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IUPUI Community Venture Fund Project to Develop a Business Plan for:

Riverside Watershed Environmental Living Lab for Sustainability

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Riverside Civic League

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BAMI-I
Buried Asset Management Institute - International

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- Ben Cote, Sanexen Environmental Services
- Camille Rubeiz, Plastic Pipe Institute
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EXECUTIVE SUMMARY:

The Riverside Watershed Environmental Living Lab for Sustainability (RWELLS) was conceptualized after several meetings between Riverside Civic League leaders and the Director of Construction Engineering Management Technology (CEMT) program at Indiana University-Purdue University of Indianapolis (IUPUI) that began in October 2010. In January 2012 this initiative was granted funds from the IUPUI Solution Center and matching funds from Buried Asset Management Institute- International (BAMI-I) to support a Community Venture Fund Project to hire one graduate and one undergraduate student to assist CEMT Director in developing a strategic business plan.

The Riverside is an urban neighborhood with a rich history, bordered by three water sources. Riverside includes unique cultural features such as historic buildings and monuments. The Riverside neighborhood borders the campus of IUPUI. This project intends to establish a pathway for developing sustainable concepts for a future model neighborhood by evaluating water, waste, and energy issues.

The mission of the RWELLS team is to establish a watershed and living laboratory to protect public health and environment, maximize life-cycle of infrastructures, enhance economic development, and build a community legacy. The ultimate goal is to improve the quality of life of people while developing technical and financial solutions for watershed and environmental sustainability. The initiative will consist of a commitment to an innovative urban entrepreneurship program for creating jobs and generating wealth.

During the spring semester of 2012, the RWELLS team conducted several meetings, workshops, and presentations to increase awareness of the importance of the RWELLS mission. Global Water Technology Inc. (GWT) and Midwest Mole both collaborated with the RWELLS team in implementing new technologies in Riverside. The GWT agreed to run their pilot project for an early leak detection technology. Also, Midwest Mole proposed rehabilitation of 48 inch of water pipe. The proposal includes opening a factory for manufacturing the lining pipe joints, resulting in hiring and training local residents in the Riverside neighborhood.

The team also met a number of officials from different organizations in the city of Indianapolis in order to build a network of partners such as Citizen Energy Group (CEG), Indianapolis Mapping and Geographic Infrastructure System (IMAGIS) and Polis Center.

The RWELLS team started in early spring semester to collect and analyze data. The water/sewer data was provided by CEG, while the demographic and economic data was given by SAVI (Social Asset and Venerability Indicators), a tool created by The Polis Center at IUPUI. Major findings include the following: The sewer/water data showed some aspects of the underground utilities and their conditions. For example, the Riverside area has a total of 118,419 linear feet (LF) of potable water mains. According to CEG, 80% of these pipes are cast iron (CI) and installed between 1898 and 1969. This high percentage, compared to the rest of Indianapolis where CI is only 33%, is due in part to the fact that the drinking water network in Riverside is one of the early established networks adjacent to the White River Treatment Plant. The rest are ductile iron (DI), reinforced concrete (RCP), and Polyvinyl Chloride PVC installed between the 1960s and 2010. All water pipes are pressure pipes. There were 61 water breaks recorded in the Riverside neighborhood in the last 30 years; the main cause of breaks was corrosion. The problem of corrosion is in part related to the age of pipes, but can be also due to other factors such as soil or method of installation. The sewers data shows 124,000 LF of sewer mains separated by 441 manholes, leaving a standard distance of around 280 LF between two manholes. All sewer pipes are gravity pipes. The flow goes from north to south connecting all sewer mains to Combined Sewer Overflows (CSO) points along The White River (Appendix III); and transmitted to the sewer treatment plant located on South Belmont Avenue.

The RWELLS team is fully committed to continue working and coordinating with different partners and other projects such as “16 Tech” and “Flow” to achieve their mission; to see the Riverside neighborhood transformed by its own residents to a sustainable area with vitality and hope.

List of Tables

List of Figures

Table of Contents

I. Introduction:

I.1 Challenges of Urban Neighborhoods: Urban neighborhoods in the United States have faced dramatic changes in the post-World War II era. The blossoming suburbs became more attractive shifting population and businesses from urban centers toward suburbs. The construction of highways exacerbated the situation by demolishing and dividing neighborhoods; while at the same time making transportation between suburbs and the rest of the city easier and faster. Downtown and urban neighborhoods were dying slowly throughout the country as more people and jobs migrated to suburban areas. Indianapolis was not an exception in this national trend. In the 1960s the effect of this trend of migration from urban to suburban areas caused hundreds of businesses and buildings in downtown Indianapolis to deteriorate at a rapid rate. According to W.J. Watt (2010) "In sixties the post-war prosperity turned people and jobs to the suburbs, a situation that lead to the deterioration of the central city." In the late 1980s and 1990s Indianapolis invested heavily in the downtown to reverse this deterioration trend; however, very little investment was made to reverse the deteriorating neighborhoods.

Riverside is an urban neighborhood in Indianapolis that is still suffering from this urban deterioration. The Riverside neighborhood has a rich history dating back more than one century. The neighborhood is one area that blossomed in the early 1900s. According to the United North West Area (UNWA 2009) "the area did have enough residents before 1900 to support at least two churches." Riverside neighborhood is located on the North West side of Indianapolis. It is bordered on the South by Fall Creek and the Indiana University-Purdue University of Indianapolis (IUPUI) campus, on the North by 30th street, and White River from the West, and the Fall Creek on the East (Figure 1.1).

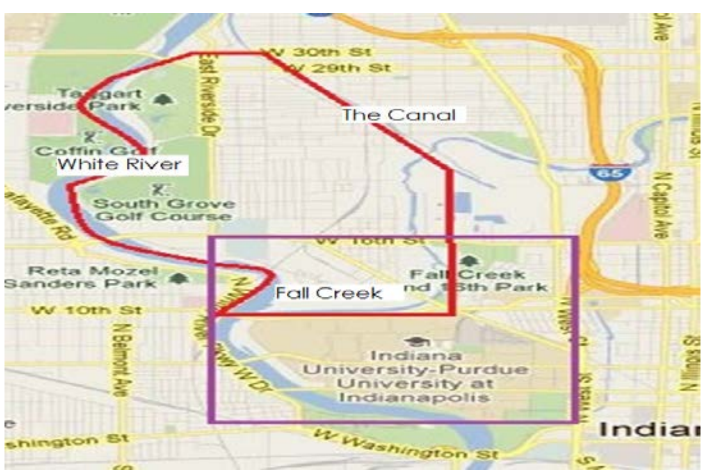

Figure 1.1 Location of Riverside Neighborhood

The Riverside neighborhood has many attractions including three golf courses (Riverside Golf Course, South Grove, and Coffin Golf Club). Riverside is also home of a historical monument in honor of Thomas Taggart, the visionary leader who served as mayor of Indianapolis from 1895 to 1901. Riverside is also home of the second oldest neighborhood association Riverside Civic League. This neighborhood also borders the campus of IUPUI, and is one of the surrounding neighborhoods that were negatively affected by IUPUI's expansion.

I.2 Infrastructure concern in Riverside:

There are many challenges that can be in a neighborhood, but the challenge that is most dominant in this area is related to the income level and unemployment. According to the Indianapolis Star (2011) the median household income for the Riverside community was $25,754 (per year) which is about half of the average Indianapolis in 2011 (Table 1.1). The unemployment rate is one of the highest in the city of Indianapolis, with 27% of the workforce being out of work in this area.

	Riverside neighborhood	Indianapolis
Population	4,374	798,000
Median Gross Income per family	$25,754	$48,755
Unemployment rate	27%	8.4%

Table 1.1: Demographic data for Riverside Source: Savi.org

The state of the underground infrastructure in this area is a major concern. It not only affects the health of people but it has environmental and economic impact. Most of the water and sewer infrastructures in this area have exceeded their useful life and have been poorly maintained. The neighborhood is adjacent to the first water supply treatment plant in Indianapolis (Indianapolis Water's White River Station) and the area is considered according to Citizen's Energy Group (CEG) to be one of the earliest establish areas, It has been estimated that 25% of potable water is lost due to leakage in the pipes in Indianapolis, and approximately 40% of the wastewater flow that gets to the treatment plant is infiltration (ground water). Drinking Water (DW) and Waste Water (WW) system leakage is unsustainable. Water leakage represents energy waste. Energy is required to obtain, treat and distribute DW to customers, as well as to collect treat and discharge WW. The cost of water loss and energy waste is recouped through increases in the monthly customer rates.

I.3 the Concept of RWELLS:

The idea of an initiative to address water, energy, and waste challenges was conceived through meetings between the leaders of the Riverside Civic League (RCL) and Construction Engineering Management Technology (CEMT) program at IUPUI. This Initiative contained an innovative component that can bring hope and opportunities back to this neighborhood. This initiative became known as The Riverside Watershed Environmental Living Lab for Sustainability (RWELLS). RWELLS is the fruit of collaboration between RCL and CEMT and advocates that addressing neighborhood problems (such as unemployment, quality of life, poverty, energy waste, water, carbon emission) requires joint effort of local businesses , academic institutions, industry, local government and, more importantly, local residents of the neighborhood and their community leaders.

The mission of the RWELLS initiative is to establish a sustainable watershed that has a neutral environmental impact and can be a model for the nation. This living laboratory will provide opportunity for evaluating and developing solutions to protect the environment and public health, to maximize life-cycle of infrastructures by establishing a strategic plan precisely for water and wastewater infrastructure, to develop waste and energy solutions, to enhance economic development, and to build a community legacy through touching lives. The ultimate goal of the initiative is to improve the quality of life while developing sustainable watershed and environmental and financial solutions through a commitment to innovative urban entrepreneurship that creates jobs and generates wealth.

Ms. Phyllis Hackett (President of the Riverside Civic League) states "We are excited about the endless possibilities RWELLS has in creating jobs and training opportunities for our Riverside residents. The Riverside community has been entrusted with the opportunity to become whatever it wants to be and we stand ready for the challenge."

RWELLS will demonstrate how solving these problems can lead to new solutions, more sustainable practices, new jobs and higher average income. RWELLS is expected to become a national and international model of a futuristic neighborhood with a goal of zero leakage in their water and sewer lines.

I.4 The Conception of a Living Lab

This approach allows all stakeholders to consider the performance of a product or service and its potential adoption by the users. Living labs could also be used by policy makers and users/citizens for designing, exploring, experiencing and refining new policies and regulations in real-life scenarios for evaluating their potential impacts before their implementations.

II- Development of RWELLS:

II-1 Community Venture Fund:

The Department of Engineering and Technology in the Purdue School of Engineering and technology received funds from the IUPUI Solution Center to support two students (one graduate and one undergraduate) to assist with developing a strategic business plan for RWELLS during spring 2012 semester. The IUPUI Community Venture Fund is a matching grant program open to not-for-profit organizations, government agencies and small or mid-sized businesses. Funds may be used to seed or enhance university-community partnerships and projects.

This community-based internship program supported by the Solution Center is intended to make an impact in the community and also aims to prepare students for the real world by translating academics into practice. This program helps students improve skills needed in their future professional life including communications, leadership, teamwork networking, etc.

Dr. Christine Fitzpatrick, Associate Director of the IUPUI Solution Center states" The project will provide these CEMT students an important participatory research experience that will enrich their preparation for careers in construction management, field engineers, and project managers." This community venture grant was matched with funds from BAMI-I (Buried Asset Management Institute-International, Inc.) These funds were used to pay students for working 20 hours per week during 16 of the project duration.

II-2 Project goals:

The main objective of the RWELLS team during the spring 2012 semester was to gather all available demographic, social, economic and technical data, and to analyze this data identifying gaps and sources of problems. This required students to learn about the principles and practices of water utility asset management as well as to develop skills in Geographic Information System (GIS) mapping, and other data management software. As part of this mission, the students were in charge of collecting different utilities data, interpreting different inspection reports, and assessing the number of failures pertaining to drinking water (DW) and wastewater (WW) mains in the Riverside area. The information for DW lines included location, condition and age. It included also how conditions of the pipes are assessed, and how decisions are made regarding pipe replacement, renovation, or repair. For the WW lines information included the number of manholes, their locations, and direction of the flow etc... The student team also interpreted the information and compared their findings with the rest of Indianapolis and the US. These findings were discussed with mentors and summarized in this report. Students also collected demographic and economic data for this area, by conducting literature review and analyzing census data. The team was able to determine what social and demographic issues this area is facing and identified the socioeconomic factors of the residents (including employment, education, income, wealth). This step of collecting and analyzing data is critical in developing an effective strategy plan to address the neighborhood's challenges.

<u>Long term goals:</u>

Many positive results are expected from this project but the ultimate goal is to bring investment to this neighborhood; and instead of bringing workers for maintenance and modernization for instance, make this a business opportunity for local residents. The intent is to encourage local residents to set up companies and create stable and long term jobs. This will make the revitalization a dynamic operation that involves residents and promotes sustainability through ownership and the power of hope.

II-3 RWELLS partners:

Numerous meetings, workshops and presentations were conducted during the spring 2012 semester. The project team formed a network of partners (figure 2.1) who were committed to the goals of the project. They provided assistance and substantial data. The contribution of these individuals and organizations was essential in the progress of this project.

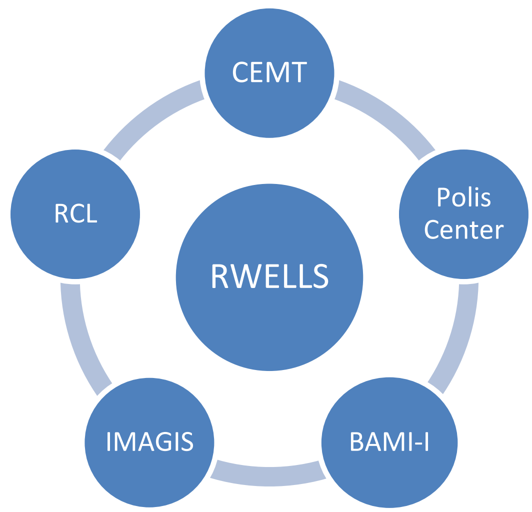

Figure 2.1 RWELLS partners

II.3.a Riverside Civil League (RCL):

Organized in 1976 and incorporated in September 1978, RCL is the second oldest neighborhood association in Indianapolis. RCL exists to benefit and enhance the Riverside community by advocating for residents on quality of life issues such as: social, cultural, economic development, safety, neighborhood pride, beautification, and affordable housing through strategic partnerships and stakeholders

II.3.b Buried Asset Management Institute International (BAMI-I):

Buried Asset Management Institute was formed in Atlanta's Department of Watershed Management in 2003 as a result of inspiration and leadership by mayor Shirley Franklin and commissioner Jack Ravan. In June 2004 BAMI-I was formed as a non-profit organization. It serves to provide a center of excellence for owners of underground water infrastructure to join with industry and researchers to evaluate and /or develop buried asset management protocols for application worldwide to benefit ratepayers and other stakeholders.

In January 2012, BAMI-I established a special projects program. One of the special projects consisted of establishing an Industry Advisory Board (IAB) for the RWELLS Community Venture Fund project. The IAB members devoted their time and financial resources to support this project.

The BAMI-I RWELLS IAB

Plastic Pipe Institute

CH2M Hill

AP/M Permaform

Midwest Mole, Inc.

Sanexen Environmental Services.

See Appendix II for detailed contact information.

II.3.c Citizen's Energy Group (CEG) :

CEG is one of the largest utility companies in Indiana; it recently acquired the water and wastewater systems from the City of Indianapolis. The transfer was finalized on August 26, 2011. The water and wastewater infrastructures in Indianapolis cover approximately 320 square miles. Citizens is the only utility company in the USA founded as a Public Charitable Trust; it plays a strong role in the communities of Indianapolis. CEG has five divisions: Citizen's Gas, Oil, Thermal, Resources and Water.

Citizens Water provides water service to more than 300,000 customers in Marion and the surrounding counties. It also supplies water to communities with their own water utilities including Speedway, Brownsburg, and Lawrence. Citizens Water also provides wastewater services to more than 230,000 customers in Marion County alone as well as having wastewater service agreements with many other counties.

II.3.d Indianapolis Mapping and Geographic Infrastructure System (IMAGIS)

IMAGIS is a multi-participant, public-private geographic information system (GIS) consortium for Indianapolis and Marion County, Indiana. The goal of this consortium is to share expertise and resources related to map design. IMAGIS produces five main products: aerial orthophotography, planimetrics, elevation, data distribution to members and the public, coordination and technical services for members. Since its creation in mid 1980s, the IMAGIS project has won several prestigious awards and continues to excel as one of the best multi-participant GIS programs in the world. IMAGIS consortium exists as a contract and the staff are IUPUI employees.

II.3.e Polis Center

The Polis Center was established in 1989 by Dr. David J. Bodenhamer . The Polis Center links two types of expertise—academic and practical—for the benefit of communities in Indiana and elsewhere. Polis Center is a self-funded research unit of the IU School of Liberal Arts at IUPUI. Polis Center's approach to understanding the communities in which we live is entrepreneurial and innovative, finding practical, effective, and cost-efficient ways for communities to enhance their capacity for meaningful changes .The Polis Center developed the nation's largest community information system, SAVI, as an interactive data and mapping resource for individuals and organizations in Central Indiana. In all of their areas of emphasis, Polis Center has earned a national reputation as a dynamic learning environment with highly professional staff who excel in collaborative, practical, and effective solutions for the community.

II.4 other projects in the area:

Many projects and initiatives are taking place in Indianapolis with the intent to revive the northwest side of downtown. "16 Downtown Technology District (16 Tech)",sponsored by Develop Indy, is one of the largest development projects in Indianapolis. The 16 Tech area is bounded by 16^{th} Street to the north, 10^{th} Street to the south, White River to the west and Fall Creek to the east. Strategically located within walking distance of internationally recognized academic institutions and centers of research, such as the IU School of Medicine (the second largest medical school in the US), 16 Tech seeks to turn the corridor between IUPUI and 16^{th} Street into a life-science research hub. This project includes building a certified technology district, transforming Bush Stadium into a residential area and bringing high-tech companies from around the world to invest in this area.

"FLOW: Can You See the River?" is an artistic project conceived by Mary Miss and commissioned by the Indianapolis Museum of Art. This artist perceives the White River as a mirror of the city and uses mirrors along the river to express that. The intention of this creative project is to promote awareness of sustainability, and engage the citizens of Indianapolis with important and unique elements of the river and its watershed. Moreover, this project aims to "tell the story" of the area adjacent to the river by presenting it to visitors in a different way using markers and snapshots. One hundred points are installed along a 6 miles stretch of the River and Canal using mirrors and markers (Figure 2.2).

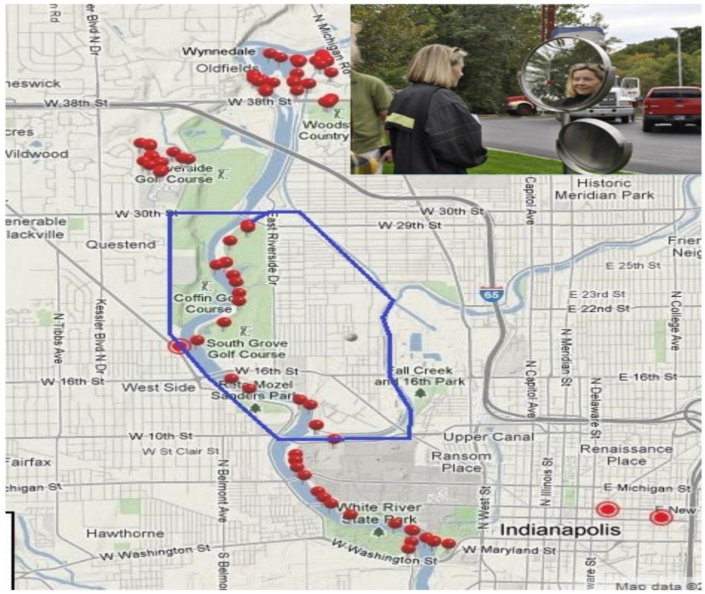

Figure 2.2 FLOW project map (the red points are mirrors and markers) and the Riverside area in blue.

The FLOW and 16 Tech projects are examples of the private and public efforts in the city of Indianapolis to bring solutions and awareness to this area. RWELLS is not intended to be a stand-alone initiative. The team strongly believes that the effective way to address challenges is by working together with all of these projects which share the same values and objectives. Therefore, the team plans to integrate this initiative with their efforts to see Riverside as a model for the city in terms of sustainability and development.

III-Development of an Asset Management Plan (AMP)

III.1 What is an AMP?:

RWELLS' initial focus on water and wastewater infrastructure can serve as a pilot program to help utilities implement an Asset Management Plan (AMP).The Asset Management Plan, as defined by the Certification of Training in Asset Management (CTAM) course, is the combination of management, financial, economic, engineering, and other practices exercised within a guided framework applied to physical assets with the objective of providing the required level of service in the most cost-effective manner. Figure 3.1 presents the 7 key questions of AMP and sources of their answers. A well-established AMP increases a utility's control over water and wastewater infrastructures by improving the predictability of pipe failure and prioritizing the maintenance and replacement of existing pipes. This allows utilities to reduce drinking water loss by minimizing breaks and leaks. It also helps to mitigate the number of wastewater overflows (SSO Sanitary Sewer Overflows) by managing Inflow and Infiltration (I/I). Therefore, AMP promotes sustainability as well as decreases cost.

ACTION PLAN
for
Underground Infrastructure
(Seven Questions)

1. WHAT do we have?	Inventory
2. WHERE is it located?	Mapping, GIS, GPS
3. WHAT is its condition?	Condition Assessment
4. WHAT is its worth?	Asset Evaluation
5. WHAT action is required?	Replace, Restore, Benchmark
6. WHEN is Action Required?	Prioritize - CIP, Master Plans
7. HOW MUCH will it Cost?	Cost Estimates & Studies grants, loans

Figure 3.1: 7 key question of AMP Source: BAMI-I CTAM course

Advantages of AMP:

- Increased knowledge of the location of the assets
- Increased knowledge of which assets are critical and which are not
- Capital improvement projects that meet the true needs of the system
- Better and more efficient operational decisions
- Improved emergency response
- Greater ability to plan and pay for future repairs and replacements
- Better communication with customers

On the other hand the implementation of an AMP by utility companies may face internal (e.g. economic) and external (e.g. regulatory) barriers:

- Economic: utility companies may assume that investing in an AMP will go beyond the budget limits and create more expenses that the company is unable to support.
- Regulatory: regulations differ from state to state but their requirements have an impact on strategies adopted by the utility companies.

Added to that, the water and wastewater industry sector is highly fragmented: there are around 54,000 water utilities and 16,000 wastewater utilities in the US. Over 90% of these utilities serve communities with less than 10,000 population. Small companies are less motivated to adopt new managerial strategies because they have more serious economic constraints.

III.2 Strategic Plan

The strategic plan, as defined by the CTAM course, starts with setting up Core Values including: a vision statement and utility values. The next stage is forming leadership and communications, involving meetings with different department leaders to promote the virtues of an Asset Management Plan and to get their support. The last step and the most critical in the development of the strategic plan is the data acquisition and conditions assessment.

Why do we need to collect data? Every project of revitalization relies mainly on data to provide a factual basis for decision making. This data constitutes the initial baseline that answers fundamental questions related to the project.

The process of collecting any data is described by Kevin Mickey, Director of Education at the Polis Center in the following chart (Figure 3.2):

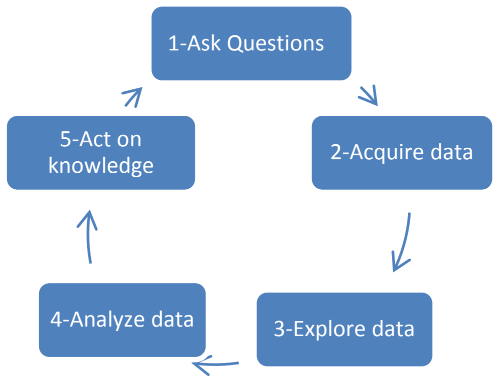

Figure 3.2: The process of collecting data

The process starts with asking questions, therefore it is necessary to shape data around the questions not the questions around data. As an example to describe this process: Starting with questions about the age of water pipe network in Riverside. The next step will be locating the sources of data (in this case it is CEG water). After acquiring data, it is critical to explore it to select useful data relative to the question. Analyzing data is the process of using data to answer the question. Last step is to use facts to initiate actions (e.g. projects to repair, replace a network system). Most of Utility data are managed currently by Geographical Information System (GIS) software. Therefore, the exploration and analysis of data requires GIS skills. Following is a brief description of GIS, the software and its application in water and sewer field.

Definition of GIS: Geographical Information System is a system for storing and managing geographical data on a computer. The acronym stands for:
Geographic: the data presented on GIS is geographically located in the form of layers on a map; a dynamic map that allows user to see and compare information. **Information:** GIS stores two types of information: features and attributes. Features are presented by shapes in the map, such as water mains, manholes or fire hydrants; while attributes link features to the database to provide description (type of material, year of installation, length.) **System**: GIS is a computer system.

It is a common mistake to reduce GIS to drawing software; it is more useful to analyze data and answer questions about the data. It is important to note that selecting features by attribute is not unique to GIS; most database management tools have this option, but GIS can link this attribute to the location and add a geographic element to the data. GIS is a set of wide range of tools and functions that can process and analyze different types of dataset. Meanwhile, the most important functions of GIS are Geoprocessing and Querying:

- **Geoprocessing** is taking one or more datasets to create new data. For example, if the data given to the students covered water pipes in Indianapolis, but they need it only for the riverside area, they have to create a boundary file for the area of Riverside, and clip the data to this specific area. The new dataset is for the Riverside area only. (figure 3.3)

Figure 3.3 Geoprocessing tool in GIS

- **Querying** is asking spatial questions of a dataset, these questions can be as simple as the location of a manhole, the type of material of a pipe or more complex such as the location of ductile iron pipes with a size smaller than 12” in the Riverside area.

The following outlines some basic GIS concepts and tools:

Raster: raster is a data storage method to describe continuous features such as scanned maps, aerial photographs, or thematic maps.

Vector: vector data storage method uses shapes to represent a feature with defined boundaries (point, line, and polygon).

Coordinate: Coordinates link the features in GIS to the real world locations (for example latitude and longitude).

Shapefile: shapefile is a non-topographic data set format created by ESRI(provider of the most popular GIS software: ArcView) ; each ESRI shapfile contains four components. Shapefiles are easy to manipulate, edit, and they require less space on the disk.

GIS Layers: GIS presents information on overplayed layers, each one is linked to a specific set of features, for example a GIS map can display a layer of manholes, over a layer of sewer mains. It is important to note that layers do not contain data, they rather point to the data. A layer is a graphic file linked to an attribute database.

GIS is a powerful tool that can have an important role in decision making for any organization but it has also some drawbacks. One of them is the accuracy: the GIS data accuracy depends on the individual who created it and it is not easy to track the source of the data to evaluate its credibility. Another issue with GIS, it is a complex tool and therefore, requires extensive training. The relatively high price of a GIS software package is a serious concern especially for small towns and small utilities companies.

GIS for Sewer and Water utilities: GIS software helps utilities store and manage a database of their assets. A well-established GIS database, constantly updated, is critical to an effective asset management plan. GIS has various uses for water utilities. For example, with different spatial tools a utility company can integrate all customers use and examine development trends to provide predictions of future demand. GIS also help decision makers in water utilities companies to find solutions to the challenges related to their physical assets.

III.3 Presentation of water and wastewater infrastructures in Riverside

The Data provided by Citizen's Energy Group contains important water and wastewater data including years of installation of pipes, their materials, records of breaks, and direction of the flow. However, this information is not complete, and not fully verified. For example, for water breaks, the cause is determined by the technician crew by the eye, and rarely a sample is taken to the lab to determine the real cause of break or the percentage of corrosion.

III.3.2 Drinking water

The data shows that Riverside has a total of 118,419 feet (22 miles) of potable water mains, carrying drinkable water to around 4374 people in the Riverside area. While water distribution pipes in Indianapolis are 4528 miles serving a population estimated around 800,000.

Some parts of the RWELLS network were installed as early as the 1800s but almost half was installed in between 1911 and 1935 (Table 3.3).

Type of materials:

Type	Number of pipe segments	Length LF	Percentage
CI	618	95415.44	80%
DI	88	9340.699	8%
PE	10	728.1026	1%
PVC	74	6669.622	6%
RC	50	5918.336	5%
Total	840	118419.4	100%

Table 3.1 percentage of water pipes by material

CI: cast iron
DI: ductile iron
PE: polyethylene
PVC: polyvinyl chloride
RC: reinforced concrete

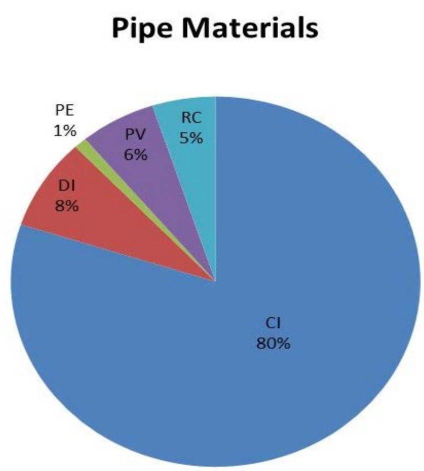

Figure 3.4 Drinking water pipe materials in Riverside

The pipe material is dominantly cast iron (80%) (Table 3.1) installed before 1969. This can be explained by the fact that Riverside is one of the early established area around the first water treatment plant in Indianapolis (The White River Plant). These percentages are different from the rest of Indianapolis where the CI is around 33.5% and other relatively new materials have higher percentage. The following table 3.2 summarizes the types of material and their length for the drinking water in the City of Indianapolis:

Material	Length of pipes in miles	Percentage
CI	1519.17	33.5%
DI	1291.61	28.5%
PE	273.18	6%
PVC	1282	28%
RC	34	0.75%

Table 3.2 Percentage of drinking water material for Indianapolis

According to the American Water Work Association (AWWA, 2009), “The use of cast iron pipes was introduced to the United States in the early 1800s. However waterworks engineers continued to use cast iron until ductile iron, a stronger and equally durable piping material became available.” DIRPA assumes that ductile iron pipes were first introduced in the market in 1955, but after 20 years from that time cast iron were no longer manufactured and all iron pipes manufactured became ductile. The following table (Table 3.3) presents each type of material by years of installation in the Riverside area and figure 3.4 summarizes the installation of pipes by periods.

Type	From	To
CI	1885	1969
DI	1964	2010
PE	1998	2005
PVC	1965	2005
RC	1929	1964

Table 3.3 year of installation of each type of material in Riverside

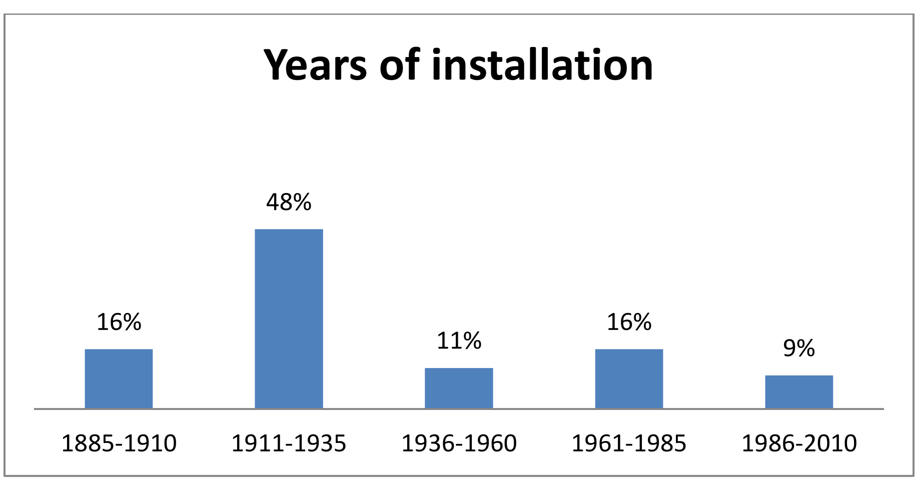

Figure 3.5 percentages of DW pipes by years of installation

Note:75% of pipes were installed before 1960.

III.3.3 Water breaks record and corrosion:

Around 61 breaks were recorded in the Riverside area in the period between 1974 and 2011. The main causes of break failures are corrosion, temperature, pressure, and contractor fault. The high percentage of corrosion (52%) (Table 3.4) is due in part to the fact that cast and ductile iron are the dominant types of material, and as both of them are made of cast ferrous with high carbon, they are more subjected to corrosion. While researchers are in disagreement whether CI is more corrosive than DI, but generally because of the factor of the installation time, corrosion is more apparent in CI pipes.

Moreover, the data provided by CEG shows a high level of corrosiveness in the pipes in service in this area. According to the AWWARF “the most common distribution system problem is corrosion of cast iron pipe.” Another relevant piece of information provided by Ms. Charline Avey, GIS Administrator at CEG Water, regarding the presence of heavy corrosion in some areas of Indianapolis that causes failures in the system , she explained that pipes manufactured during the World Word II period have a wall thickness less than the allowable (due to a shortage in raw material) See Figure 3.6 for a pipe installed in 1945 that was subject to several breaks. According to the article ”Corrosion, not Age, is to Blame for Most Water Main Breaks” Corrosion is the leading cause of over 700 daily water main breaks throughout North America. Furthermore, a 2002 Congressional study found that corrosion costs U.S. drinking water and sewer systems $50.7 billion annually in 2008 dollars.

Cause of Failure	Frequency	Percent	Cumulative Percent
Contractor	2	3.3	3.3
Corrosion	32	52.5	55.7
Movement	2	3.3	59.0
Pressure	8	13.1	72.1
Previous Disturbed Soil	1	1.6	73.8
Temperature	16	26.2	100

Table 3.4 Break causes of DW Pipes in Riverside

Figure 3.6 Several breaks occurring

in a 12 " CI installed in 1945

III.3.4 Wastewater (WW) Data:

A wastewater system is a separate conveyance system for transporting sewage from houses, industries and commercial buildings to treatment and disposal. Data provided by CEG Water shows 124,000 LF (23.4 miles) of WW mains in Riverside (including large interceptors passing through the golf courses and are not connected to the neighborhood system). Pipes are separated by 441 manholes, leaving a standard distance of around 280 LF between manholes. The total WW mains in Indianapolis are 3240 Mi, with 66537 manholes (on average 257 LF between manholes). EPA estimates that for the United States the network of sewers is around 900,000 miles long with 20 million manholes. All pipes in Riverside are gravity pipes, and the flow goes from north to south conveying all sewage to the CSO points along the White River (Appendix III); and transported to the sewer treatment plant located on South Belmont Ave.

Pipes: The following is a table of each type of material and its percentage (table 3.5) in Riverside and a graphic chart presenting these values (Figure 3.7).

Type of material	N. of pipes	Total length	Pipe size range	Percent
VCP(Vitrified Clay Pipe)	263	65,750 lf	6"-36"	53%
BRK (Brick)	21	6400 lf	10"-72"	05%
DIP (Ductile Iron Pipe)	2	1670 lf	36"	1.5%
RCP (Reinforced Concrete	135	46200 lf	8"-102"	38%
PVC (Polyvinyl Chloride)	11	1736 lf	6"-8"	1.5%

Table 3.5 WW pipe materials in Riverside

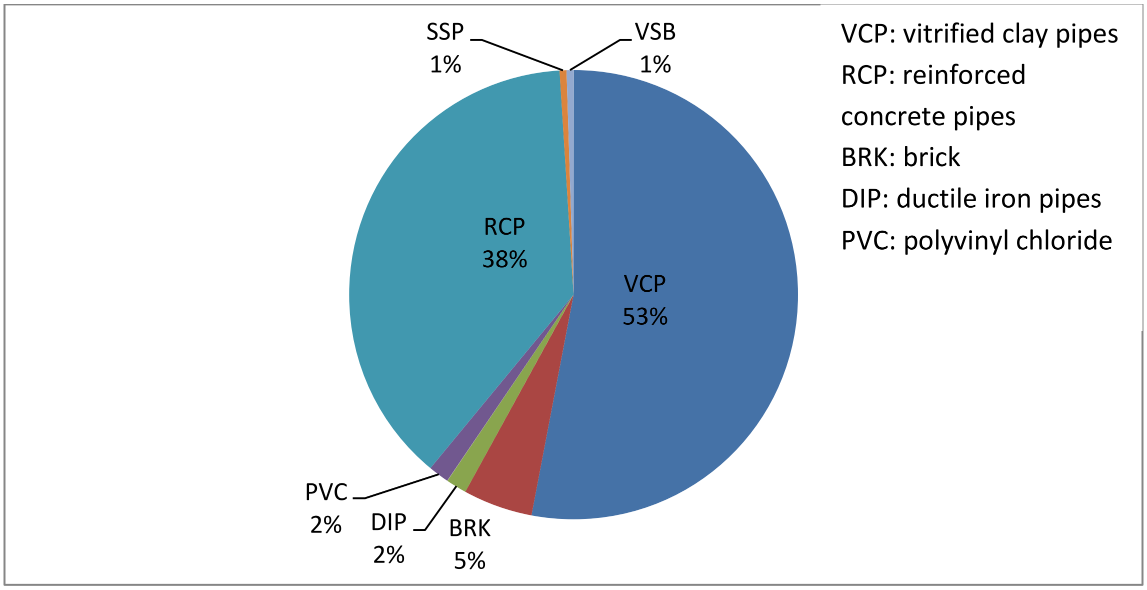

Figure 3.7 Type of WW mains materials In Riverside

The Vitrified Clay Pipes (VCP) and the Reinforced Concrete Pipes (RCP) are the most used types of material in this area (Figure 3.7). While PVC pipes are only 2%; compared to the rest of Indianapolis where the percentage of PVC is high 32.6%, the second after VCP (42.6%). PVC pipe is in increasing on the global underground market taking the place over the conventional types of material because of its qualities (light, corrosive resistant and economic table 3.6). VCP is made from clay that has been subjected to vitrification. VCP is widely used for sewer gravity mains in North America because of its reasonable price, resistance to different type of sewage, and most important for its resistance to chemical corrosion.

Piping Comparison of WW mains by Wastewater Technology Fact Sheet EPA:

Type of Material	Utilization	Advantages	Disadvantages
Vitrified Clay Pipe	*VCP has been used for hundreds of years for sewage.	*Resistant to chemical corrosion. * Thermal Expansion is less than DI or PVC	*Joints are exposed to chemical attacks. *Brittle may crack. *Short length makes it prone to infiltration.
Ductile Iron	*DI is the standard pipe material for high pressure services and large networks.	* Good corrosion resistance when coated. * High strength. * Ability to deform without cracking.	*Heavy
Reinforced Concrete	*Used primarily for gravity lines.	* Good corrosion resistance * High strength * Widespread availability	*Susceptible to attack by H.S and acids when not coated. *Heavy
PVC	*Preferred for small diameters. * Good for pressure services, *utilization is in increasing in the world	*High strength and good stiffness, * good resistance to acids and organics, * flexible economic and lightweight,	*Require special bedding. *Has to be protected from sun light. *Susceptible to attack by solvents.

Table 3.6 Comparison of WW Pipe Materials in use in Riverside

Manholes: A manhole is a junction chamber that allows inspecting and cleaning and maintenance of sewer lines. .The maximum spacing between two manholes in Riverside is 370 LF for small pipes (less than 24”), and 470 LF for large pipes (over 24”) which is within the allowable spacing according to Sewer Design Guidelines (2008)

Pipe Size	Maximum Manhole Spacing
8-inch to 24-inch	400 LF
27-inch and larger	600 LF

Table 3.7 Manholes limitation

Life cycle:

According to the Asset Management Guide (2006), an asset life cycle depends on different elements and differs from site to site "Factors such as poor installation, defective materials, poor maintenance, and corrosive environment will shorten an asset's life." The EPA confirms that the material used and type of installation of the pipe can be greater indicator of failure than age. Therefore, some generic records can be used as "age limits" for example the expected life cycle of gravity sewer lines is between 80-100 years, and for manholes 20 to 50 years. According to AWWA journal (2011) selecting the wrong pipe material or failing to protect pipe can greatly shorten the lifespan of sewer and water lines.

IV. Conclusion:

In the spring 2012 semester the RWELLS team conducted several activities, meetings, and workshops, to bring light to this project and to explore possibilities of cooperation with different partners. The team has also collected some key data about the Riverside neighborhood. This data can help assess the needs of this neighborhood; and to determine future actions. Moreover the team studied the past of this area, and identified information about history and challenges for all urban neighborhoods in Indianapolis.

This project will continue to coordinate with different partners and Riverside local leaders to promote a futuristic vision that involve local neighbors in developing solutions that create jobs and promote sustainable environmental practices. President of the RCL, Ms. Phyllis Hackett one of RWELLS community partners, stated “RWELLS is a dream come true for us. It is not built around talk, but, solutions to real world problems which would benefit our residents in new found job options and entrepreneurial opportunities. We know by building strategic partnerships with stakeholders such as IUPUI, our time to flourish and nourish the roots of our foundation has come.”

RWELLS team is committed to assist other utilities to develop and implement an Asset Management Program (AMP); to address aging and deteriorating water and wastewater pipes. AMP is a program that assess all water/sewer assets of the utility: their conditions (when installed, what material, corrosion level, wall thickness, etc.), and their criticality (under highway, in residential area, in vacant land, etc.). AMP can propose scheduled maintenance based on prioritization, instead of emergency maintenance that costs more for the utility and does not address the source of the problem.

In the future, the RWELLS team is planning to conduct in depth studies for water, wastewater, and energy usage in this area. Moreover, the team will prepare a complete online database for this area including all information and facts about water and energy for Riverside. This combined with campaigns of awareness in middle and high schools in this area rising awareness of water and promoting best sustainable practices to save energy and water.

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- White A. (2010). *Price of Progress*.IUPUI. Indianapolis, IN.

Appendix

Appendix I: Chronological Summary of RWELLS Meetings

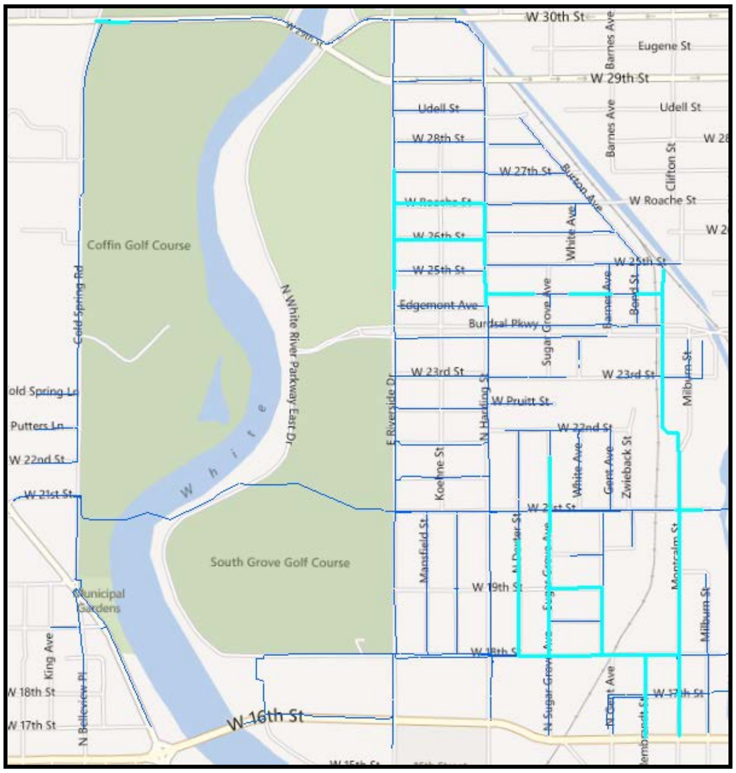
Date	Attendees	Comments
Jan 31, 2012	Peggy Gamlin, RCL Phyllis Hackett, RCL Dr. Tom Iseley, IUPUI Dr. Dan Koo, IUPUI Eminou Nasser, IUPUI Hamed Zamenian, IUPUI Jessica Rochon, IUPUI John A. Mainella, IUPUI Guy Westermeyer, Westcomm Jamie Olsen, Westcomm	Workshop Overall project goals and strategic plan was discussed and every one presented his/her view and expectations Westcomm as a consultant firm for media and advertising gave RWELLS some guidance on how to present this project.
Feb 7, 2012	Matt McCormack, IMAGIS Jim Stout, IMAGIS Dr. Tom Iseley Dr. Dan Koo Eminou Nasser Jessica Rochon	Defining Source of Data Jim Stout suggested that RWELLS team contact CEG for data on water and sewer, explains that the team needs access to GIS software, and for demographic data he advised the team to coordinate with the Polis Center
Feb 22, 2012	Dave Coats, Polis Center Jack Schimtz, Polis Center Matt Ray, IUPUI Dr. Tom Iseley Dr. Dan Koo Eminou Nasser	Dave Coat committed to give the team a workstation on the Polis Center Lab, and to assist the team in GIS analysis. He presented also the Indianapolis Encyclopedia. Schmitz presented the SAVI tool to the team.
Feb 28, 2012	Charline Avey, CEG Dereck Eliott, CEG Dr. Tom Iseley Dr. Dan Koo Eminou Nasser	Collecting Data Solicit Citizen's to provide the team with all gas, water and wastewater data for the Riverside area. CEG commited to provide all the necessary data in short time.
March 16, 2012	CHD North Carolina NC Rural Economic and Development Center	RWELLS to the National Level The purpose of this presentation was CTAM+ course and RWELLS. The presentation was well received and opened more perspectives for RWELLS initiative at the national level.

Date	Attendees	Comments
Mar 28, 2012	Charline Avey Eminou Nasser	Data Collection All sewer and water data related to the Riverside area was acquired by the team in geodatabase format.
March 28, 2012	Eric Hromadka CEO GWB Tom Iseley, Dan Koo Eminou Nasser, Hamed Zamenian	Meeting with Global Water Technology GWT is promoting a new technology for early detection of water pipe breaks; They are waiting for a permission from CEG to run a pilot project.
April 5th, 2012	Kurt Wright, CEO Kurt Wright and associates, Inc, Tom Iseley Dan Koo Hamed Zamenian Eminou Nasser Jessica Rochon	Update of the RWELLS progress, including a presentation of the project. The team also made a tour with Kurt to the Riverside area. Kurt presented his experience in developing a plan of rehabilitation of the sewer and water systems in Spindale, North Carolina.
April 13th, 2012	Eminou Nasser Jessica Rochon	IUPUI Research Day Presentation of the RWELLS poster for the public, and answering questions about the concept and the output of the project.
May 04, 2012	Dan Liotti - President of Midwest Mole Jason Miller - Vice President Stephen R. Nielsen Director – Wet Distribution Engineering CEG Mo Ehsani University of Arizona Dr Thomas Iseley Randy Marra, Consultant Hamed Zamenian	Development of a proposal to rehabilitate 48" water pipe located in Riverside. With building of a small factory for lining joints. This is an aspect of RWELLS goals where solutions brought by the industry involve creation of jobs for the local residents
May 31, June 1st,2012	Eminou Nasser	GIS training course in Polis Center taught by Kevin Mickey. The course is to develop skills in geoprocessing, and querying of Geodatabase data,

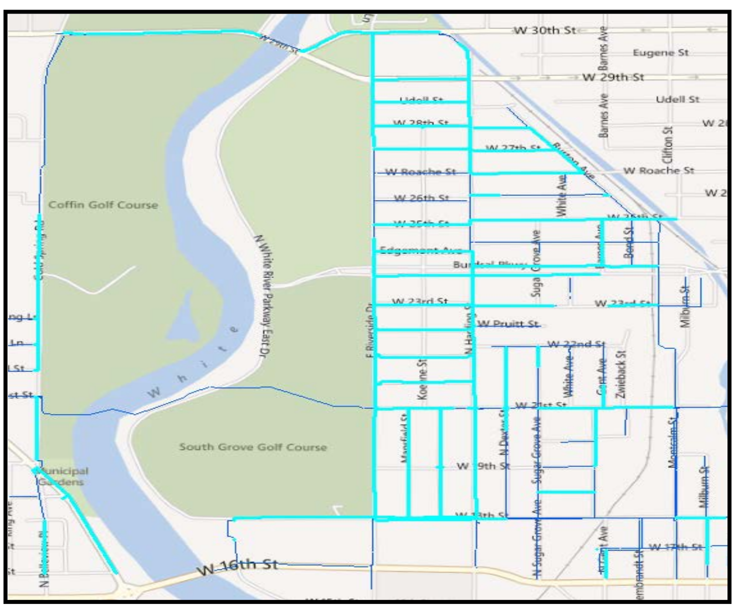
Appendix II: Contacts of IAB of BAMI-I

Name	Title	Phone	E-Mail	Company
Camille George Rubeiz,	-Director of Engineering	Tele: (469)499-1050 Cell: (703)472-4432 Fax: (413)235-6997	crubeiz@plasticpipe.org	PLASTICS PIPE INSTITUTE
Richard (Rick) E. Nelson	-Vice President Conveyance Infrastructure Fellow -Conveyance Global Service Leader	Tele: (816)421-5550 Fax: (816)421-5560	Rick.nelson@ch2m.com	CH2MHILL
Benoit Côté (Ben Côté)	-Vice-President Aqua-Pipe -Sanexen Environmental Services	Tele: (450)652-9990 Cell: (514)977-6868	bcote@sanexen.com	aquapipe WATER MAIN REHABILITATION
Dan Lotti	-President Midwest Mole Inc.	Tele: (317)545-1335 Cell: (317)710-9861	danl@midwestmole.com	MIDWEST MOLE, INC.
William E.Shook	-President AP/M Permaform	Tele: (800)662-6465 Cell: (515)865-0015 Fax: (515)276-1274	www.permaform.net www.centripipe.com www.conshield.com	AP/M PERMAFORM

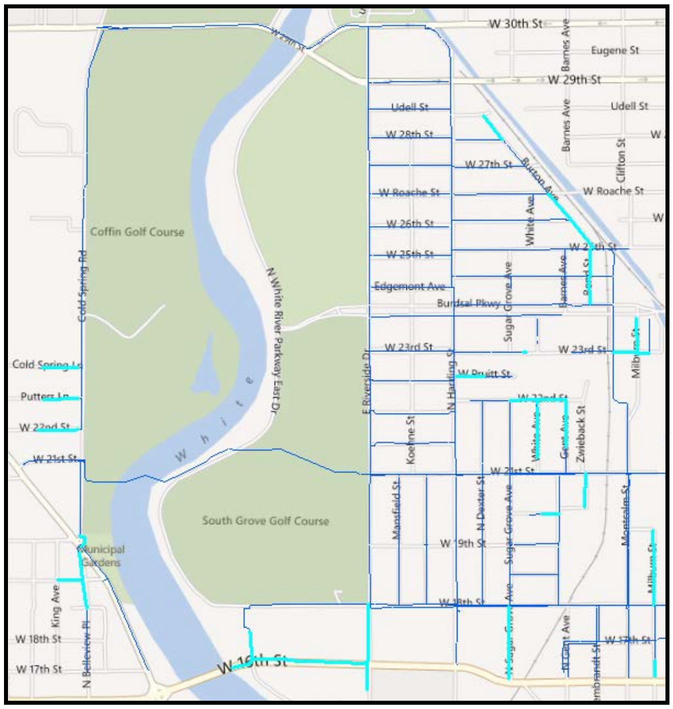
Appendix III: Water Pipes installed between 1885 and 1910:



Water Pipes Installed between 1911-1935:



Water Pipes installed between 1936-1960:



Appendix III: Direction of the sewer pipes flow (CSO in green bullet):