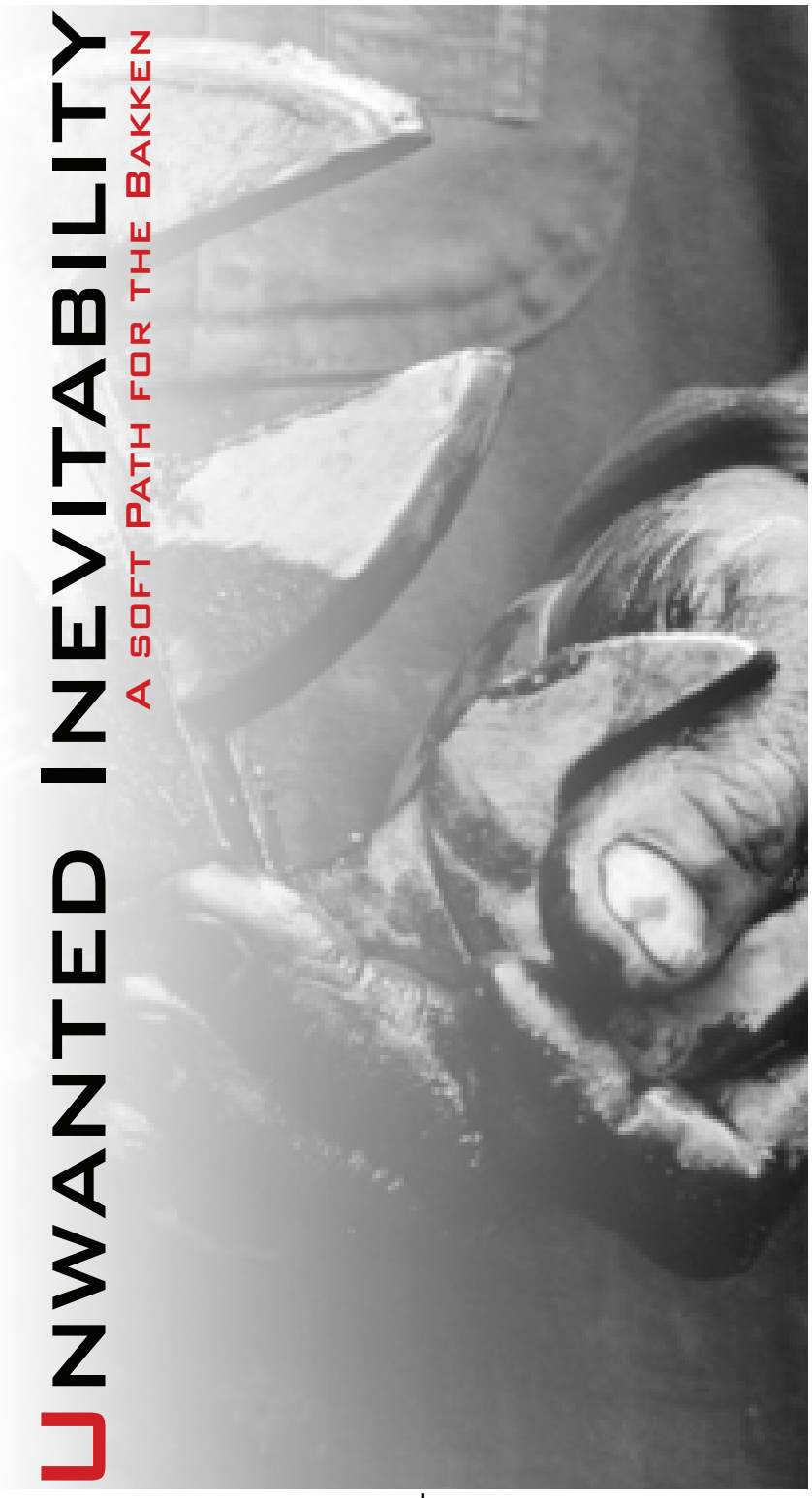
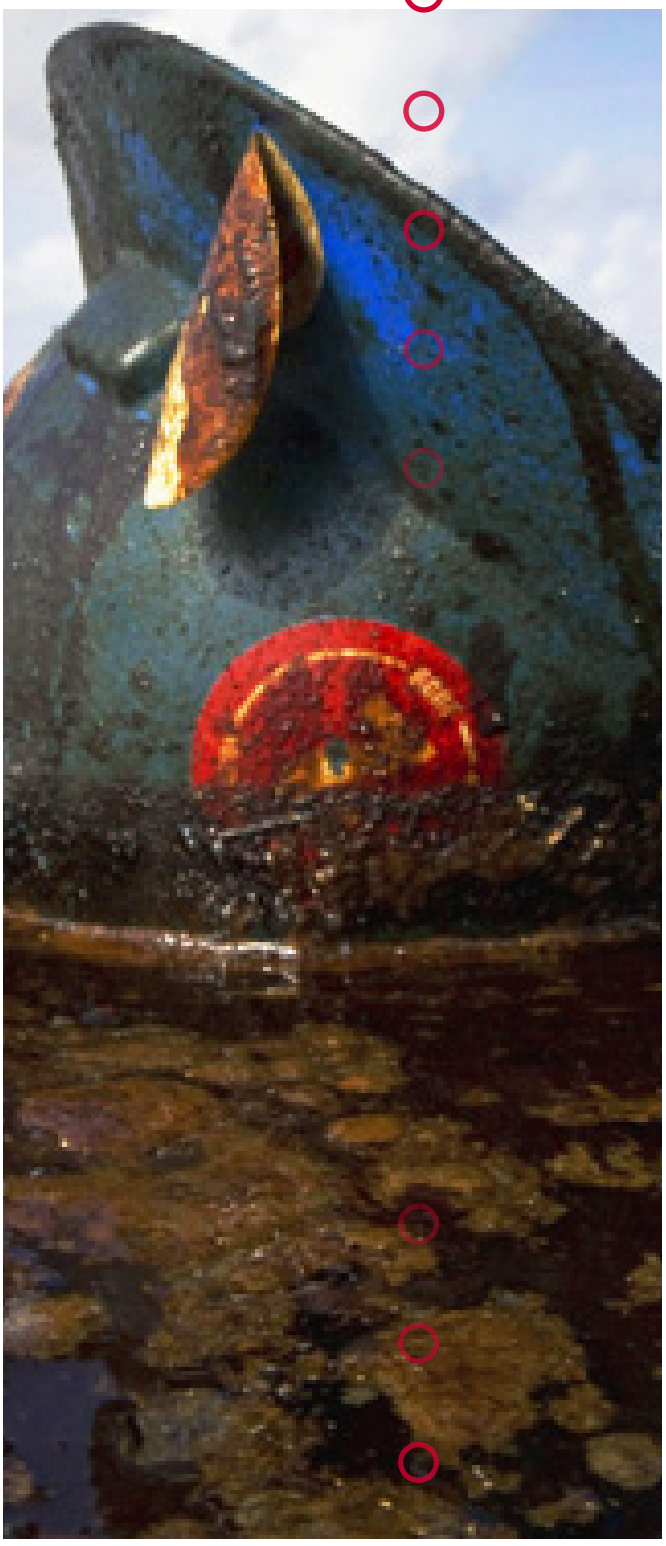
Unwanted Inevitability

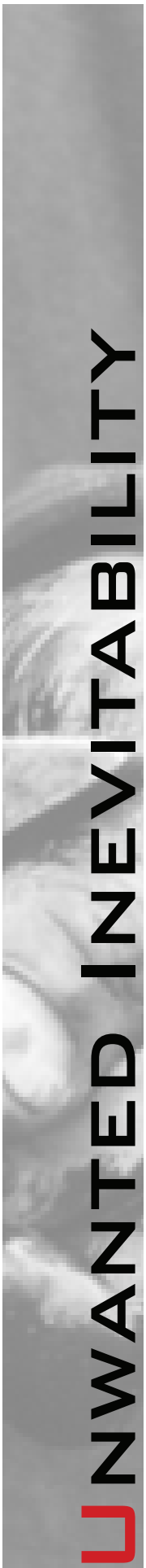
A soft Path for the Bakken





Zach Sager | North Dakota State University

A thesis program for Williston, ND



A Design Thesis submitted to the
Department of Architecture and Landscap Architecture
of North Dakota State University

By

Zachary Sager

For fulfillment of the Requirements
for the Degree of
Bachelors of Landscape Architecture

Primary Thesis Advisor

Thesis Committe Chair

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THESIS ABSTRACT

Zachary Byram Sager

Title

Unwanted Inevitability

Summary

According to the USDA, The upper midwest as well as the rest of the regions of the United States have been in a climatic wet-cycle since 1993. Excess precipitation has lead to increased flood likliness.

In many countries around the globe, the inevitability of "Water Scarcity" has become all too real. These countries stuggle to meet daily requirements of freshwater to uphold civilization. As the Earth's population grows, the amount of freshwater available for each individual becomes less and less.

It is common climatic knowledge that a wet cycle is typically followed by a much more prolonged dry cycle. In a time when every drop of fresh water is becoming more precious, it is essential to develop systems to maintain, purify, and properly utilize the resources remaining within site parameters.

Through new techniques and extensive research, it is the goal of this thesis program to develop techniques to aid in two areas:

1). Collecting "produced water" from surrounding oil field derricks, transferring the water to a designed filtration system, purifying the "produced water," and recycling the water for future industrial and residential use.

2). Within the same system, design to conserve and recycle water to replenish a depleting natural resource within the region.

Keywords

Produced Water |Water Scarcity | Ecosystem Reclamation | Soft Path

PROBLEM STATEMENT

In a region straining its natural resources due
to increased population, development, and industrialization,
is it possible for design to improve conditions through
soft path and remediation techniques?

Statement of Intent

Typology

High Volume River Corridors | Oil Fields

Claim

According to Worldwater.org, a natural resource, water, will become scarce in most countries around the world unless steps are taken to plan/design systems for preserving this commodity.

Supporting Premises

According to Worldwater.org, “by 2030, nearly two billion people will live in countries with absolute water scarcity.’ ‘The Middle East and parts of North Africa are currently water scarce.’ ‘To compensate for this water shortage, water normally used for agricultural use is being domestically utilized.” (2009).

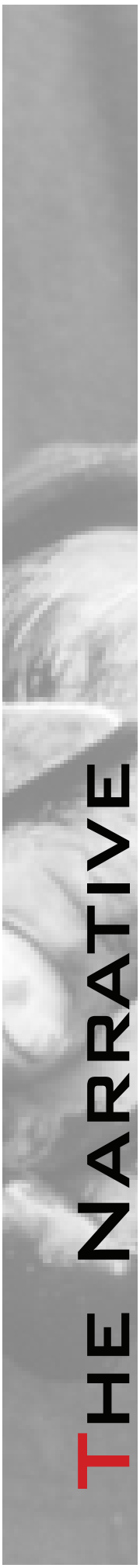
Weather, as well as Mother Nature herself, is cyclical. The wet cycles of North America are giving way to prolonged dry cycles. Portions of the southwest are currently experiencing dry and desolate times. Water is never more precious than when it is not easily available. The only way to combat a potential world-wide water pendemic is to begin storing and preserving water.

Conclusions

Properly designed and utilized water systems can recycle the produced water from oil rigs and conserve it to replenish a water supply.

Project Justification

Overusage of a natural resource for means of mining oil has placed a strain on a region’s water supply, as well as great hazards that could taint an existing ground water network.



THE NARRATIVE

In today's fast-paced and often under-thought world, the concept of natural resource depletion rarely crosses the average human's mind. The impact of local and regional population increase has lead to a crossroads. With population increase comes an increased resource demand. The industry of mining crude oil has impacted a region greatly and it is seen in its people, its increased economy, and most importantly, its natural resource management.

The loss of a set natural, fresh water supply is just one of the effects of this increase. Proper design tecniques, such as water waffling, wetland banking, and more advanced conservation methods are being utilized by Landscape Architects to help rejuvenate a precious commodity. Through proper design techniques it is possible to manage the water supply to meet the needs of a growing population.

Managing these newly developed water conservation areas will become a crucial long term objective. It is easier to design for something that has not happened yet versus experiencing your design's success or failure as the event is happening. Therefore, it is vital to provide a stable design to suit not only future generations but future economies for the next 50+ years.

In the end, questions arise: Is a wanted commodity worth the innevitabilty of possibly losing the most precious natural resource available? Is it possible to design to lessen the impact on the resource, and will officials be willing to change policies to aid the situation?

This thesis strives to investigate these questions on a detailed level in an attempt to find an answer through Landscape Architecture. Landscape Architects will play a crucial role in designing and managing sustainable water conservation/purification methods for the areas impacted by industrialization, population increases, and resource depletion.

User Description

The Client:

Williams County Water Resource Board

The Williams County Water Resource Board was founded to provide a service for water management. Williams County, has been struggling with managing their resources in a highly-populated region.

The City of Williston, North Dakota

The city of Williston, North Dakota is the central hub of activity in the newly developed Bakken Oil Field region. This region has little to no resource management, an ever increasing population, and a potentially high output of pollutants into natural fresh water supplies.

Williams County Planning and Zoning Committee

The Williams County Zoning committee has been struggling to keep up with the environment around it. The county has a general need for most public amenities, but has little time to plan a proper zoning layout for structure.

The Users:

Williams County and Surrounding Citizens

Numbers:

According to the 2010 US census, Williams County and the surrounding area had an estimated 22,000 residents. According to Williams County officials, the total population is expected to double by 2012.

Peak Usage:

Currently, there is no design for a public water conservation and purification area within the region. The oil indistry is running nearly 24 hours a day and drawing millions of gallons of water for each well. In the end, the toxic water is dealt with in hazardous ways.

User Description

Physical Limitations:

The proposed conservation methods will utilize a designed park space that will be in compliance with the 2011 Americans with Disabilities Act Standards for Accessibility.

Parking:

Each newly implemented conservation park space will utilize a designed parking space. These parking spaces will be designed to directly correlate to the happenings at the site. Proper drainage and accessibility are key priorities.

Health Issues:

Any time one is dealing with pollutants and water purification, there is the chance for health hazards. Through proper channeling, filtering, and public guidance, the site will maintain an overall safety level that is comfortable for all visitors.

Social, Economic, and Cultural Issues:

Williams County has had an increase in population. With the new population nearly out numbering the previous population, there is always the social issues of multi-cultural regions. The proposed design will attempt to design a space to where all social, economic, and cultural backgrounds are drawn.

Major Project Elements

Site Ecology:

Ecosystems:

Williams County has the potential to redevelop and reestablish its ecosystems. The ecosystems of the area have been drastically changed due to excessive land use. The design solution will evaluate which areas of the landscape are suitbale to develop ecosystems to conserve water, purify fresh water, and redevelop natural habitats.

Plant Diversity:

Monocultures have become a common practice in today's design field. By utilizing biodiversity and agriecological methods, "elements such as pest control can be left to nature through intercropping or planting to make the site more ecologically sustainable." (Benton, 2003).

Biodiversity helps reestablish areas that have been subject to high levels of change. The changes are often harmful to the native plant species, and this harm causes the overall decrease of an area's ecosystems.

Management:

Management is essential to establish a successful landscape design. Guidelines and management codes will be implemented to evaluate water flows, water quality, land usage, animal conservation, plant requirements, and planting patterns.

Along with this, the conservation park will have its own set of management guidelines to direct the land use, planting schemes, and overall use of the park by its visitors.

Connections:

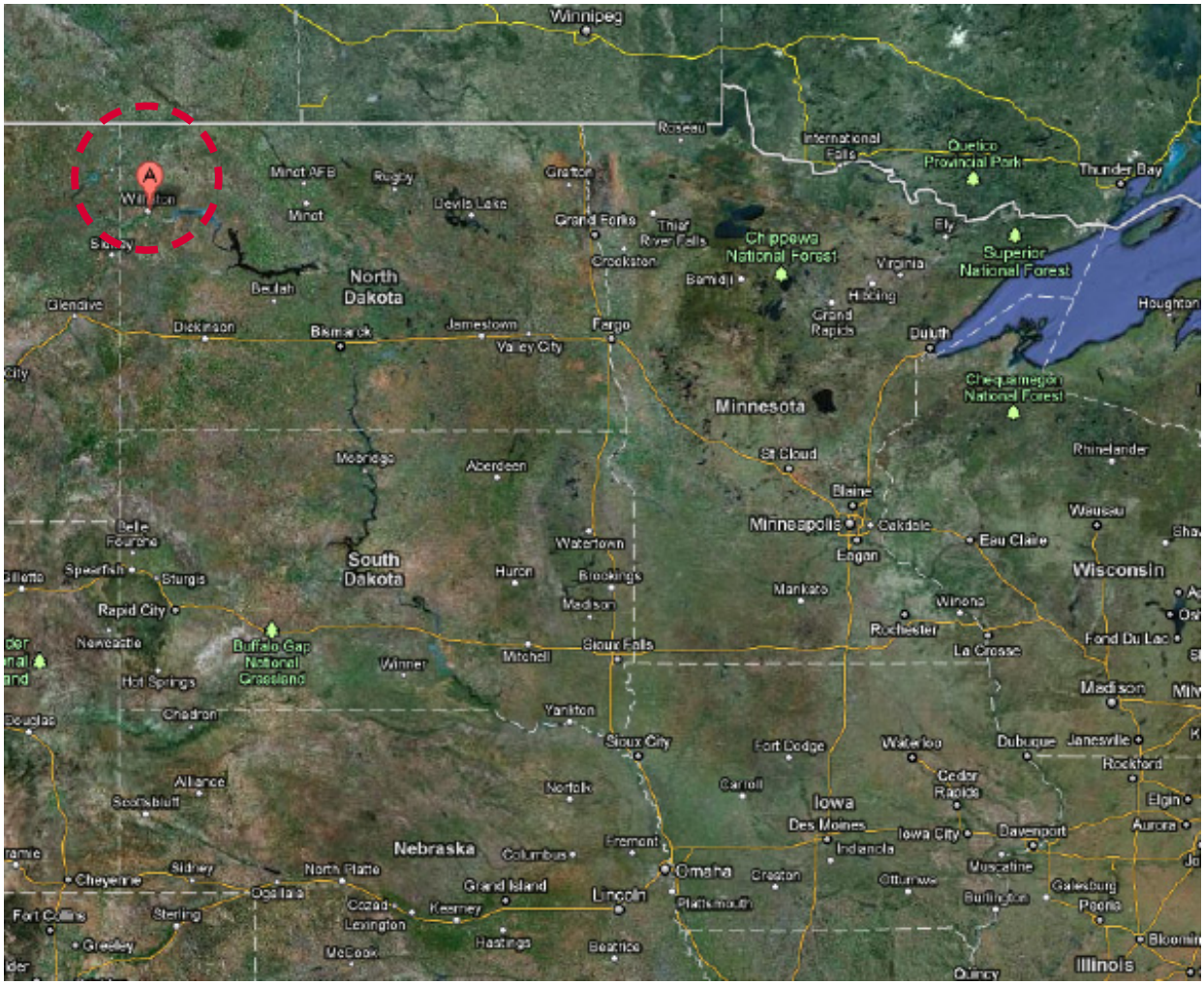
Pedestrian Corridors and Accessibility:

The proposed water conservation site does not yet exist and, therefore, does not have a pedestrian corridor established. A focus of the design will be to implement a network of designed greenspaces connecting conservation sites to their nearby residential or highly populated areas. In some cases, the conservation parks may be close enough to allow walkable pathways from residential neighborhoods to the parks. In other cases, the conservation park may be out of walking distance, and suggested signage and greenways will lead the visitor to the site.

Each pedestrian corridor will be in compliance with the 2011 Americans With Disabilities Act and Standards policies.

SITE INFORMATION

MACRO: REGION



Google Maps

North Dakota is located in the upper Midwest region and is surrounded by Minnesota, South Dakota, Montana, Saskatchewan, and Manitoba provinces. The state has several ecosystems, including: Grass prairies, deciduous forests, and semi-arid Badlands.

Northwestern North Dakota is unlike most areas of North Dakota. The annual precipitation is often less than that of other regions within the state. Climatic changes, however, have shown that this area of the state can receive well over 100 inches of annual snowfall.

SITE INFORMATION

MACRO: County and City

Williston, North Dakota is located in Williams County. It is roughly 125 miles west of Minot, North Dakota. Its population is currently increasing but can be averaged at around 25-30,000 residents. The population is expected to rise and possibly double within the next year due to the strong job market and steady economy of the region.

The Little Muddy and Missouri rivers are the main water channels through the city and county. The Missouri River flows near Williston at a rate of 50,000 cfs. The Little Muddy varies its cfs based on the rise and fall of the Missouri River.

Urban development, oil-well drilling, and forms of pollution have lead to contaminated runoff entering these main water arteries.

MICRO: SITE

The site location for the conservation parks will be quite expansive. To create an area of water conservation to meet the needs of a much larger area, the site must be larger as well. The site is located to the East of Williston, North Dakota. The boundaries lie along US HWY 1804, the Little Muddy River corridor, and the Missouri River Channel of Lake Sakakawea.

The idea is to create a network of green networks and corridors for public use. The conservation parks will be utilized to collect runoff from surrounding oil fields, purify the water, and place it within the cells of the waffleplan for further conservation and future use.

PROJECT EMPHASIS

Population increases and natural resource depletions have lead to the current phase for this design project. The areas of emphasis for this project are in Water Conservation, Produced Water purification, Natural Resource Management, and Ecosystem Renewal.

It is the intention of this thesis to do the research necessary to understand how the existing system works, how the system can be improved through the emphasized methods, and how the design can be implemented regionally as a way to conserve water.

Research Direction:

The thesis is comprehensive, relevant, and useful, and investigate: the theoretical premise, unifying idea, project typology, historical context, site analysis, and programmatic requirements.

Design Methodology:

This thesis utilizes a mixed method quantitative and qualitative approach.

Mixed method analysis will include ArcGIS and USGS map databases of the site. These maps will include hydrology, soil composition, geology, vegetation, and land usage. The Williams County website is also a useful resource in finding maps and articles relevant to the design. Site history will be gathered from libraries, interviews, and website databases.

Mixed method qualitative data will be gathered from site visits and direct contact. Measurements, interviews, photographs, and multiple site visits will provide the data necessary to make a thorough design. The information gathered will be analyzed and interpreted from multiple vantage points in order to come to a final design that meets every requirement set.

Documentation of the Design Process:

A developed and organized process requires multiple sources. It is the intention of this thesis to utilize every available reource to create comprehensive documentation. Digital materials such as renderings, photographs, and sketches will be placed on disks and saved. Physical work such as sketches will be scanned and also saved digitally onto disks. The original drawings will be placed in folders and kept for future reference. Each public interview for this thesis will be hand typed and documented along with the digital works within the disk.

The Final product will be presented via a bound thesis booklet. The design of this booklet will be summarized so the viewer can easily follow the thesis presentation. The work will also be displayed digitally and presented as a means to educate the public on what NDSU Landscape Architecture Thesis students have been doing.

The final product will be handed over to NDSU Libraries and stored for future students to refer to.

Timeline For Completion

1/10-1/13	Semester Introduction/Studio Scheduling and Expectations
1/16-1/20	Design Methodology: Research Analysis
2/13-2/24	Design Development I: Schematic Design
2/27-3/02	Design Development I: Master Planning
3/05-3/09	Design Development I: Master Planning
3/12-3/16	Thesis Break
3/19-3/23	Design Development II: Site Planning
3/26-3/30	Design Development II: Design Detailing
4/02-4/06	Design Development II: Design Detailing
4/16-4/20	Design Development II: Board Compostion
4/23-5/04	Thesis Presentations: Boards/Formal Review
5/07-5/11	Thesis Presentations: Documentation
5/12	Graduation

Previous Studio Experience

LA 271: Fall Semester 2008
Landscape Architecture I - Kathleen Pepple
TeaHouse and Garden: Fargo, ND
Halvorson Park: Fargo, ND

Battle Lake, MN

LA 272: Spring Semester 2009
Landscape Architecture II - Mark Lindquist
Cold Smoke: Shelter Project: Fargo, ND
Winnipeg Park Design: Winnipeg, MT
NP Avenue Streetway: Fargo, ND
Pedestrian Flow: Fargo, ND

LA 371: Fall Semester 2009
Site Planning and Design Studio - Stevie Famulari
Defiant Gardens: Fargo, ND
Regent Environmental Art Installation Plan: Regent, ND
Snow Sculpture Symposium: Winnipeg, MT

LA 372: Spring Semester 2010
Community Planning and Design Studio - Kathleen Pepple
Roosevelt Neighborhood Masterplan: Fargo, ND
United Tribes Technical College Plan: Bismarck, ND

LA 471: Fall Semester 2010
Urban Design Studio - Jay Kost
Duluth Harbor Master Plan: Duluth, MN

LA 472: Spring Semester 2011
Remediation and Planning Studio - Stevie Famulari
Phytoremediation Project: Fargo, ND

LA 571: Fall Semester 2011
Environmental Planning Studio - Dominic Fischer
Red River Valley Flood Mitigation

THEORETICAL PREMISE RESEARCH

Scarcity is a word mostly associated with economic problems. The dictionary will define it as “the problem of having many humans with unlimited wants and needs in a space with limited resources.” (Wikipedia) If one dives into what it means to be scarce, it is simply “to be rare.” (Robbins 1932). When applied to this particular thesis proposal, the term scarcity will play a role much larger than the economic issues it is usually associated wth.

According to Ban Ki-moon, United Nations Secretary General, “every continent on the world is currently affected by water scarcity.’ ‘Around 1.2 billion people, almost one-fifth of the world’s population, are living physically scarce, another 500 million people are approaching this situation, and yet another 1.6 billion people are facing economic water shortages.” (Ki-moon 2007). The United States currently finds itself in a position to take notice of the world-wide natural resource depletion and act accordingly.

Integrating water conservation tactics such as wetland banking, waffle planning, and constructed wetlands through a process of successful design and planning phases will greatly contribute to maintaining freshwater levels. Currently, “the United States supplies 8% of the world’s fresh water through its millions of miles of river systems, lake acreage, and wetlands.’ ‘Along with this fact, it is important to note that when compared to other nations, the United States draws fresh water resources faster than most countries (400 billion gallons per day).” (Daniels 2003).

It is an important facet of this thesis to understand the effects of land useage on aquifer replenishing, the differing soil’s effect on water percolation, the effect of impervious surfaces on mass erosion, and the overall effect each of these has on the ability to successfully store water above and below ground for extended periods of time.

Want versus Availability

One of the sources of any problem is a lack of awareness of circumstances. Each day within the United States, fresh water reserves are drawn from with, with the public having little to no knowledge of a steadily increasing issue. Certain states have been drawing upwards of 5 billion gallons of water from their reserves on a daily basis. This has a direct correlation to the current water shortage problems within these states. Most water scarce regions not only have limited fresh ground/surface water, but they are often subject to very little annual rainfall to replenish what has been
used.

The concept of want versus availability is common in human nature. The goal of an established city or state is to grow and expand beyond its borders and meet all of its needs. “Water scarcity has a large effect on economic growth and population limiting.’ ‘In cities such as Atlanta, GA the demand for water is expected to grow by 50% in the next ten years.” (Daniels 2003). Because this fact is becoming true for most larger cities within the United States, newly developed strategies have been adopted: ensuring long-term water supplies and managing water demand.

This considers the fact that there are water shortages turning into scarcities that will directly affect the site location. The area of Williston, ND, serving as the site for this thesis, lies above one of the largest aquifers in the country. The Upper-Missouri Basin stretches through most of Montana and enters directly into the Mississippi Basins. Because of the direct relation to the availability of extensive fresh water reserves, the oil industry has had little trouble utilizing millions of gallons of freshwater to tap into the Bakken Shale formation. In doing so, the want versus availability point is made. The area is currently experiencing the strain of what a “boom” can do to an area’s resources.

Landscape Architects will play a vital role in planning to purify the runoff from oil fields and conserve the water needed to maintain an industry while helping to adapt new ways of handling produced water and where fracking water comes from.

Environmental Impacts of Developing Nations

The issue of water scarcity has been clearly stated. One of the most needed natural resources in the region is being used up faster than it can be replenished. One of the biggest reasons for the depletion of natural fresh water reserves is the over developing of land. Urban sprawl creates an impervious footprint that lessens infiltration to ground water. Outside of an urban environment, “the infiltration process can take between hours to months depending on the porosity of soils and rocks.” (Daniels 2003). This means that the areas in the region with the highest demand for water are acting counter-productively toward meeting their needs by continually designing and installing impervious surfaces. “A general rule of thumb is that when more than 10% of a watershed is covered with impervious surfaces, serious and continued water quality and quantity problems will always result.” (Beach 2002).

There typically isnt as much blame placed on Landscape Architects for issues arising from poor design implementations. The problem of water scarcity began as soon as the first city was built and the first well was tapped. Natural resource depletion is a concept that is hard to conceive based on the simple fact that it has always been there. It has only been recently that the region has started seriously looking at what it has done and what the results could be. The need for successful water supply planning will fall heavily into the hands of Landscape Architects with the importance of maintaining ecosystems while lessening human impact upon them. Landscape Architects, along with engineers and city planners will need to “review any new major development or expansion against projected future water supplies of the area.” With the idea of water storing and purifying in mind, the region must instill “rising block rate pricing for water usage versus today’s rate of paying less as you increase your water usage.” (Daniels 2003).

In Tom Daniel’s book on Environmental Planning, there is an entire section dedicated to the Federal Government’s approach to water supply planning. Daniels states that the “Federal Governments utilize policies of constructing dams and diverting water.’ ‘The government relies heavily on state water boards, water companies, landowners, and quasi-public water authorities to conduct water supply planning.” The problem with the Federal Government listing policies for water supply planning is that the plans are often too expensive and are often not the best solution. Because of the facts that Daniels states, it is easy to see that Landscape Architects can step in to mitigate these issues. Landscape Architects can work and design on a level that better suits not only landowners, cities, and states but also the ecosystem management needed.

Water Supply's Rule Contradictions

Within Tom Daniel's sections on water supply planning, he states that "Planning and regulating surface water and groundwater are often done by different state agencies, local water districts, water authorities, municipal water utilities, and private water companies. Streamflow withdrawals are regulated by state water boards while ground water withdrawals are not regulated at all." Daniels stresses that there is a state water law, but says that this law primarily "defines the rights of individuals, communities, and state to use fresh water and to allocate water among competing uses, but that it touches very little on the idea of conserving water." Along with the State water laws, surface water laws have been in place for many years. Surface water laws protect the rights of landowners by stating that if land is owned adjacent to a river, the landowner is allowed to utilize this water by any means. The freedom given to landowners appears to be based on an honor-system. The remaining stipulations of the Surface Water law say that it is expected of the landowners to only draw a "reasonable" amount of water with little to no monitoring. With little monitoring, officials in areas with abundant fresh water have little control over how much water is drawn from precious river corridors.

The area of Williston, ND chosen for this thesis program is currently abundant in ground water and surface water. In 2011, the year of this thesis, the Missouri River flowing through Williston, ND reached record levels. This was due, in large part, to the 55,000 cfs release from Fort Peck Dam in Montana due to the increased annual snowfall. (Nick Smith, Williston Herald).

Long-term water supply policies must go against many of policies in place presently. For instance, Daniels states in the section of Surface Water Law that there is a concept of "use it or lose it." This basically means that a landowner not drawing from his/her water source for successive years will forfeit his/her right to that water. "This aspect of the law creates a major obstacle to water conservation." (Daniels 2003). When looking at the Ground Water Law, it is stated that "groundwater may not be transported to land not directly above the source." (Daniels 2003). This in-place law should not affect water conservation as much because with proper conservation policies in place, the idea is to let free standing, conserved water percolate back into underground aquifers to replenish nature's water tanks.

Extended Detention: Purifying out Sediments

"Extended detention aims at improving water quality. In still water, solid sediment particles and the pollutants attached to them settle out and microbiota may begin to degrade some dissolved constituents." (Ferguson 1998). The process of extended detention is utilized in scenarios in which water must be held back to reduce peak water flows, but it is also utilized to purify wastewater. In all cases, runoff and stormwater collects sediments and potentially hazardous materials as it flows downstream to its destination. It is crucial for the general public to understand that although water appears to be pure and harmless, it rarely is. In places like Williston, oil-well production has caused a mass increase in the amount of hazardous material that could potentially end up in the ground water and into the surrounding lakes and rivers.

The process of merely filtering this runoff will not be enough to ready it for entrance back into the main river corridor. Extended detention basins are a great benefit to the natural ecosystems affected by this hazardous runoff. The term "extended" refers to the amount of time it takes to purify most wastewater. According to Ferguson, author of "The Introduction to Stormwater," it takes "materials such as gravel, sand, and fine sand only seconds to settle out in water." Other sediments are not so easily settled. Clay soils, consistent in most watersheds, need "230 days" for their sediments to settle. Colloid substances can take upwards of "60 years" to fully settle out within water. (Ferguson 1998).

When considering that the preceding sediments are merely comprised of soil and do not require a large breakdown period like that of harsh chemicals and toxins within the water, it is easy to see how important it is to maintain and filter runoff water before returning it to a main water source.

Through utilization of multiple systems of extended detention basins, it is possbile to remediate an area of its toxic runoff conditions. Williston could benefit greatly from a combination of extended detention basins that collect water from surrounding oil sites, purify it, recycle it, and eventually replenish it back into a water source.

OilField Wastewater Hazards

With the influx of Oil field drilling and services in the area surrounding the site of Williston, there has been an increase in the amount of hydrocarbons, solids, toxic materials, and other contaminants within oil field wastewater streams. In recent years, wastewater disposal facilities have been the means of neutralizing harmful contaminants. The problem with these systems is that they are not viable solutions to remove toxins in an environmentally friendly way. According to an online article titled "Contaminant Issues: Oil Field Waste Pits," The United States Fish and Wildlife Service states that waste pits pose extreme danger not only to wildlife but to humans. "Wastewater pits accumulate significant quantities of produced water that often have crude oil and contaminants on the surface of the ponds." The article also stated several examples of how the wastewater pits affect the environment, such as:

1. No site security such as fencing and locked gates to prevent unauthorized entry and unauthorized disposal of wastes at the facility.

2. The accumulation of oil on the evaporation ponds.

3. Oil and water separation occur in the main evaporation pond.

4. Skim ponds or open topped separation tanks are not equipped to prevent birds and other wildlife from entering them.

5. Presence of visible sheens on the water surface indicate contamination.

6. Concentrations of salt in the ponds may result in hypersaline conditions which can pose a risk to migratory birds and cause mortality.

(Ramirez, Jr. 2005)

Along with these notable conditions, the United States Fish and Wildlife Service also noted that "the process used for seperating crude oil from produced water using heat treaters is highly ineffective.' 'The produced water is either discharged into surface waters, injected underground, or transported to a commercial oil field waste water disposal facility."

Considering these facts, it is crucial that viable solutions and designs be conceived by Landscape Architects and officials to remediate the extensive amounts of potentially life-threatening contaminants entering surface and ground water reserves.

Contemplating Waste

Waste is not a new term derived to scare the masses. In a time where it appears everything human-kind touches crumbles and falls from the face of the Earth, its important to understand that some things are inevitable. “Contrary to what many say, humans did not invent waste; nature did.’ ‘The squirrel eats a nut and dumps the shell, the ocean floor leaks and pollutes marine ecosystems, and gases escape the Earth and harm whole ecosystems.” (Engler 2004). The real key to contemplating waste is to understand the “disparity might be our cultural constructs and taboos of what waste is.’ ‘These have largely interfered with wise management, confusing real and perceived dangers.” (Lynch 1990).

One of the largest setbacks of handling waste, specifically garbage, is that it simply goes against the ways human-kind thinks. The problem society has with trash and waste is: We had a great time enjoying it while we had it and we got rid of what we did not want. The problem now is that garbage won’t leave and it’s smelling up our life. Garbage is demanding our full attention while giving nothing in return, and eventually we kick it to the curb and pawn it off on the next guy. Like a bad relationship, humans and garbage coexist in a tension filled niche where one acts as if it doesn’t exist while the other gets larger and larger and more noticable.

Metaphors aside, it is crucial to start planning for a more “waste not, want not” approach. Many cities today utilize “new facilities for recirculation of used goods to bridge the gap between supply and demand.” (Engler 2004). New concepts have been adopted that allow facilities to “take incoming human waste and utilize it as fertilizer for vermiculture.’ ‘Some sewage plants now utilize constructed wetlands and aquaculture for secondary and tertiary cleansing, as well as for fish culture.’ ‘There, selected plants, fish, snails, and microbes purify water before it enters streams and resevoirs, creating wildlife habitat and a slice of nature for urbanities.” (Engler 2004).

With these points in mind, it is important for this thesis to utilize the “waste not, want not” concept. Produced water and waste from surrounding sites will be designed to enter the system and be recycled as best as possible.

Water Banking Creates High Tensions

In the drier, western portion of the country, a technique known as water banking has been "embraced as a tool for making water supplies reliable, sustainable, and marketable." (Barringer 2011) In recent years, however, as the climate has changed, so to has the planet. Water as a resource has become less and less prevelant, especially in semi-arid portions of the United States. According to Felicity Barringer, a journalist for the "New York Times," resedential residents are noticing a trend in the way water has been handled. In a recent dry summer, the residents of Bakersfield "noticed that toilets would not flush, washing machines would not run, and water levels began to go down.' 'The community figured out that wetland banking was to blame, more specifically, water-right holders in the rural West.' 'The community took the appeal to the state level to challenge the farming interest that had been dominating the water banks.' 'The community presented lawsuits that claim enormous withdrawals of water lowered the water table, causing goelogical damage, service disruptions, and costly repairs." (Barringer 2011).

According to Barringer, "the case was found to be the responsibility of the Kern County Water Agency, but the agency denied all blame and made no effort to cover the cost of the losses which forced the residents to pay costly bills to have the wells deepened."

In Barringer's article, it is clear to see that when water shortages hit an area, the effects are noticed instantly. Across the country, there are stories of water shortages that go by the wayside because no one is willing to take responsibility for what is happening. It is human nature to be stubborn, but it is in the best interest of everyone for designs to be continually pressed for large scale water storage facilites. Not only are large scale storage facilities in high demand now, but if we start using what we know now, it will lessen the efforts needed in the future. Through proper conservation tactics, storage plans, and successful designing, the tension can be remedied.

Converting Lifestyles

With the economy booming in the Bakken oil fields, Williston and its surrounding communities have been experiencing the benefits. One of the benefits of living above or around an oil deposit is that companies will often try to purchase land from the landowner. According to Geology.com, an informational source used to determine how minerals and surface royalties are paid, "mineral rights of the leaser's land include a sign on bonus to be followed up with no less than 12.5% of the profit made from each well-head on the leaser's land." A rumor associated with oil work is that farming landowners have been receiving payments for their land and changing their lifestyles. The once proud farmer no longer has to farm to provide for a family.

Another way for landowners to make money is to sell their water rights to oil companies for a profit. In a recent article in "WyoFile," a policy driven Wyoming website, a Wyoming farmer was interviewed regarding water irrigation and oil field work. According to the article, writting by Dustin Bleizeffer, "Kenneth King of Burns, Wyoming plans on postponing his farming operation for two or more years and sell as much water as he can to oil companies." All over the country, reports of landowners selling water rights to Oil companies for use are springing up. "Thirty-five cents per barrel is ten times what King might earn off his water when he uses irrigation.' 'Dozens of irrigators in southeast Wyoming are vying to sell their water to oil drillers, and in recent months, the Wyoming State Engineer's Office has approved 40 temporary water use agreements (required to divert irrigation water to another use).' 'King states that it is not uncommon for a landowner to make upwards to $1600 weekly selling water." (Bleizeffer 2011).

Oil For Water

Drilling for oil takes a great deal of water. "Drilling is required to make drilling fluid, or mud, that controls downhole pressure, and it is used to flush cuttings to the surface.' 'The biggest consumer of water during the process is fracking.' 'Fracking mixes water, sand, and chemicals to be pumped into the wellbore under high pressure to crack open the shale and stimulate the flow of hydrocarbons." For each well drilled, it often takes 15 or more fracks to complete the work. "For wells in Pennsylvania, it takes upwards of 500,000 gallons of water to drill and 4.5 million gallons to hydralically fracture each well, according to Cheapeake Energy." (Bleizeffer 2011).

Oil For Water

"Five million gallons of water often fills 119,047 barrels.' 'It equals about 11.5 acre-feet of water' 'If an irrigator were to sell that much water next year at 35 cents per barrel, he/she would make $41,666." (Bleizeffer 2011). It is often difficult to estimate how much water is takes to drill and frack an oil rig. Bleizeffer provides a good comparison when comprehending the amount of water used for drilling. "If it requires 4 to 5 million gallons of water to frack and drill one well, that is equivalent to how much water is consumed in New York City every seven minutes."

In many areas such as Williston, aquifers are drawn from faster than they can be replenished. Some aquifers are running toward depletion within the coming years. Because of this, "if landowners are to sell their water rights, it must be a zero-sum game meaning if a landowner normally has 20 acre feet and sells 15 acre feet, the landowner now has 5 acre feet for irrigation that year." According to Bleizeffer, "landowners can not comprehend this fact.' 'Landowners consistently state that if an oil drilling industry is buying, why not pull and sell as much water as one can?" (Bleizeffer 2011).

It is crucial for designers and officials to educate the public on how much fresh water has been depleted, why it's happening, why it must be stopped, and what the appropriate steps are to replenish the resource.

Research Summary

This research has illustrated the vast array of policies, procedures, and design knowledge necessary for long-term water supply and purification. Daniels states, in a section on Wetland Conservation, a few principles that are necessary for maintaining natural ecosystems to ultimately conserve massive water amounts.

1. Local planning officials should draft goals to protect wetlands as part of a comprehensive plan.

2. The protection of natural wetlands should be listed as a goal in the Economic Base section of the plan.

3. Land Use and Community Facilities should have objectives to direct development away from wetlands.

4. Use zoning overlays to protect large, contiguous wetlands.

5. Protect wetlands through outright purchase and the purchase of conservation easements.

Many other resources will be researched to find the best scenario with which to purify and design to retain water levels for future use. The intent of this thesis is to create a design proposal to balance out what is currently legal and what can be adapted to purify water removed from oil wells as well as provide a system to conserve and recycle the same water.

The research concludes with the proposal of newly integrated laws to allow water to not only be held on a site without withdrawal but also the ability to filter, process, and transport it to areas of need. The design elements following this research section will address long-term solutions to help resolve an issue that is steadily increasing.

Typological Research

Aerated Lagoon Park

↳ Ho Chi Minh City, Vietnam 2005-present

This project is located along the Den Canal, northwest of the Tan Hoa Lo Gom watershed. The wide expanse of open space is an absolute rarity in one of the largest cities in the world.

The intention of the project is twofold: to explore an alternative solution to waste water treatment of a polluted water source while freezing urbanization of a large plot of land in order to improve future water uses.

HTTP://WW2.GOOGLE.COM/MW-PANORAMIO/PHOTOS/MEDIUM/44437434.JPG

Located within one of the denser urban environments in the world, the Aerated Lagoon Park purifies runoff and wastewater from the surrounding watersheds.

HTTP://WWW.TINMOITRUONG.VN/PUBLIC/MEDIA/MEDIA/PIC-

Aerators are utilized to hasten the first respiration process.

HTTP://WWW.SGGP.ORG.VN/DATAIMAGES/ORIGINAL/2009/11/

Upstream from the Bình Hưng Hòa, the water quality is highly contaminated.

Wastewater Processing:

The black water of the Den Canal is first pumped to a pond, two meters higher than its original level, where aerators begin the respiration process. The water then flows across a sedimentation pond followed by three consecutive maturation ponds. The entire process takes a total of eleven days. The purified water is suitable for irrigation, and local residents also use the last maturation pond as a fish pond.

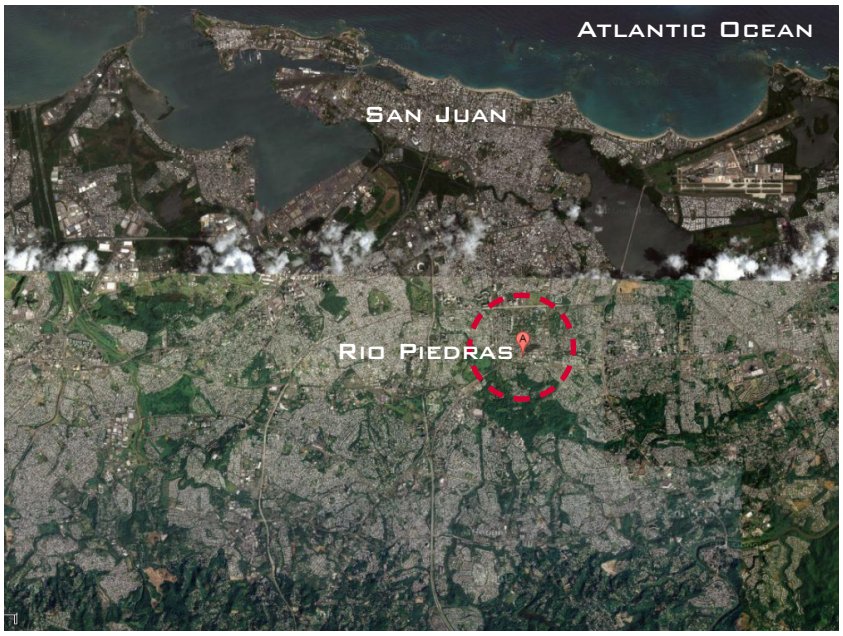
The project was installed in 2005, and all of the Vietnamese standards were met within a few months. Officials in Vietnam have decided that not only can this facility be improved through a management process, but also that more projects will be put in place. (Callwey Verlag 2007).

Rio Piedras: Restoration Project

↳ San Juan, Puerto Rico 2006-present

The restoration plan for the Rio Piedras in San Juan, Puerto Rico establishes a framework for healthy habitats, an opportunity to control flood waters, and an innovative platform for future education and research.

Over the past 40 years, a combination of accelerated population growth, development, and conversion of farmland into industrial zones has increased sediments contaminant flow, and both the frequency and severity of flooding. (Callwey Verlag 2007)



The Rio Piedras watershed lies just south of the Atlantic coast and offers an array of terrains that will be utilized as terraces for the new plan.

Devising a Plan

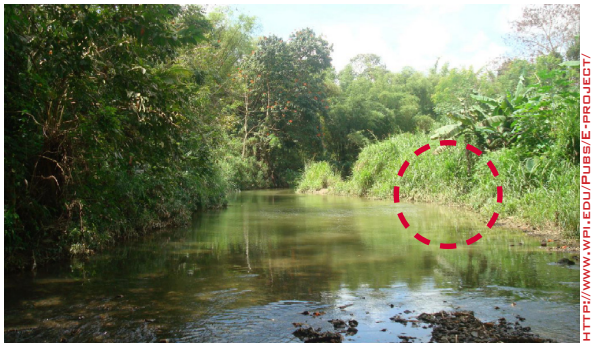
The United States Army Corps of Engineers devised an improvement strategy for the Rio Piedras and its upstream tributaries. The plan relied heavily on large concrete channels to contain massive amounts of water. The University of Puerto Rico devised a seperate plan to eliminate flood waters from this hidden, inaccessible stream, and turn it into a public and ecological asset. New spaces, structures, and programs enable the public and academic communities to interact with the river. Programs include:

1. Aquatic and Agronomic Stations
2. Educational Piers
3. Aviary Nesting Posts
4. Floodplain and Wetland Plant exhibits
5. Recreational upper terraces
6. Intermittent islands for increased biodiversity and habitat

Finished Project

A thorough preliminary analysis of six key watershed dynamics identified surface treatments, bank protection, reinforcement methods, and vegetation regimes that will best function for each stretch of the stream.

The finished product is designed to be a biodiverse region composed of terracing levels utilized to purify surrounding runoff and stormwater. The site is also highly educational through the universities and other educational bodies throughout San Juan.



Coastal Plain river corriors lined with vegetation.

POINT FRASER WETLAND

↳ PERTH, WESTERN AUSTRALIA MAR 2004 | JUL 2006

Perth, Western Australia is largely defined by the Swan River running through it. The river influences movement, recreation, cultural events, and the spirit of the people.

The site is a 5.8 acre site along the river shore. The main objectives of the project are to improve the quality of urban stormwater, create a protective habitat for animals, and provide recreation for the public.

An inner-city wetland, the site will be designed to purify water and provide recreational uses as well. The wetland is an example of an ecological approach to urban development.

HTTP://WWW.SUSTAINABLESITES.ORG/LARGE/20080930123421.

Bird's eye of construction in 2003.

HTTP://WWW.PERTH.WA.GOV.AU/IMAGEDB/138.JPG

Native reeds and vegetation purify water in stages while signage and boardwalks guide guests through the site.

DUE PROCESS | PHASING

The project, begun in 2002 and completed in 2006, was divided into two phases. Phase one included the creation of a bio-filter comprised of native reeds, hedges, shrubs, and trees. The bio-filter was divided into three groups that allowed stormwater to pass through three levels of filtration. The process of moving through these filters lessens the nitrogen and sediment reduction by 45% and 75%, respectively. Phase one is accented with pedestrian pathways, boardwalks, and signage to engage visitors.

Phase two involved the creation of large transpiration swales. The swales divert water away from the city in the event of a flood. The smaller swales instantly became a multi-purpose form of seating. Retaining walls, riparian buffers, intensly designed boardwalks, and gathering spaces make the site successful for landscape architecture. (Callwey Verlag 2007).

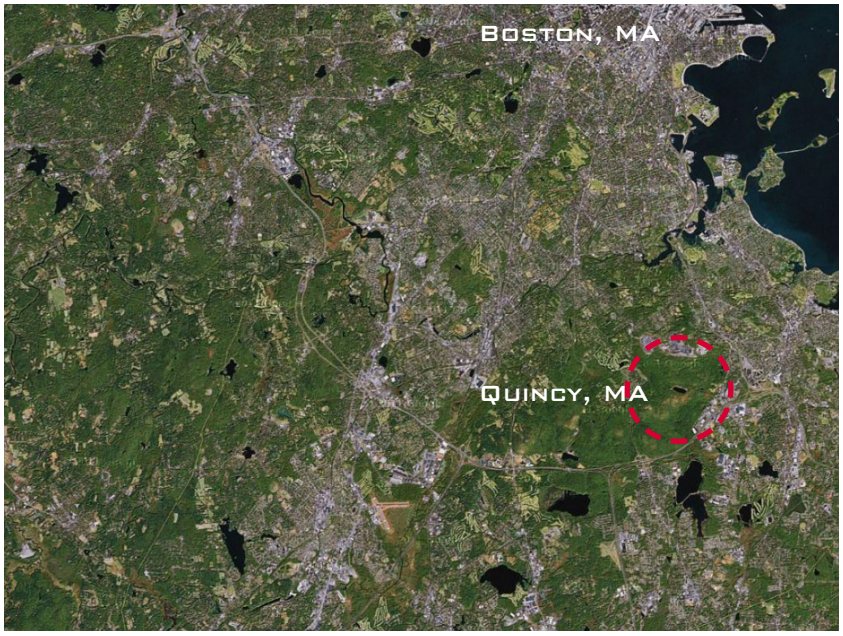
Typological Research

Blue Hills Covered Storage Project

↳ Quincy, Massachusetts 2001-Present

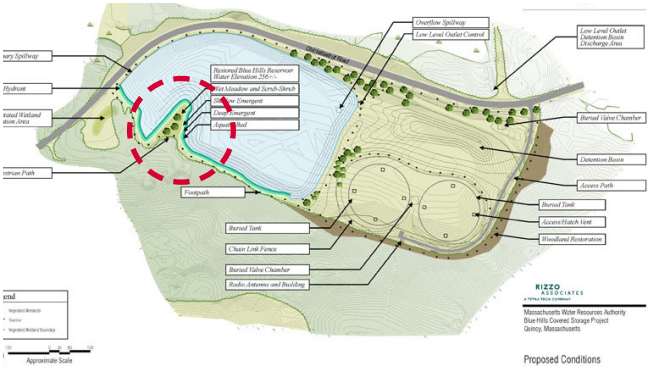
Environmental agencies in Massachusetts have required that water storage facilities be covered to protect the quality of treated drinking water.

Two 10 million gallon buried water tanks were constructed in the Blue Hills reservoir. The tanks will provide water for consumption and for emergencies such as water shortages. (MWRA 2008)



Google Maps

Blue Hills Resevoir lies within the Blue Hills Reservation and in close proximity to the Quincy Bay to the East.



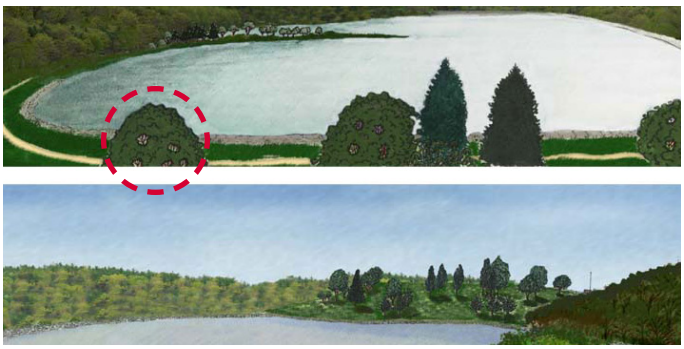
http://www.mwra.state.ma.us/01news/2007

Origins of the Project

Devised after the attacks on Sept. 11, 2001, as a security conscious approach to protect the coastal areas' drinking water. The project was passed and construction began in 2002.

This project is part of a statewide covered water storage construction program led by Massachusetts Water Resources Authority to eliminate open distribution storage resevoirs and replace them with secured covered tanks. The covered storage facility will provide emergency water storage and increased stability in water pressures for Quincy, Milton, and parts of Boston.

The project covers approximately 20 acres and included draining the existing reservoir, partially demolishing the dam, excavating two 10 million gallon tanks, constructing concrete tanks, building new dams, and creating a rehabilitated wetland and wildlife ecosystem space. (Vanasse Hangen Brustlin Inc. 2011)



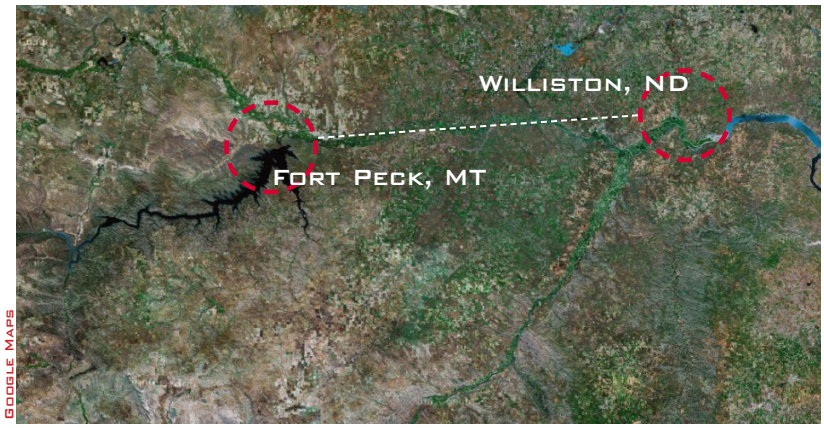
http://www.mwra.state.ma.us/01news/2007

Artist's renders of a newly integrated wildlife and wetland ecosystem.

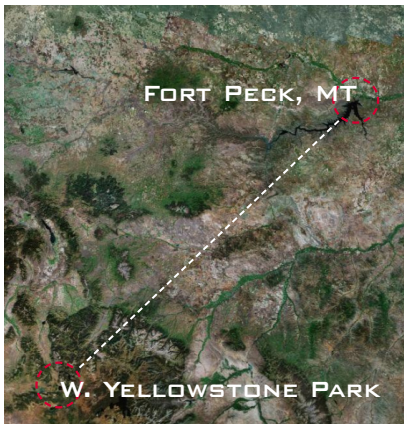
Historical Context

Narrative

Water scarcity and storage are not impending dooms currently facing Williston, North Dakota. What Williston has a surplus flow of naturally flowing spring water that is fed continually from Fort Peck Dam in Montana. The water source begins near West Yellowstone in the northwestern portion of Wyoming. With climatic changes, the annual snowfall in the Big Sky mountain range has increased, causing an increased spring runoff through Montana and inevitably through Williston.



An aerial perspective of Fort Peck Dam in Montana with its proximity to Williston, North Dakota.



An aerial perspective depicting the proximity of Yellowstone to Fort Peck.

This thesis is derived from a concept that doesn't necessarily stem from a problem occurring in the region for which it is designed. The proximity of Williston to a large, naturally flowing water source enables a design to be proposed for large scale water storage. The thesis concept is proposed to study and improve a current situation while attempting to prevent a future problem.

The study and program developed for Williston through this thesis is fourfold: to develop a long term, large scale means of storing water for future use; to study and monitor the current water runoff quality produced from surrounding oil field conditions; to develop a phasing system to not only store water, but to reduce the potentially toxic conditions of the current water; to develop a cohesive design concept that meets storage and quality stipulations but also mitigates the increasing annual flood cycle.

Historical Context

Narrative

The term water scarcity has been around for a long time. As long as there has been water, there have been species and phenomena to utilize it. It has not been until recently that designers have started envisioning solutions to this drastic problem. The problem of water shortage is worldwide and has gone from a problem to an epidemic. “We’ve all heard the projections so many times: The next World War will be that fought over water.’ ‘In July of 2009, three people from Bhopal, India were thought to have stolen water from their neighbor.’ ‘The water situation had become so dire that their neighbor decided to stab first and think later.” (Paul 2009) It is stories like this that provide a broader perspective on what it actually means to be water scarce. The United States is in the beginning stages of water shortages. There is a big difference between not having enough water to run mega-plex water parks and not having enough water that one will rish his/her life to have it. Situations such as the one described drive designers to create solutions for long term water storage to alleviate suffering countries and strengthen the supplies of the richer nations.

http://en.wikipedia.org/wiki/File:AralShip.jpg

An abandoned ship in what was once the Aral Sea near Aral, Kazakhstan.

http://peakwater.org/wp-content/uploads/2010/10/world

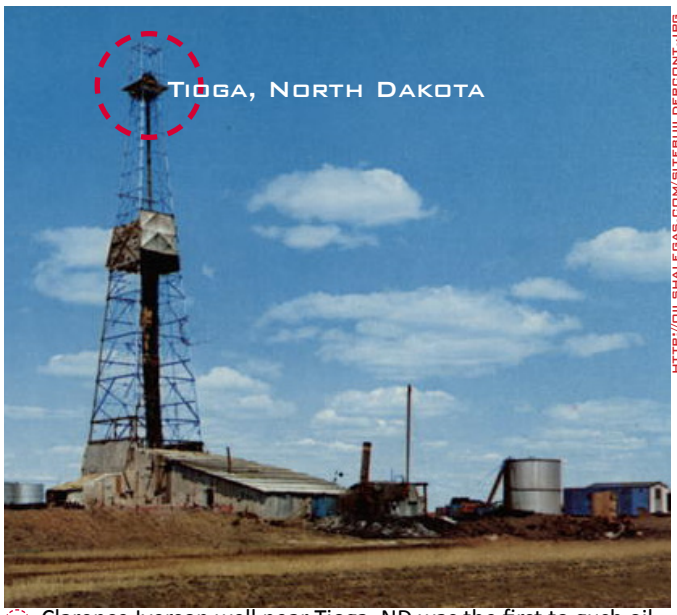
http://blogs.cfr.org/asia/files/2011/02/RTR2GZU

http://graphics8.nytimes.com/image

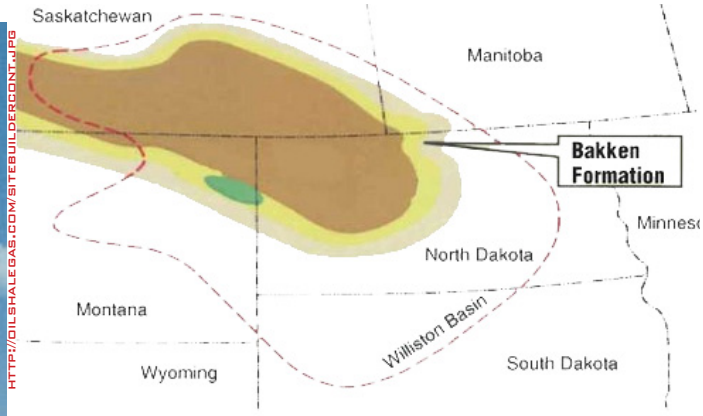
OIL

WILLISTON, NORTH DAKOTA
1951

Williston, North Dakota lies in the Williston Basin, directly over the Bakken formation. A dense formation of shale, dolomite, sandstone, and siltstone, the Bakken formation "first produced oil in 1951 near Tioga, ND." The formation was named the Bakken by JW Nordquist in 1953, but was never able to produce oil on a mass scale due to difficulties of drilling through the formation.



Clarence Iverson well near Tioga, ND was the first to gush oil.



Busting 1900-1951

Western North Dakota has seen its share of successes and failures when it comes to the early years of searching for oil. Throughout the early 1900s until the 1950s, many wells were attempted and all failed. In a public interview for Minnesote Public Radio, Al Golden, the first to draw oil in the Bakken formation recalled the early years: "I had some terrible disappointments.' 'I drilled a well right in the center of four producing wells and was horribly disappointed."
(Gunderson 2006)

On the evening of April 4, 1951, the Clarence Iverson well produced, and "within two months, 30 million acres or two thirds of North Dakota were under lease." (Haga 2010)

Booming 1951-1960

"After the Iverson well came in, oil activity spread rapidly across the Williston area. In 1953, Amerada Hess (Hess) built an oil camp for 150 people with homes, a recreation center, and storage facilites.''The first boom subsided in the 1960s and early 1970s as market fluctuations and production costs made North Dakota's oil unprofitable.' 'The now booming towns were withered down to nearly nothing.' 'Williston was said to now be retrenched and suffering." (Haga 2010)

BoomStatistics 1979-1981

Employment Rate: +10.2% (1979)
+12.4% (1980)*
+12.3% (1981)*

*County gave out $17,000 - $32,000 in food stamps

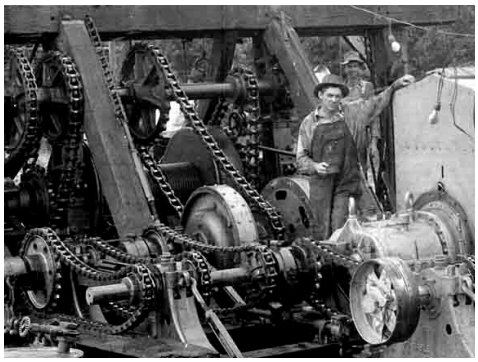
Historical Context

OIL ROLLER COASTER BAKKEN

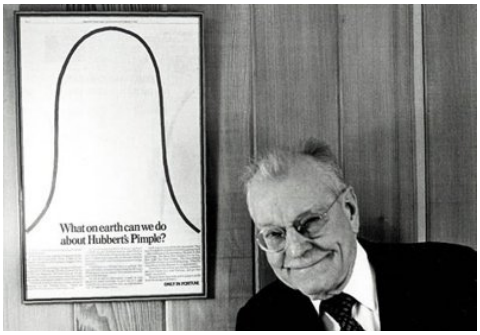
1960 1980 20??

Historical Context

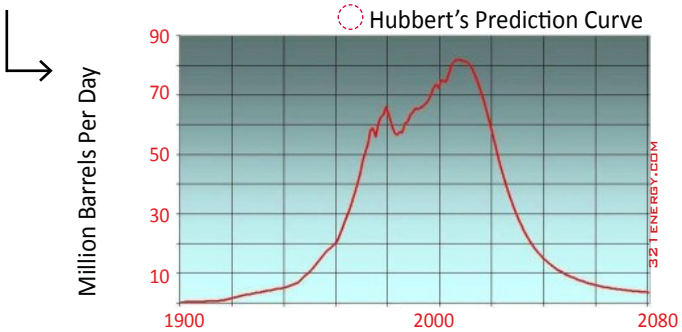
In the history of the Bakken formation, oil booms have typically been followed by harsh falls. Towns grow and shrink as markets fluctuate, job opportunities reopen, and thousands of new residents move in and out. The Williston area was "busting" in the 1960s and 1970s after the first boom, "busting" again through the 1980s until 2008, and currently finds itself in the largest boom of its history.



All Photos From: http://www.historicphotography.com/vintage_oil.htm



"In the 1950s a geologist working for Shell Oil named Marion King Hubbert noted that oil discoveries graphed over time tended to follow a bell shaped curve." "Hubbert predicted that the rate of oil production would follow a similar curve, now known as the Hubbert Curve.' 'In 1956, he predicted that production in the lower 48 states would peak between 1965-1970. (Winfrey 2010)



HISTORICAL CONTEXT

In today's society, the economy has made life more tense than in previous years. The unemployment rate has been higher and the number of Americans living in poverty is increasing. Williston, ND has been the exception to the rule when following nation-wide trends. In a story for "National Public Radio," John McChesney states that "the tough economy has taken its toll on most states, putting budgets in the red and putting people out of work.' 'North Dakota has a low 3.5 percent unemployment rate and a state budget with a billion dollar surplus.' 'Thats because of a major oil-boom in the western part of the state, a discovery of at least 2 billion barrels to be gained by fracking - the controversial process of injecting fluid deep into the underground rock formations to force the oil out." (McChesney 2011)

The boom and oil findings in the Bakken Formation could be the largest ever in the lower 48 states. "Its expected that North Dakota will be the third largest producer next to Alaska and Texas.' 'Residents, however, are not singing "Happy Days are Here Again," they are saying "ENOUGH." (McChesney 2011)

In recent years, the city of Williston and the small rural towns surrounding it, like most other North Dakota communities, have been experiencing dwindling.
Almost in a weeks time, the populations of all of these towns doubled with newcomers, primarily thousands of young men without families. "What we have now is the industrialization of western North Dakota.' 'To imagine a county of only 20,000 could absorb another 20,000 is ludicrous," says Dan Kalil, chairman of the Williams County Commission. The new boom has consumed every resource in the area, consumed the small town residents by taking every available job, destroyed road systems, used up water resources, stressed the city sewage systems, and overwhelmed all former leadership and school systems of the area. "We are planning over the next two decades to drill and fracture every square mile of the area," says Lynn Helms, director of North Dakota's Department of Mineral Resources. A comment like this hits hard on the residents of the area. Each rig requires atleast 120 workers to run it (297 total rigs as of December 2011) and it takes a total of 10,000 more workers to provide infrastructure for the system to work. (McChesney 2011)

OIL TODAYS WILLISTON

2011

Historical Context

Estimates of the area predict that there could be more than 48,000 new residentsbin this area of North Dakota in the near future. When one visits the area, it is easy to see that there is a general haste to everything that is happening. The work appears to be done at a pace of getting the oil and work done before something happens. The reasoning for this, McChesney states, is that “Land leased in 2006 to 2008 is expiring after 2011.’ ‘Land that cost $100-$200 would go up to $1500-$2000 per acre.” This is quite a large increase and it also explains the extreme pace of work in the entire area.

The state and area completely support the oil boom as it is all about the money. In a time when every other state appears to be suffering, North Dakota has prospered. “11.5 percent of every dollar per barrel of oil go directly to the state, and there is no interest in slowing that down.” (McChesney 2011)

The city and area of Williston are in need of a massive urban development and complete overhaul of city sewage and wastewater handling systems. The doubling of an area’s population will always put strain on the ecosystems and Williston has no way of benefiting unless a solution is proposed.

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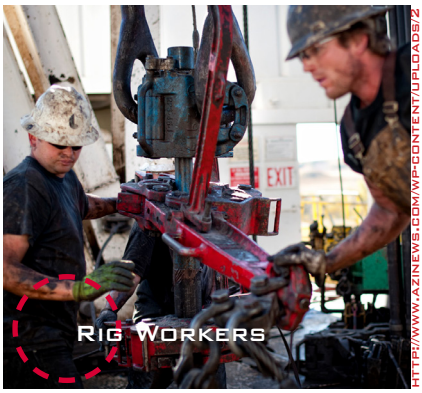

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HTTPS://LH4.GOOGLEUSERCONTENT.COM/-LBJJVRFATAC/

THE HISTORY OF STORING WATER

HISTORICAL CONTEXT

The history of storing water dates back to ancient times. “Archaeologists have found a sophisticated collection of rainwater and storage systems on the island of Crete.’ ‘But with the improvements made through the ages, the real masters of moving and storing water were the Romans.” (Hasse 1989) The Romans were so grand and advanced for their time that they were able to provide water resources to areas that had none.

Throughout history, from that point on, it was a common practice to collect all water from the rooftops of buildings and to collect it within cisterns for all the use. As history shows us, the civilizations that were best off became larger cities, and as the Roman empire grew, so did its demand for water resources. “As a result of urbanization, the consumption of water increased.’ ‘This lead to the development of covered cisterns.” (Hasse 1989). There were two known advantages to covering the water cisterns: They were able to control the amounts of water used as well as lessen evapotation. Secondly, the covering of the cisterns would greatly lessen the chances of the water becoming polluted.

Further along in history, Hasse writes about the developing of larger, more ellaborate, cisterns and water storage. “The world’s largest cistern was built in Yerebatan, Sarayi.’ ‘It measured 140 meters by 70 meters and was able to hold eighty thousand meters of water.” (Hasse 1989) The Sarayi cistern and cisterns like it were abandoned due to the lack of control of human excrements flowing into the underground water supplies.

The means and advances that the Romans went to to bring water to their civilizations was never again rebuilt or devised, but civilizations were able to push the boundaries of storing water once again. It semi-desert areas in which there is little to no water to speak of, people were able to live and build communities. These communities relied heavily on capturing dew and rooftop runoff and storing it in wells.

It is common to see in all stages of historical context that humans tend to use as much water as they have available to them. They have been grand at adapting ways to collect and capture it, but have never developed long term means of keeping it and replenishing the resource.

THE HISTORY OF STORING WATER

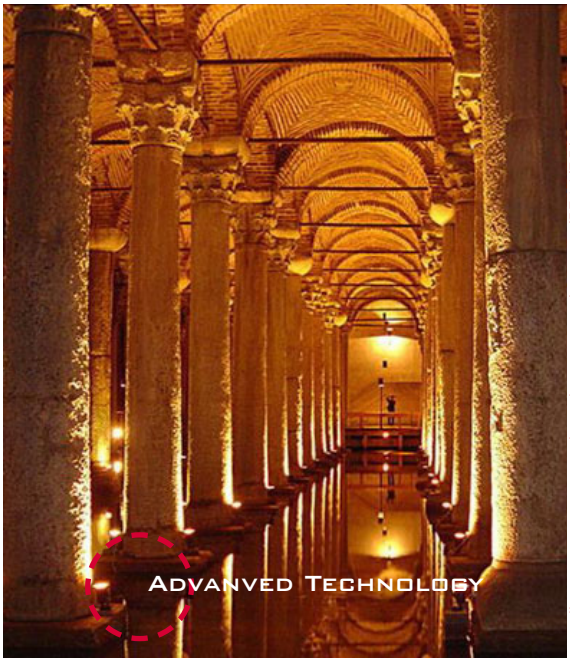
HISTORICAL CONTEXT

http://brightbuy.webs.com/Roman%20Aqueduct.jpg

http://www.cfgreensolutions.com/wp-content/uploads/old-ston

Learning From the Past

The lengths in which early civilizations went to capture and store their water gives us a solid framework for future development. Ancient civilizations did not have as much understanding of the risk of contamination to their water resources as today. Today we utilize a complex system of pumps and water towers to store and increase pressure to our consumers. We have the ability to pump water to the furthest edges and to the driest portions of the planet. The real question is can we and will we store water to replenish ground water aquifers and meet our future needs?



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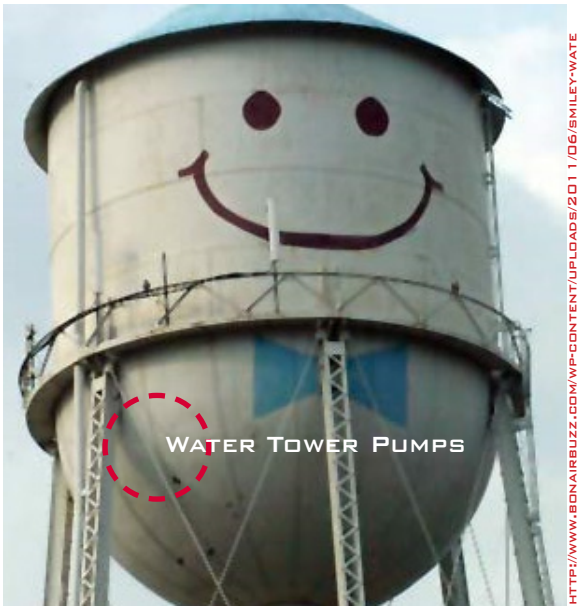


http://www.bonairbuzz.com/wp-content/uploads/2011/06/smiley-wate

TODAYS WATER STORING

Today, designers have come up with several means of preserving, filtering, and utilizing water in the most efficient way possible. The website entitled “Design for the Other 90%” gives a great layout of the possibilities being utilized around the world to gain access to water in areas that go for months without it. In Africa, the International Development Enterprise designed simple water storage techniques for dry-season nations. The design “collects rainwater during the monsoon season, making it available for domestic and small plot irrigation during the long dry season.” (Cooper-Hewitt) In nations such as these, there is often the problems of too much water followed by periods of no water which “requires emergency drinking supplies.’ ‘By providing a 10,000 liter plastic storage bag and enclosing it in a hand-dug pit, this system is one-fifth the cost of an existing ferro-cement tank.” (Cooper-Hewitt)

HTTP://OTHER90.COOPERHEWITT.ORG/DESIGN/WATER-STORAGE-SYSTEM

Plastic bag cistern developed for countries within India, Africa, and the Middle East.

It is evident through much research of water shortages in foreign countries that very little has been designed and even less installed to remedy water scarcity issues. The time for designing and installing these features may not be here yet, but it is definately in the futures. With the concepts presented throughout the premise research, case studies and historical context, there is a pattern of designs that work and designs that dont. The next step in the process is for contries with large water supplies to begin storing and producing water to alleviate lesser off contries. Also there must be a bigger push to install simple concepts such as plastic bag cisterns within these contries.

Goals Of the Thesis

Academic:

Theoretical Premise:

The Theoretical premise serves as the basis for the entire design. Each article, story, and text researched brings a different perspective to aid in solving the problem. The research has been gathered and a holistic approach to a successful design is better understood.

Thesis Proposal:

A thesis and programmatic study is only as strong as the initial proposal made. The valuable and crucial information discovered throughout the proposal section will greatly effect the final design for Williston, ND.

Design Suitable for Theoretical Premise:

The final design must be a direct correlation to the research gathered and the case studies presented. The issues have been stated and several design approaches have been presented to aid in the final design stages.

Long Term Design Solutions:

The main focus of the design is to propose a concept to last through the years. The design will stive to be a basis for other nations to study to meet their own water shortage issues.

Research Documentation:

Extensive documentation of the premise research and unifying idea will create a design worthy of a capstone thesis program. The documenting of this work will provide a framework for future student use and understanding of world-wide conditions and ways in which Landscape Architects approach it.

challenging Schedule:

A demanding schedule of when work is due will help the process of maintaining time management and continue the thesis project on the current path. The work will be completed in a timely manner while always keeping mind on quality over quantity.

Goals Of The Thesis

Professional:

Professional Program Designing

The final works of this thesis should resemble the work of an educated student that has spent five years learning the type of designer and individual he/she is.

Professionally Acceptable:

This thesis should be thorough enough and stood behind as the students best work in five years. The student will have a strong understanding of the topic of research as well as the conepts of how to manage the situation.

Personal:

Challenging

The thesis presented should be an intellectually challenging work. The problem addressed must envelope the passion for designer and be shown through the final works.

Academic Challenge:

The schooling and education I have received at NDSU have been five years of learning what type of designer I am. I have learned more about myself as a person in my growing through the Landscape Architecture program. I have grown as a steadfast, strong, opinionated individual that believes I can make a difference and control my situations.

Project Introduction

A city transformed by one of the largest economical booms in recent history.

A state defined by its individuals to meet every challenge.

A nation steadfast in the belief of helping one another in hard times.

A world of resources, full of gracious giving struggling to maintain

A design intervention to purify, restore, and save the future

SITE ANALYSIS

Narrative

The city of Williston, North Dakota, and more specifically, the area of study in the Muddy River and Missouri River corridors is years in the making. The history of the site, the land use, vegetation, and vehicular movement are equally as important to understand as the hydrology, geology, soil makeup, and climate of the area.

When observing the history of the site, it was found that the area has succumbed to the effects of an industrialization, nearly 100 years in the making. The site and city of Williston have worked as a heartbeat throughout time, pumping out goods and services and then receding, only to cycle again.

Land use is one of the large reasons for this thesis study. The overwhelming over industrialization of the location has caused the land to suffer. In a semi-arid climate, the once respectable farmlands of western North Dakota have transitioned into an industrious oil-drilling haven. A total of 202 rigs have been established with little end in sight. The constant truck traffic, building construction, renovating, drilling, scarring, pipe laying, and fracking have left the land in poor condition. The land still produces many acres of farmland, and this, coupled with heavy oil-work has raised a red flag regarding the handling of the area's water.

There is little vegetation in the area. Since the area was left primarily untouched by glacial sediment, the soils were left without lush top soil found in surrounding areas. Williston is in a semi-arid badland locale. Badlands are formed when infrequent rain mixes with little vegetation and soft sediment makeup to cause massive erosion. The results are buttes, plateaus, and other geological features that allow water to percolate easily.

All of the issues surrounding the site lead to a large strain on lives, businesses, land uses, and natural reources. The input of large oil drilling facilities have left their mark physically on the landscape above and below ground. The area is changing, for worse or for better, and the unsung natrual resources are going by the way side as a result.

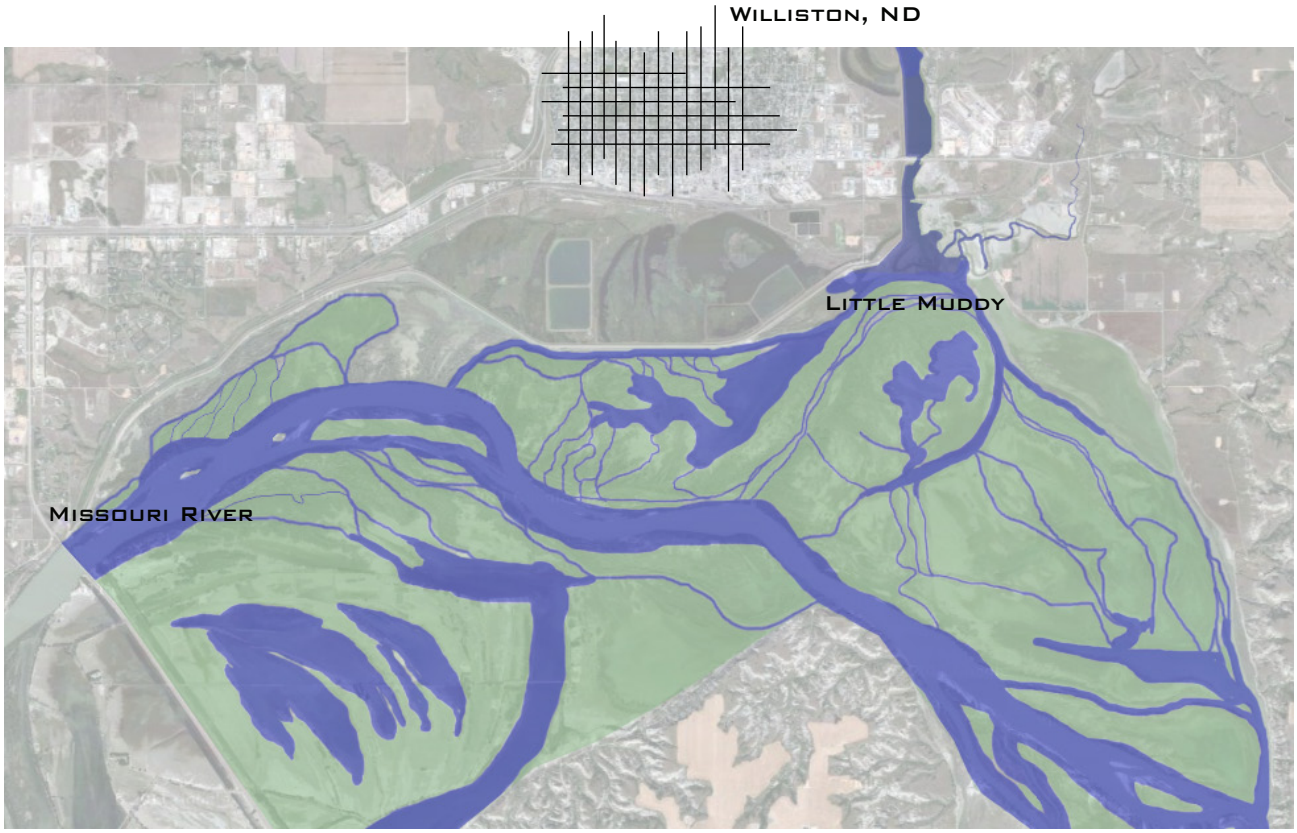
Narrative

The hydrology of the site is possibly the most important area of study for this thesis program. The natural flow of the Little Muddy and Missouri Rivers and the intersection of the two creates the epicenter for the final design proposal. Since the area around Williston is known to be fragile, soft, sediment, both the Little Muddy and Missouri Rivers collect heavy amounts of sediment as they move ever south toward the Mississippi River. Heavy erosion of sediments mixed with potentially toxic runoff water from agriculture and oil field sites creates an immediate area of interest in the site.

The geology of the site makes the design implementation work best. With the abundance of slopes, hills, and valleys, it is possible to utilize a proper terracing system when collecting and filtering water throughout the process. The geology, as it exists works against itself by allowing runoff water to travel faster and more aggressively and to pick up more sediment along the way. The geological makeup of the area is soft sediment deposits that are easily removed and disturbed.

The entire climate is a direct correlation of the geological make up and soil deposit. The semi arid climate has little precipitation in an average year. The climate has differed in the last few years with record snowfalls occuring, which has had a direct consequence in the rise of the annual spring runoff.

Site Analysis Immediate Context



Missouri River

The Missouri River flows 2,341 miles through the central United States and is a large tributary of the Mississippi River. The Missouri River watershed covers much of the Great Plains and east of the Rocky Mountains.

Spring Runoff

Flood Stage: 22’ Major Flood Stage: 26’ Record: 28’ in 1912

2011 Status: According to the Earth Observatory, the Missouri River at Williston crested at 29.29’ and broke the previous peak record.

Sources: Big Sky Mountain (2011): 37% increase in snow put the Big Sky and south west corner of Montana at +200” of snowfall.

Fort Peck Dam, Montanta (2011): The dam released a historic 50,000 cfs by June, 2011, to release the pressure of the added snow and to make room for 2012 snow amounts.

Little Muddy River

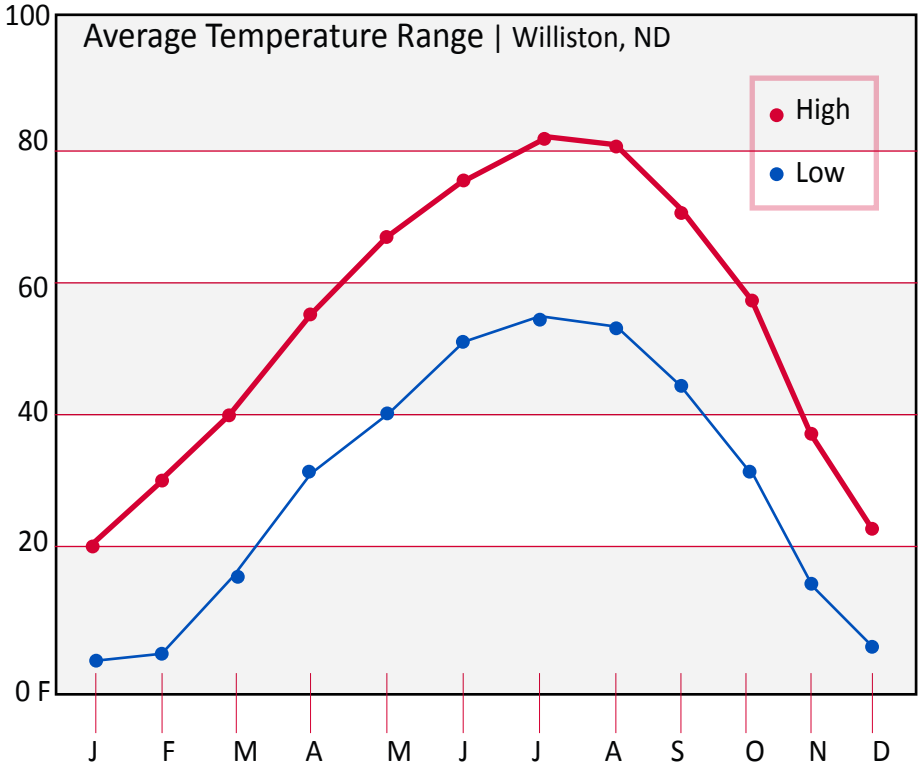
A main tributary to the Missouri River in North Dakota, the Little Muddy is a 45 mile long creek that drains much of the prairie region in northern Williams County around Williston.

Spring Runoff

Flood Stage: 10’ Major FLood Stage: 14’ Record: 13.57’ in 1960

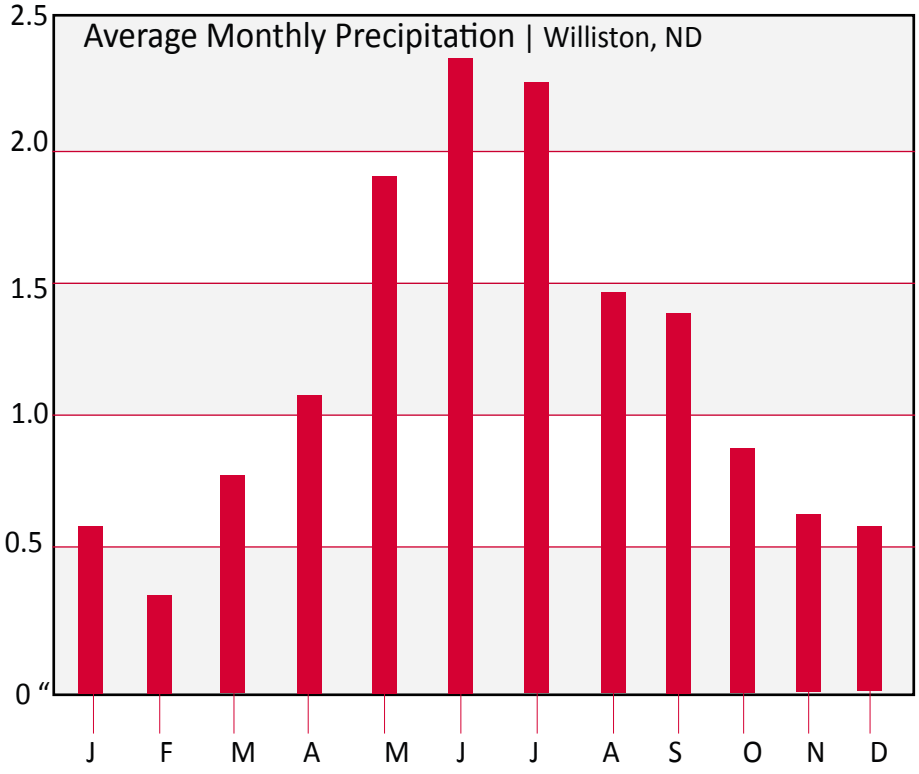
2011 Status: The Little Muddy River went over its flood stage and backed up into several areas of town by going over 12’.

Site Analysis Climate Patterns



Temperatures

The temperature range in Williston is highly valued for this thesis program because it is needed to know when spring thaw occurs and how quickly runoff will leave the ground.



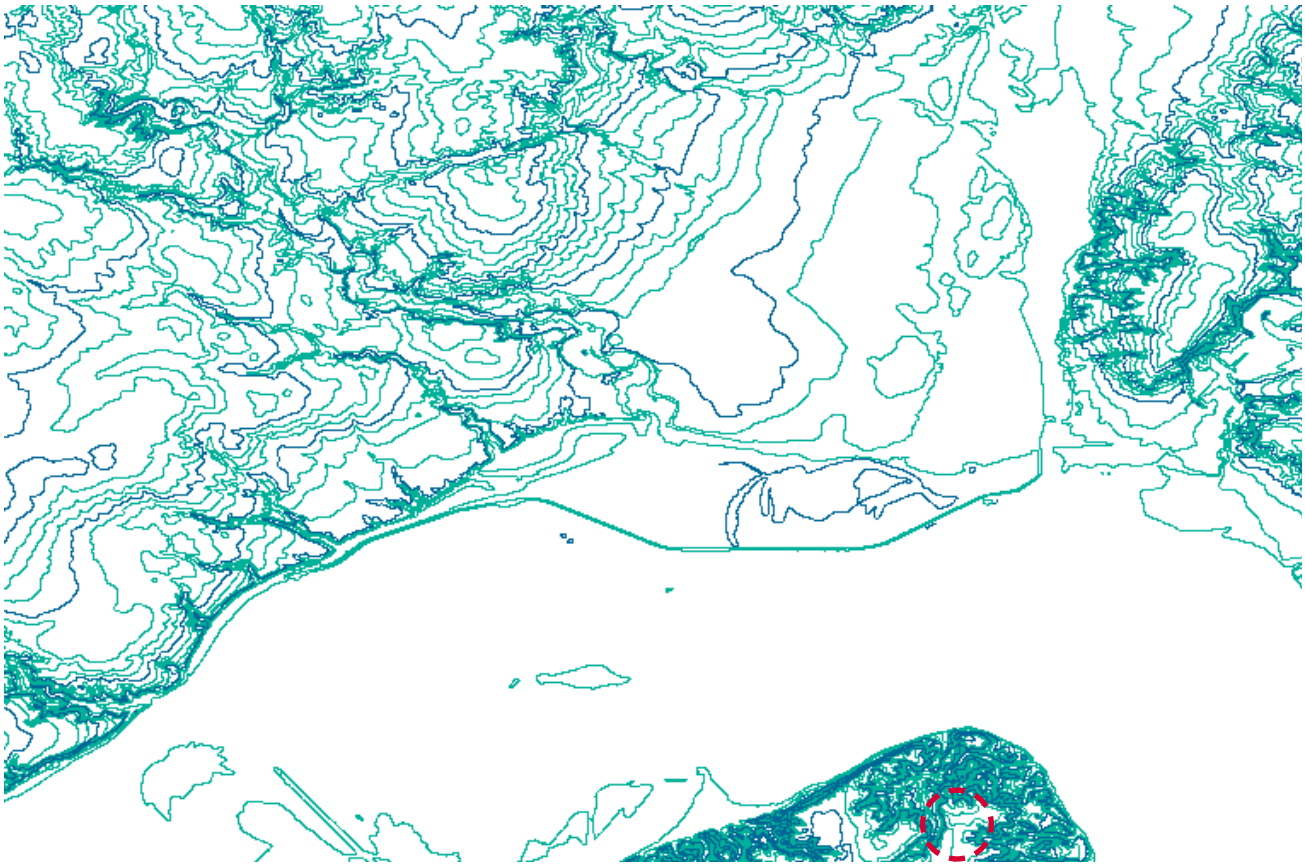
Precipitation

Average precipitation is vital to the study because it is important to know when the heaviest amounts of water within the system will occur.

Information Gathered from:

National Weather Service

Site Analysis Topography



Ups and Downs

The site analyzed has multiple water channels leading to the main flow of the Missouri River. The highest elevations are located to the south of the site along the rising Bluffs. The bluffs also account for extensive sediment erosion because they are comprised of primarily soft sandstone.

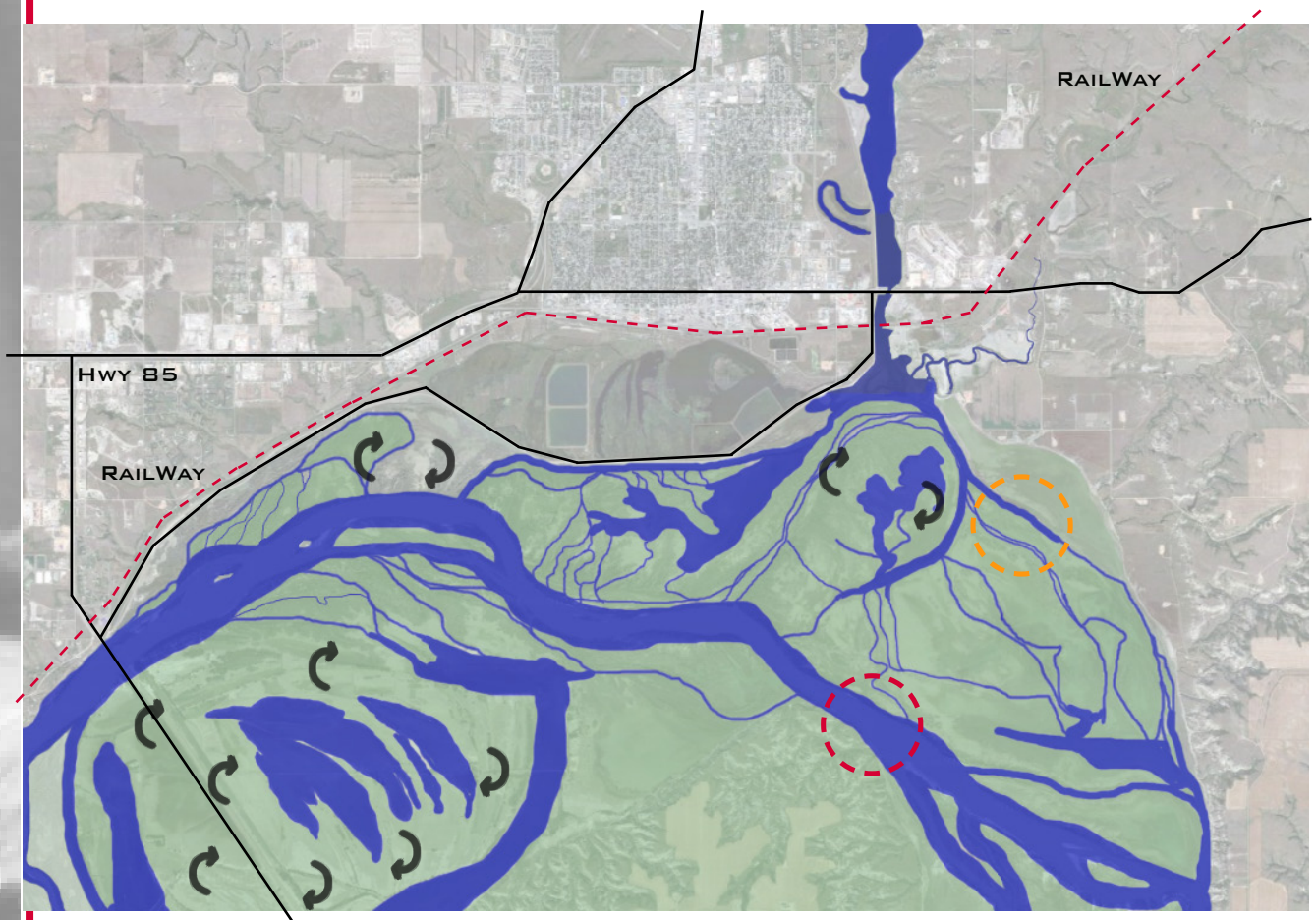
SITE ENTRANCE | 1804 SHORELINE

The site entrance, as it exists, lies along the side US Hwy 1804, which runs east and west across the site. To the north of Hwy 1804, the Little Muddy River makes its way from the north to converge with the waters of the Missouri River to the south of Hwy 1804. The site has two dominant structures within the proposed entrance area. Both Halliburton and Hess corporations have large facilities just north of Hwy 1804 along the shores of the Little Muddy River. The third most notable feature from the air is the disection of the site by means of railroad tracks and highway systems.

HTTP://SO.GEOGRAPH.ORG.UK/PHOTOS/14/80/148

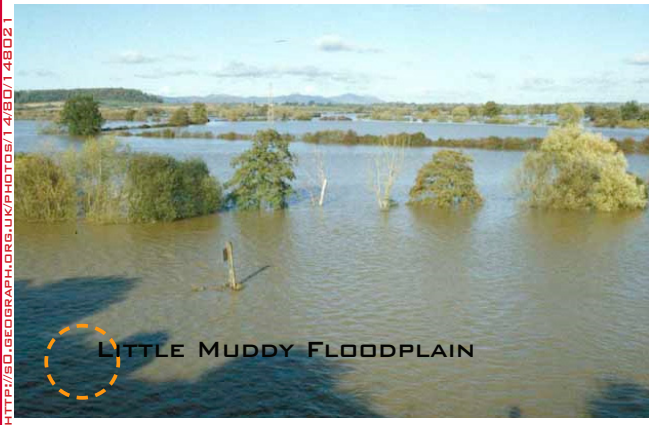
Picture perspective looking south from Hwy 1804 towards the rail way crossing and out into the Missouri River flood plain.

Site Analysis Site Overview



Missouri FloodPlain | Two Rivers Meet

With the convergence of two separate bodies of water, a whirlpool effect is created and the natural banks are erroded. The above depiction shows the most dominant flows of water from the Missouri River from the west and the Little Muddy from the north. The green shading depicts the unpredictable tendencies of the Missouri River to create its own direction.



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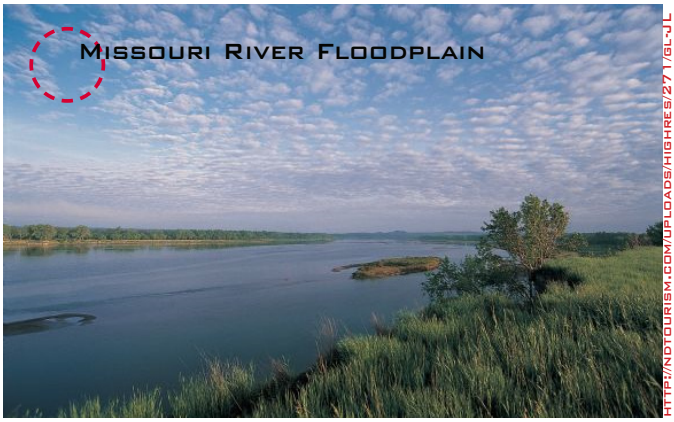
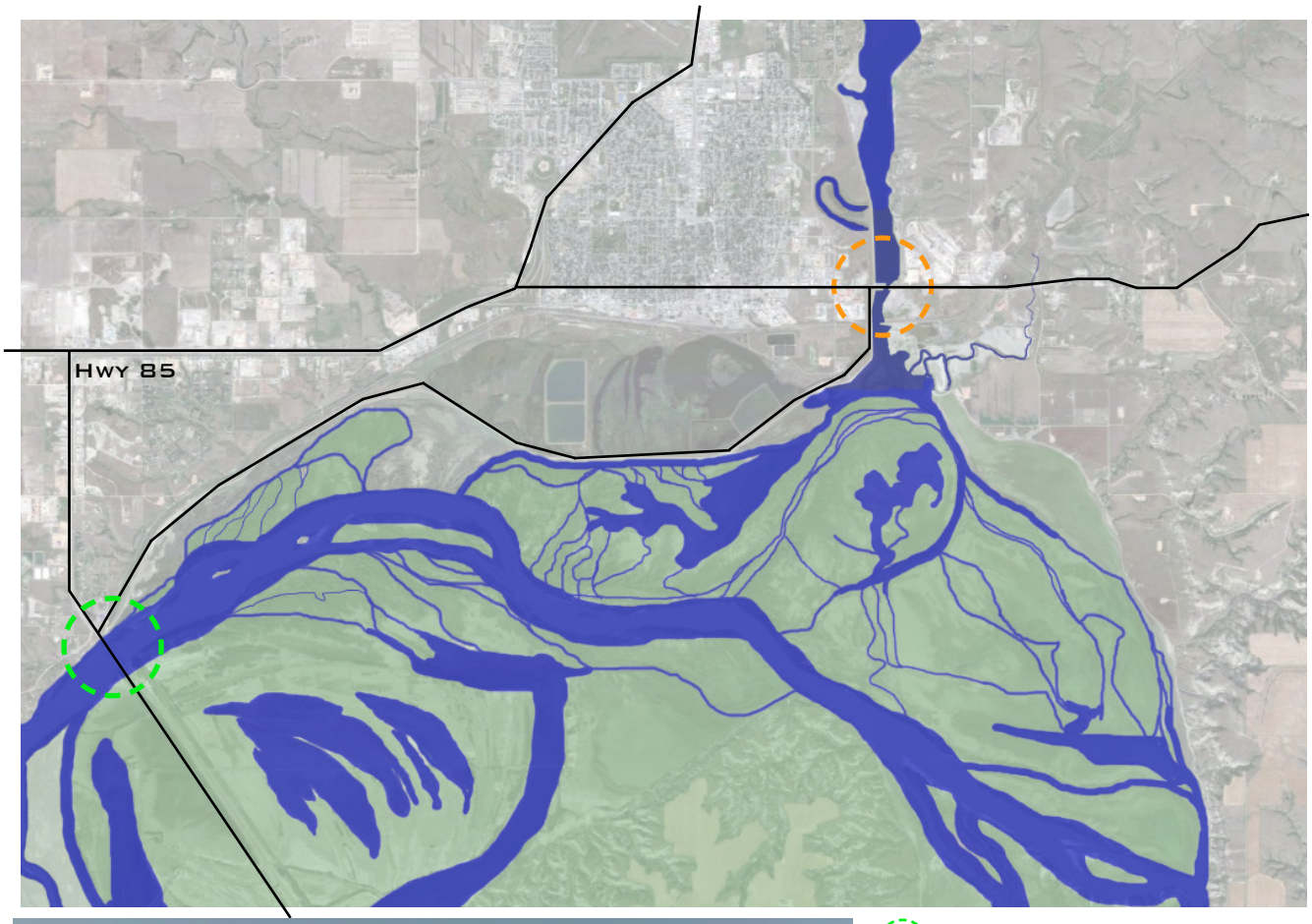
The Little Muddy River is shallower than the Missouri and tends to have a more predictable flood pattern.



HTTP://NDTOURISM.COM/UPLOADS/HIGHRES/271/GL-JL

The Missouri River is fast flowing and carries far more water than the smaller Little Muddy River. The floodplain shows that the Missouri River has an unpredictable flood course.

Site Analysis Roadways



Traffic Reports +30,000 vehicles per day

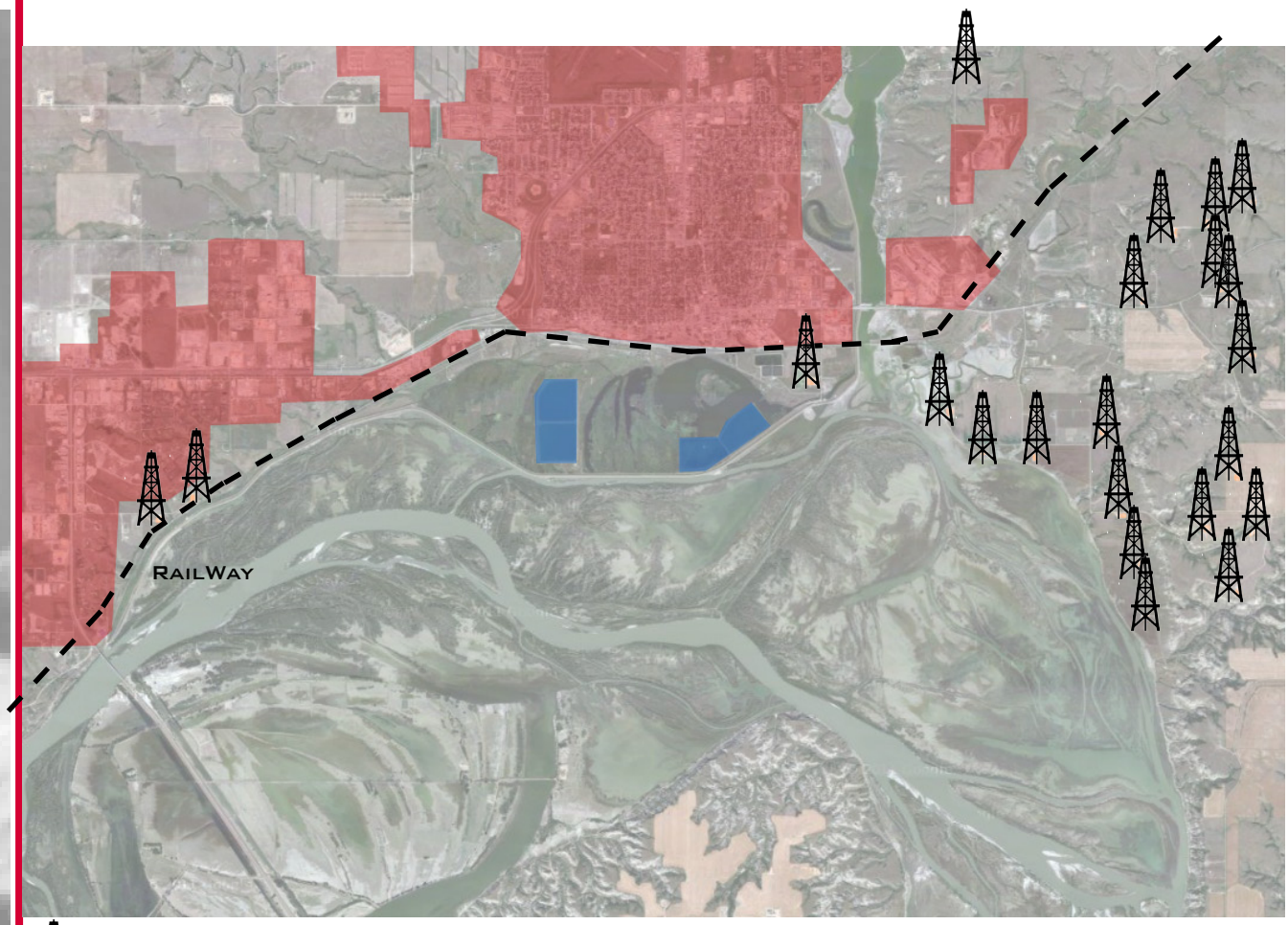
The former state highway has been improved into what is now called the "Super 2" highway. The State approved a $44 million project to add passing and turn lanes to the oil field highway. (Smith 2011)

Highway 1804

Highway 1804 is one of the main arteries into town. Many of the oil wells to the east of Williston are accessed through 1804. Hundreds of trucks travel this road daily, making it a high risk and dangerous roadway.

Traffic Reports +5,000 vehicles per day

Site Analysis Infrastructure



Oil Rig Infrastructure

Within the proposed site there are a total of 22 Oil rigs. The number of wells within the area is increasing every day and the total number of oil rigs within the area is now up to 202.

Surface | Mineral Rights

Besides the usual signing agreement to the leaser, leasees often sign a contract stating that the leaser will receive no less than 12.5% the of the oil from the wellhead.

Williston Business vs National Average

The business and economy of Williston has boomed equally as much as the oil-field industry.

Unemployment	Recent Growth	Job Growth
1.30% vs 9.10%	27.09% vs -.12%	92.88% vs 31.35%

Williston Lagoon | Sewage

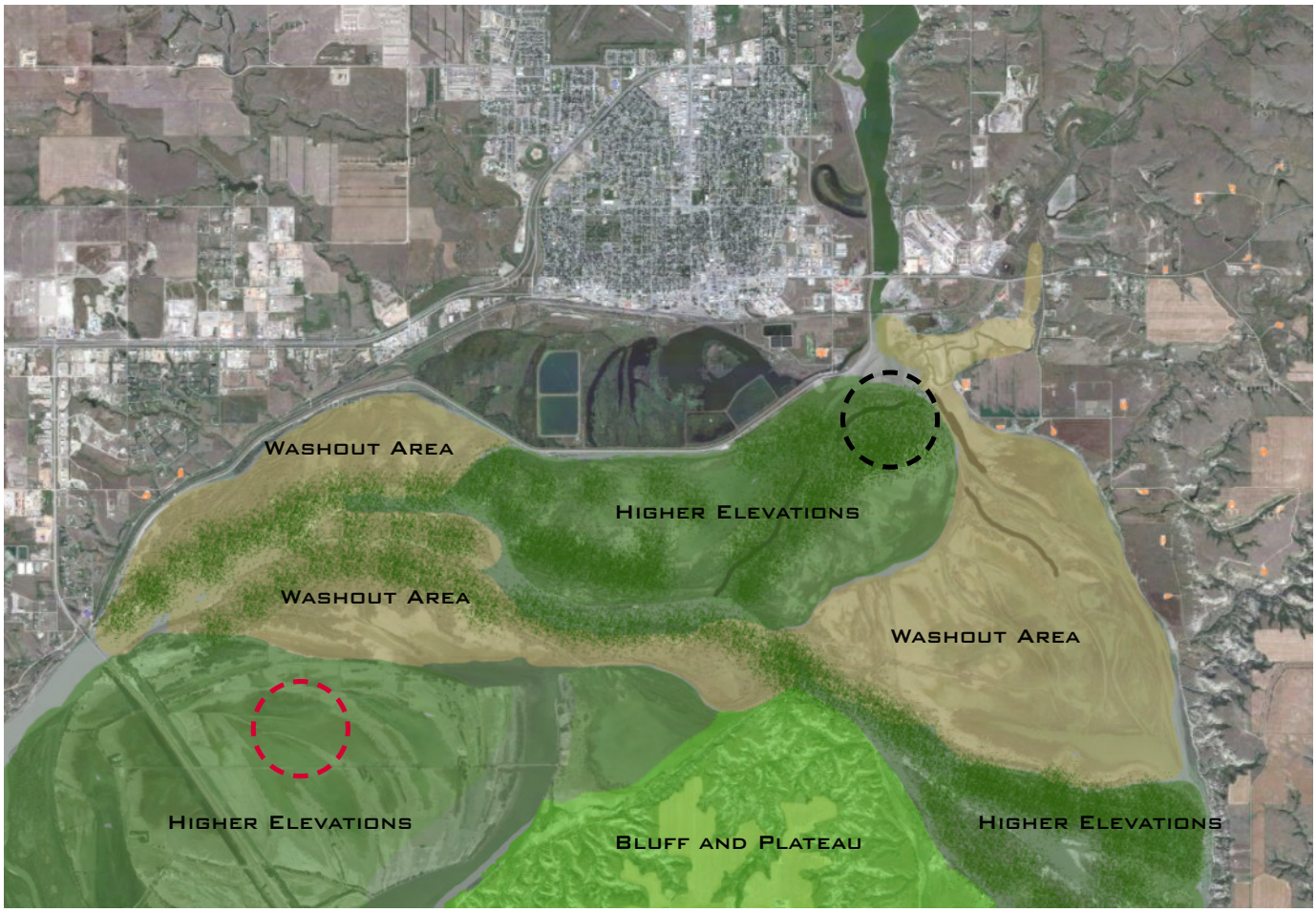
The initial influx and steady rise of population have created many jobs to maintain and add to a stressed sewage system.

BNSF | Amtrak Railway

Burlington Northern Sante Fe Railroad is proposing a massive increase to the already 1000 miles of Bakken Track systems to move oil and goods.

BNSF INC

Site Analysis Watersheds



Rivers Converging

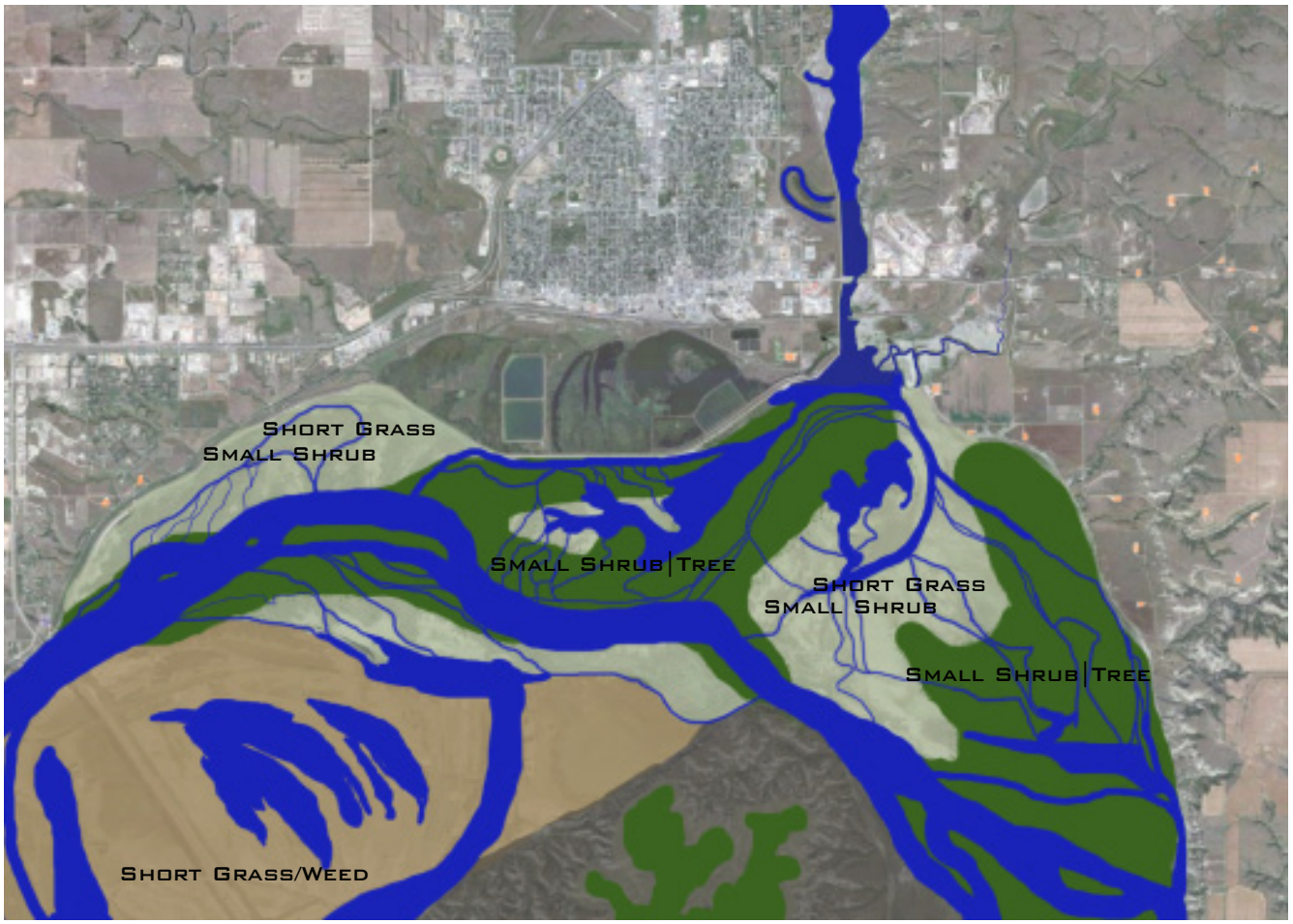
When the two rivers converge, they create a whirlpool effect and allow a large buildup of sediments, creating several drumlin-like features withinthe landscape.

The primary vegetation within the floodplain is found along these sediment rich drumlins.

Standing Water

During peak Missorui River flows, the water reaches higher elevations within the floodplain. After peak flows, the water resides and leaves small bodies of water that eventually become saline pools.

Site Analysis Vegetation



Short Grass|Weed

Genus	species	Common	Growth Habits
Buchloe	dactyloides	Buffalo Grass	Drought Tolerant - Spreads with runners- One of the only true Native Turf Grasses
Digitaria	ischaemum	Crabgrass	Slender-Spreding stems-wide flat leaves
Genus	species	Spurge	Low-growing, creeping weed

Small Shrub|Short Grass

Genus	species	Common	Growth Habits
Crataegus	arnoldiana	Hawthorn	Typical Shelter Belt shrub-moderate growth Wide spreading-Fully Hardy

Small Shrub|Tree

Genus	species	Common	Growth Habits
Populus	tremula	Poplar	Fast growing-Varying size
Rhamnus	cathartica	Buckthorn	Fast growing-Aggresive-shallow

All information from: PFRA Shelterbelt Centre

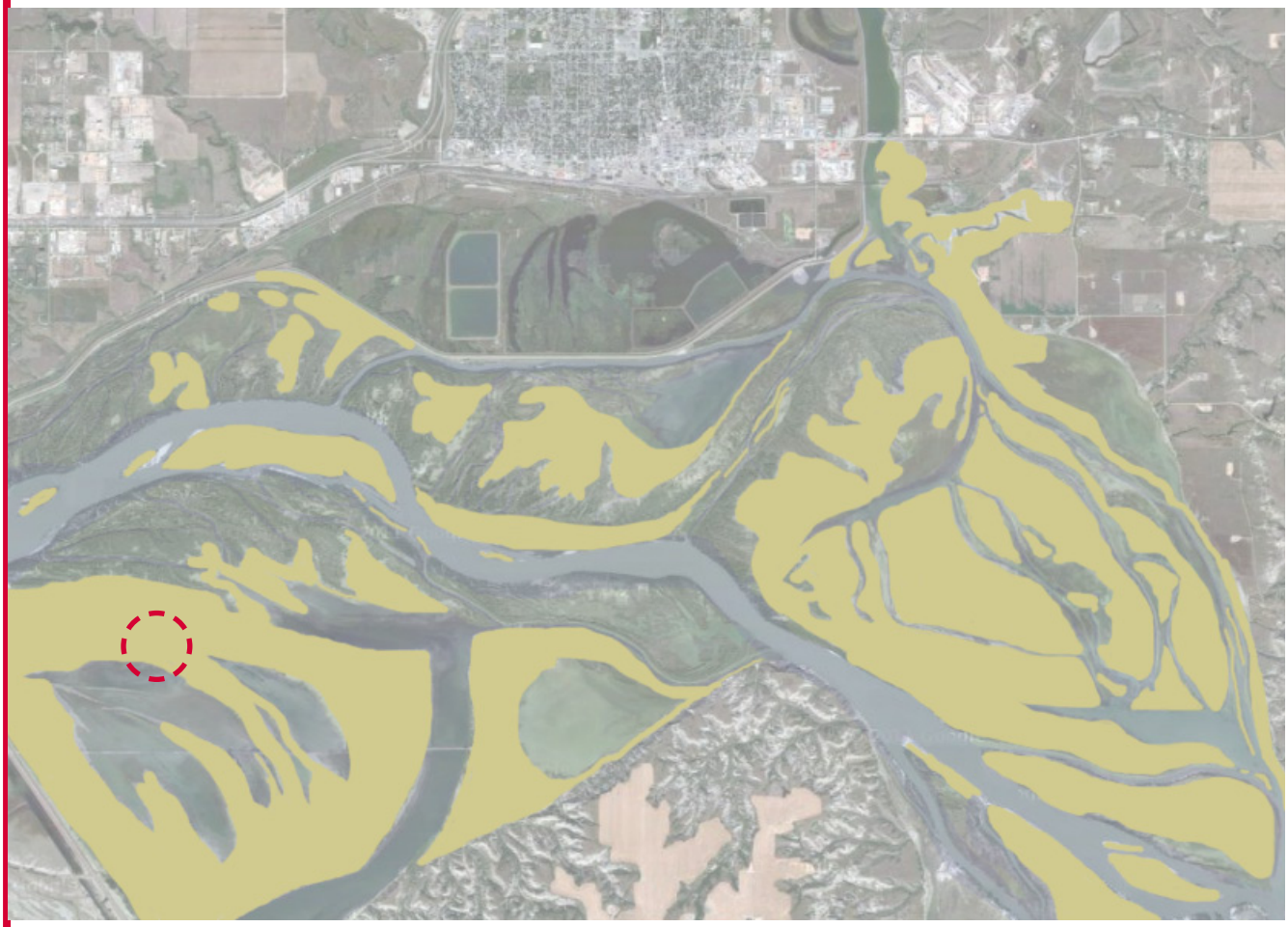
Site Analysis Riparian Buffers

Riparian Buffers

When contemplating water quality, it is important to analyze what runoff water must travel through to reach the main stream flow. The site has its rise and fall in water levels, but there are substantial areas of grassy strips, root systems, and other vegetation for the water to travel through.

The heavy levels of sediment deposits create built up areas, acting like drumlins, that allow for vegetation to grow along the shoreline during the summer months. One disadvangtage to the riparian system within this site is that the city has an earthen levee all along the northern edge of the river corridor to protect the city. The installation of this levee means that water must travel around the structure, collecting more contaminants before it enters the flow.

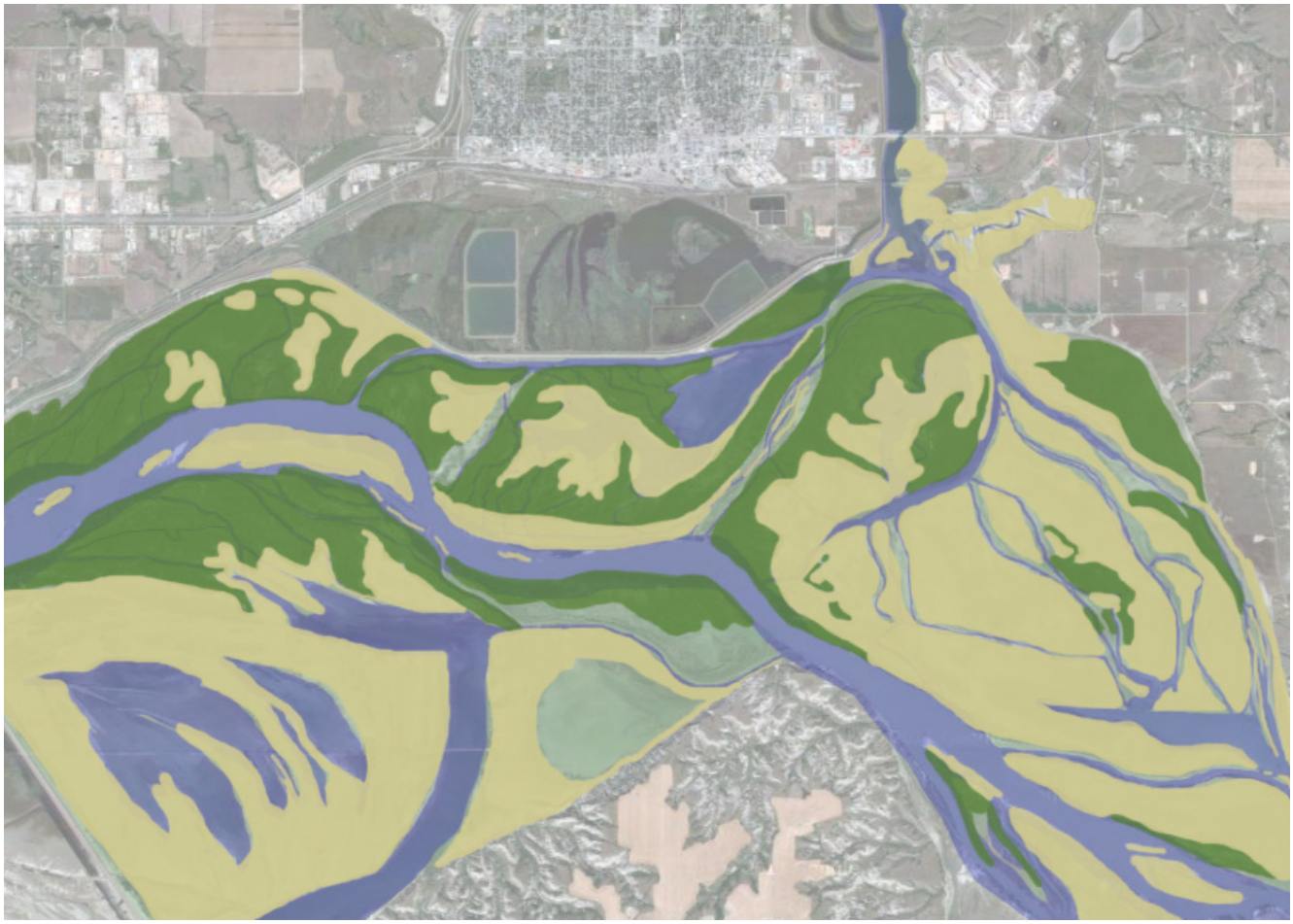
http://3.bp.blogspot.com/-7ASf_i2GkaM/TksaH-nX6PI/AAAAAAAAATE/EoYcTUost+%252814%2529.jpg



Sediment Deposits

The Missouri River and Little Muddy River bring separate forms of sediment. The Missouri River travels across Montana's grasing pasture lands with less agricultural influence before it enters the site. The Little Muddy River collects runoff from many oil fields, agricultural lands, and the surrounding urban environment before it enters the site.

The sediment deposits are primarily loose shale and sand stone that have been built up by the constant rushing of water, flooding, and snow fall. These sediment deposits are not the lush, vegetated areas found in the riparian buffers. These sediment areas are non-vegetated and are the first areas to be disturbed by rising flood waters.



EcoSystems in Motion

The site is an area that is contantly moving, reshaping, and redefining the type of space that it is. The motion of the river systems is always carving and cutting the landscape and building sediments to create new locations. Each year, portions of the site are wiped clean and restarted from scratch.

Issues

The issues with the movement of water and the reshaping of the landscape is that it doesn't allow proper time for the riparian sections to firmly establish and spread to further the water purification. When the ecosystems are forced to reestablish each year, it takes time for it to return to what it was and it greatly depreciates the effectiveness of the entire system.

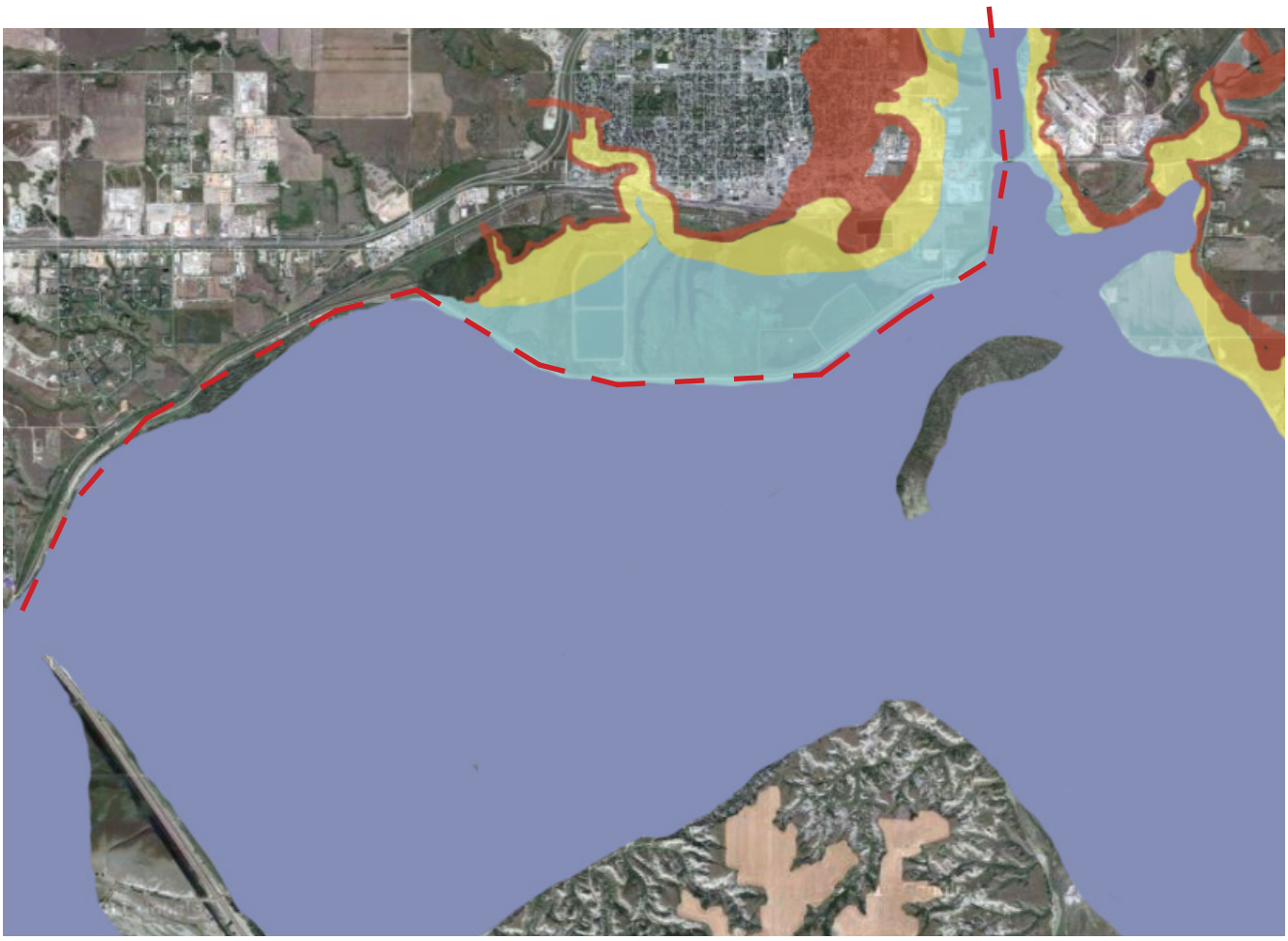
Site Analysis Spring Runoff

March-April

During the months of March and April, the snowmass in Montana as well as the snowmass surrounding the Williston Basin begins to melt. This melting depends entirely on climate. The temperature has only part of the influence; if the months of March and April see additional rainfall, it adds to the overall level but also speeds up the melting process.

http://www.kfyrtv-videos.com/uploadfile2%5C20110609_163535.jpg

Site Analysis 500 year Flood



0-5 Feet

5-15 Feet

15-30 Feet

30-60 Feet

If the Levee Breaks...

According to the Fort Peck Dam Flood Study done in 2009, Williston is at a substantial risk of catastrophic flooding if the levees were ever to fail or breach. Most of the city of Williston would succumb to at least five feet of water, if not more. The western edge of town, including the heavily trafficked bypass would remain unharmed. (Black 2011)

In order for a flood of this magnitude, multiple situations would have to come about. The mountain regions of Southwest Montana would need to experience over 250" of snowmass, Fort Peck Dam would need to be over taken with water, and the levees in Williston would need to fail. The chances are poor, but a 500 year flood is not out of the range of possibilities.

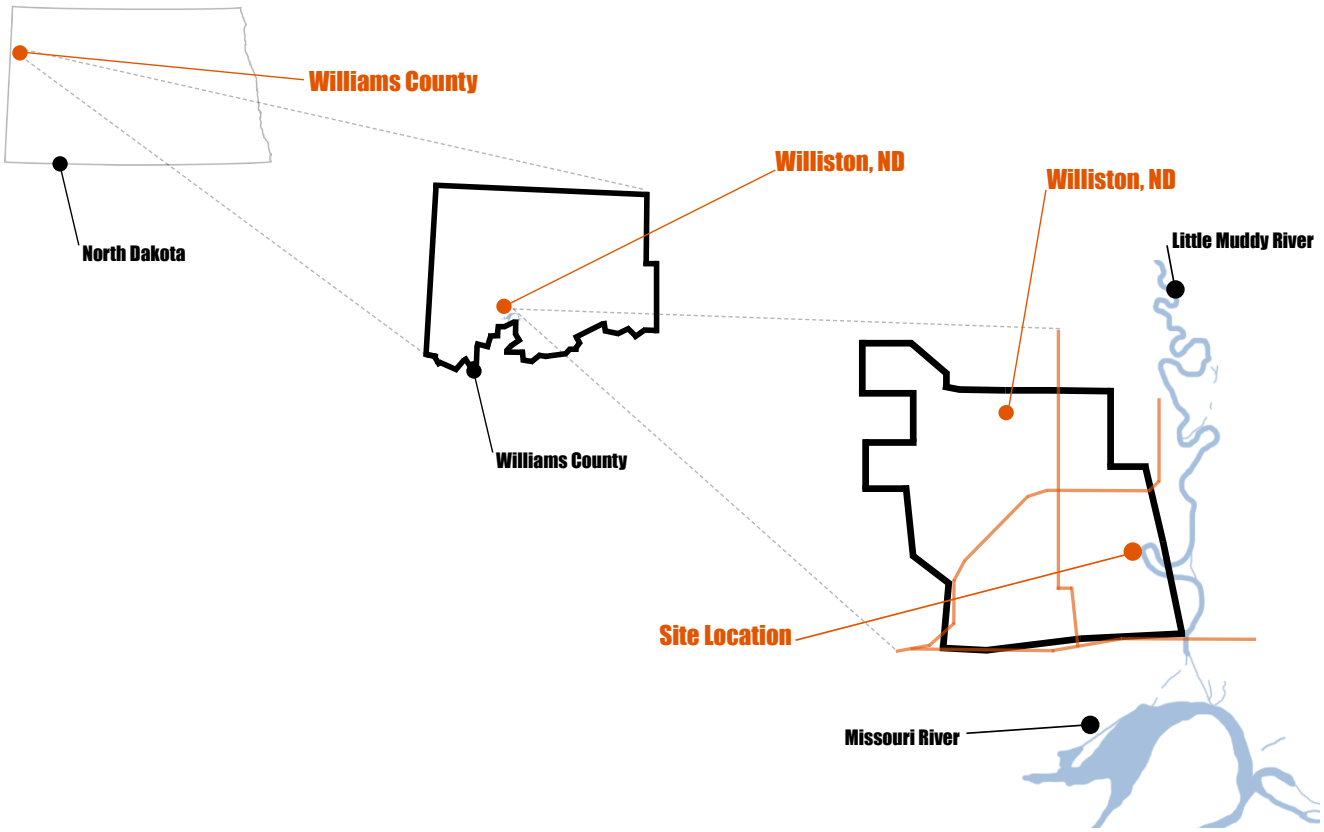
Progrommatic Requirements

The site, as it exists, is a unique display of ecosystems and mother nature working together in one harmonious location. In the early spring, mass amounts of water find their way to the site and change and modify the landscape to look entirely different each year.

The design proposal is to establish a system for introducing produced water in hopes of purifying it for future use and to conserve water to be utilized throughout the region effected by the oil boom. Before the water can be used for drinking water, industrial, and domestic use it must first be purified. The site is located in close quarters to multiple oil derricks which pose an immediate runoff threat. It is not uncommon for oil derricks, vehicular processes, and manufacturing processes to create large amounts of contaminents that are easily picked up by flowing water. This water finds its way into the site and moves downstream. The site will not only collect produced water, but collect the runoff from the surrounding derricks in hopes that minimal contamination be caused to the area's water sources.

The second portion of the design proposal is to establish an educational resource area within the space. The newly developed space will include a large park system, green networks connecting to the city, informational centers, and many other design innovations that will educate the visitor on the potential hazards of handling produced water before and after the system's installation.

In the end, the space will utilize the amount of water in an advantage for the area rather than a nuissance. The site will also utilize the influx of population in the last few years to design, construct, and manage the entire system.

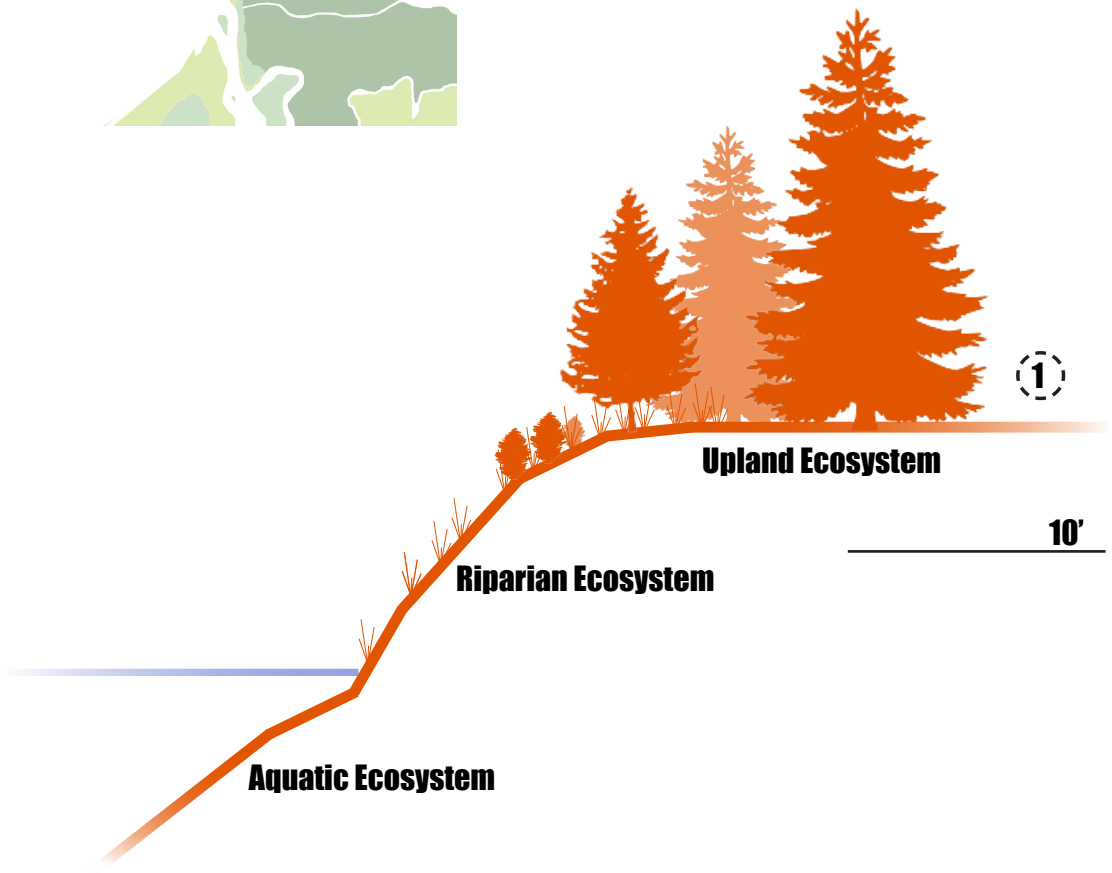


Recapping the site location: North Dakota, to Williams County, to Williston, to Immediate Site Location alongside the banks of the Little Muddy River.

Existing Softscapes

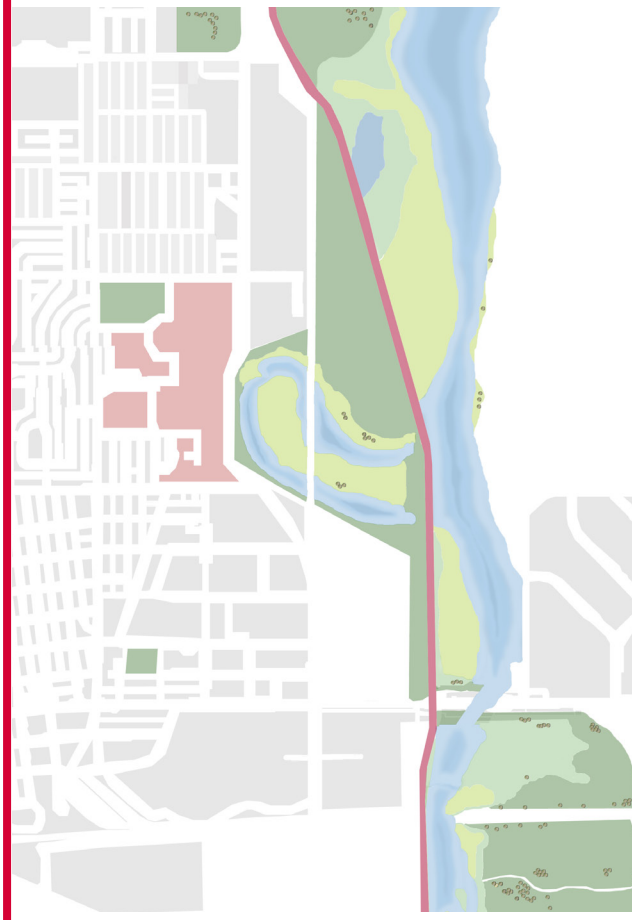
The existing softscape depicts an area of diverse soil conditions, vegetative covers, and seperated open spaces.

Further planning and development calls for a strengthening of corridors and pedestrian walkways.



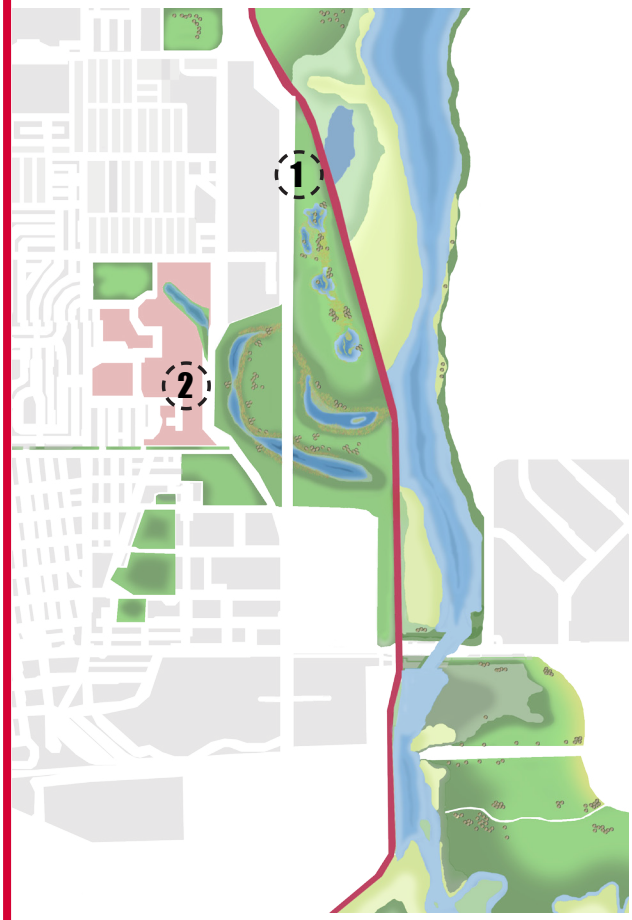
Making the Grade

The shores of the Little Muddy River are consistently severe in nature. These severe slopes lead to land-slides and errosion. Future planning calls for the strengthening of errosion control and implementation of filter strips along the river corridors.



Existing Site

The site is close to Williston's city limits, close to Williston State College, and several existing green spaces.

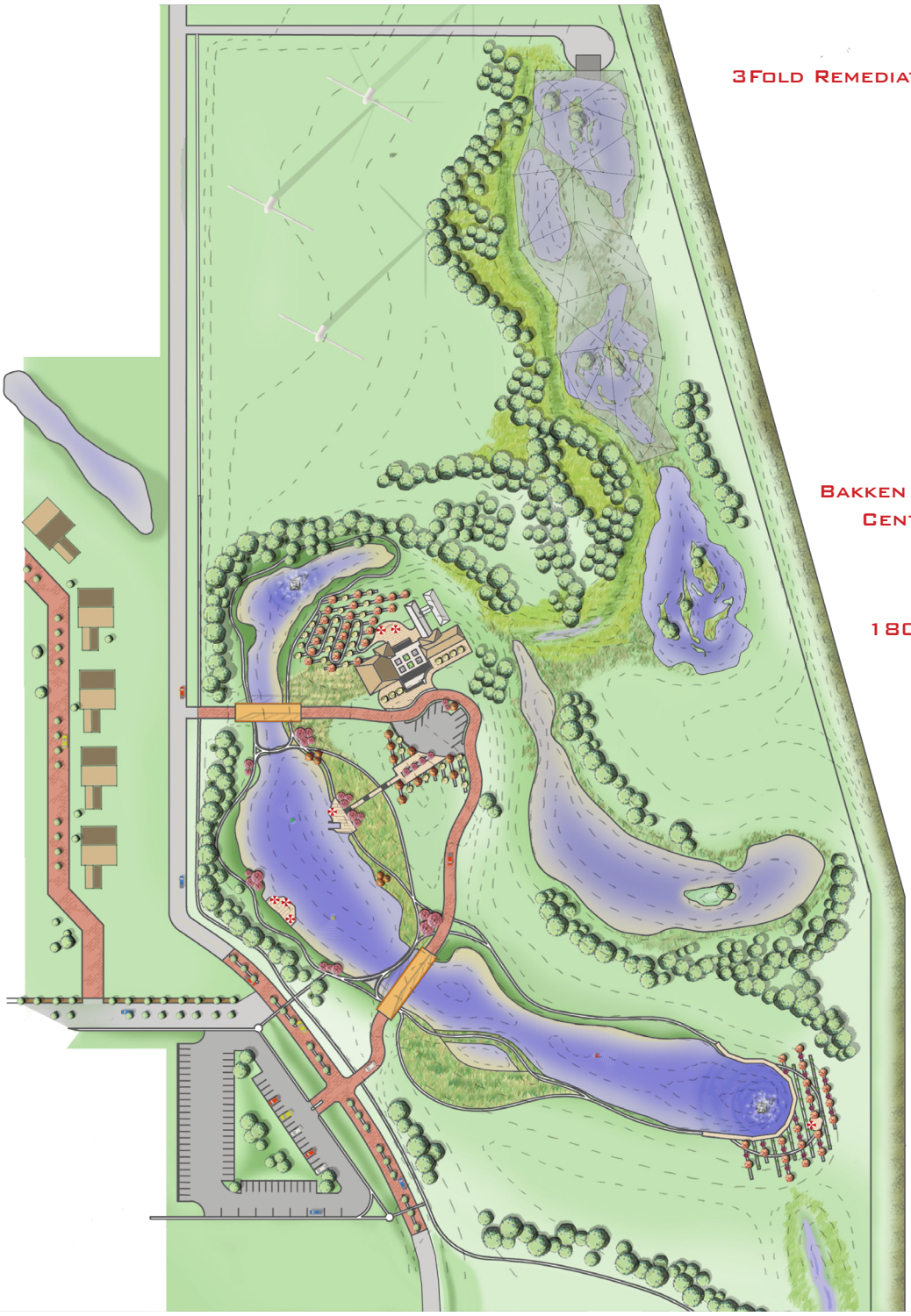


Phase One: 3Fold Remediation

The 3Fold Remediating ponds are designed to collect produced water from a nearby, producing oil well. Once within the system, multiple stages of phytoremediation remove toxic contaminants from the water, eventually purifying it enough to be recycled for industrial purposes.

1. 3Fold Remediating Ponds
2. Proposed Park Space

Final Master Plan



Wind Technology

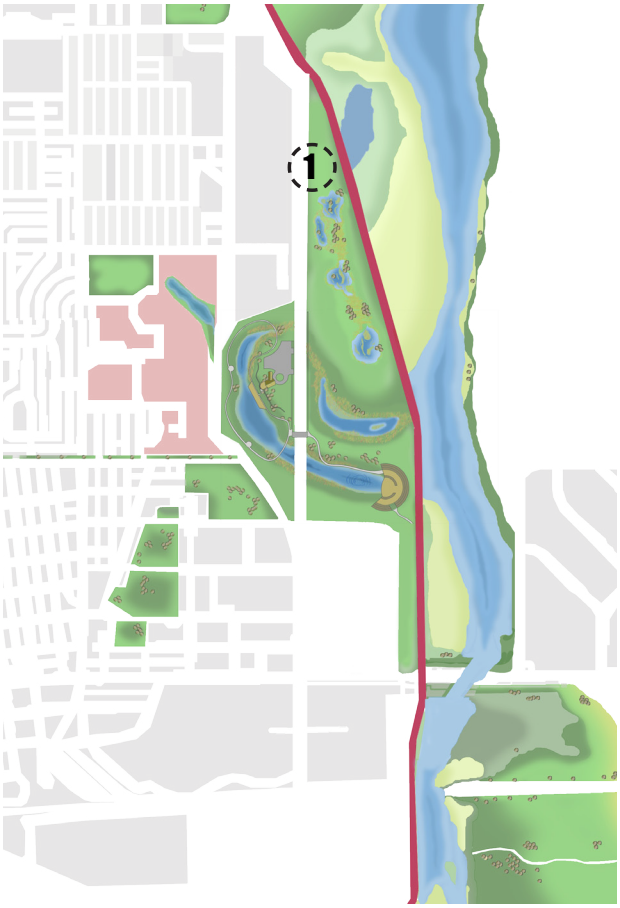
3Fold Remediation

Bakken Educational Center

1804 Recreation

Water Features

New Parking Spaces

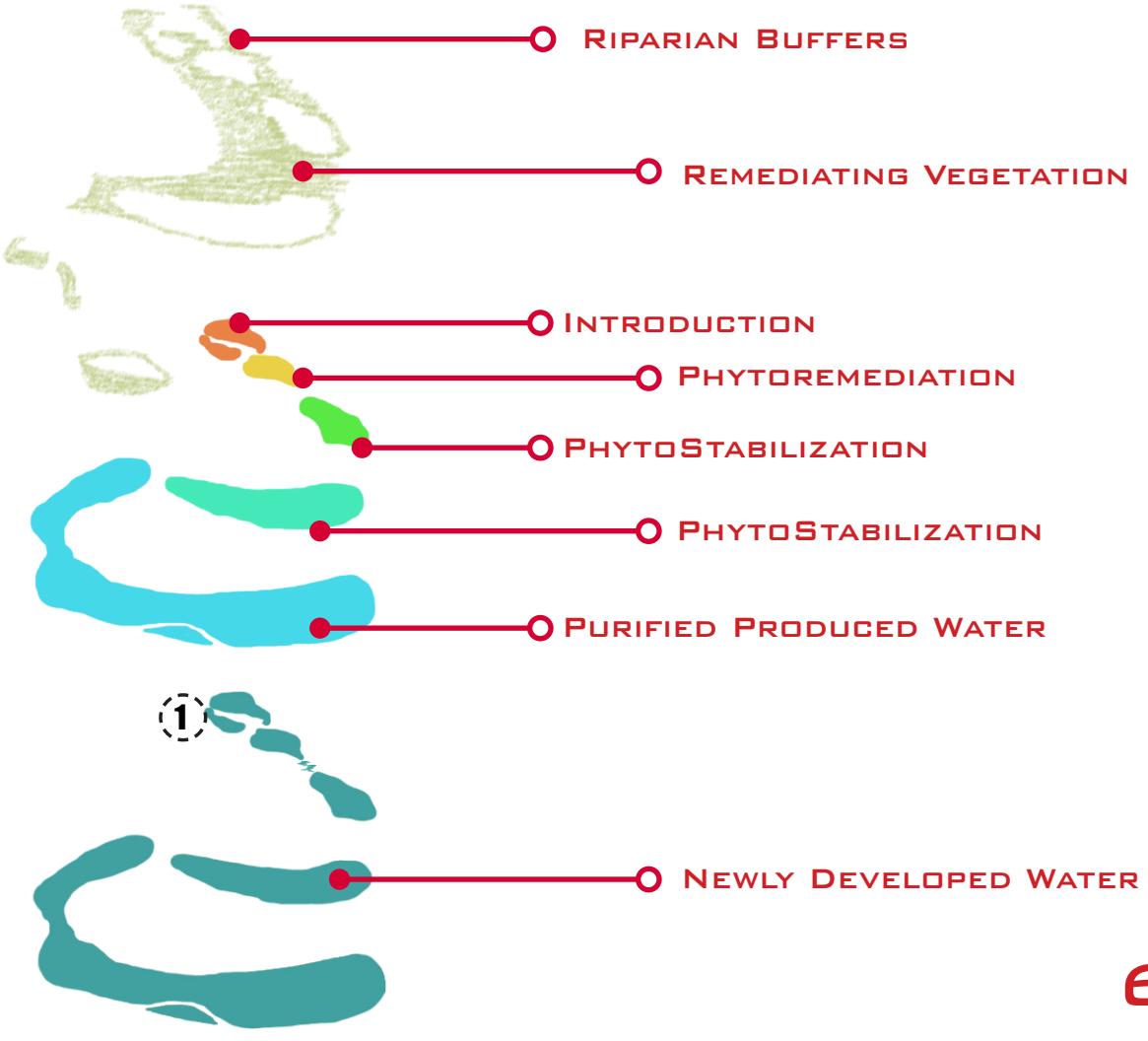


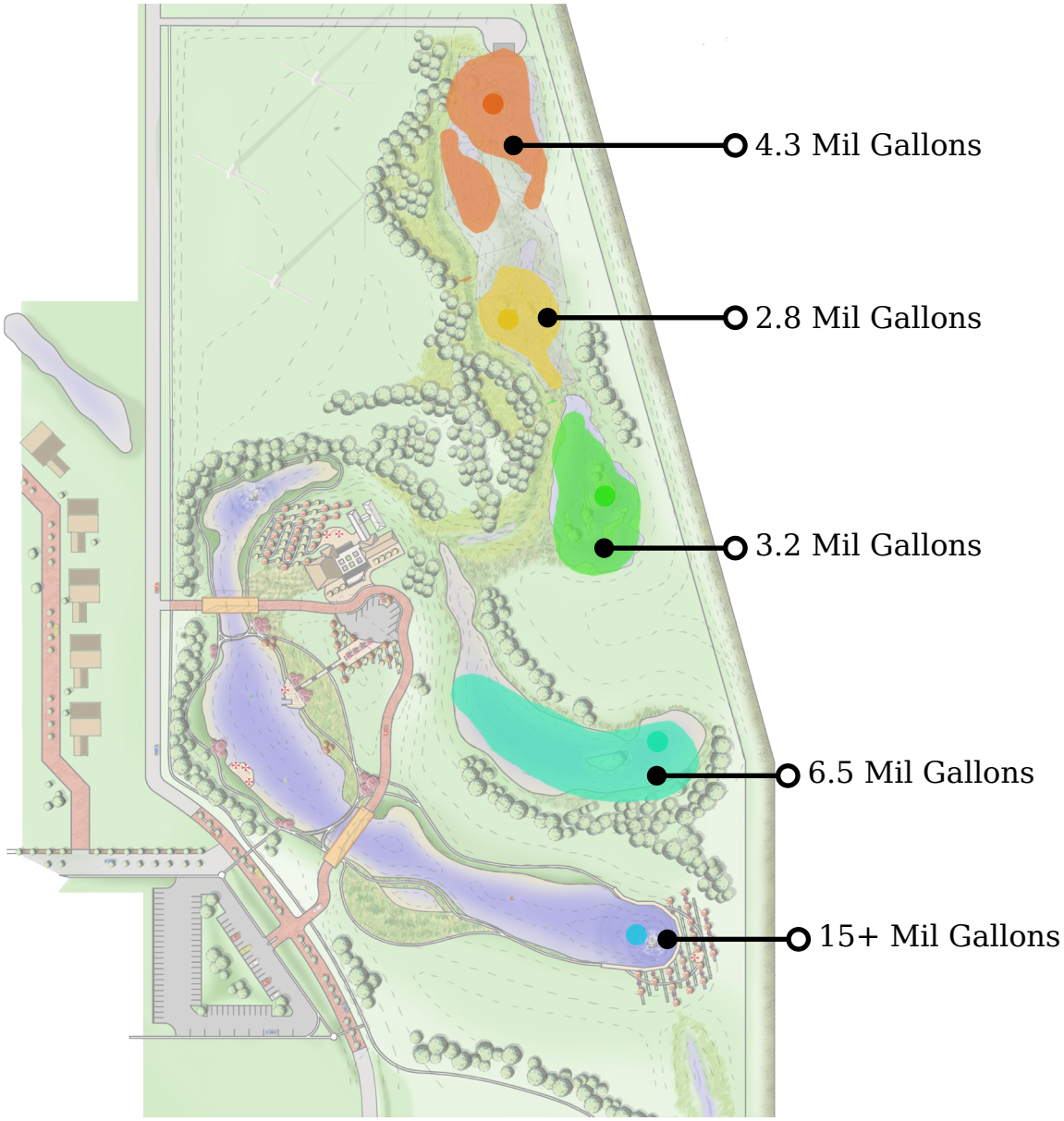
Preliminary Park Space

The preliminary design for the park space was designed to simply get a feel for the space available.

Proposed parking spaces, community centers, amphitheaters, walkways, and boardwalks surround the southern most pond within the remediating system.

The water within this pond is deemed sanitary for contact and poses little threat to visitors.





- Phase 3 Purified Produced Water | Reestablishment
- Phase 2 Fine Settling | PhytoStabilization
- Phase 1: Step 5 Low Remediation | Algae Filter
- Phase 1: Step 3 Medium Remediation | Algae Filter
- Phase 1: Step 1 High Remediation | Gravity Filtering

Remediating Planting Plan

Agropyron smithii
Western Wheat Grass

Buchloe dactyloides
Buffalo Grass

Symphyotrichum ascendens
Purple Aster

Trifolium pratense
Red Clover

Acer rubrum
Red Maple

Populus deltoides
Cottonwood

Agropyron smithii
Western Wheat Grass

Gladitsia triacanthos
Honey Locust

Salix alba
Golden Willow

Panicum virgatum
Switch Grass

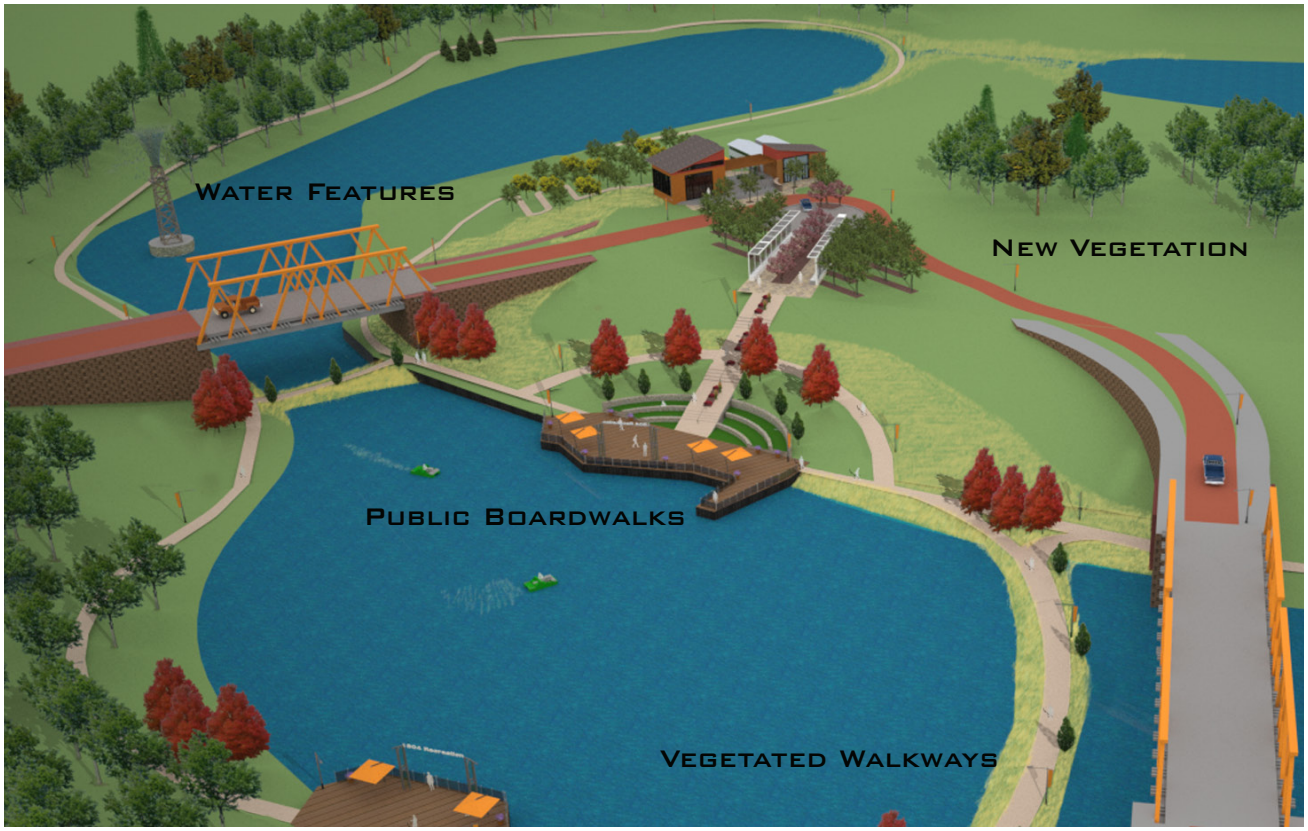
Bouteloula gracilis
Blue Gamma Grass

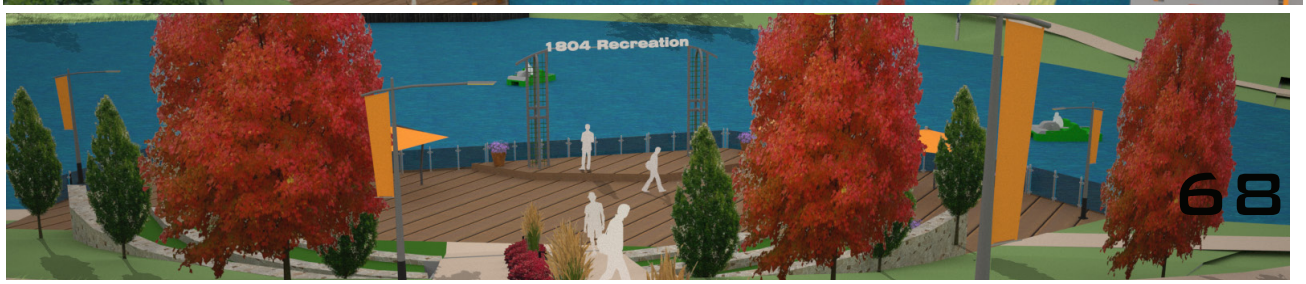
1804 Recreation

Central Park Space

The Central Park space is designed to be the central hub of the public portion of the design. Large public boardwalks, gathering spaces, vegetated walkways, water ammenities, and destinations attract visitors of all ages.

The site is designed to give a needed escape from the hectic surroundings of the bustling boom-town.



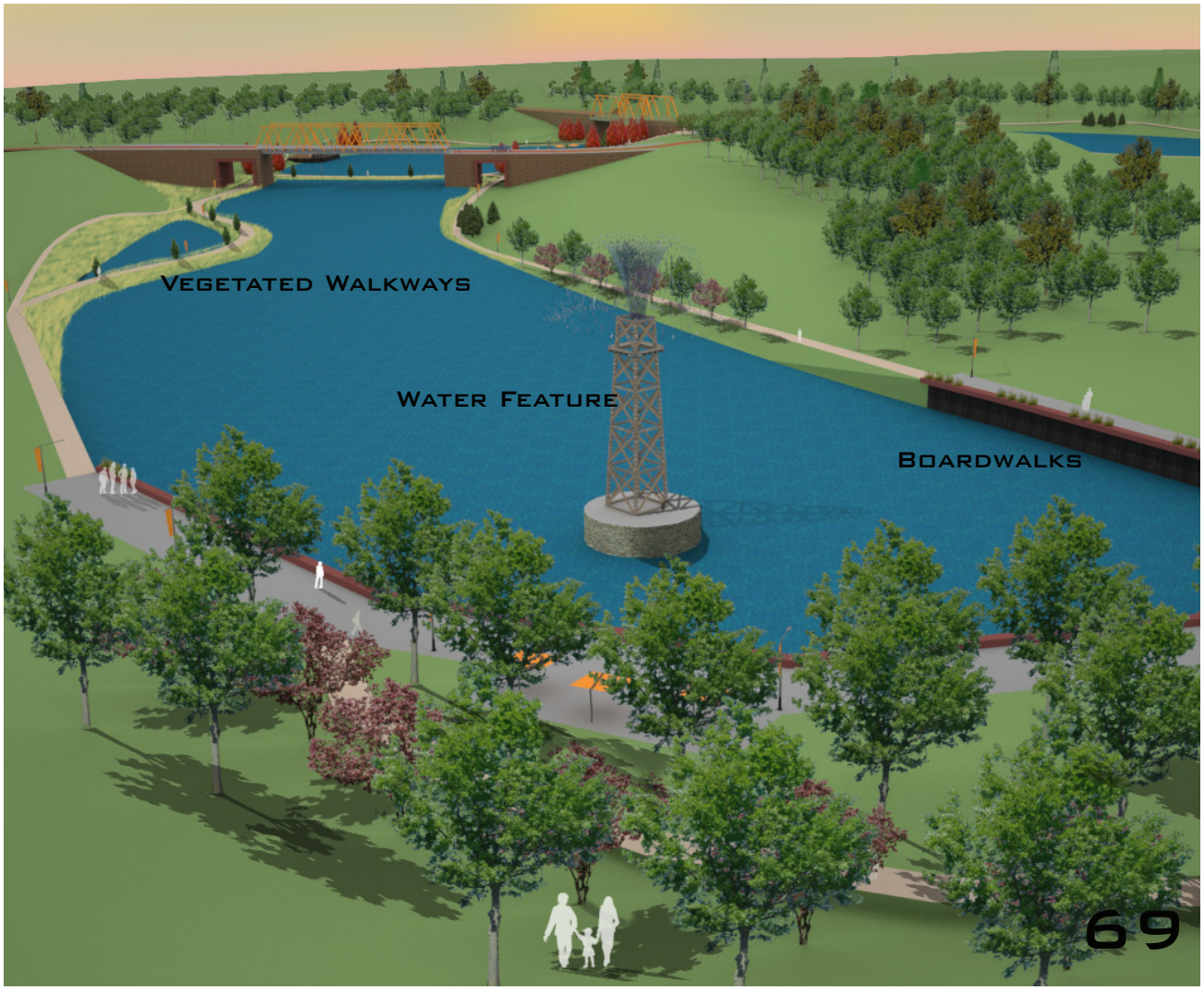


Southern Park Space

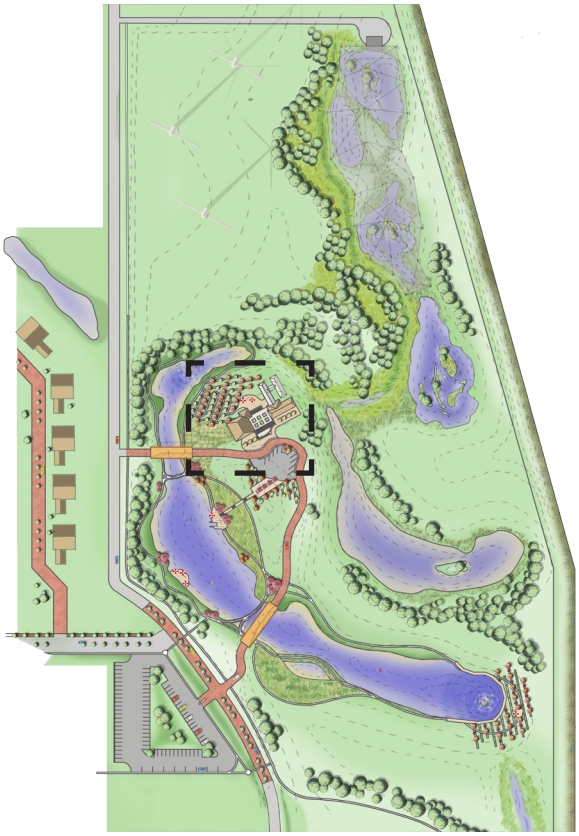
The Southern Park space allows for a more private space within the 1804 Recreation area.

The site offers water features, vegetated walkways, boardwalks, and massive spaces for recreation.

The space also features a large playground space for younger children.



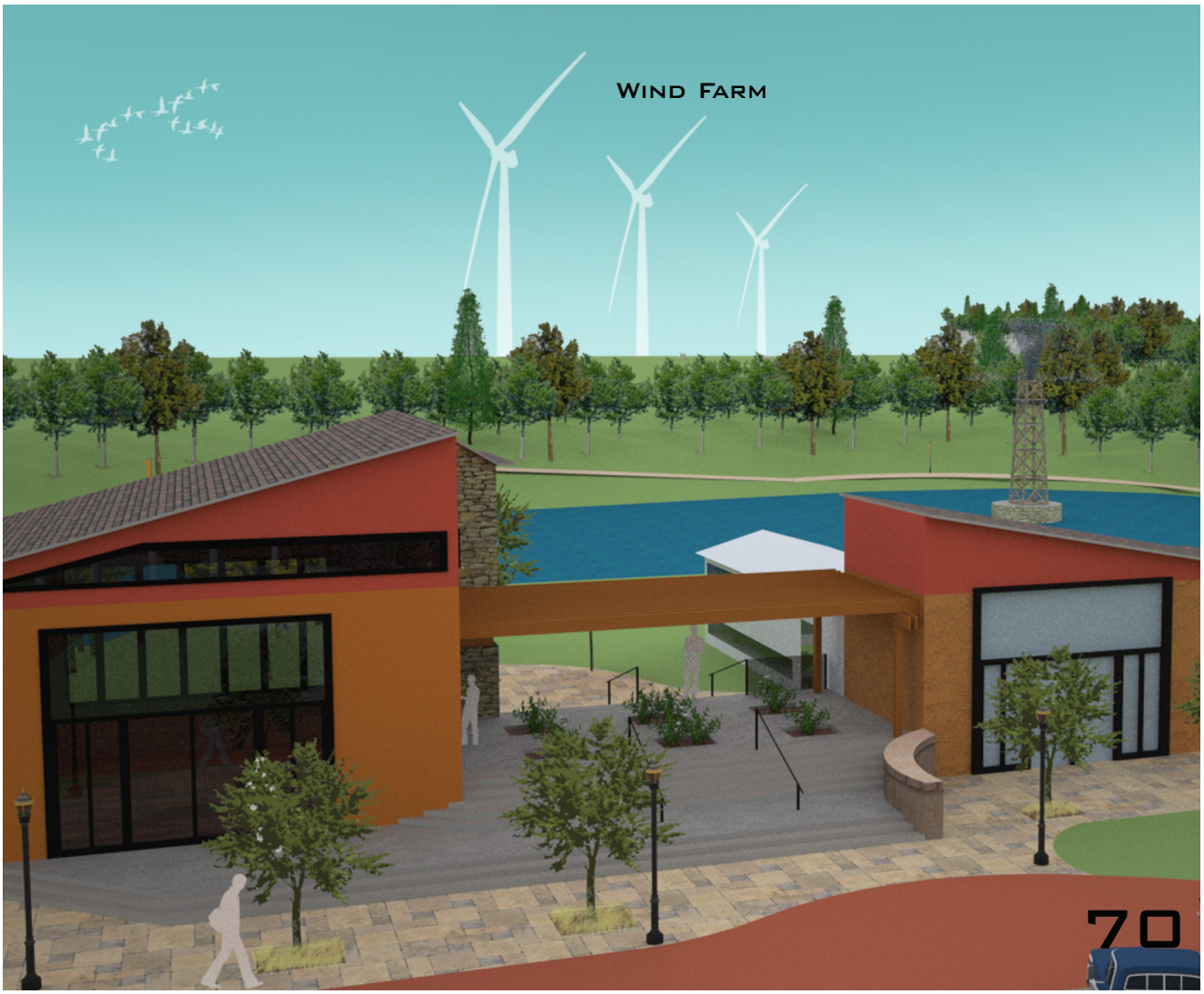
The Bakken Educational Center



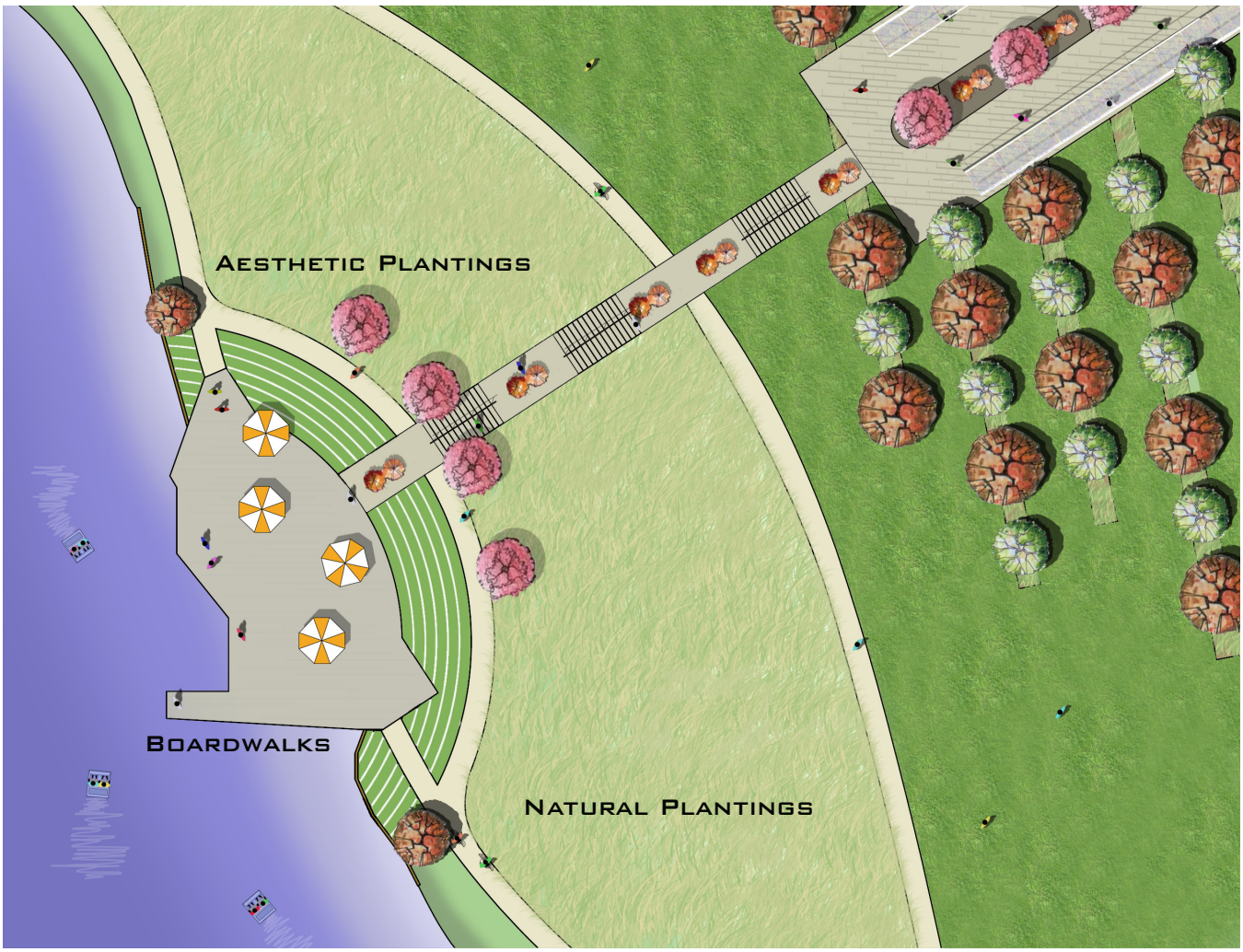
Bakken Educational Center

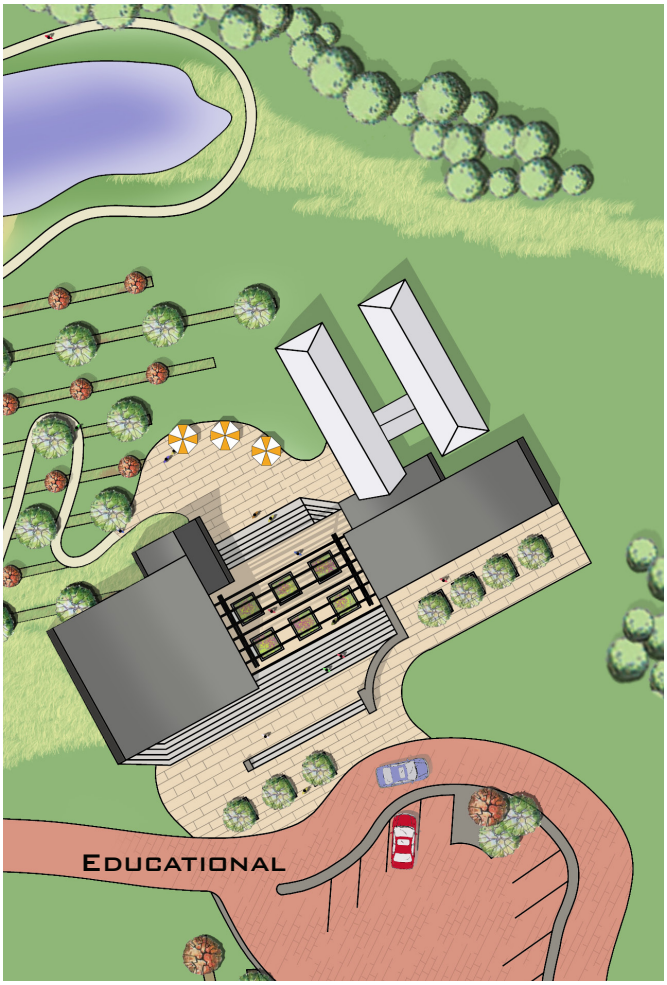
The Bakken Educational Center is designed to educate the visitor of the processes utilized by the oil companies working within their own community.
The educational center depicts the process of producing water, how it is being remidiated, and the dangers it can pose if handled improperly.

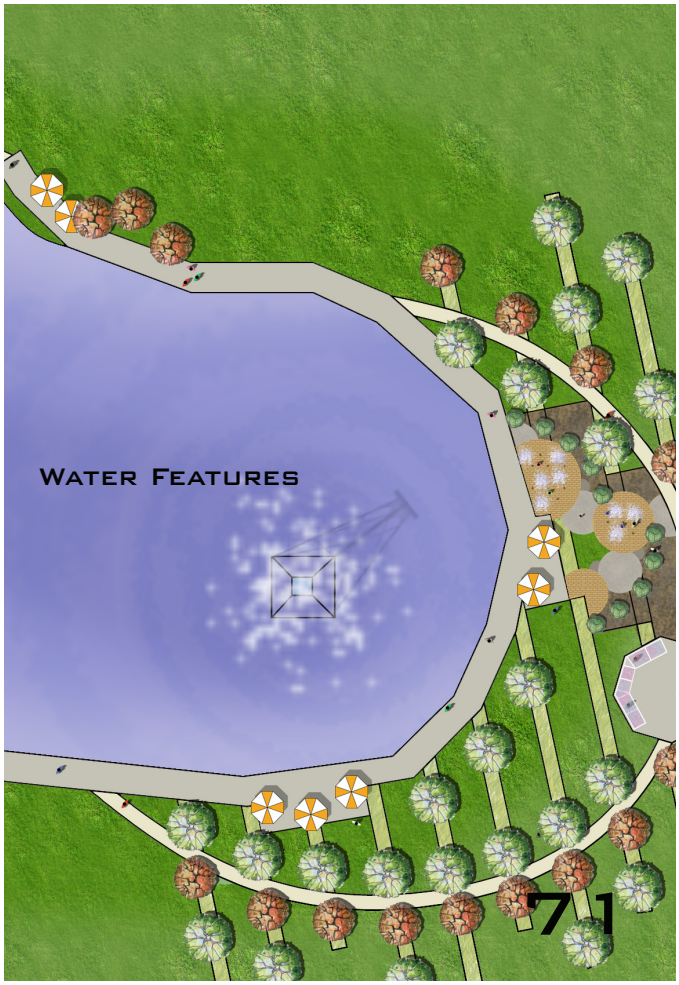
The space also doubles as a small community gathering space.



Plan Drawings







Final Perspectives

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Quote about NDSU:

"Stick up for yourself. One of the biggest aspects of college is to discover who you are. Don't let others dictate who you are."