted to control "water pollution by regulating point sources that discharge pollutants into waters of the United States" (EPA, 2012). In Washington State, King County was the first to be issued a storm water municipal permit in 1995 (King County, 2008). Under the current version of King County's storm water municipal permit, the requirements focus mostly on storm water impacts associated with new development (preventing the existing situation from getting worse). The permit requirements do not consider the impacts associated with older developed areas of King

County, which have a lack of storm water control methods in place or utilize ineffective ones (EPA Application Grant, 2010). The Water and Land Resource Division's Science Section is in the process of developing a storm water retrofit plan for key areas of WRIA 9 (excluding the city of Seattle and areas upstream of Howard Hanson dam) that would include older developed areas of King County. More specifically, the Science Section needs to know if this plan and its associated costs will change due to future population growth and climate change in the study area (Simmonds, 2012). These key pieces of information will enable the Science Section to "successfully implement storm water BMPs and LID techniques in previously developed areas of WRIA 9" (EPA Application Grant, 2010) For more insight into the basic structure of the Science Section please refer to the organizational diagram in Figure 2.

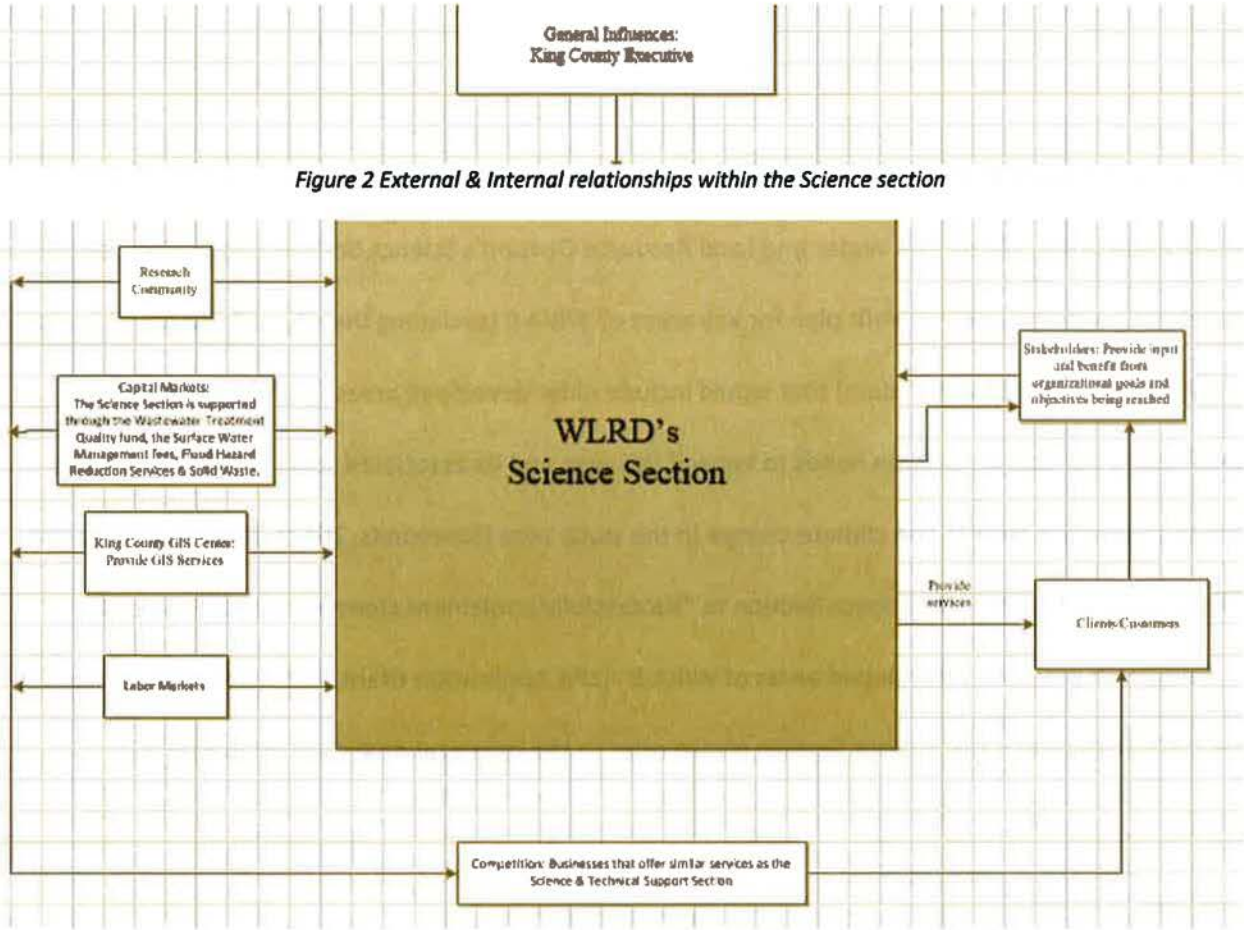


Figure 2 External & Internal relationships within the Science section

Figure 2: External & internal relationships within the Science Section

Project Statement/Goal

The overall project goal (deliverable) of our portion is to suggest improvements to a 2040 land use cover layer that can be used to help the Water and Land Division complete their overall Storm water retrofit project for Green River Watershed (WRIA 9).

Objectives

Our overall objective is to evaluate the use of a 2040 layer of projected land cover and land use that will enable King County to produce budget estimations for future storm water infrastructure income.

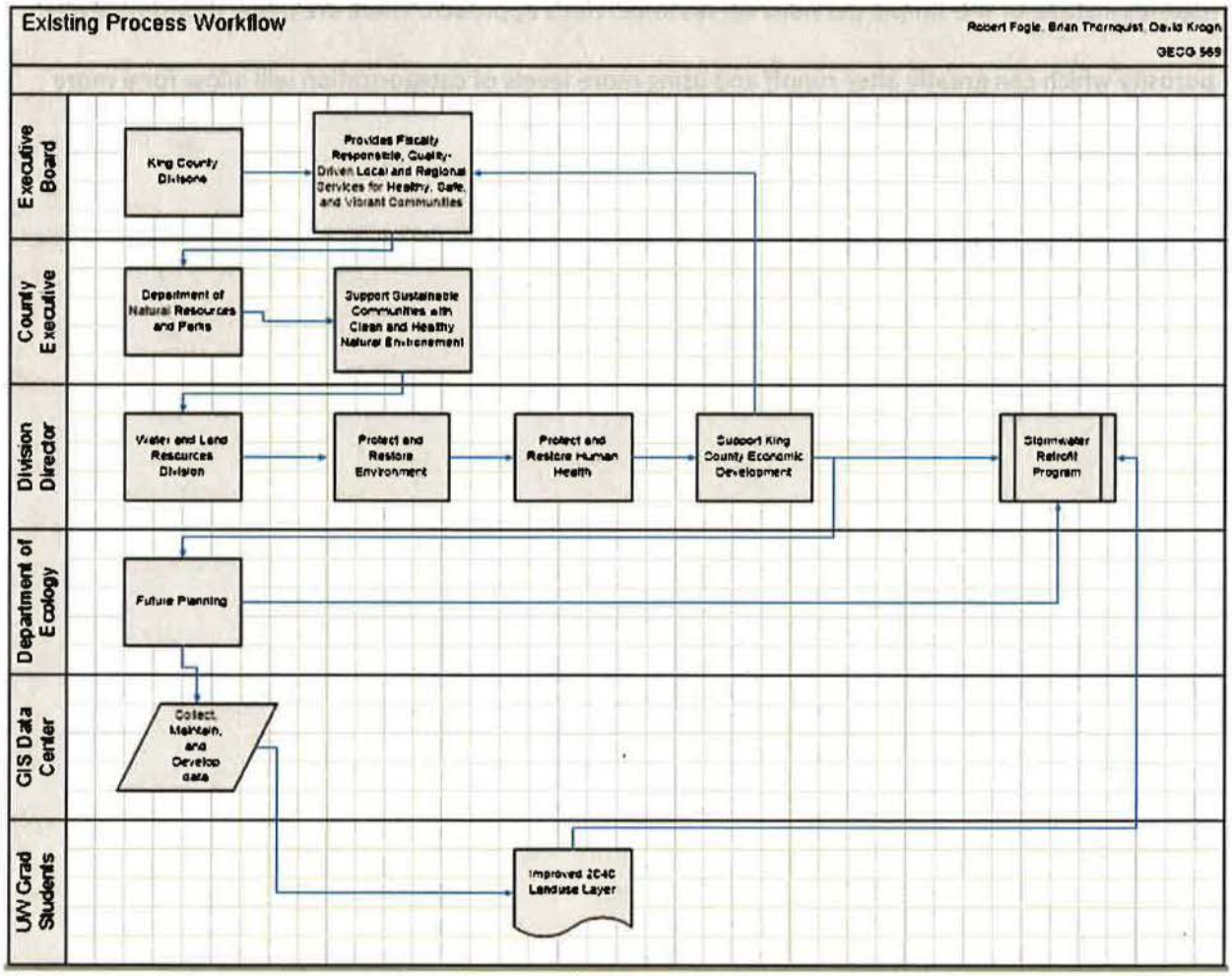
These budget estimations will be based on the change in current land use to proposed land use. For example, if a parcel will be changed by a developer, the developer will incur the costs to come up to the King County Storm water drainage requirements and these are costs that the county will not incur.

Also, by knowing which parcels will need the King County storm water services in the year 2040, estimations of fees being collected can be calculated. Project IVs pervious/impervious project could also assist here.

To improve upon the existing 2040 land use/land cover layer we propose using more fine grained categories instead of the simple pervious versus impervious approach. There are many different levels of porosity which can greatly alter runoff and using more levels of categorization will allow for a more accurate analysis.

Existing Process Workflow

King County is run much like the U.S Government; processes usually are delegated downhill through applicable divisions. The executive board within K.C oversees all divisions and provides quality driven local services (extrapolated through the divisions). The County Executive is responsible for his/her department within K.C (in this case we are looking at the DNRP). Within each department lie different



divisions; each division being run by a director. The WLRD is driven both by current issues and by future planning (driven in this instance by the DOE). Within future planning there is the collection and maintenance of data and the Retrofit Plan. The overall process workflow includes the UW's small effort within future planning but this could include any applicable affiliate for planning processes.

Figure 3 Existing Process Workflow

Existing Activity Workflow

This workflow (see Figure 4) depicts what the Science Section had originally planned to do meet their stormwater infrastructure needs for this project. Originally, the UW Urban Ecology Research Lab created a 2040 land use/land cover layer to meet their needs. It can be assumed that in order to create the layer a literature review and research on UrbanSim had to be performed. This research and literature review gave them an idea of their data needs, which was obtained through another party, such as a GIS analyst. This data allowed the Research Lab to create the 2040 land use/land cover layer. The Science Section obtained the 2040 land use/land cover layer and evaluated it against their needs for the stormwater retrofit plan. It was determined that this layer will not fully meet the needs for their purposes and they want to look at and compare with other methods of estimating future land use.

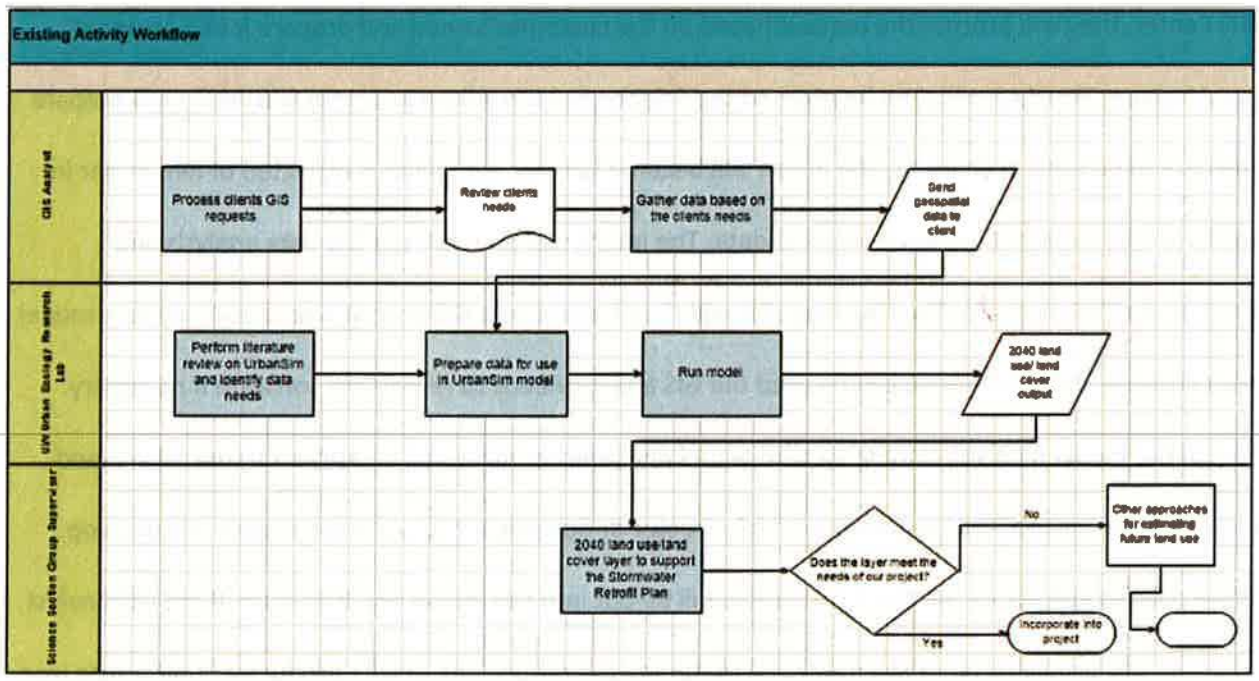


Figure 5 Existing Activity Workflow

Proposed Activity Workflow

Our project management team was assigned the task of working with the Water and Land Resource Divisions Science Section who are currently in the process of working on a stormwater retrofit plan project. Our objective is to suggest an improvement in the creation of a 2040 land use/ land cover layer. Through conference calls with our project sponsor and background research done during summer quarter 2012, we were able to learn how the organization operates and get a better understanding of their needs for this project. This allowed our team to suggest our sponsor use Envision to create multiple future land use/land cover scenarios. Our results will be presented in an executive summary on the 17th of August to our sponsor. From here our project sponsor investigates our report in more detail to decide if our method will help them meet their needs. If it doesn't meet their needs, then they go back to the drawing table to consider another approach. If they do use our approach, then they will send in a request to the King County GIS center based on their data needs. Once received by the King County GIS Center, they will process the request based on the customer's need and prepare it in a personal geodatabase. The data will then be given to the Science Section where an intern will work with prepare the data to be used in Envision. The intern will become familiar with what is expected of him or her in terms of what needs to be done with the data. The intern will then run the GIS data analysis and produce an IDU shapefile. The IDU shapefile will then be sent to a GIS analyst who uses it to run a model with Envision. Before Envision can be used the GIS analyst needs to review the software if necessary. Part of the model involves coming up with actors and policies which will be applied to the future land use scenario. In coordination with the WLRD director or Science Section, the GIS analyst will develop these policies and actors. All this information will be put into the model and it will run. If the GIS analyst runs into any problems he or she may need to modify the model. The results produce a 2040 future land use scenario and this process is repeated for other future land use scenario. This is then sent to our

intern who will convert the data into a shapefile. This data will then be given to the Science section so they can begin their analysis.

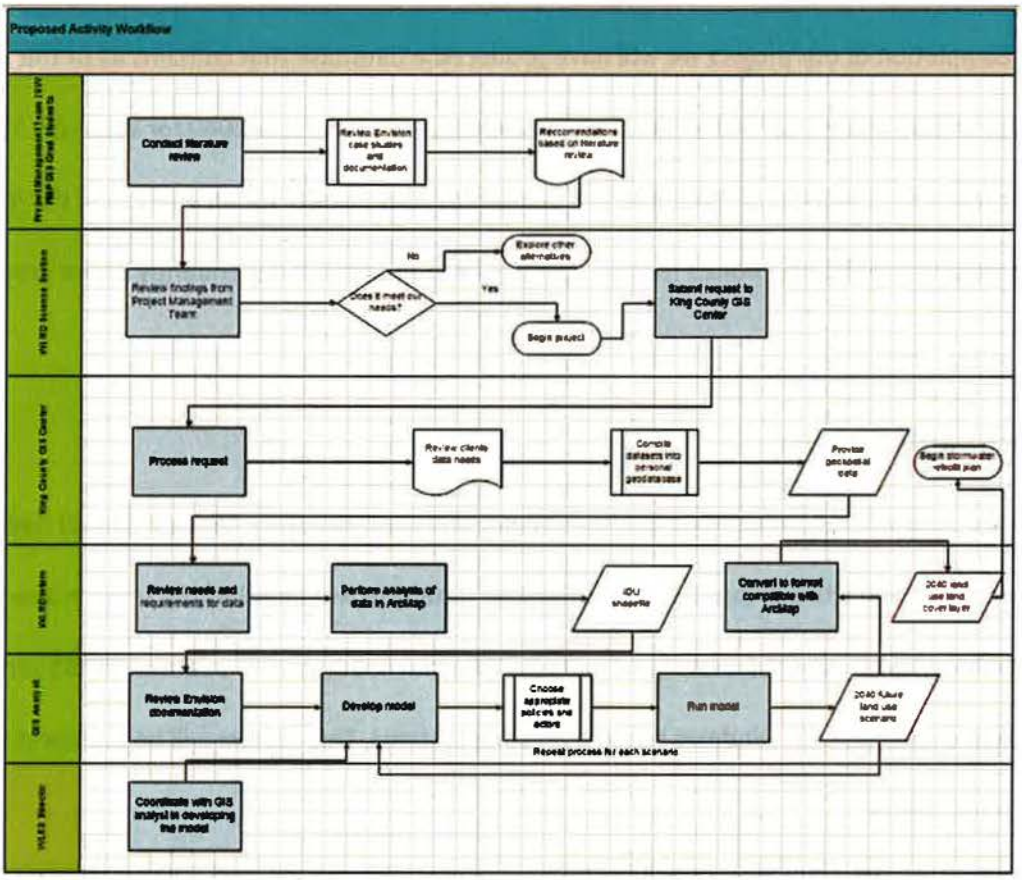


Figure 6 Proposed Activity Workflow

Information Categories Anticipated

The successful completion of this product would use current land use categories as defined by the U.S Soil Conservation Service to develop the improved 2040 land use layer. Each land use category would have a hydrologic soil group number (pertaining to the geographic region) associated with it. In addition to the land use categories any other applicable feature classes will be added (roads, urban

growth, stream networks, urban areas, etc.) The land use categories will need to be researched an created to ensure accuracy for the various land cover scenarios in WRIA 9.

Information Products

At the completion of our project we will have produced a database that contains all of the applicable data to look at physical and environmental conditions for the year 2040 for WRIA 09. This layer will be formatted to work in ArcMap and will be used by King County for an analysis of the WRIA 09 area and compared to the mentioned models that will be completed independently of our group project.

Hardware Requirements

Due to the scale of this project King County's Water and Land Resource Division should have all necessary capabilities and storage capacity. Our produced database will be relatively small in size and can be stored/shared with even the most basic systems. The current system is a central DMBS server with workstation clients on with windows based operating systems. This system will be sufficient for current and future needs.

Software and Networking Requirements

Existing King County Water and Land Resource Division Ethernet network is sufficient for a project of this size. Within our project we are able to accomplish data sharing and collaboration by virtue of using free file-sharing websites and Skype file transfer.

We are using Windows based PCs running ArcGIS 10 to accomplish our tasks. A Windows based server (such as at King County) would greatly help in processing time but is not a large hindrance for the project.

Graphics based programs such as Visio and MS Project would be a requirement for better visual display of process flows and organization charts.

ArcGIS Diagrammer has been very helpful in the portrayal of our data models and would be a nice addition to a software suite.

Personnel and Time Requirements

Estimations from the Science and Technology Division for the work effort of this project was 1 man-month (1 person working for 4 weeks full time). This estimate was based on an experienced person who was familiar with King County and their processes. The UW project team estimates for time is for 3 people working over a 9-week period part time (between 10 and 20 hours/week). This would give us an estimate of 270 – 540 hours total.

II. Data Acquisition

Data Design

For our project, progressing from Box 1: Reality to Box 7: Spatial Temporal Database first involves exploring the reality of our situation. This constituted the earlier phases and stages of our project and involved gaining a thorough understanding of the Science & Technical Support Section within the Water and Land Resources Division as well as having a better understanding of the project in terms of its goals, objectives and deliverables. These were accomplished through background research and conference calls with our sponsor. Box 1 can be thought of as the baseline; in essence our understanding of the reality up to this point will shape the way we tackle other stages of the project, as well as how we proceed from reality to the spatial-temporal database. We can always revisit reality to refine our understanding of the situation, but better sooner than later. As our project progressed we realized that our project scope was way too broad, so we had to go back to investigate reality which allowed us to eventually narrow our project scope to something much more manageable.

Having narrowed down our project scope allowed us to move on to explore our data needs, which will be discussed in the Data Analysis section of our report. While exploring our data needs, we also need to explore some issues associated with our data design. According to Tomlinson, one important aspect of creating the data design involves having a clear understanding of the characteristics associated with the data, such as scale, map projection, etc (2011). Scale will be an important consideration for this project as this project encompasses a much smaller study area (a portion of WRIA 9) compared to other case studies done in the past using Envision. For example, the Puget Sound Near shore Ecosystem Restoration Project used Envision to create three alternative future scenarios for the Puget Sound Region (2010). Some of the data they used to create the future scenarios in their study may not necessarily be appropriate for the needs of this project. Map projection and choice of datum will be important to consider as well. Each map projection can preserve only one property, while other properties are distorted to a certain degree. Thus, it is important to choose the map projection that will have the least impact on one's database. UTM Zone 10N or Washington State Plane North (Lambert Conformal Conical) are options for projection choices given the territory the project encompasses. This process represents Box 4: Space-Time.

Given the data needs for this project, a file or even a personal geodatabase (object-relational database model) will be quite enough to store the data into feature datasets. Using this database model one can take advantage of the advanced behavior and rules associated with this model such as topology and relationships if necessary. (Tomlinson, 2011). Please see Figure 6 for a geodatabase schema that was created in ArcGIS Diagrammer, which depicts how a potential geodatabase could be setup to store the data.

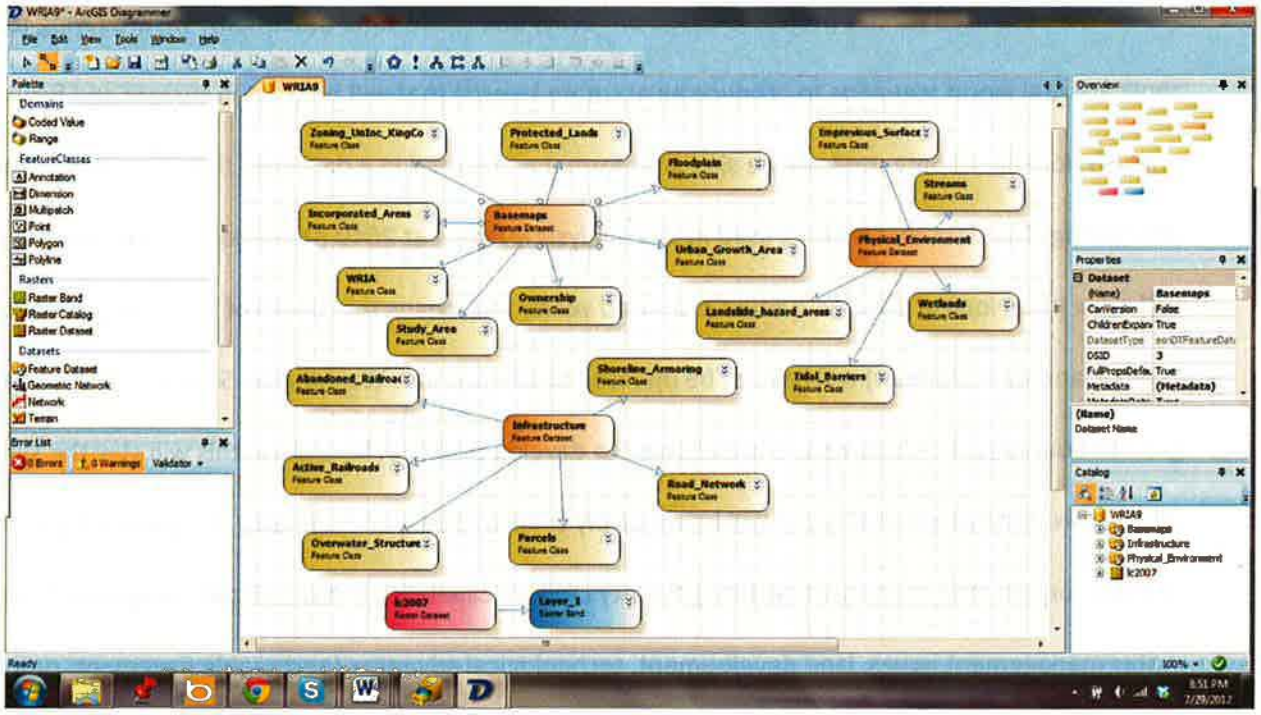


Figure 7 Geodatabase Schema

Data Source, Fitness for Use & Metadata

See Input Data section below.

Future Database Development

Planning for future scenarios is going to be a continual process that will be revisited annually. In the case of this project, we are looking at a 2040 land use/land cover model (because that is how far population projections currently reach). In the future efforts will be made to look even further down the road and similar analyses will be completed. With this in mind we need to be able to access/gather the applicable data to do similar projects in the future. The data categories will stay the same but future analysis will need to use updated versions of the data layers. Some of this data will be incorporated into the data center, but because of their strict requirements of data, some of it will not be included in the data center. The entirety of the data will be stored within the Water and Land Resources Division.

The data used for this project is based on reality and space-time essentially; we are trying to replicate real world scenarios to produce an accurate layer(s) that will be used in current and future analysis. Ideally, all data used will be similar in format and stored in a database that is created within ArcCatalog. The data that is being used in this analysis is aimed at 2040 projections so future analysis will most likely look at 2050 or 2060 as proposed years; this means that some of the data (population, rainfall, and development) will have to be updated to be accurate. Washington State has a set urban growth boundary, in which we are not allowed to develop past that boundary; this will stay the same for all analysis. A database of this size will be relatively small and easy to maintain, the system requirements will not surpass that of any standard King County Division capabilities. Any judicial changes to storm water management issues, land development, technological advances (permeable pavement, runoff management, and other environmental technological advancement) will have to be addressed as they develop. The main issue is going to be the location of the database, over the next 30 years personnel within King County is going to change several times, it will be easy for data to get misplaced or lost over time, and perhaps even recreated costing more money and man power. There are several solutions to the issue, we will review our proposed solution in the following.

Proposed Solution

King County is very diverse with many different sections and divisions that span across all public and environmental factors. This often creates an issue with data access and development. As Jim Simmonds (Supervisor of water quantity and quality in the Water and Land Resources Division) stated in conversation "typically we do work with data center, they are in high demand, in addition, WLR staff (about 30 people), use GIS, it is a tool for doing their job. We use layers and data that are maintained by the data center in their project specific analyses. We want to get an improved 2040 layer but it isn't something they want to push to the data center at this point. We are billed for GIS center time so they do not want to approach them without a very specific project that they can't complete with their own

knowledge." As mentioned they do not want to work through the data center, which means we will be gathering and developing our own data. To find all applicable data we have to look through the data center, WAGDA, graduate students at UW, and through the Water and Land Division. I suspect that a lot of "rework" takes place because of lack of accessibility to existing information. Rework costs extra time and money and can be avoided if projects are coordinated across all divisions.

What we propose for future data management and research is a search engine of sorts which will provide data, metadata, location of data, and who developed the data, a Wikipedia of sorts if you will. The data information could be uploaded by all users (instead of the rigorous process it takes to get it into the data center) and searched by all users. This would streamline the information process for data and information acquisition. This search engine would even allow people to look up what types of projects have been completed. At this point we are not trying to store all of the data in one location (the cost and manpower to implement something of that scale would be extreme), all we are proposing is a simple, user maintained, search engine that allows all organizations and divisions to quickly see what is available and where it can be located. A tool like this would eliminate a lot of the rework that takes place on similar projects in separate divisions where communication across the organization is minimal.

III. Data Analysis, Information Products and Findings

Input Data

Envision is open source software that allows the user to do land use modeling and can assist the user in designing alternative future scenarios. This software utilizes a multi-agent model approach that allows for several different scenarios to be created from the input data, policies and policymaker information that is put into Envision (Tanahara & Weber, 2012). It should be noted that before actually using Envision to run the model, some prep work needs to be completed. First of all we need to consider

the data needs, which are in the table below. This data list is based on prior case studies and a student project that used Envision to create a future land use scenario. The input data is used to create a single shapefile or what Envision refers to as an Integrated Decision Unit (IDU), which contains "multiple attributes describing polygon characteristics" (PSNERP, 2010). The IDU is created using overlay techniques such as intersect and spatial join (Tanahara & Weber, 2012).The attributes in the IDU are key to developing the policies which will shape the future land use scenario. Policies are influenced by actors as they are the ones who actually make the decisions about which policies they want to implement (Tanahara & Weber, 2012). Therefore, it also is important to consider which actors you want to include in the model.

Dataset Name	Source	File Format	Metadata/Documentation	Description
Study Area Boundary	Water and Land Resources Division	Shapefile	To be determined	Boundary for storm water retrofit plan project
2007 land use/ land cover	Urban Ecology Research Lab	Raster	Yes	Current LULC using Landsat ETM satellite data
Parcels	King County	Shapefile	Yes	Parcel boundaries within King County
Urban Growth Areas	King County	Shapefile	Yes	Areas designated for Urban Growth
WRIA	Dept of Ecology	Shapefile	Yes	WRIA boundaries
Zoning	King County	Shapefile	Yes	Zoning boundaries within unincorporated King County
Impervious Surfaces	PSNERP	Shapefile	Yes-limited	Impervious surface distribution derived from many sources
Ownership	PSNERP	Shapefile	Yes-limited	Land type ownership within the Puget Sound region
Incorporated Areas	Office of Financial Management	Shapefile	Yes	Incorporated Areas of King County
Protected Lands	PSNERP	Shapefile	Yes-limited	Depicts land protection status within the Puget

				Sound Region
Road Network	King County	Shapefile	Yes	Road network within King County
Current Wetlands	PSNERP	Shapefile	Yes	Distribution of current wetlands in Puget Sound
Floodplain	King County	Shapefile	Yes	Areas within 100 year floodplain
Streams	King County	Shapefile	Yes	Streams in King County
Over Water Structures	PSNERP	Shapefile	Yes	Locations of overwater structures in Puget Sound
Landslide Hazard Areas	King County	Shapefile	Yes	Areas prone to severe landslide risk
Armoring	PSNERP	Shapefile	Yes	Distribution of shoreline armoring in Puget Sound
Active Railroads	PSNERP	Shapefile	Yes	Active railroads within the Puget Sound region
Wetlands	King County	Shapefile	Yes	Wetlands within King County
Abandoned Railroads	PSNERP	Shapefile	Yes	Railroads abandoned in the Puget Sound near shore region
Tidal Barriers	PSNERP	Shapefile	Yes	Structures that impede tidal hydrology

Data Analysis

Data analysis/development is an important resource for the Water and Land Resources Division within in King County. Typically it is developed by the GIS Center, but in this case the Water and Land Resource Division will be working in collaboration with other organizations and UW to develop the necessary components. According to our project sponsor, the main goal "is to continual gather and develop science based data pertaining to environmental factors". Our group will be working on only one small aspect of the overall project; we will be suggesting categorical improvements to the mentioned 2040 land use layer, however, these incremental improvements will provide crucial data acquisition improvements for use in future analysis.

During our collaboration with King County we will be looking at their existing 2040 land use layer and the existing 14 land use categories. The current categories look at three levels of urbanization, land cleared for development, grass, four designations of forests, agriculture, wetlands, open water, shoreline, and bare rock. We are proposing using less, but more defined categories that will provide more quantifiable information and can be used in various analyses when actual facility planning begins.

Analysis Within our Project Scope

In our collaborative effort in King Counties Stormwater Retrofit Analysis we will be suggesting categorical improvements to the existing 2040 land use/ land cover layer for use in planning and budgeting the WRIA 9 area. The goals of this project are not unlike that of the MOLAND project in which we want to provide up-to-date, standardized, and comparable information on the past, current, and likely future land-use development (Campagna, 2005). We will not be doing any work on the 2040 layer but will be showing how the suggested categorical improvements will improve upon the 14 existing land use categories. The simple land use category improvements will provide the base information for many other potential hydrologic analyses (to what degree is up to King County). The simple addition of hydrologic soil group classifications to each land use category provides an associated curve number. This curve number can be used with existing charts to model runoff.

The information potentially provided by our incremental improvement will help aid the Retrofit Plan's overall goal in returning stream health to an acceptable level.

Out of Scope

- Flow and water quality data throughout the study area.
- Computer Modeled flow and water quality conditions in selected study area rivers and streams for idealized fully forested conditions, current conditions, and anticipated 2040 conditions considering population growth and climate change.

- Stream flow and water quality goals throughout WRIA 9.
- Analysis of storm water retrofits needed to achieve in-stream flow and water quality goals, including estimated costs.
- Prioritized watershed scale storm water retrofit plan.
- Planning-level cost estimate(s) and methodology to implement storm water retrofit projects throughout the Puget Sound region.

IV. Financial and Strategic Analysis

Financial Analysis

The crux of financial analysis involves looking at "cash flows related to an investment" (Awwa Research Foundation, 2007). When doing financial analysis there are many variables that need to be carefully considered. Rather than present numbers associated with key variables, which in some respect is well beyond the scope of this project, recommendations will be made as to which variables one should highly consider when performing financial analysis. These key variables will be explained in detail shortly and reference will be made to our proposed activity workflow if applicable. Also, it is important to document any assumptions being made when performing financial analysis.

The inflation rate is an important variable one might consider when performing financial analysis. The Bureau of Labor Statistics is a reliable source one can use to obtain this information. For longer projects that estimate the future values of costs and benefits it is strongly encouraged that the inflation rate is taken into consideration. If taken into consideration, this variable should be used thoroughly within the process of financial analysis. If not taken into consideration it should be documented as one of the assumptions within the financial analysis (Awwa Research Foundation, 2007).

Labor rates are another important category that has key variables which should be addressed when performing financial analysis. It is highly advised that one fill this worksheet (see appendix) out in

coordination with the Human Resources Department in their organization. It should be noted that for this project since we are not working with the Human Resources Department and given time constraints, it is not possible to fill this worksheet out in its entirety. One important variable involves identifying job categories that are affected by the project and their associated costs. In terms of the scope of our project, Jim Simmonds from the Water and Land Resource Division said our work would be the equivalent to one county employee working for about a month, which would cost around $10,000 (2012). When calculating the average hourly rate for each job category one has identified, if this is for a future project, it is advised that one use the current hourly rates for the identified job categories (Awwa Research Foundation, 2005). The information filled out in this worksheet will be used to fill in the labor cost multipliers worksheet, which has variables that one may need to consider when performing financial analysis. One needs to consider here whether labor costs will be calculated per hour or per FTE. Based on the input (the labor cost and valuation method), this worksheet calculates future labor costs based on the inflation rate that was identified (Awwa Research Foundation, 2007).

Contract and procurement costs are an important variable to be included in when performing financial analysis. These costs include onetime project costs and costs that are ongoing throughout the course of a project. Sometimes not all cost categories will apply to a given situation so just fill in what is relevant to the project. For each cost the dollar amount should be identified. It is important to note that if this is for a future project, use future dollars, that is with the inflation rate taken into consideration (Awwa Research Foundation, 2007). In terms of the scope of our project, a onetime cost would be creating the future 2040 land use/land cover layer based on our suggested improvements from the proposed activity workflow. Once the Water and Land Resources division has this layer, then it can be used for other applications within their section and other departments.

It is important to consider any benefits one's project generates when performing financial analysis. A tangible benefit is a variable that is used to identify benefits which are quantifiable. It is

important to note that not all benefits are quantifiable. In this case, these benefits should be incorporated into the strategic analysis section, which focuses specifically on intangible benefits (Awwa Research Foundation, 2007). Specifically relating to our proposed improvement, there were a few tangible benefits that were identified by Jim Simmonds. The WLRD has a floodplain management program which aims to reduce flood threats in King County. Our proposed activity would greatly assist with the planning process in the floodplain management program. (Simmonds, 2012).

When performing financial analysis to take a look at your project's future investment, it is a good idea to perform sensitivity analysis. Sensitivity analysis involves experimenting with the values for the variables associated with financial analysis. For example if any of the contract or procurement costs change as the project progresses, this may change the results of the financial analysis (Awwa Research Foundation, 2007). Thus, sensitivity analysis is a way to deal with and document the uncertainty associated with the variables identified above as well as others.

Strategic Analysis

The creation of a 2040 land use/cover layer would add strategic value by allowing KC DNRP to be able to better manage and plan projects going forward. Ideally, the 2040 land use/cover layer might be able to provide geographic areas of focus for storm water management.

Usage of this layer could be shared with groups outside of the Sciences and Technology division and even outside of the King County organization. City planners within the affected areas could use the output in their planning efforts.

While the 2040 layer is a portion of a larger Storm water Retrofit project, the work effort and data could also be utilized in other UW projects such as the digitization of photos for determining pervious/impervious layers.

Types of possible Risks

The identified risks below are based on Tomlinson, pp. 159 – 160. The measurement of risk is taken from Tomlinson but based on industry best standards as documented in the ISO 31000 Risk Management publication.

Risks are discussed with mitigation strategies for Medium Risk and above (no High Risk factors were identified.) A measurement of each risk is included using *Probability of Risk* ***X*** *Financial Impact = Total Risk* as a score. Mitigation of risk will not be considered to calculate a Residual Risk Score due to the overall minimal project risk but should be considered for larger, more complex projects.

Probability of Risk

This will be measured on a scale of 0 – 1.0 with 0 meaning that it will not occur to 1.0 meaning that it will definitely occur within the timeline of the project.

Financial Impact

This will be measured on a scale of 1 – 5 with 1 meaning no financial impact if the risk comes to fruition to 5 meaning a financial impact so great the project will have to be abandoned.

- *Technology* – current technology (both hardware and software) exist and are sufficient for the creation of a 2040 land use/cover layer. Low Risk (.1 X 2 = .2)
- *Organization functions* – there should not be an organization changes required or as a result of the creation of the 2040 land use/cover layer. Low Risk (.1 X 1 = .1)
- *Organizational interactions* – this project is being done within a single team/group within the King County Department of Natural Resources and Parks so coordination with outside teams is minimal. Low Risk
- *Constraints* – funding issues are almost nonexistent for this project due to the fact that the work is being done by UW students at no cost to King County. Due to our reduced scope there should not be any time constraints for the completion of the 2040 land use/cover layer. Low Risk (.2 X 2 = .4)

- *Stakeholders* – our stakeholder for this project is the Science and Technology division within the KC DNRP. Thus, single level of complexity with a centralized point of contact. Low Risk. (.1 X 2 = .2)
- *Overall Complexity* – the only complexities within this project are the technical proficiencies of the co-leads. Our ability to create a usable 2040 layer will require skills that, while we have learned, we are not experts with. There are not any federal mandates we must follow and the work is basically self-contained within our group, meaning little reliance on outside groups. Low to Med Risk (.4 X 2 = .8)
- *Project Planning* – Originally our project was not well defined within the UW project team. This has been corrected and we now understand our deliverables and timelines. Low Risk (.2 x 1 = .2)
- *Project Management* – Single point of project management is helping deal with issues. While all members are contributing, one person is responsible for final report and QC efforts. Low Risk (.2 X 1 = .2)
- *Project Scheduling* – Usage of Visio timelines has helped with project scheduling. Outside influences such as life and work have delayed a couple of deliverables but we are back on track. Med Risk – mitigation is more frequent touch-bases during project (.4 X 2 = .8)
- *Project Resources* – As mentioned in Overall Complexity, having the correct and adequate training in the usage of ArcGIS and other modeling software could prove to be slightly encumbering. That being said, having three people should help mitigate this. Med Risk – mitigation is team member spending extra time to familiarize ourselves with the software (.4 X 3 = 1.2)

A summary of risk/migration statement follows in the "Recommended Course of Action" section.

Recommended Course of Action

Our progression through the planning and proposed implementation of the improved 2040 land use layer has brought to light many potential risks and benefits. The strategic and financial analyses do raise some questions about cost versus benefit; however, I think we have shown that the benefit has the potential to be much greater than the cost. In the following we will look more closely at both the financial and strategic risk before we form our final recommendation.

The relatively small nature of this project means there is not that much financial risk involved. King County already utilizes the hardware, software, and personnel necessary for implementing/managing this project. With that being said there are virtually no startup cost and the ongoing cost should stay stagnant if the project is implemented efficiently. Labor costs were estimated to be in the 250 man hour, $10,000 in wages range, this should be reasonably managed with existing staff. Quantifiable benefits would include flood potentials, runoff quantities, and peak discharges. This will improve accuracy and significantly aid in stormwater facility planning.

The low strategic and financial risk of the improved 2040 layer makes it easy for us to recommend a forward progression with this. The improved quantifiable data that will be obtained from the new land use categories will have numerous positive impacts on modeling with minimal alteration to the land use categories.

V. Future Direction

The Stormwater Retrofit Program focuses on planning for hypothetical (but plausible, based on historic patterns) land change. The idea is to preemptively plan for stormwater management to return local stream health to an acceptable level. This proactive planning addresses not only the sustainability for WRIA 9 but will produce a streamlined process that can be used for other resource index areas. Our proposed action of more granulated runoff categories for use in the existing 2040 layer will provide more science based data, application, and potential analysis.

The suggested improvement to this layer is based on the nationally accepted categories produced by the U.S Soil Conservation Service. With minimal effort land use categories can be developed for WRIA 9 that use the associated hydrologic soil group classification. By using this classification the door is opened to quantifiable runoff, flood potential, and peak discharges (Dunne and Leopold, 1978). This information will be extremely valuable when planning stormwater facilities and the flow quantities that they will potentially have to handle. Using the hydrologic soil group designation along with the associated curve number will provide a user with rainfall and runoff data in inches. Using this information in collaboration with precipitation data, watershed analysis, and existing stormwater facilities a user will be able to look at potential high flow and the high flow hazardous areas that need to be addressed to ensure runoff pollution management. Having accurate pervious/impervious designations will aid when imputing data into Envision.

Ideally, this information will fuel the modeling that will take place in Envision. To be as comprehensive as possible several future scenarios should be ran through envision each dealing with potential land use, policy, development, and urban change. A traditional approach to exploring the future has been to extrapolate the past" (Walker & Salt, 2008). This method has been proven to be limited when attempting to explore future scenarios of social ecological systems. Social ecological systems are complex and there will be bound to be surprises that we don't anticipate (Walker & Salt, 2008). Rather than look at the past to gain insight into the future we can develop multiple scenarios for what might happen. This is referred to as scenario planning. With this strategy there is no best strategy, instead "rather a series of strategies which allow an organization to be prepared for different situations" (UW Urban Ecology Research Lab, 2008).

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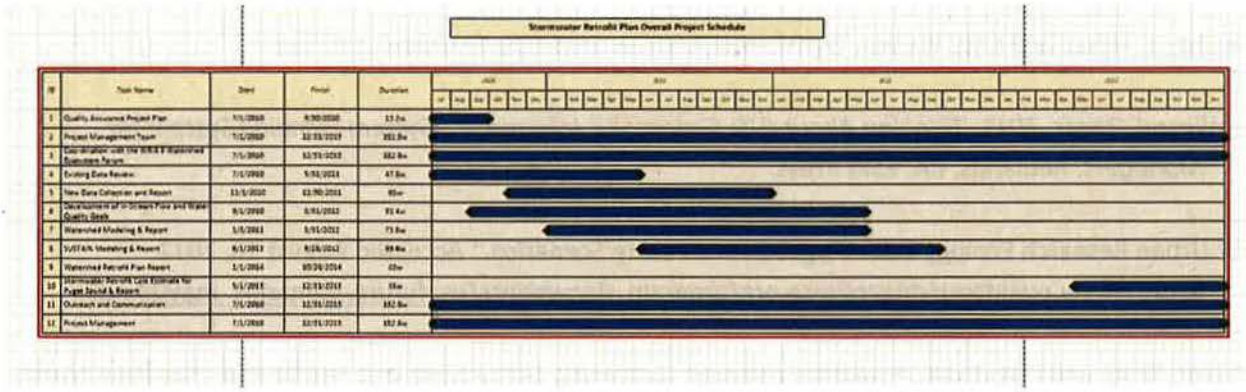
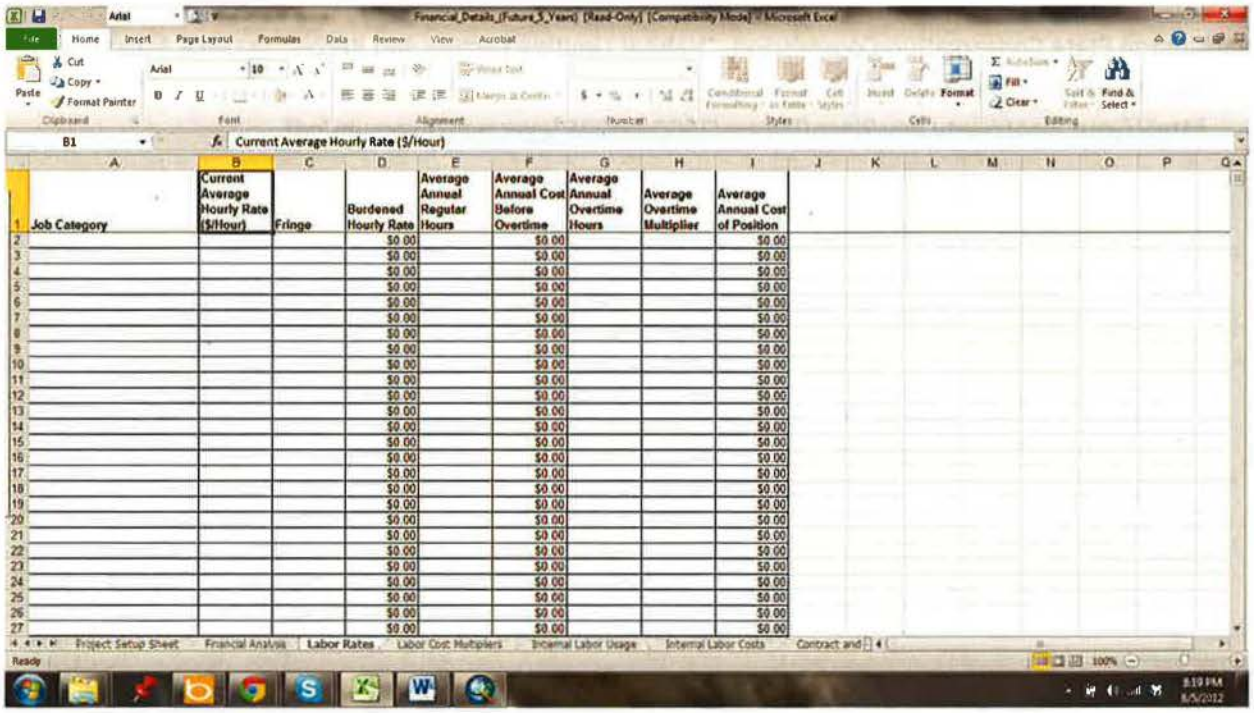
Appendix


Stormwater Retrofit Plan Overall Project Schedule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Editing
B1
Current Average Hourly Rate ($/Hour)
Job Category
Current Average Hourly Rate ($/Hour)
Fringe
Burdened Hourly Rate
Average Annual Regular Hours
Average Annual Cost Before Overtime
Average Annual Overtime Hours
Average Overtime Multiplier
Average Annual Cost of Position
Project Setup Sheet
Financial Analysis
Labor Rates
Labor Cost Multipliers
Internal Labor Usage
Internal Labor Costs
Contract and
Ready