

ABSTRACT

Title of Thesis: CLIMATE CHANGE AWARENESS
THROUGH DESIGN:
SAVING THE POLAR BEAR

Abby Joy Winter, Master of Architecture, 2017

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Architecture, Planning and Preservation

This thesis seeks to explore how architectural design can raise awareness about climate change. Climate change is becoming ever more apparent in today's world, most recently evident by the mass flooding in Texas by Hurricane Harvey. The world as we know it, and all the living creatures that inhabit it, will soon have to face its fate if humans do not alter their unsustainable way of life. However, statistics show that only 40% of Americans believe that climate change will harm them personally and therefore, do not see climate change as a concern. Climate change is an issue of unsustainability, but it is also an issue of public awareness. This thesis explores how architecture can raise awareness about climate change through a monument, polar bear habitat, and a museum and will be strengthened by its location on the National Mall in Washington D.C.

CLIMATE CHANGE AWARENESS TROUGH DESIGN:
SAVING THE POLAR BEAR

by

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Dedication

To the starving polar bears of the world, who need our help now more than ever before. I hope this project will bring awareness to people all over the globe and that my grandchildren will still be able to experience these beautiful creatures many years from now.

To my parents, who have given me an amazing opportunity to study architecture and have shown me unconditional love and support throughout this entire process.

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Professor Steven Hurtt

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“The only way at this time to save bears is to have people change their habits, and the way to do that is through zoos and aquariums,” he said. “Polar bears are just ambassadors for their friends in the Arctic.” --- Juliet Eilperin, Washington Post, 2012

List of Definitions & Abbreviations

AZA – Association of Zoos and Aquariums

Landscape Immersion – term coined by Landscape Architect Jon Coe, which means to “virtually immerse the visitor in the same natural habitat as the animal”¹

USDA – United States Department of Agriculture

PBPA – The Polar Bear Protection Act

MMPA - Marine Mammal Protection Act

Pinniped – Marine animals that have front or rear flippers. Ex. walrus, seal, sea lion.

¹ K Venkateshwarlu, “Landscape Immersion Still Ideal Design for Zoos’,” *The Hindu*, last modified 2011, accessed May 9, 2017, <http://www.thehindu.com/news/national/landscape-immersion-still-ideal-design-for-zoos/article2604575.ece>.

Chapter 1: Introduction

The Facts – Climate Change is Real

This thesis assumes that climate change is in fact real and it is happening. This thesis is also based on the assumption that climate change is a manmade cause. The average global temperature of the earth has risen 3°F since the beginning of the industrial era and scientists have found a direct correlation between carbon dioxide and global temperature rise.¹ Due to this increase in global temperature, sea ice is decreasing at a rapid rate of 11% each decade. In 1980, the winter sea ice extent was about 8 million square kilometers. In 2015, the winter sea ice extent was only 4.6 million square kilometers. Naturally, melting sea ice is leading to sea level rise. Since 1995, sea level has risen about 84.8 millimeters.²

The Problem – Lack of Public Awareness

If we do not reverse the effects of climate change now, there are going to be detrimental consequences to earth and all that live on it. However, this is not just an issue about unsustainability - it is also an issue about public awareness. In 2016, Yale created a series of public opinion maps about global climate change and how U.S. citizens perceive climate change. The results were striking. Only 24% of people in the U.S. hear about global warming in the media at least once a week. Only 40% of people believe that global warming will harm them personally. However, 70% believe that global warming will harm plants and animals. Only half the U.S. population believe

¹ “Rising Global Temperatures and CO₂,” *Climate Central*, last modified 2017, accessed December 16, 2017, <http://www.climatecentral.org/gallery/graphics/co2-and-rising-global-temperatures>.

² “Climate Change: Vital Signs of the Planet,” *NASA*, last modified 2017, accessed December 16, 2017, <https://climate.nasa.gov/vital-signs/sea-level/>.

that global warming is caused mostly by human activity. Clearly the first step to reversing climate change is education and awareness.³

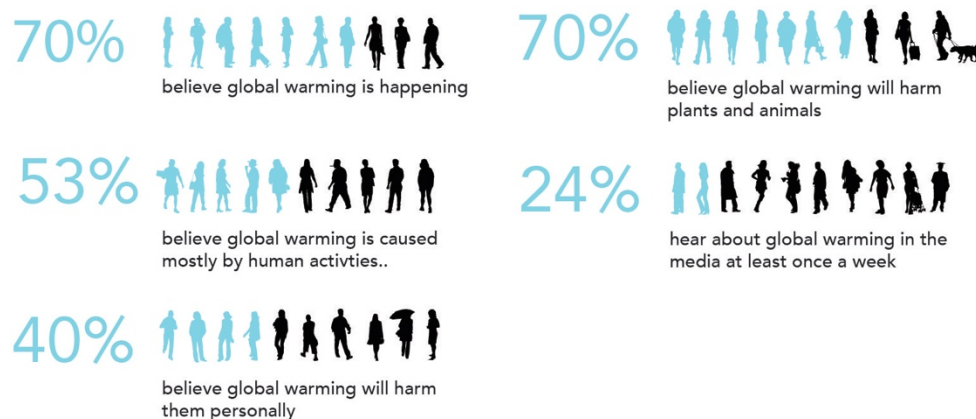


Figure 1. Climate Change Survey (Source: Yale Climate Opinion Map - Pictograph: Author)

Program - Museums, Memorials, and Zoos

This thesis explored different institutions that aim to raise awareness about climate change. There are many futuristic memorials and museums that are currently in the design phase. However, zoological parks are at the forefront of this climate change awareness movement. They have already been educating visitors about climate change and the plight animals for years.

Memorials

Memorials, in the traditional sense, are usually designed to create a sense of reflection for a particular event or person. Memorials often have a sad connotation to them because they help visitors remember those who have been lost. On the National Mall in D.C., there are many memorials – the Vietnam Memorial, the WWII Memorial, the Martin Luther King Memorial, the Korean War Memorial, the Lincoln Memorial, and the FDR memorial, to name a few. All of these

³ Peter D. Howe et al., “Geographic Variation in Opinions on Climate Change at State and Local Scales in the USA,” *Nature Climate Change* 5, no. 6 (April 6, 2015): 596–603, accessed December 16, 2017, <http://www.nature.com/doifinder/10.1038/nclimate2583>.

memorials remember a particular group of people who have passed away and have made some positive contribution to society and are therefore should be remembered. In addition to an underlying symbolism of remembrance, each memorial has similar design elements. All of the memorials possess either a statue, a quote, a statistic, or wall or a combination of a few different elements. Water is also a big part of many monument designs.

It is time to start thinking about memorials not only to remember things retrospectively, but to use them to start memorializing what could happen. In the case of climate change, many people and animals have died senselessly because of climate change and natural disasters, and they will continue to do so unless we change our habits. Memorials can be used to remember those who have died, but they can also be used to prevent those in future danger of dying. There is a new term out there called Climate Chronograph. Edward T. Linthal, professor at Indiana University, says that “Climate Chronograph is a new form of memorialization that commemorates the aftermath of the present.”⁴

Memorials are starting to commemorate what could happen in the future. In 2016, the National Capital Planning Commission held a contest called Memorials for the future which challenged architects to monuments could focus on future events, not just past ones.⁵ The winning design was done by a Landscape architecture firm called *Azimuth Land Craft*. This design is intended to show the future implications of sea level rise in Hains Point in Washington D.C. As the water rises over the years, which is will, the cherry blossom trees that are planted in the design

⁴ Azimuth Land Craft, *Climate Chronograph Team Report* (San Francisco, California, 2016), https://future.ncpc.gov/pdf/Climate_Chronograph.pdf.

⁵ Adele Peters, “This Climate Change Memorial Will Slowly Disappear As S | Fast Company,” *Fast Company*, last modified 2016, accessed October 21, 2017, <https://www.fastcompany.com/3063637/this-climate-change-memorial-will-slowly-disappear-as-sea-level-rises>.

will become submerged and die. This gradual decay of the cherry blossom will hopefully show visitors what the future will be like.



Figure 2. Rendering of Climate Chronograph Memorial (Source: Azimuth Land Craft)

Museums

Like memorials, museums are typically used to educate the public about a particular event or issue. There are many museums along the national mall that educate visitors about various different issues, however there is currently no museum on the mall that educates about sustainability and climate change. Sustainability museums are still a novel idea. Currently, Bjarke Ingels Group is in the process of designing an environmental education facility in lower Manhattan, NYC. One of the spaces in the museum is built right into the East River, allowing visitors to experience tidal changes and sea level right. The project is also designed to protect the city from hurricanes and flooding in the future. Berms built around the perimeter of the project are designed to stop floodwater from entering the city. This project is a very interesting idea, however it is still a futuristic design.⁶

Zoos

⁶ “NYC: The BIG U | Rebuild By Design,” *Rebuild by Design in Partnership with 100 Resilient Cities*, last modified 2017, accessed December 16, 2017, <http://www.rebuildbydesign.org/our-work/all-proposals/winning-projects/big-u>.

After comparing the different functions of museums, monuments and zoos, it became clear that the final design should encompass all three of these different programmatic types. However, the focus of the design would be the zoo, since the zoo typology has been more successful thus far at raising awareness about climate change than the museum or the memorial. However, monuments and museums are starting to do their part as well to raise awareness, which is evident through the two futurist precedents mentioned above. The next chapter will go into detail about zoo history and how climate change awareness has become the focus of the current day zoo.

THIS THESIS = MEMORIAL + MUSEUM + ZOO

Chapter 2: The Zoo

History of Habitat Enclosures

The idea of animal captivity started as collections of exotic and bizarre animals called menageries. Throughout the ages, menageries became a symbol of grandeur and status for the royal. Only the wealthy and powerful could afford to own these “cabinets of curiosity”. Royals kept animals such as bears, elephants, cheetahs, monkeys, and giraffes in their collection.⁷ Wall carvings found in Egypt and Mesopotamia are evidence that menageries were created as early as 2500 BCE. Zoos were also prominent in later years in places like China, Greece and Rome. The Aztec emperor had one of the earliest zoos in the western hemisphere. The first modern zoo was built in 1793 in Paris, France, called The Menagerie de Jardin des plantes. The animals of the French aristocrats were taken to this facility during the French Revolution. Early zoos like this one were often considered museums of living history, not natural habitats because of the small display areas.⁸

Public zoological parks became prominent in the 1800s during the enlightenment. This period in Europe was centered around the ideas of science, reason and logic. During the enlightenment period, animals in captivity were no longer only for display and spectacle - they also were used as scientific subjects. Scientists started to use zoological parks to study animal behavior and anatomy. To achieve this, animals were kept in zoological parks near their natural habitat, or in places that strongly resembled their natural habitat.⁹

⁷ Jake. Page, *Smithsonian's New Zoo* (Washington, D.C. : Smithsonian Institution Press, 1990).

⁸ Jake. Page, *Smithsonian's New Zoo* (Washington, D.C. : Smithsonian Institution Press, 1990).

⁹ “Zoo - National Geographic Society,” *National Geographic*, accessed April 6, 2017, <http://www.nationalgeographic.org/encyclopedia/zoo/>.

Current Day Habitat Enclosures

The current day habitat enclosure is still much like the menageries and the zoos of the 18th century. The animals are still on display for the visitors' enjoyment and leisure. Current day visitors come to the zoo for a variety of reasons: for a contrast with their urban environment, to connect with animals, to be entertained, and to be educated. According to the Association of Zoos and Aquariums, a non-profit zoo accreditation organization, approximately 175 people visit a zoo or an aquarium each year in the US. This is more than half of the US population. The animals are clearly still being used for entertainment purposes as well as scientific subjects. However, there are many new functions of the present-day zoo.

Animal Conservation is among the primary goals of the current day zoological parks and is achieved through husbandry. Many zoos across the country participate in the AZA's Species Survival Plan (SSP) Program. This program "aims to manage the breeding of specific endangered species to help maintain healthy and self-sustaining populations that are both genetically diverse and demographically stable." Through animal husbandry, zoos can raise a captive population of an endangered species and then gradually release them back into the wild.¹⁰ In the past three decades, zoos have saved six species from extinction, including the black-footed ferret, the California condor, and the red wolf. Currently, zoologists have been successful at breeding endangered Pandas and releasing them back into the wild and their status has now been upgraded from endangered to threatened.¹¹

¹⁰ "How Do Zoos Help Endangered Animals?," *Scientific American*, accessed April 7, 2017, <https://www.scientificamerican.com/article/how-do-zoos-help-endangered-animals/>.

¹¹ "Giant Panda Status Upgraded from 'Endangered' to 'Vulnerable'," *Smithsonian's National Zoo*, last modified 2016, accessed May 9, 2017, <https://nationalzoo.si.edu/animals/news/giant-panda-status-upgraded-endangered-vulnerable>.

To successfully conserve animals for years to come, zoos must be able to educate the public about the animals themselves. Most zoos try to create a thematic narrative within the exhibit to better connect the visitors with the animals, its ecology, and the species' struggle in the wild. Part of the research for this thesis includes visiting different zoos. The Bronx Zoo, one of the top ranked zoos by the AZA, has a team of designers (architects, landscape designers, graphic designers and museum designers) that work together to create a seamless narrative about the animal. Zoos help to educate visitors about geography, evolution, and how important the use of renewable energy is to the wildlife. Most importantly, a zoo aims to educate the visitor about the very real threats to endangered species and ultimately how people's actions can help save the species from total extinction.

Zoological Park Functions = Leisure + Study + Conservation + Education + Activism

The goal of this thesis is to enhance the educational and conservation element of zoo habitats.

Criticisms of the Current Day Zoos

Recently, there have been rising criticisms from animal activists, other individuals, and organizations about animal captivity. PETA (People for the Ethical Treatment of Animals) is at the forefront of this activism. Due to these criticisms of modern day urban and suburban zoos, many zoo keepers fear that the zoos may be shut down in the near future. David Towne, who once oversaw the Woodland Park Zoo in Seattle, Washington says, "I am cautiously optimistic we'll be able to overcome this, but I'm not sure. The animal rights people have imposed their will on the

elephants. I'm not sure that they aren't going to move on to Gorillas, then other primates, then what?"¹² Here are some of the main criticisms many animal activists have:

1. Too Small

The space that zoos provide for animals, especially large carnivores, is regarded as too small according to many animal activists. SeaWorld, which has been known for its killer whale shows, has felt tremendous backlash from PETA and other animal activist groups regarding their tank facilities. They feel they are extremely small, compared to the vast ocean. Animal activists have also had qualms about elephants held captivity for the same reason – the habitat space is simply regarded as too small compared to their natural habitat. Many people feel that “large animals - who are hardwired to roam free across thousands of square miles, don't have a place in American zoos.”

¹³ Animals In 2011, National AZA Guidelines were adopted to require all zoos either expand their elephant exhibits, or be forced to close or repurpose the exhibit.

2. False Conservation Efforts

PETA is skeptical about the zoos conservation efforts. PETA views conservation as a noble goal, but believe zoos mainly favor the conservation of the species that will bring in more visitors, and neglect the smaller animals in their conservation efforts. They also argue that captive animals that were raised in captivity will lack the survival skills necessary to survive in the wild once released. PETA feels that the only way to successfully save species is to focus on protecting their wild habitats instead of creating a warehouse for animals.¹⁴

¹² Justin Worland, “The Future of Zoos,” *TIME Magazine*, 2017.

¹³ The Associated Press, “Elephants Will Likely Be Harder to See at Zoos in Future - NY Daily News,” *NY Daily News*, last modified 2015, accessed March 26, 2017, <http://www.nydailynews.com/life-style/elephants-harder-zoos-future-article-1.2202101>.

¹⁴ “Animal Rights Uncompromised: Zoos,” *PETA*, accessed April 20, 2017, <http://www.peta.org/about-peta/why-peta/zoos/>.

3. Inaccurate Habitat

The inaccuracy of the habitat is another criticism. Architect and former director of Seattle's Woodland Park Zoo, David Hancock, feels that zoos are spending more effort on portraying the illusion that the animals are well cared for rather than taking the time to design a habitat that ensures the animals are well cared for. Many landscape features within habitat enclosures appear to be real, but are in fact artificially made to look real. At the Bronx Zoo in New York City, the lemur exhibit has a few large trees in the habitat which the lemurs climb can climb on. However, they are not real trees. The large trees are constructed of structural columns coated in a material to look like a tree. Hancock states, "A concrete tree is as useless as a light pole. They give the illusion that they're making progress, but I think from the animal's point of view, they're really no better off."¹⁵ Landscape immersion has become a buzz word amongst habitat enclosure designers, but has not become standard practice.

4. They Compromise Well-Being

Some believe that habitat enclosures are designed in such a way that they compromise the animals' well-being. Recent Studies have shown that "many animal species are far smarter and more feeling than previously understood, giving new insights into how they may suffer from anxiety and depression when they are removed from nature."¹⁶ Habitat enclosures compromise the animal's well-being because they do not allow them to exhibit the same behavior that they would in the wild. The lion, a major predator, that enjoys the hunt, will never be able to hunt antelope in the

¹⁵ Worland, "The Future of Zoos."

¹⁶ Ibid.

wild. The polar bear, accustomed to long walks along the sea ice and hunting for seal, are not able to have such an experience in a habitat enclosure. Restricting natural behavior is believed to lead to physical and mental frustrations. These frustrations often lead to “abnormal, neurotic and even self-destructive behaviors.”¹⁷

5. Unsustainable

Many feel that these large zoological parks with many small enclosures will be hard to maintain for years to come. Historically, they were not very sustainable in terms of energy and waste. However recently, many zoos have begun to implement many sustainable practices to strengthen their conservation message to the public. Despite this growing sustainable trend, some zoos have yet to implement sustainable strategies within their parks, mainly due to lack of funds. The World Association of Zoos and Aquariums (WAZA) has developed a comprehensive sustainability report that details how zoos should deal with energy, water, waste, transportation and procurement.¹⁸

6. Inaccurate Storytelling

The goal of the zoo exhibit is to tell the story of the animal itself and its plight in the wild. Sue Chin, zoo architect at the Bronx Zoo, explained in an interview that the goal of the animal exhibit was to make the visit fall in love with the animal they were viewing. After that happens, the next goal is to educate the visitor about the plight of the animal in the wild. After that, the exhibit should help to explain how the visitor can help be more sustainable and ultimately help save the animal.

¹⁷ “Animal Rights Uncompromised: Zoos.”

¹⁸ *Sustainability to Implement*, n.d., accessed May 4, 2017, http://www.waza.org/files/webcontent/1.public_site/5.conservations/environmental_sustainability/Sustainability_Report.pdf.

After visiting many polar bear habitats, it became clear that many did not tell this storyline successfully.

Thesis Goal:

The zoo has had a long history of housing wild animals for entertainment and more recently for research, education, and conservation. The zoo has also faced many criticisms throughout its history. The goal of this thesis is to try to successfully implement landscape immersion into habitat enclosures, specifically the polar bear habitat enclosure. Successful landscape immersion within a man-made habitat enclosure will attempt to address all the criticisms mentioned above and help to raise awareness more effectively. More specifically, the goal of this thesis is to create an improved habitat enclosure for a specific animal that:

1. Is a sufficient size
2. Helps in the animal's conservation efforts
3. Accurately incorporates the animal's natural environment
4. Is beneficial to the animal's well-being
5. Creates a more sustainable example
6. Create a better storyline

Although it is important to try and address all these elements in the thesis, the main goal is to try and improve understanding about climate through a more accurate habitat design. The priority is not to appease PETA and other animal activists, although the animal's well-being was certainly considered during the design process.

Chapter 3: The Polar Bear

Why the Polar Bear?

1. It's Time

Landscape immersion has not been as successfully implemented in polar bear habitat enclosures as it has been with other animal habitat enclosures. One of the more obvious reasons for this is the fact that the arctic environment is more difficult to recreate than many other natural environments. Both Zoo Architect, Sue Chin, from the Bronx Zoo and Zoo Architect, Wayne Chang, from CLR Designs in Philadelphia, PA expressed that the polar bear is one of the hardest animals to design for which to design a habitat enclosure. Not only is it difficult to recreate the arctic environment in general, it is also hard to provide the necessary amount of space needed for the polar bears.

It is time to start examining and addressing the polar bear's needs and requirements for a more ideal captive environment. A study conducted several years ago by the Association for Zoos and Aquarium examined the stress levels of captive polar bears. The study was conducted at 20 zoos within Canada and the USA. Out of 54 polar bears examined in the study, 50 were reported to have stress problems. As a proud Philadelphian, it is necessary to note two of those four polar bears without stress problems lived at the Philadelphia Zoo. Clearly it is time to address the needs of the polar bear and the design flaws in their typical zoo habitat.

2. They May Need a New Home

Man-made climate change has become a major threat to polar bears. According to Canadian and International sea ice experts, the polar bears are losing about 11% of their sea ice habitat

each year.¹⁹ The shrinking summer sea ice extent is detrimental to the polar bear because they depend on the ice to hunt for seal. Polar bears walk along the sea ice in hopes of being able to catch a seal surfacing for air. Since the ice melts earlier in the summer and forms later in the season, the polar bears' hunting season is shortened on average by about 30 days each year. Global climate change is causing polar bears to starve, not overheat, as many people assume.²⁰

Internationally, the polar bear was upgraded from a species of Least Concern to a Vulnerable Species in 2005 by the IUCN Polar Bear Specialist Group. In the United States, they were listed as threatened species in 2008 under the Endangered Species Act. As of 2014, there are between 22,000-31,000 polar bears in existence. This overall population is broken down into 19 different polar bear sub-populations. The trends in polar bear subpopulations can be found below.

21

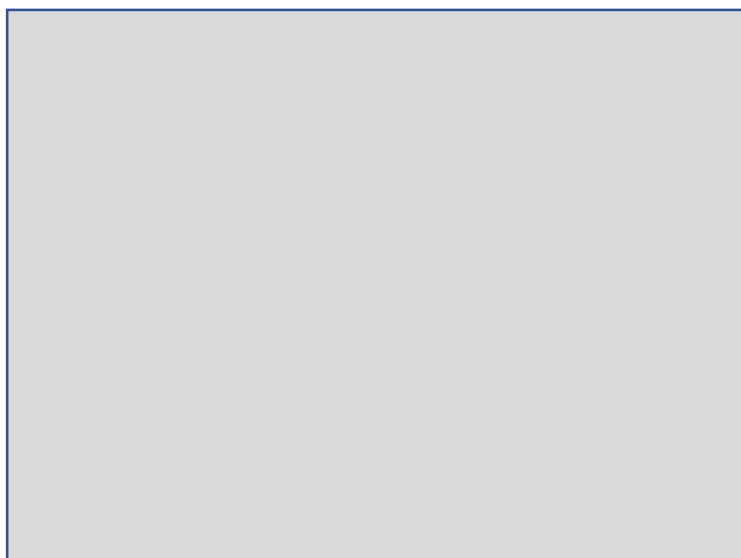


Figure 3. Trends in Polar Bear Sub-populations (Source: WWF)

¹⁹ "The Last Ice Area," *World Wildlife Fund Global*, accessed May 4, 2017, http://wwf.panda.org/what_we_do/where_we_work/arctic/last_ice_area/.

²⁰ Steven J. Desch et al., "Arctic Ice Management," *Earth's Future* 5, no. 1 (January 2017): 107–127, accessed May 9, 2017, <http://doi.wiley.com/10.1002/2016EF000410>.

²¹ "Polar Bear | Species," *World Wildlife Foundation*, accessed May 4, 2017, <http://www.worldwildlife.org/species/polar-bear>.

The effects of global climate change on the polar bear's habitat and population begs the question, "What will happen to the polar bears if the sea ice is completely eliminated?" If in fact climate change cannot be reversed and the arctic sea ice does completely melt, the wild polar bear will most likely become extinct. Scientists predict that by the turn of the century, about 2/3 of the polar bear population will be gone.²² Some scientists even predict that polar bears will be entirely extinct by 2050.²³ Humans, however, might have the opportunity to save the remaining polar bears by removing them and placing them in a temporary habitat enclosure. The hope would be to protect these beautiful creatures and reintroduce them into the wild once and if climate change can be reversed and sea ice reforms. Although it seems like an extreme idea, this idea may need to be realized sooner than we think. This thesis can act as a small-scale prototype of a larger man-made arctic environment that the polar bears may require for their continual survival.

3. They are Ambassadors of the Catastrophic Effects of Climate Change

The polar bear is considered a flagship species. "A flagship species is a species that acts as an ambassador, icon, or symbol for a defined habitat, issue, campaign or environmental cause."²⁴ The polar bear acts as a symbol of the current environmental crisis – global climate change. The global climate change created by man-made activities is directly affecting the polar bear's arctic

²² Jane Palmer, "Will Polar Bears Become Extinct?," *BBC*, last modified 2014, accessed October 23, 2017, <http://www.bbc.com/earth/story/20141107-will-polar-bears-become-extinct>.

²³ Larry Greenemeier, "U.S. Protects Polar Bears Under Endangered Species Act - Scientific American," *Scientific American*, last modified 2008, accessed March 2, 2017, <https://www.scientificamerican.com/article/polar-bears-threatened/>.

²⁴ "Global Species Programme: How WWF Classifies Species | WWF," accessed April 12, 2017, http://wwf.panda.org/about_our_earth/species/flagship_keystone_indicator_definition/.

habitat as well as all other arctic species. However, man-made climate change is not only affecting the Arctic - it is affecting the entire Earth and all living creatures on it.

Ever since 1979, satellites have been measuring sea ice extent. This information has helped to lead scientists to believe that Earth is suffering from global climate change. These many years of collected data show that it has been eerily warm in the Arctic (and across the globe) the past two winters. Warm temperatures are melting the Arctic sea ice faster than before and Arctic winter sea ice has reached an all-time low for the third consecutive year. In March 2017, the Arctic sea ice was 471,000 square miles less than the average area of 5.57 million square miles. NSIDC director Mark Serreze says these past two winters are unlike anything he has seen in the past 35 years.²⁵ Scientists believe that the declining sea ice is caused by natural weather, but also by man-made climate change caused by burning fossil fuels (coal, oil, gas).

Many scientists believe that the dramatic decline in sea ice is one strong indicator of global climate change. “Nature is sending us yet another distress call – the time to address human-caused climate change is now,” said Lou Leonard of the World Wildlife Fund. “The Arctic is dramatically changing and worldwide, people, communities and wildlife are at risk from its cascading effects.”²⁶

The polar bear, who is directly affected by climate change and is dramatically losing its sea ice habitat, can act as an ambassador to help educate the public. The polar bear can act as an ambassador to climate change both out in the wild and in captivity. In the wild, polar bears are

²⁵ Doyle Rice, “The Arctic, Antarctic Poles Just Set a New Record for Low Levels of Sea Ice,” *USA Today*, last modified 2017, accessed March 23, 2017, <http://www.usatoday.com/story/weather/2017/03/23/artic-antarctic-sea-ice-shrinks-record-low/99530332/>.

²⁶ “Global Species Programme: How WWF Classifies Species | WWF.”

slowly starting to starve to death due to lack of sea ice. National Geographic photographer, Paul Nicklen, has taken several photographs of polar bears, both dead and alive, to raise awareness about climate change and the polar bear's dire situation. His photos are very powerful and help to portray the situation very clearly.

The polar bear can also act as an educational ambassador in captivity. As explained earlier, one of the main functions of a zoo is to educate the public, not only about the species itself, but also about the situation the species faces out in the wild. Therefore, the polar bear can help to educate the public about climate change through its habitat enclosure. If the public can learn about the polar bear and its current situation through the habitat enclosure, then perhaps they will take stock of their own situation and devise ways to reverse the effects of our self-imposed climate change. We want humans to learn as much as they can about the polar bear if we want them to understand climate change and its detrimental effects to the animal as well as to mankind.

Thesis Goals

The goal is to use the polar bear and the polar bear habitat enclosure as the iconic symbol of the effects of global climate change. Many people are vaguely aware of situation polar bears are in. The hope is that this exhibit will help to dramatize the situation and bring a greater understanding to the issue.

This specific habitat is not specifically intended for animal repopulation and release back into the wild. Rather, it is intended for a more educational purpose to save the endangered population in the wild.

Chapter 4: Polar Bear Needs

Chapter Goals

The goal of this chapter is to examine the polar bear's natural environment and their needs in the wild. This chapter will help lay the framework for the driving design elements of the thesis.

Where do they live?

Polar bears live in the circumpolar arctic in Alaska (US), Canada, Greenland, Norway and Russia. About 60-80% of polar bears reside in Canada.²⁷ Although many of the environmental conditions in these 5 countries may be similar, the thesis will analyze Barrow, Alaska for a few specific measurements. The town of Barrow is located on the northern edge of Alaska in the tundra region, between the Arctic Ocean and the Taiga forested region.

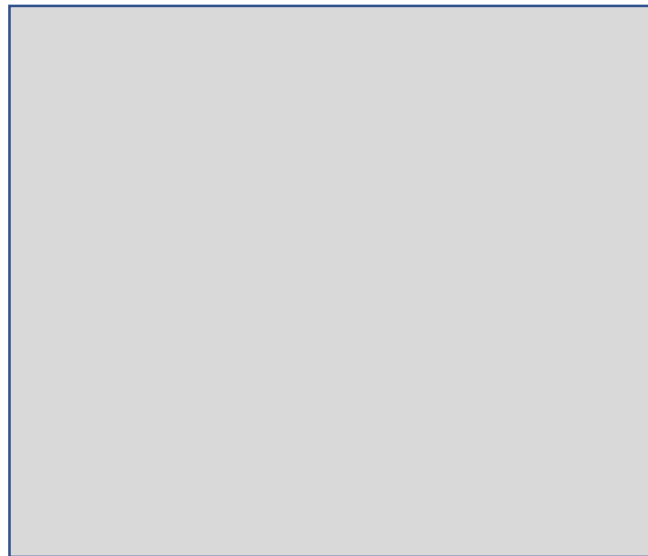


Figure 4. Regions of Alaska (Source: National Park Service)

²⁷ "Habitat," *Polar Bears International*, accessed March 5, 2017, <http://polarbearsinternational.org/polar-bears/habitat/>.

This specific sea ice region was chosen because polar bears in this area are most the most threatened and therefore, may need to be saved first. It should also be the easiest climate for the visitor of the habitat enclosure to understand, considering the thesis site and Alaska are both in the same country.

The map below shows the critical sea ice habitat defined by the ESA that are essential for the polar bear conservation in Alaska. Barrow is at the top of Alaska



Figure 5. Sea Ice Critical Area (Source: U.S. Fish and Wildlife Service)

Natural Habitat Characteristics

1. Air conditions

The temperature in Barrow, Alaska can range anywhere between -20°F to 47°F. The average low in February is -20°F and the average high in July is 47°F.

2. Water Conditions

The Beaufort Sea borders Barrow, Alaska to the North. This 184,000-square mile area of the Arctic Ocean is 3,239 feet deep on average. However, on the coast of Barrow it is about 210 feet deep.

The salty surface water temperature ranges from 29.5°F in the late summer to 28.8 °F in the winter.

²⁸ Salt water must be 28.8°F in order to freeze and form sea ice.²⁹

3. Sea Ice

The polar bear needs sea ice to survive and thrive. Since they do not hibernate like other bears, polar bears spend most of their lives on the sea ice.³⁰ The polar bear follows the movement of the sea ice, so if the ice does not move very far, neither does the polar bear. Sea ice goes through a constant cycle – it freezes and extends in the winter and then melts and recedes in the summer. During the winter, Arctic sea ice can be anywhere between 1-2 meters deep, with a thin layer of snow covering it.³¹

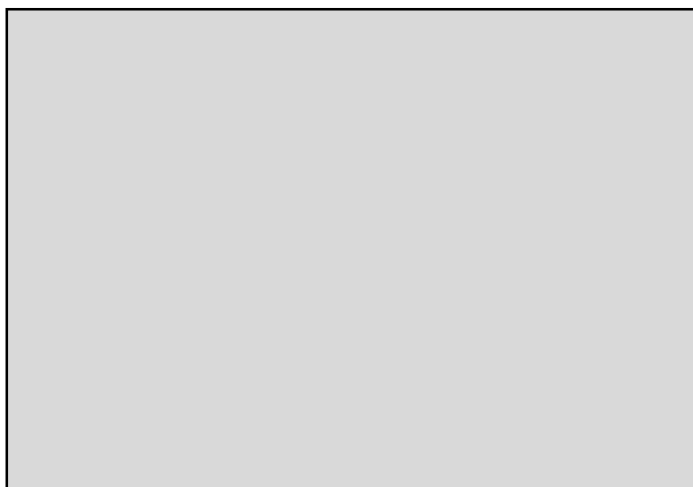


Figure 6. Polar Bear on Sea Ice (Source: Gert Polet / WWF)

²⁸ “Beaufort Sea,” *Britannica*, last modified 1998, accessed April 23, 2017, <https://www.britannica.com/place/Beaufort-Sea>.

²⁹ “All About Sea Ice | National Snow and Ice Data Center,” *National Snow & Ice Data*, accessed April 23, 2017, <https://nsidc.org/cryosphere/seaice/index.html>. “Beaufort Sea.”

³⁰ Susan McGrath, “National Geographic Magazine - NGM.com,” *National Geographic*, last modified 2011, accessed April 16, 2017, <http://ngm.nationalgeographic.com/print/2011/07/polar-bears/mcgrath-text>.

³¹ R. Kwok, “Annual Cycles of Multiyear Sea Ice Coverage of the Arctic Ocean: 1999–2003,” *Journal of Geophysical Research* 109, no. C11 (2004): C11004, accessed April 16, 2017, <http://doi.wiley.com/10.1029/2003JC002238>.

4. Seals

Polar bears spend about 50% of their lives hunting seal, their main source of food. Seals are the only food source which are high enough in fat content for the polar bear. Since the seal's blubber is so high in fat and protein, polar bears can survive about a week before they need to successfully capture another seal. The ringed seal is also the most abundant type of seal in the arctic. The polar bear also likes the ringed seal because its small size also makes it easy to capture.³² When seals are not available to hunt, the polar bear may eat walrus or beluga whales. As a last resort, polar bears will eat small mammals, bird eggs and vegetation.³³

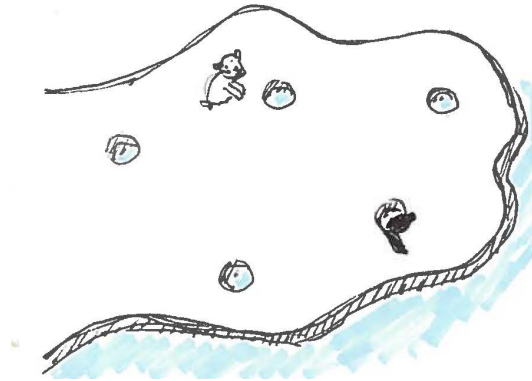


Figure 7. Seal and Polar Bear Relationship (Source: Author)



Figure 8. Ringed Seal poking head out of breathing hole (Source: Polar Bear International)

³² National Marine Mammal Laboratory, "National Marine Mammal Laboratory" (n.d.), accessed May 9, 2017, <https://www.afsc.noaa.gov/nmml/education/pinnipeds/ringed.php>.

³³ ("Beaufort Sea" 1998)

Polar Bears hunt and capture seals using three different tactics. The most common tactic is for the polar bear to wait at the edge of a breathing hole (agulus) in hopes that a seal will pop his head out. Seals cut about 10-15 breathing holes into the ice up to 6 feet deep, which remain open all winter long. Seals may also surface for air in leads (cracks or water channels) or polynyas (open areas of water surrounded by ice). A second yet unpopular option is to dive into the water to capturing them. The third option is to venture into the seals' Op; between the snow cover and sea ice to capture mother and seal pups. The polar bear is easily able to locate the seals using its keen sense of smell. ³⁴

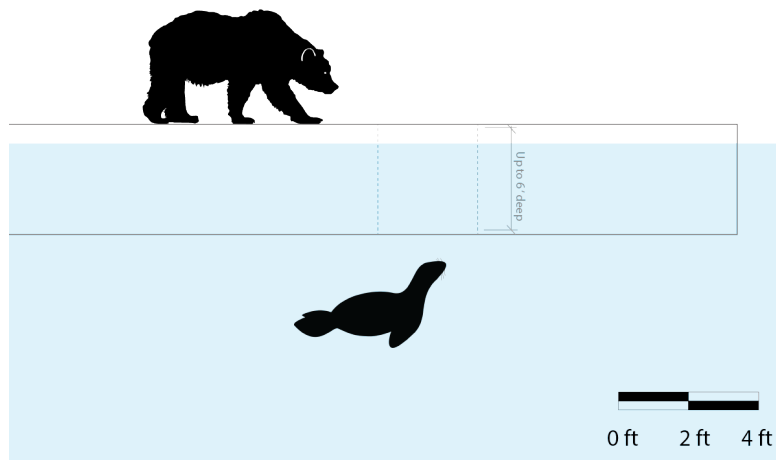


Figure 9. Relationship between Polar Bear and Seals (Source: Author)

³⁴ "Polar Bear Hunting," *Polar Bears International*, accessed May 4, 2017, <http://polarbearsinternational.org/polar-bears/hunting/>.

5. Social Interactions in the Wild

Polar bears are usually solitary animals, unless they are mating or taking care of their young.



Figure 10. Polar Bear Social Relationships (Diagram by Author)

Polar bears are mainly solitary animals for hunting purposes. Polar bears usually hunt alone on the sea ice since it doesn't make sense for many polar bears to sit around one seal blow hole. However, once a seal is captured, polar bears are known to be very generous with their food and will share with others. It is common to see several polar bears feasting on a seal or whale carcass.³⁵ This thesis is designed for multiple polar bears, including a litter. Therefore, there will need to be ample room for all the polar bears to have their own space and enough space for their litter.

Mating Relationship

Although they are solitary animals, polar bears are not anti-social. Male and female polar bears interact during mating season (late spring and early summer). Couples stay together for only 1-2 weeks.³⁶ If there is one polar bear in the designed habitat, then the habitat can participate in an animal breeding exchange program. However, if there are two or more polar bears then the habitat can be designed with separate spaces for male and female during non-mating seasons.

³⁵ Ian Stirling, *Polar Bears* (Ann Arbor: The University of Michigan Press, 1998).

³⁶ "Polar Bear | Species."

Mother and Cub Relationship

Mother polar bears start to dig out a large den in Autumn where snow has accumulated, usually by a water's edge. The gestation period of a polar bear is only 3 months, and the mother cub welcomes their cubs in December or January. The mother usually has 2 cubs and the twins will stay with their mother for about 2-2.5 years after birth and then the female will mate again.³⁷

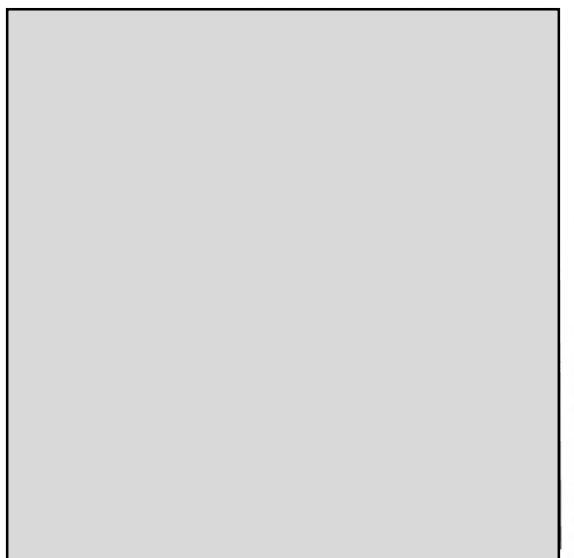


Figure 11. Birthing Den Typologies (Source: *Polar Bears* by Ian Stirling)

6. Sufficient Space

The polar bear's habitat area and distance traveled depends solely on the moving sea ice and the location of the seals. Polar bears do not require a specific amount of territory for this reason. If the sea ice does not move and there is ample amount of seal prey, then the polar bear does not need much space. Scientists believe that a polar bear's home base is a few hundred miles in length.³⁸

³⁷ "Polar Bear Species Profile, Alaska Department of Fish and Game," accessed April 16, 2017, <http://www.adfg.alaska.gov/index.cfm?adfg=polarbear.main>.

³⁸ "Polar Bear Habitat," *Polar Bears International*, accessed May 4, 2017, <http://polarbearsinternational.org/polar-bears/habitat/>.

Again, this movement is only due to the changing sea ice. However, polar bears seem to have a sufficient need enough space to walk about and swim.

Satellite tracking records have shown that one female polar bear walked a total of 4,796 miles. Tracking located another polar bear who swam for 426 miles straight but this is not a normal travel distance.³⁹ These extreme distances traveled are the result of climate change. The polar bears need to travel further and further to find suitable sea ice to hunt. If the sea ice only moves a few miles, then in theory, so does the polar bear.

7. Long Horizontal Views

Polar bears in Alaska are accustomed to long, unrestricted views in the wild. They either see vast arctic ocean or the Boreal Forest in the distance and sea ice in the foreground. Their eyesight is comparable to that of humans which means they can see clearly for long distances.⁴⁰

8. Interactions with Humans

Polar bears have always interacted with humans. Historically, Inuit used to hunt polar bears for food and clothing.⁴¹ Recently, humans and polar bears have been interacting more frequently. Due to recent shrinking sea ice, polar bears are starting to roam closer to human settlement. Also, cruise ship tourism allows humans to interact with the polar bear from the ocean. Polar bears are usually at the same level or higher than the humans and they prefer this interaction.⁴²

³⁹ Ibid.

⁴⁰ “Polar Bear Species Profile, Alaska Department of Fish and Game.”

⁴¹ Stirling, *Polar Bears*.

⁴² A Z A Bear TAG, “Polar Bear (*Ursus Maritimus*) Care Manual” (2009): 1–95, https://www.aza.org/assets/2332/polar_bear_care_manualr.pdf%5Cnpapers3://publication/uuid/15EDEE99-2C27-462F-A9D9-EF08DD5A139F.

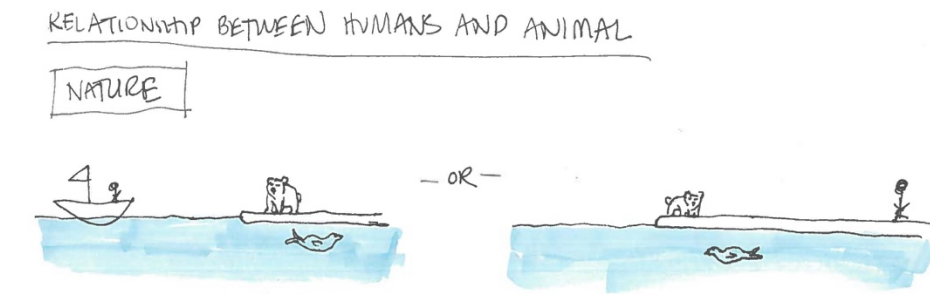


Figure 12. Relationship Between Humans and Animals (Source: Author)

In summary, the polar bear's natural environment consists of:

1. Water
2. Sea Ice
3. Seals
4. Cold Air Temperature
5. Ample Space to Roam
6. Den Space
7. Solitude
8. Social Interactions for Mating
9. Long Horizontal Views (to water or trees)
10. Human Interactions

The following elements are needed to educate the public and properly tell the polar bears story through the exhibit. If all the other elements are not in the exhibit, the visitor will still be able to understand what is happening in the wild if these three elements are incorporated.

- 1. Water**
- 2. Sea Ice**
- 3. Seals**

Thesis Goals

The goal is to recreate the exhibit as best and as accurately as possible, mainly for educational purposes. Water, sea ice, and seals must be incorporated into the design to properly tell the plight of the polar bear effectively.

This exhibit will have 1-2 polar bears. It is not necessary to have more than 2 polar bears because the goal is to educate, not to become a conservation center for the future. Polar bears prefer to be in solitude unless mating. Also, since the purpose is not to breed polar bears with the intent of releasing back into the wild, the design does not have to be exact. For example, fresh water can be proposed instead of salt water, as long as the visitor still understands that polar bears live near bodies of water.

Chapter 5: Site Selection

Initially, three different sites were taken into consideration for the polar bear habitat enclosure – the Arctic, a Zoo, and an educational hub.

Option 1: In the Arctic

Logically, the polar bears' natural habitat was the first site explored. Polar bears are naturally found living on Arctic sea ice, specifically in Alaska, Canada, Greenland, Norway and Russia. Polar bears are unique in the sense that their habitat is not constant, but changes with the changing sea ice extent and the location of their seal prey. Sea ice thaws in the summer and refreezes in the winter. Ultimately, the last polar bears will be found wherever the sea ice extent remains in the summertime. Scientists have designated four different regions of sea ice based on geography, statues, sea ice levels, and most importantly for this site selection, susceptibility to climate change. Scientists have deemed the Archipelago Ice region as the most resilient to climate change and predict this region will be the only remaining summer sea ice in 2040. However, if climate change continues, all sea ice is expected to be nonexistent by 2050.⁴³

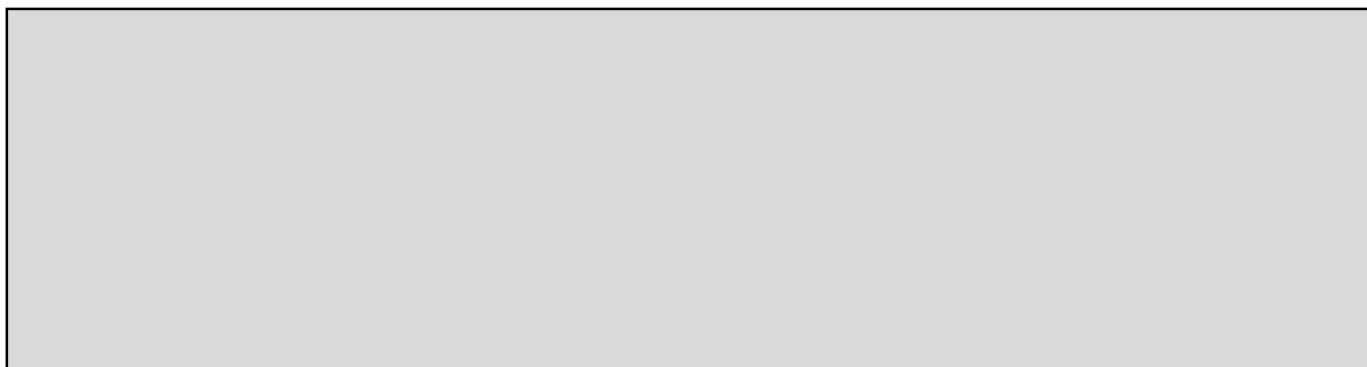


Figure 13. The Archipelago Ice. Map Produced (Source: Polar Bears International)

⁴³ "Polar Bear Habitat."

The Archipelago Ice Region is in The Gulf of Boothia, Kane Basin, Lancaster Sound, M’Clinktock Channel, Norwegian Bay, and the Viscount Melville Sound. This region of sea ice is specifically located on the coast of Nunavut, a northern territory in Canada. If this site were chosen, the habitat enclosure would be located on land near one of these six bodies of water, perhaps on Boothia Peninsula or Somerset Island, for example.



Figure 14. The Last Sea Ice – 2040 (Source: WWF-Canada, March 29, 2010)

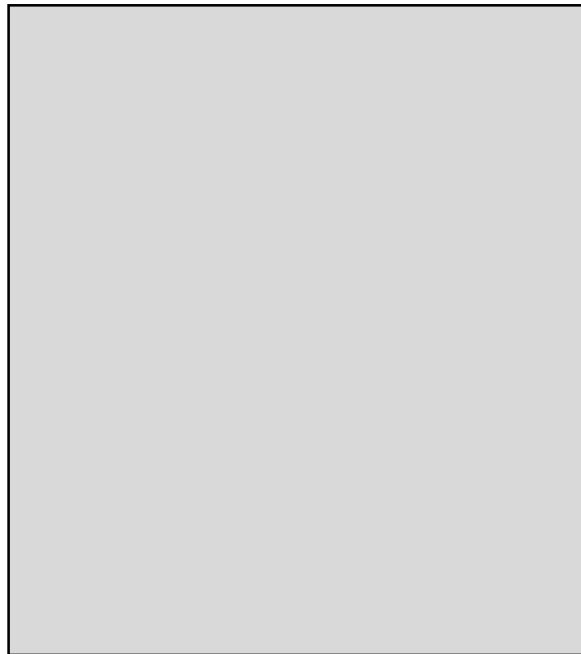


Figure 15. Archipelago Ice Region in Nunavut (Source: Worldatlas.com)

This site location was important to explore because this could be the last natural habitat on earth for the polar bear. Once the Arctic sea ice is eliminated, the only polar bears remaining will be those in captivity, and this site will allow them to be as close to their natural habitat as possible.

At first thought, the idea was to perhaps build a shelter nearby for the remaining polar bears, where they could retreat in 2050 after the sea ice is completely melted. They could stay in this manmade habitat forever, or until humanity finds a way to reverse the effects of global climate change.

There are a few issues with this site, such as educating many people about climate change. Placing the habitat enclosure in Nunavut would only attract visitors who deliberately sought it out. The people who would be visiting the area would most likely already be believers in climate change.

Option 2: In a Zoo

The second location considered for the habitat enclosure was the currently existing elephant house structure at the National Zoological Park in Washington, DC. Currently, there is no polar bear exhibit in this zoo. This location would bring the global climate change issue into the politicians' backyard. It would also bring the issue to many visitors who frequent the zoo. The National Zoological Park is one of only three zoos in the U.S. that currently is still free because this zoo is part of the Smithsonian Institution. This option is a better location than Nunavut because there would be more visitors to this site than to Nunavut and therefore better for the intended educational purpose. Placing the museum in D.C., the heart of America, would allow many people to access free education and awareness about the issue of climate change. Also, placing it in a zoo allows visitors who did not intentionally seek out the habitat

enclosure, to stumble upon it and learn from it. By placing it in a zoo, the habitat enclosure can educate both the believers and the non-believers of the global climate change issue.

As previously mentioned, there is no current polar bear habitat in the National Zoological Park. From 1959 to 1980, the park housed 13 polar bears. The NZP ceased to house polar bears because the facilities were no longer adequate by the AZA. At present, there is no plan to create a new exhibit because to do so would be too costly.⁴⁴ Moreover, it would be hard to obtain a polar bear for the exhibit. There are currently only 43 polar bears in captivity in 24 zoos and it is very difficult to legally remove a polar bear from the wild.⁴⁵

The idea to repurpose the elephant exhibit at the National Zoological Park would be a sustainable tactic. Usually, reusing an existing building uses less energy, materials and fuel than building a new structure. Although repurposing the elephant house would likely be sustainable and fit with the theme of the habitat enclosure, it does not seem economically justifiable to redesign a space that has just been upgraded in 2013, at the cost of 56 million dollars. The original exhibit from the 1930s, was not large enough for the elephants. The exhibit is now 8,943 square meters, which is large enough to hold eight to ten Asian elephants.⁴⁶ National Guidelines adopted in 2011 required some zoos to either expand their elephant exhibits by 2017, or be forced to close or repurpose those facilities. The National Zoological park clearly valued having an elephant exhibit and chose to upgrade its facilities. The initial thought behind repurposing the elephant exhibit was that it had enough space

⁴⁴ Juliet Eilperin, "Captivity Could Help Polar Bears Survive Global Warming Assault, Some Zoos Say - The Washington Post," *Washington Post*, last modified 2012, accessed March 26, 2017, https://www.washingtonpost.com/national/health-science/captivity-could-help-polar-bears-survive-global-warming-assault-some-zoos-say/2012/03/21/gIQAkIWfAS_story.html?utm_term=.1c2d1bd90c99.

⁴⁵ Worland, "The Future of Zoos."

⁴⁶ "National Zoo's Elephant Trails Gives Animals More Room To Roam | The Huffington Post," *The Huffington Post*, last modified 2013, accessed March 26, 2017, http://www.huffingtonpost.com/2013/03/19/national-zoo-elephant-trails_n_2902892.html.

needed for a polar bear habitat (according to the AZA polar bear care manual). 1-2 Polar bears need about 6,000 square feet of dry land and a minimum of 760 square feet of water. The elephant house site was large enough to house at least 2, if not more, polar bears if so chosen for the habitat enclosure.



Figure 16. Elephant Trail Exhibit Size Comparison (Google Maps edited by Author)

Option 3: Within an Educational Hub

The third option under consideration was near the National Mall in Washington D.C, specifically at Constitution Gardens. This site seemed most ideal for the habitat enclosure location because of its history, its position adjacent to other Smithsonian uses on the mall, and the very large number of visitors who frequent the site each year. The national mall is the most visited National Park in the country, welcoming 21.3 million visitors in 2015. 2 million of these visitors came from overseas. Most people from outside the USA come from China, United Kingdom, Germany, Australia, France, India, South Korea, Brazil, Italy and Japan.⁴⁷

⁴⁷ “Media Fact Sheet | Washington.org,” *DC Press*, last modified 2017, accessed March 27, 2017, <https://washington.org/DC-information/washington-dc-fact-sheet>.

Although a couple million visitors enter the National Zoological Park, far more people visit the national mall each year. Since this is the case, more people can be exposed and educated about climate change and the plight of the polar bear by placing the museum on the national mall. Also, by placing it in the Nation's capital, not only will American citizens become educated, but people from all over the world as well can be exposed to the message. It is important to note that most of these visitors are the wealthy people from the countries that contribute the most to climate change. Since climate change is indeed a global issue, it makes sense to choose a site that will have a global audience.

While the U.S. has been active in leading climate change efforts through education and agreements among many nations, it is still very far behind in progress compared to other countries. In addition to educating the public, this site will also bring the climate change issue to the politicians' backyard. Some politicians believe that climate change is fictitious and there has been talk about the U.S. pulling out of the Paris agreement. By placing this habitat on the National Mall, the habitat enclosure can help to educate the non-believing or uninformed visitors. It can also help to alert and warn the non-believing politicians.

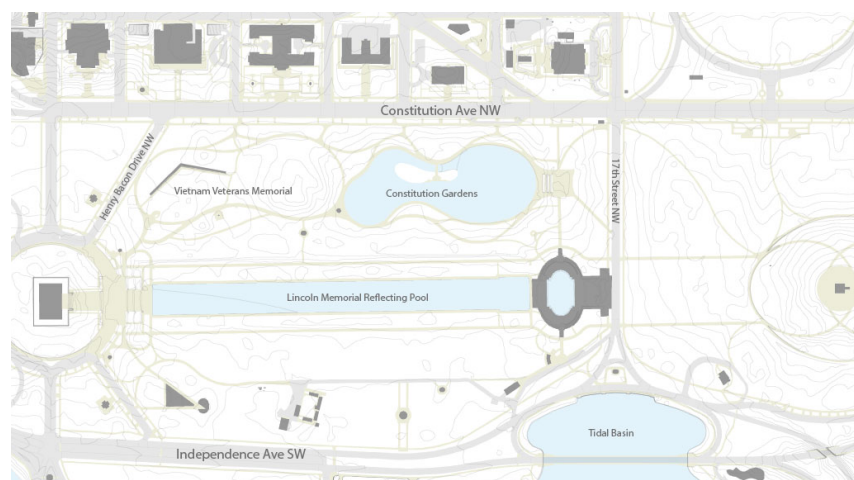


Figure 17. Map of Site (Source: Author)

A few different areas around the National Mall were explored and considered for the site. One key characteristic that linked all the considered sites was the proximity to a body of water. Around the National Mall, there are four prominent bodies of water – most famously, the Lincoln Memorial Reflecting Pool. Other bodies of water are the US Capital Reflecting Pool, The Tidal Basin and Constitutions Gardens Pond. Placing the habitat enclosure on either the Lincoln Memorial Reflecting Pool or the US Capital reflecting pool seemed unfeasible and too close to prominent historic structures, the Lincoln Memorial and US Capital, respectively. The Tidal Basin was also eliminated as an option because it is surrounded by major roadways, with almost no land beside the water to build on and it is connected to the Potomac River. It would be harder to manage the water on this site.

Out of all the bodies of water on the National Mall with proximity to the Smithsonian museums, The Constitution Gardens Pond seemed to be the ideal location for the habitat enclosure. First, there is enough space along the edge of the pond. Building on this location would provide more land and water area than is required for a polar bear habitat, according to the Polar Bear Care Manual.

The Polar Bear Care Manual “should be considered a work in progress, since practices continue to evolve through advances in scientific knowledge.”⁴⁸ The square footages listed for a polar bear habitat are considered minimum standards for the well-being of the captive polar bear, and designing above the land and sea area required for a habitat is not discouraged. Although polar bears have the potential to travel up to hundreds of miles in their natural habitat, most of the time they are simply walking back and forth along the same area of sea ice. The Constitution Gardens

⁴⁸ TAG, “Polar Bear (*Ursus Maritimus*) Care Manual.”

36-acre site would provide the polar bear way more space than the manual requires, giving them ample room to roam and walk around.



Figure 18. Constitution Gardens Comparison Size (Source: Google Maps edited by Author)

Another reason why Constitution Garden pond is a great location is because of the views that the polar bear might be provided. In an urban setting, it is difficult to get long views. However, within the Constitution Garden Site, the polar bear might be afforded an unobstructed view of at least up to 400 feet.

In addition to the many reasons stated above, Constitution Garden Pond would be an ideal location for the habitat enclosure because it is right on axis with the Smithsonian museums. This site location would allow the visitors who frequent the museums to easily find, or accidentally discover, the polar bear habitat enclosure during their visit to the National Mall. Also, as previously mentioned, by placing the habitat enclosure by these institutions of education and learning, it strengthens the habitat enclosure's mission to educate the public about a global issue. The history and development of the National Mall and the Smithsonian Institute will be considered in the next chapter.

Chapter 6: Site Analysis

History of the National Mall

The plan of the city of Washington was designed by Pierre L’Enfant in 1791. To this day, the plan is still close to what L’Enfant imagined. He traveled from France to become a trusted city planner for George Washington. L’Enfant envisioned a U.S. capital full of wide avenues, public squares and inspiring buildings all centered around his idea of a “public walk”.⁴⁹ As seen



Figure 19. L’Enfant Plan of D.C. (Source: Library of Congress)

⁴⁹ Kenneth Fletcher, “A Brief History of Pierre L’Enfant and Washington, D.C. | Arts & Culture | Smithsonian,” last modified 2008, accessed April 9, 2017, <http://www.smithsonianmag.com/arts-culture/a-brief-history-of-pierre-lenfant-and-washington-dc-39487784/>.

in this photo, Constitution Gardens was non-existent. The Potomac River flooded over this region instead and was later dredged to become a park.

L’Enfant’s grand urban plan was expanded by the MacMillan Commission in 1902. This map shows how L’Enfant removed water from the Potomac to create land for the central axis for his scheme. Here, the Washington Monument is directly in line with the white house. Today, the Washington Monument is actually 300 feet to the east because the intended spot was too swampy for the heavy structure.⁵⁰

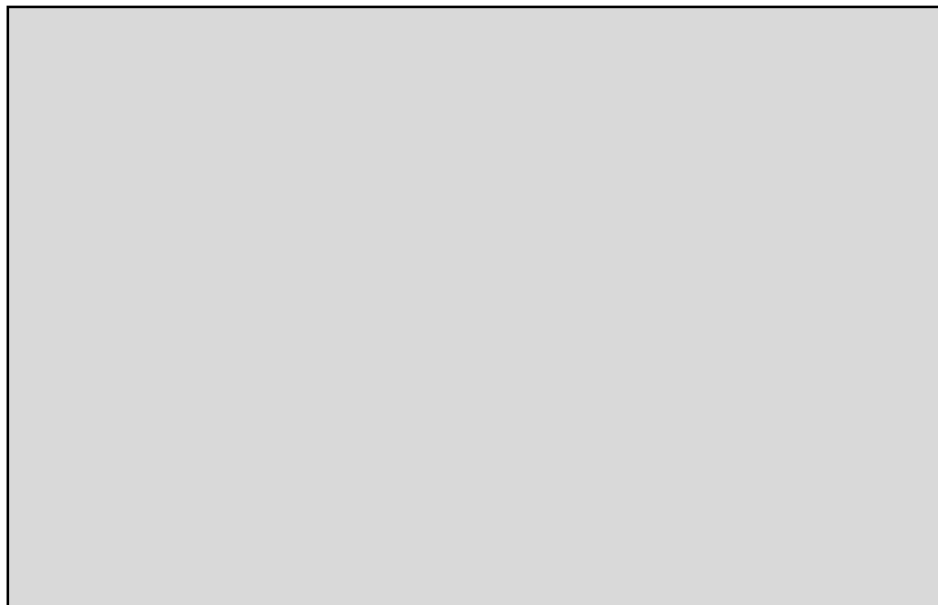


Figure 20. The McMillan Plan of Washington D.C. (Source: Cultural Landscape Foundation)

History of the Smithsonian Institute

In-between these two phases, the Smithsonian Institute was created. The Smithsonian Institute was founded in 1846 by British scientist, John Smithson. Smithson left Britain on a quest to create the Smithsonian Institute in Washington D.C. which would be “an

⁵⁰ Berg, Scott W. Grand avenues: the story of Pierre Charles L’Enfant, the French Visionary who designed Washington, D.C. New York: Vintage Books, 2008.

establishment for the increase and diffusion of knowledge.” “The Smithsonian became part of the process of developing an American national identity - an identity rooted in exploration, innovation, and a unique American style.”⁵¹ The Smithsonian is made up of 19 museums, 9 research facilities and a National Zoo, founded in 1889. Many of the Smithsonian Institutions are in the Washington D.C. area – 17 museums and a zoo. Two other museums are in New York City and one in Chantilly, VA. All Smithsonian museums are free of charge, except the Cooper Hewitt Museum in New York.⁵² The most recent Smithsonian museum is the African American History and Culture Museum, opened in 2016. Placing a habitat enclosure that educates about global climate change near the Smithsonian museums on the national mall would be perfectly consistent with John Smithsonian’s original intention – to increase and diffuse knowledge.

History of Site

All 50 acres of Constitution Gardens originally used to be under the Potomac River. The U.S. Army Corps of Engineers dredged the land in 1882 and created Potomac Park. In 1918, the government built temporary office structures on the site, called “tempos”. These structures were used by the US Navy and Munitions Department. President Nixon ordered the tempos to be demolished in 1971 and the land to be reused as a park. This later became known as Constitution Gardens. In 1976, the park was dedicated as a tribute to the American Revolution Bicentennial. It was designed by Skidmore, Owings, and Merrill and landscape Dan Kiley however, their original design was not realized. They wanted to build an east end pavilion with food service but it was never built. In 1984, the Memorial of the 56 Signers of

⁵¹ “Our History| Smithsonian Institution,” *Smithsonian*, accessed March 27, 2017, <https://www.si.edu/about/history>.

⁵² “Visiting Our Museums and Zoo| Smithsonian Institution,” accessed March 16, 2017, <https://www.si.edu/visit>.

the Declaration of Independence memorial island was built in the middle of the pond, created by EDAW (now AECOM). In 1986, President Ronald Reagan proclaimed that Constitution Gardens was to be a “legacy tribute to the Constitution.”⁵³

Site Analysis - Local Context

Constitution Gardens is situated on the National Mall in Washington D.C. The site is located on the corner of Constitution Avenue NW and 17th Street NW. Constitution Avenue borders the site to the north and 17th street NW borders the site to the east. There is no street bordering it on the south. The site is located near four of the most visited sites on the National Mall. It is situated to the west of the Washington monument, north of the Lincoln memorial reflecting pool and the WWII memorial, and east of the Lincoln Memorial.



Figure 21. Map of National Mall (Source: National Park Service)

⁵³ (“National Zoo’s Elephant Trails Gives Animals More Room To Roam | The Huffington Post” 2013)

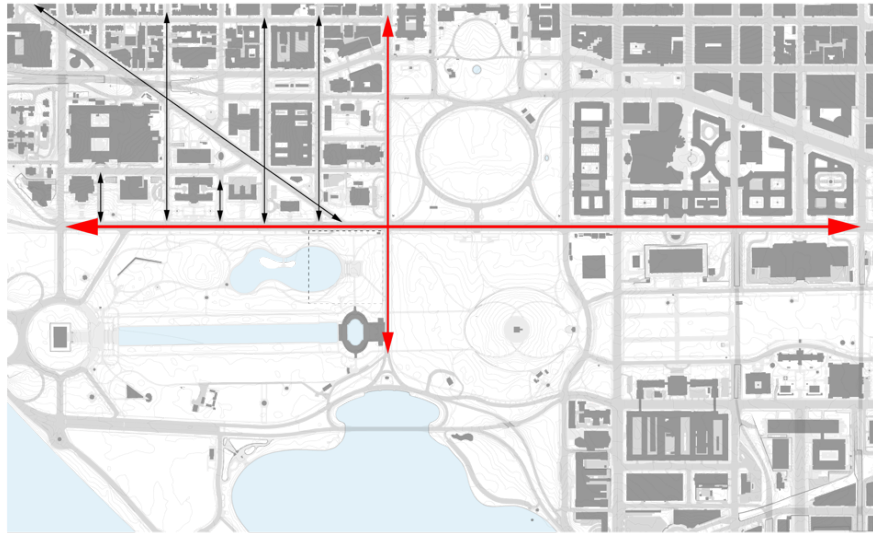


Figure 22. Major Roadways Near Site by Site (Source: Author)

Access: The site is easily accessible by foot, bike, car, and bus. The Metro Bus and D.C. Circulator both stop multiple times to the north of the site along Constitution Ave NW. There are also several metro stations nearby within walking distance such as Farragut North, Farragut West and McPherson Stations, Metro Center, Federal Triangle, Foggy Bottom – GWU.

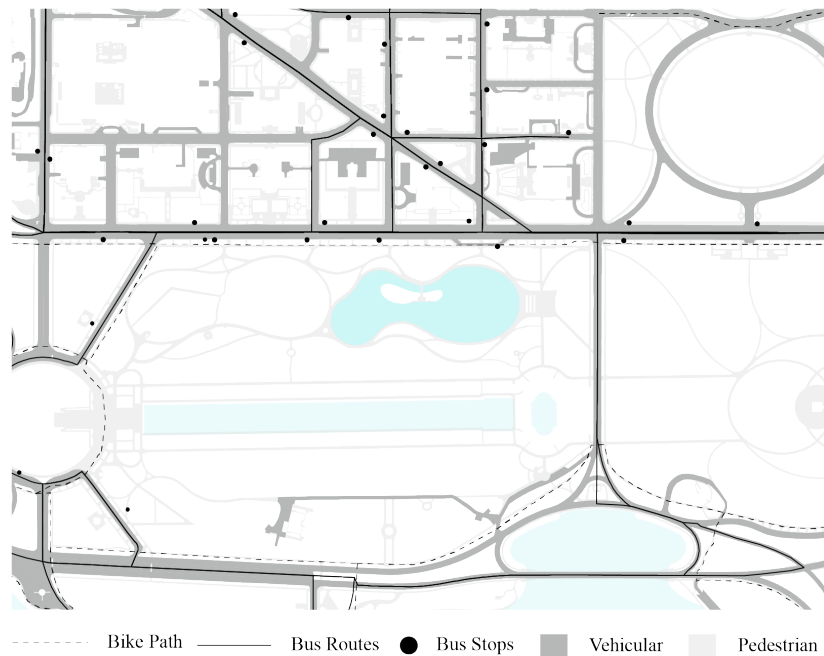


Figure 23. Access to Site (Source: Author)

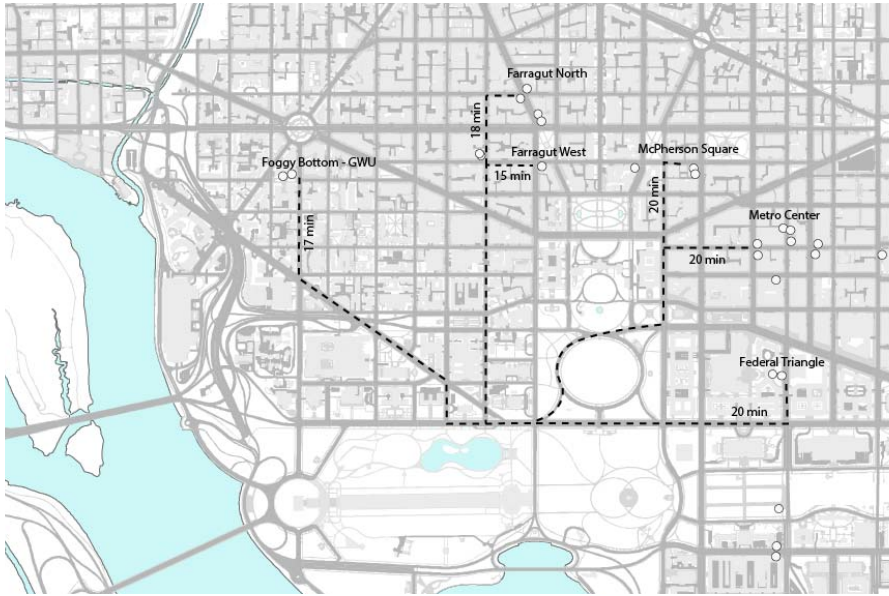


Figure 24. Map of Nearby Metro Stations (Source: Author)

Relationship to Smithsonian Museums: The Constitution Garden site is on axis with nearby Smithsonian buildings on the National Mall, within a 1 ¼ mile from the Smithsonian museums. The closest museum is the Smithsonian National Museum of African American History.

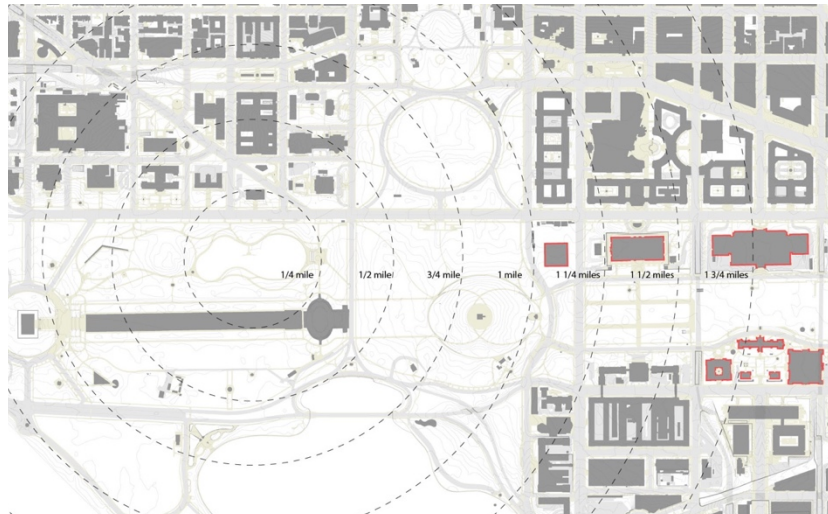


Figure 25. Distance Between Site and Smithsonian Museums (shown in red) (Source: Author)

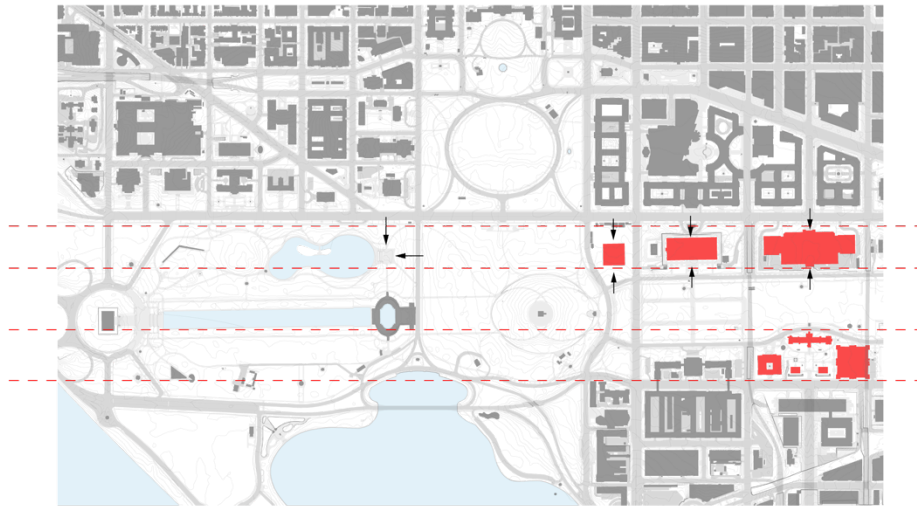


Figure 26. Relationship to Smithsonian Museums and their Entrances (Source: Author)

All three of the Smithsonian buildings are on axis with Constitution gardens have an entrance from the north and from south. From the north, pedestrians can enter off Constitution Ave NW. From the south, pedestrians can enter off Madison Drive, NW. Both roads are accessible by car and people can therefore park right next to the museum if there are any parking spots available along the street. It makes sense that the entrances to these buildings are located off the nearby streets.

Based on the relationship between the major and secondary roads and the relationship to the Smithsonian museums, the location that seems best suited for the natural habitat is the east side of the site. This location would allow more accessibility and visibility from people traveling by car and by foot to the site. The entrance to the enclosure could be placed along the north side of the site, to be in line with the Smithsonian museum entrances or also on the east side of the site.

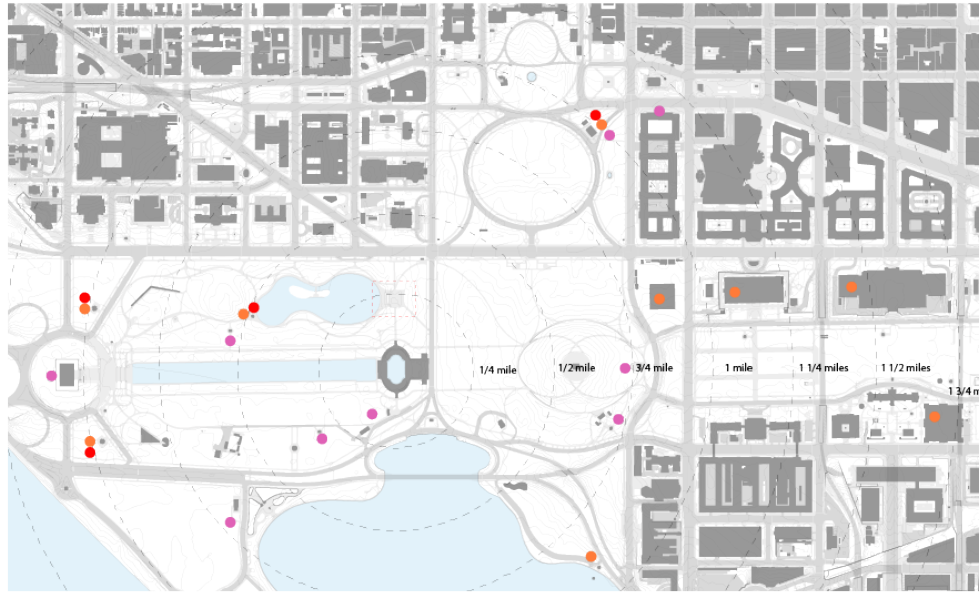


Figure 27. Amenities around the Site (Source: Author)

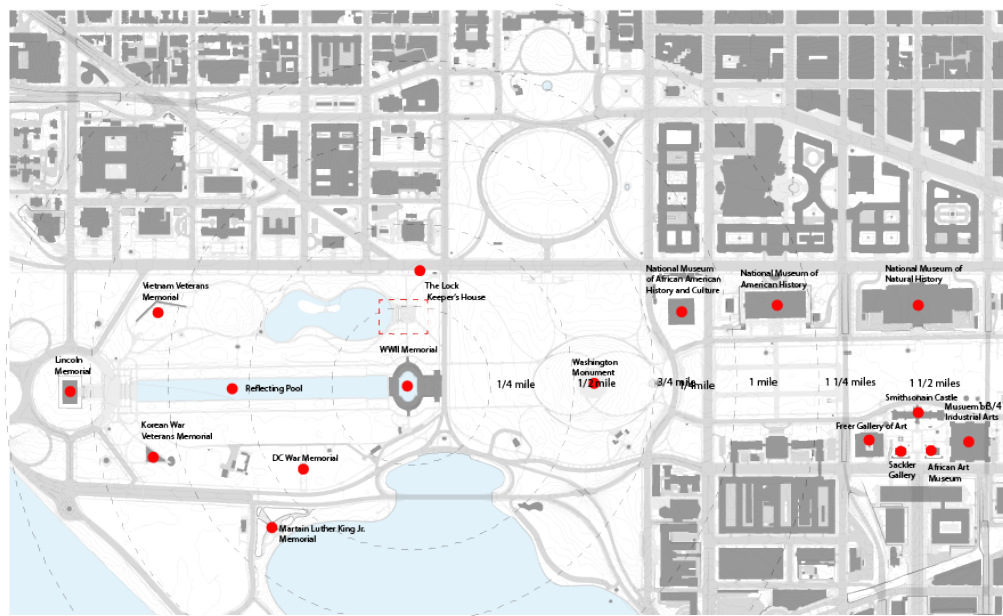


Figure 28. Attractions around the Site (Source: Author)

Site Analysis – Direct Context

Geometry: Although it is on line with the Smithsonian's and part of the McMillan plan, the entire Constitution Gardens site very organic in shape. The design was intended to “contrast the formalism of the grand axis.”

Topography: Naturally, The Constitution Garden Pond is situated at the lowest part of the site. There are many high points around the pond, ranging from 8-14 feet above the pond. These high points that surround the site provide a visual barrier and allow the park to feel like an urban oasis.

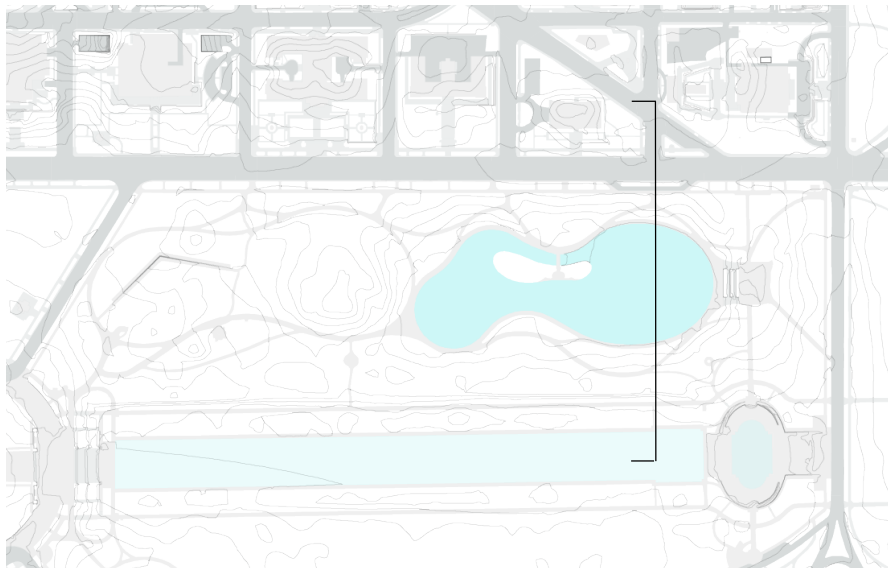


Figure 29. Elevation Diagram – 2 Foot Contours (Source: Author)

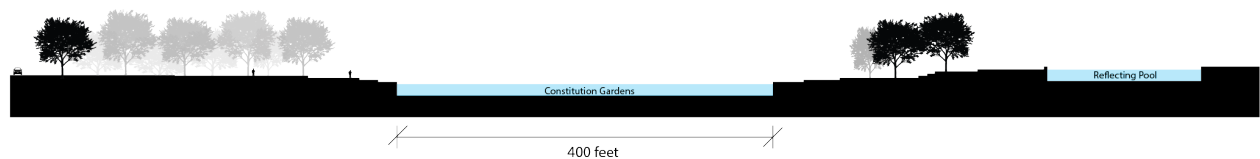


Figure 30. Transverse Section Across Site (Source: Author)

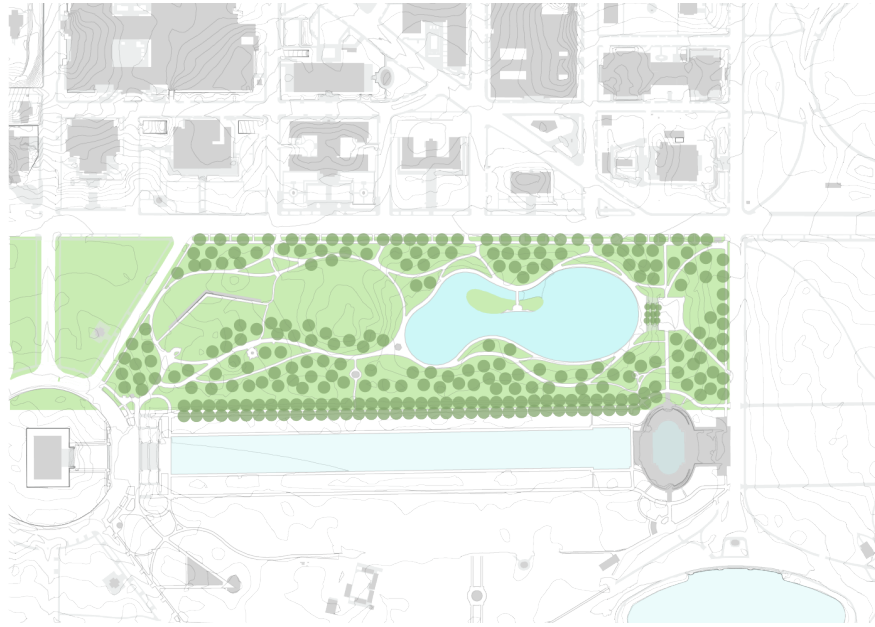


Figure 31. Existing Trees and Green Spaces at Constitution Gardens (Source: Author)

Existing Elm Trees ●

Vegetation: Designed as an urban oasis, Constitution Gardens is abundant with Elm trees. These trees provide shade for the many visitors and urban wildlife. Elm trees line the Lincoln Memorial to the north and south as part of the McMillian Plan. (Landscape firm citation)

Views from the Site: The site is surrounded by iconic landmarks – Lincoln Memorial, Lincoln Memorial Pool, The WWII Memorial, the Vietnam Memorial, and the Capital Building, and the National Monument to name a few. However, because of the topography and the amount of vegetation on the site, the only memorial that can be seen from within the park is the Washington Monument. It's soaring height allows it to be clearly seen above the trees, even from a visitor on a pathway by the pond. The memorial can be best seen from the north side of the site. The only other structure that can be from the site is the pavilion on the south west end of the pond.

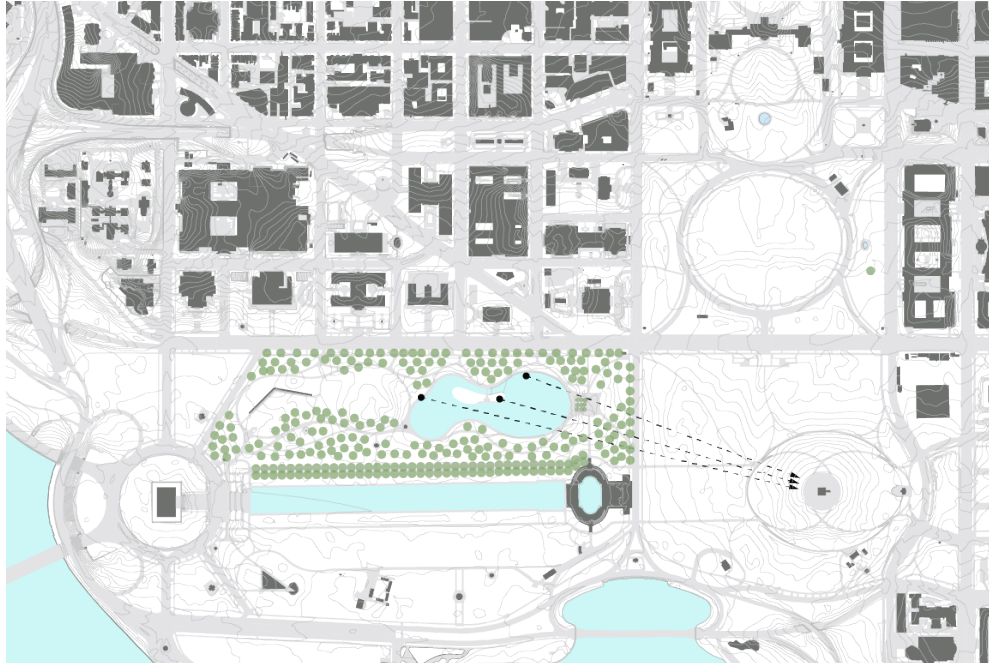


Figure 32. View Corridor of Washington Monument (Source: Author)



Figure 33. View of Washington Monument from West Side of Site (Source: Author)



Figure 34. View from East End Stairs (Source: Author)

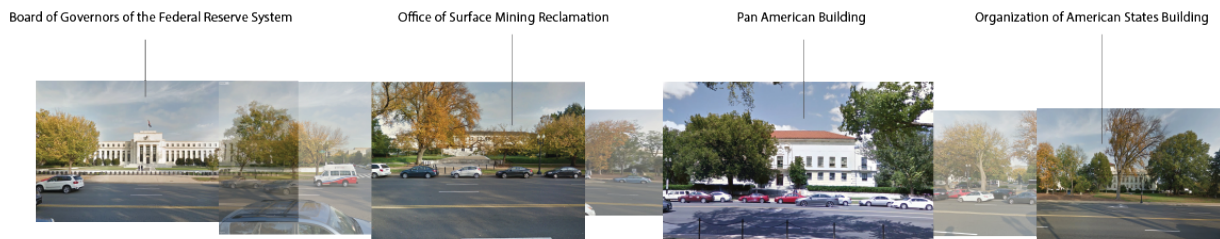


Figure 35. Facades of Constitution Ave NW (Source: Author)

Street Elevation of Constitution Ave NW: Although not easily seen because of the topography, vegetation, and distance from the park, the North side of Constitution Ave is built up with historic buildings. All the facades are very classical, mainly white, and portray a formal order.

The legal height limit for the city was 160 feet in order to allow light and air into the streets so these buildings are no taller than 160 feet.

Current State: The site is deteriorating, and will require some maintenance and restoration in the near future. According to PWP landscape architects, the site has become very degraded. The six-acre pond water is of poor quality and contains algae and trash from visitors. The 42-inch-deep concrete bottom pool is too shallow to sustain any wildlife, especially fish. The only wildlife that uses the water are the occasional ducks who like to swim in the murky water. The soil is in disrepair. Although there is a lot of shade and greenery around the site, the plantings and the trees are in failing condition.⁵⁴

Floodplains: Since the National Mall was originally under water, this leaves it prone to flooding in the future. “This map shows the overall footprint of the area that has some risk of storm tide flooding from hurricanes” based on data collected in January 2016 from the U.S. Army Corps of Engineers. (GIS page) It is widely known that D.C. was also built on swamp lands. “Washington D.C. is susceptible to three types of flooding: Potomac and Anacostia river flooding, coastal storm surge, and interior.”⁵⁵ In 2014, the U.S. Army Corps of Engineers constructed a

⁵⁴ “Constitution Gardens,” *PWP Landscape Architecture*, accessed May 4, 2017, <http://www.pwpla.com/constitution-gardens>.

⁵⁵ Sarah Gross, “D.C. Levee Closure Construction Completed at 17th Street – Improvements Will Better Protect Federal Triangle and Residents,” *US Army Corps of Engineers*, last modified 2014, accessed September 1, 2017, <http://www.nab.usace.army.mil/Media/News-Releases/Article/547399/dc-levee-closure-construction-completed-at-17th-street-improvements-will-better/>.

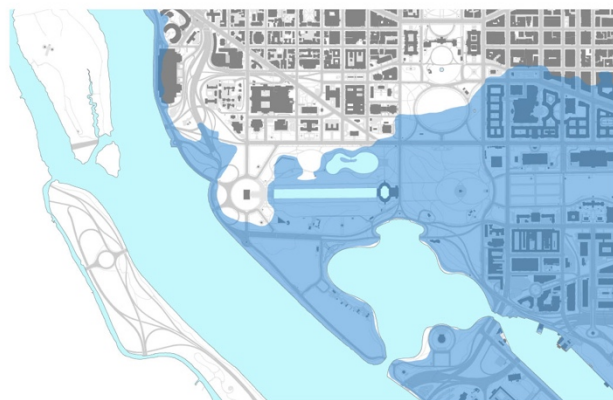


Figure 36. Storm Surge Risk Area Around Site (Source: Author)

flood wall on either side of 17th street, the road to the right of Constitution gardens. The wall provides a foundation for a removable levee system closure structure to be attached in case of a flooding emergency. This structure “reduces risk to the human safety and critical infrastructure downtown from flooding of the Potomac.” This wall is part of a larger Potomac Park Levee System and part of the resiliency movement to protect the district from flooding.⁵⁶

1985, Leon Krier had the idea to bring water from the Potomac back into the National mall site, to the west of the national monument.⁵⁷ It was never realized; however, this idea causes designers to think about embracing the water in downtown D.C. instead of fighting it.

Constitution Gardens vs the Arctic: Although not found in the arctic, Constitution Gardens emulates similar regions. The polar bear’s natural habitat is made of the Taiga, Tundra and Arctic Ocean. Taiga consists of coniferous trees such as pines, spruces, and larches. Currently, there are deciduous elm trees on site. Since the elm trees are in are failing condition, perhaps new coniferous trees could be planted along this are of Constitution Gardens.

⁵⁶ Ibid.

⁵⁷ “Leon Krier: Completion of Washington, D.C., 1985,” *Architectural Design* 56, no. 9 (1986): 30–37.

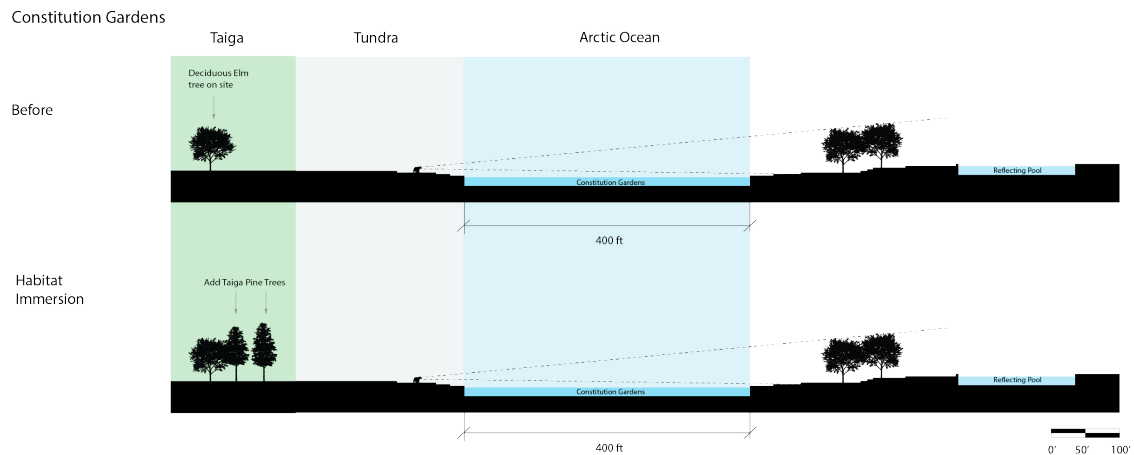


Figure 37. Regions of Constitution Gardens (Source: Author)

Weather Analysis of Washington DC

Temperature: The hottest months of the year in Washington DC are July (88° F average maximum) and August (86° average maximum). The coldest months are December (32°F average minimum) and January (28° average minimum).⁵⁸

Precipitation: August and July receive the most precipitation each year with about 4 inches each month.

Wind: January, February, March and April receive the most wind at 5 meters per second.



Figure 38. Wind Direction and Speed in Washington DC, USA (Source: 2017 Windfinder)

Sun: In July, the site gets about 225 hours compared to July where there is only 75 hours of sunlight.⁵⁹

Although the current weather conditions of Constitution Gardens do not match the weather conditions of Barrow, Alaska, the polar bear is still able to live in these conditions. The polar bears who were able to thrive at the Philadelphia Zoo lived in weather conditions very similar to the DC area. Zoo keepers help polar bears adapt to their warmer zoo surroundings by feeding them a leaner diet. In the wild, polar bears need to eat seals in order to form a thick blubber layer. The less fatty foods, the less blubber and therefore the more comfortable they are in warmer climates. They also help the polar bears stay cool through other means, such as cold pool water, shaded areas, movable air conditioning units, and natural breezes.⁶⁰

Existing Design Proposed for the Site

There is currently talk about building on the Constitution Gardens site. The Trust for the National Mall held a national design competition in 2012 to see who could come up with a plan to revitalize Constitution Gardens. There is now a plan to redesign Constitution Gardens for the first time in 40 years. The idea is to revitalize the area and add a sun pavilion which has both indoor and outdoor spaces. This design will provide a space where people who are visiting the WWII memorial and Vietnam memorial can come and contemplate and reflect.⁶¹

The sun pavilion is designed to be situated on the east side of the pond, towards the Washington Monument. Currently, there is a set of terraced stairs where they plan to build. The

⁵⁹ “Monthly Averages: Washington DC, United States of America,” *World Weather and Climate*, accessed May 7, 2017, <https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,Washington-DC,United-States-of-America>.

⁶⁰ JoAnne Simerson, “Polar Bears: Keeping Cool,” *San Diego Zoo*, last modified 2012, accessed May 7, 2017, <http://blogs.sandiegozoo.org/2012/08/20/polar-bears-keeping-cool/>.

⁶¹ Leah Demirjian, “National Mall’s Constitution Gardens Redesign Approved and Moving Forward,” *Architect Magazine*, last modified 2014, accessed May 4, 2017.

sun pavilion will be half open air, where the city can stage events. Attached to this will be a restaurant with a lovely view out on the lake and a walk-up concession area at lake level. They are even contemplating putting a National Park Service office in the pavilion. Designers imagine turning the lake into an ice skating rink in the wintertime, and in the summer time, people could sail model boats.⁶²

To improve the condition of the site, the new design plan is to help revitalize the water and the soil. The design proposes to dig the pond 12 feet deep. Aquatic shelves and aquatic plants will be planted to help cleanse the garden naturally. All of the water collected on the site will be recaptured and reused and about 20.5 acres of new garden will be planted. Designers imagine that Constitution Gardens will be “a place for a natural example, expanding the idea of what a sustainable idea is, and the way we know we’re going to have to do for the rest of our future. It’s going to be a classroom for environmental sustainability, so that this becomes really a story about the future, as much as it is about the past.”⁶³ This idea is exactly what this thesis is trying to accomplish by building a polar bear exhibit. The designers believe that this site and this project will be as much about the future as it is the past. Just as WWII and Vietnam were the crises of our past, global climate change could become the crisis of our present and future.

⁶² Leah Demirjian, “National Mall’s Constitution Gardens Redesign Approved and Moving Forward,” *Architect Magazine*, last modified 2014, accessed May 4, 2017.

⁶³ Leah Demirjian, “National Mall’s Constitution Gardens Redesign Approved and Moving Forward,” *Architect Magazine*, last modified 2014, accessed May 4, 2017.



Figure 39. Constitution Gardens – 2012 Constitution Gardens Winning Design (Source: PWP Landscape Architects and ROGERS PARTNERS + Urban Designers)



Figure 40. Placement of Sun Pavilion on Constitution Gardens (Source: Rogers Marvel Architects)

The fact that these firms are proposing to build on the north-east corner of the site validates my instinct to build on that side of Constitution Gardens Pond as well.

Chapter 7: Precedents

Historical Zoo Design

In addition to looking towards the future, it is also important to look towards the past for inspiration and architectural lessons. Berthold Lubetkin designed a penguin pool in 1934 in the London Zoo that is worthy of study for this thesis. Obsessed with concrete, Lubetkin built a double helix spiral for penguins out of unsupported, reinforced concrete. Through his design, he hoped to improve the well-being of the penguins and lift the spirits of people of London. The penguin pool was an absolute success with everyone involved. The visitors enjoyed watching the penguins slide down the ramps and the zoo staff were very pleased with its ease of operation and maintenance. Most importantly, the penguins thrived and bred successfully within the exhibit. Although it did not achieve landscape immersion (concrete is not found in the arctic), this habitat was still extremely successful. The penguin pool is an important precedent because it shows how essential entertainment and amazement are to make a habitat enclosure effective.⁶⁴



Figure 41. Penguin Pool - London Zoo (Source: Janet Hall / RIBA Library Photographs Collection 1995)

⁶⁴ Malcolm. Reading and Peter. Coe, *Lubetkin & Tecton : An Architectural Study* (London : Triangle Architectural Pub., 1992).

Current Polar Bear Habitat Designs

Since the latest Polar Bear Care Manual update was in 2009, any precedent projects completed before 2009 are not legitimate for habitat size exploration, unless they have been updated since 2009. However, looking at these precedents before 2009 can still be very helpful in determining specific programmatic elements for the visitor and the zoo keepers. Due to the small number of polar bear habitats completed after 2009, the polar bear habitat enclosure is a valid area of study for future improvement.

ZooLex.org is a great website that contains a large archive to many zoological projects and exhibits. Many of the projects explored on the following pages were found on ZooLex.com.

1. FRANZ JOSEF LAND | VIENNA ZOO

Opening day: May 2014

Architect: DI Peter Hartmann, Vienna

Animal: Polar Bear

Cost: € 10,700,000

This design represents an estuary in the tundra. The habitat is designed for the solitary polar bear. There are two habitat areas, one side for the female and her cubs and one side for the male. The two habitat areas are divided axially by a central pedestrian passageway. At the end of the passageway is an educational visitor center where visitors can learn about polar bear conservation.⁶⁵

Total Exhibit – 46,284 ft²

Polar Bear

- Outdoor exhibit – 18,298 ft²
- Indoor Space – 1,614 ft²
- Body of water - 4843 ft² of combined water surface area
 - 166,428 total gallons of water
 - (salt water and fresh water pools)

Visitors

- Indoor – 4,951 ft²
- Outdoor – 8,611 ft²

Others

- Indoor – 8,611 ft²
- Outdoor – 1,184 ft²

Food Services: Stock trout in fresh water ponds

Sustainable Features

- The visitor center is cooled by natural cold groundwater sources
- 47 solar panels on roof that supplies 7 kW/h
- 1 water change per year due to a good water filtration system

⁶⁵ Jonas Homburg, Harold Schwammer, and Monika Fiby, “Vienna Zoo - Franz Josef Land,” *ZooLex.com*, last modified 2014, accessed December 17, 2017, <http://www.zoolex.org/zoolexcgi/view.py?id=1557>.



Figure 42. Franz Josef Land (Source: ZooLex.com)



Figure 43. Floor Plan of Franz Josef Land (Source: ZooLex.com)

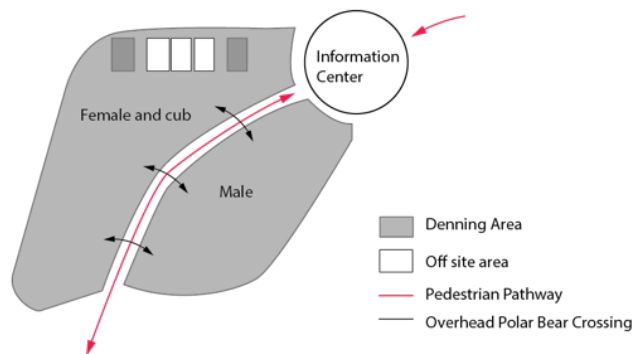


Figure 44. Habitat Enclosure Layout (Source: Diagram by Author)

2. GLACIER RUN | LOUISVILLE ZOO

Opening Day: April 2011

Design Firms:

- PGAV Destinations, St. Louis, MO
- Arasmith, Judd Rapp, Chovan Inc., Louisville, KY
- Zoo Horticulture Consulting

Featured Animals: Polar bears (3), grizzly bears, seals, sea lions

Cost: \$21,900,654

This design is modeled after the tundra town Churchill, Canada.

Total Exhibit – 156,830 ft²

Visitors

- Entry plaza – 6,996 ft²
- Outdoor spaces – 16,684 ft²

Animals

- Indoor – 7,534 ft²
- Outdoor display enclosure - 15,715 ft²
- Animal holding areas – 7,534 ft²
- Pool - 88,000 gallons (total volume)

Staff

- Working areas – 6,565 ft²

Sustainable Features

- The holding building is built underground to allow for natural convection cooling
 - Provides the air conditioning system a 20°F cooling advantage in the summer
- Original walls were maintained and used as retaining wall
- Using steep grade to eliminate additional construction
- All chillers, HVAC and lighting systems are extremely energy efficient

All information found on Zoolex.com.⁶⁶

⁶⁶ Darlene O'Bryan, Corinne Bailey, and Monika Fiby, "Louisville Zoo - Glacier Run: Bears," *Zoolex.com*, last modified 2011, accessed December 17, 2017, <http://www.zoolex.org/zoolexcgi/view.py?id=1483>.



Figure 45. Louisville Zoo Glacier Run Map (Source: Louisville Zoo, 2012)

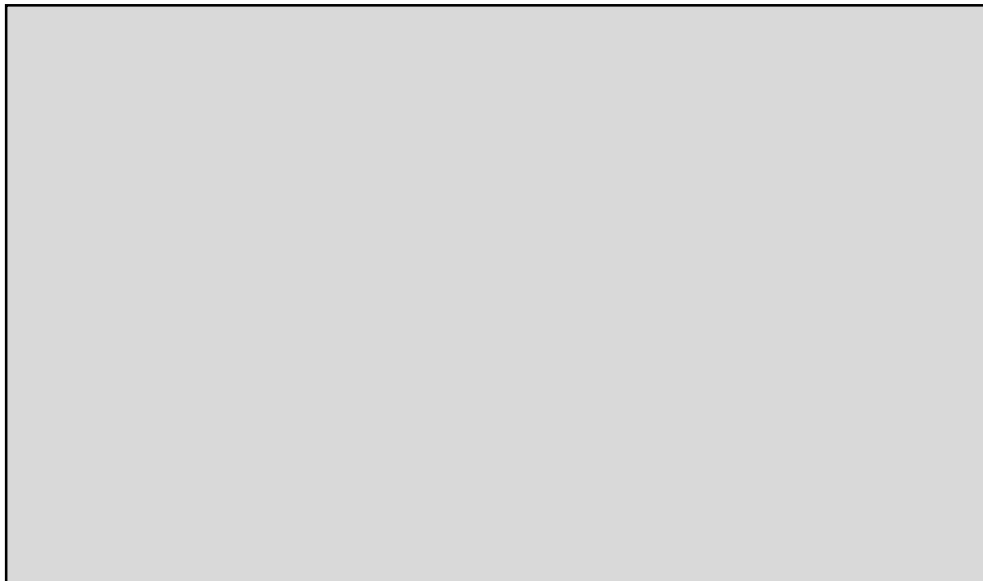


Figure 46. Holding Area (Source: Staff Member at Louisville Zoo, 2012)

3. POLAR PASSAGE | OREGON ZOO | Portland, Oregon

Opening Day: 2019

Architectural Firm: CLR Design, Philadelphia, PA

Featured Animals: Polar bears

This design will provide the polar bears with a larger space to roam, and emulates the arctic environment with natural tundra plants and ground materials.⁶⁷



Figure 47. Polar Passage Hand Rendering (Source: CLR Design)

Sustainable Features

- The design is void of concrete, which absorbs and maintains heat in the summer
- Efficient water filtration system that saves energy and water
- Educates visitors about the effects of global climate change on the polar bear

⁶⁷ “Polar Passage,” *Oregon Zoo*, accessed May 6, 2017, <http://www.oregonzoo.org/discover/new-zoo/polar-passage>.

4. POLAR FRONTIER | COLUMBUS ZOO

Opening Day: 2010

Architectural Firm: PJA Architects

Featured Animals: Polar bears (2), Alaskan brown bears (2), Arctic foxes (4)

This design represents a long-abandoned mining town you would find in Alaska.⁶⁸

Total Polar Bear Exhibit

- 1.3 Acre polar bear habitat
- Pool volume – 167,000 gallon (volume) still-water pool
- Water temperature – stays between 55-65 °F

Sustainable Features

- Geothermal loop system
- Repurposed building
- Filter polar bear pool water to be reused
- Planted 700 trees
- Interactive center allows visitors to learn about polar bears, climate change, and ways that they can help practice conservation at home

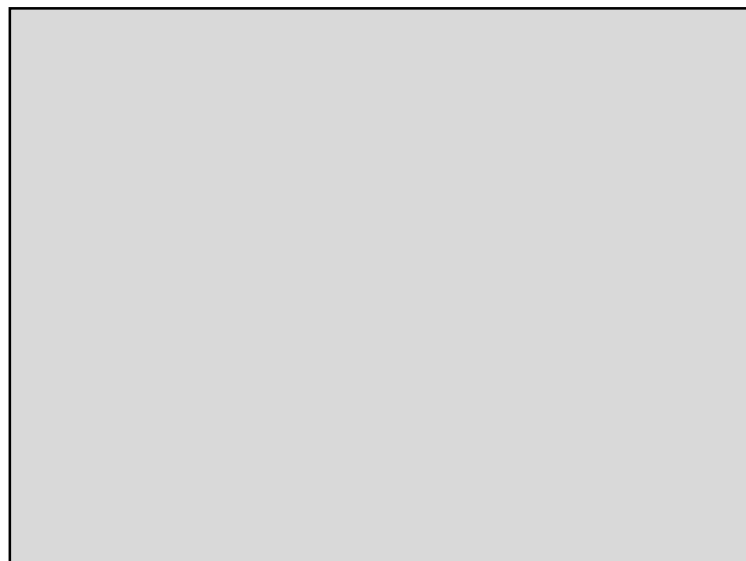


Figure 48. Polar Frontier (Source: USA Today)

⁶⁸ “POLAR FRONTIER: MEDIA KIT” (n.d.), accessed May 6, 2017, <https://columbuszoo.org/docs/default-source/media-tools-content/polar-frontier-media-kit.pdf?sfvrsn=2>.

5. ARCTIC ENCOUNTER | TOLEDO ZOO | OHIO

Opening day: January 2000

Architect: CLR Design, Philadelphia, PA

Animal: Polar Bear (5), seals, wolves

Visitors

- Interpretive space- 2,637 ft²

Animals

- Land - 3,778 ft²
- Animal holding areas –
- Pool – 90,000-gallon saltwater pool
 - 94 inches deep

Staff

- Keeper Kitchen
- Keeper Office
- Behind the scenes holding area and veterinary facilities

Polar Bear and Seal Building

- 108 m²
- animal space off-exhibit
 - 5 holding dens approx. 360x360 cm each
 - Birthing Den 255 x 180
 - Outside holding saltwater pool stall 1440 x 840 cm (10,000 gallons)
 - Dig yard 930 x 2130 cm (soil and plants)

Other Notable Features

- Chillers maintain water at 55-65 °F
- Polar bears and seals, an illusion that they are together
 - The barrier between the two species isn't seen
 - There is a blow hole in the glass separating the polar bears and the seals allowing the polar bears to smell the seals

All information from Zoolex.com.⁶⁹

⁶⁹ Vanessa Neeb et al., "Toldeo Zoo - The Arctic Encounter Polar Bear Exhibit," *ZooLex*, last modified 2000, accessed December 17, 2017, <http://www.zoolex.org/zoolexcgi/view.py?id=772>.



Figure 49. Arctic Encounter Hand Rendered Aerial, Polar bears and Seals (Source: CLR Design Inc., 2002)

Future Zoo Designs

The standards have gotten higher for zoo design, as seen in the previous precedents, due to the growing amounts of criticisms. Not only have the standards gotten higher and more complex, but designers are beginning to think of new ways to create habitat enclosures. Famous landscape architect, Jon Coe, imagines three different zoo types of different sizes – one of them he calls the “elite medium-sized zoo”.⁷⁰ This focuses on one type of animal/environment and allows the animals to have ample room to roam. This thesis aims to think creatively about the future of zoo habitat design, which makes it necessary to take a look at habitat enclosures that are still in progress.

⁷⁰ Worland, “The Future of Zoos.”

This next precedent has not been built yet, but it is an example of a habitat enclosure designed specifically for the panda. It is designed to emulate the panda's natural environment as well as fulfill the needs of the panda.

PANDA HOUSE | BIG | Copenhagen, Denmark

In Progress

Architectural Firm: Bjarke Ingels Group

Featured Animals: Pandas (2)

This enclosure is designed in such a way that the visitor feels like they are experiencing the panda in their natural home, contrary to many exhibits where the visitor feels like they are visiting a panda taken away from a far-away land. The enclosure forms the most free and naturalistic environment, providing the pandas the freedom to roam and the most ideal environment to mate. Pandas are currently a threatened species. Zoologists have had a difficult time breeding pandas in captivity for conservation purposes. Therefore, the enclosure had to design a space that would improve the mating process.

Bjarke Ingels, the principle of BIG, says that, “to design a home for someone is like capturing their essence, their character and personality in built form.” This is exactly what this thesis is trying to achieve – a place that captures the character and personality of the polar bear in a built environment.

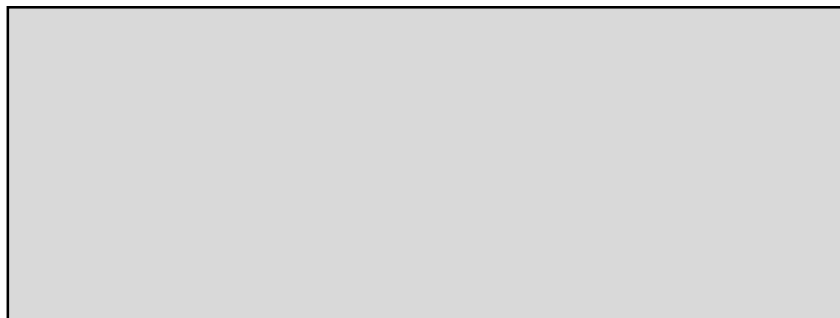


Figure 50. Panda House (Source by BIG)

Total exhibit size: 2,450 square meters

The habitat design consists of two, but separate habitats, to house the male and the female pandas. They can only access each other during mating seasons. Although the pandas cannot see each other, visitors are able to view the pandas from every angle at every elevation. The entire enclosure is accessible to the visitor from 360 degree. The visitor can walk completely around the enclosure.

The habitat enclosure mimics the natural environments of the panda - the misty forest area and the bamboo forest. The design allows pandas to move up and down the hillside like they would in the wild. The habitat incorporates other plants native to the Nordic region in addition to bamboo.

There is a restaurant integrated within the habitat enclosure, where visitors can enjoy a meal watching the pandas.⁷¹

⁷¹ Bjarke Ingels Group, "Panda House | Architect Magazine | Bjarke Ingels Group (BIG), Copenhagen, Denmark, Cultural, Entertainment, New Construction, Sustainability, Community Projects," *ARCHITECT*, last modified 2017, accessed December 17, 2017, http://www.architectmagazine.com/project-gallery/panda-house_o.

ZOOTOPIA | BIG | Givskud, Denmark

In Progress

Architectural Firm: Bjarke Ingels Group

Featured Animals: Gorillas, Wolves, Bears, Lions and Elephants

The goal of Zootopia was to “create the best possible and freest possible environment for the animals’ lives and relationships with each other and visitors.”⁷² Through this complex project, they hope to improve the quality of life for all users – the animal, guests and the zoo keepers.



Figure 51. Re-envisioning the Safari (Source: BIG)

Instead of designing buildings to look like the vernacular of an animal’s country, the architecture should be seen as little as possible and should be covered up by the natural landscape instead. The earth comes up and meets the structure on all exterior sides of the enclosure.

The animals can be viewed by all sorts of different means - on the ground (through walking, biking, or by car), by boat (boat safari), and in the air (by flying gondola safari). The habitat consists of three different continents, all accessible through three different entrances from the central core building. A visitor can sail through Asia, bike through Africa, and fly across America.⁷³

⁷² “Zoo,” *BIG | Bjarke Ingels Group*, last modified 2013, accessed May 9, 2017, <http://www.big.dk/#projects-zoo>.

⁷³ *Ibid.*



Figure 52. Zootopia Rendering (Source: BIG)



Figure 53. Interior Zootopia Rendering (Source: BIG)



Figure 54. Exterior Zootopia Rendering (Source: BIG)

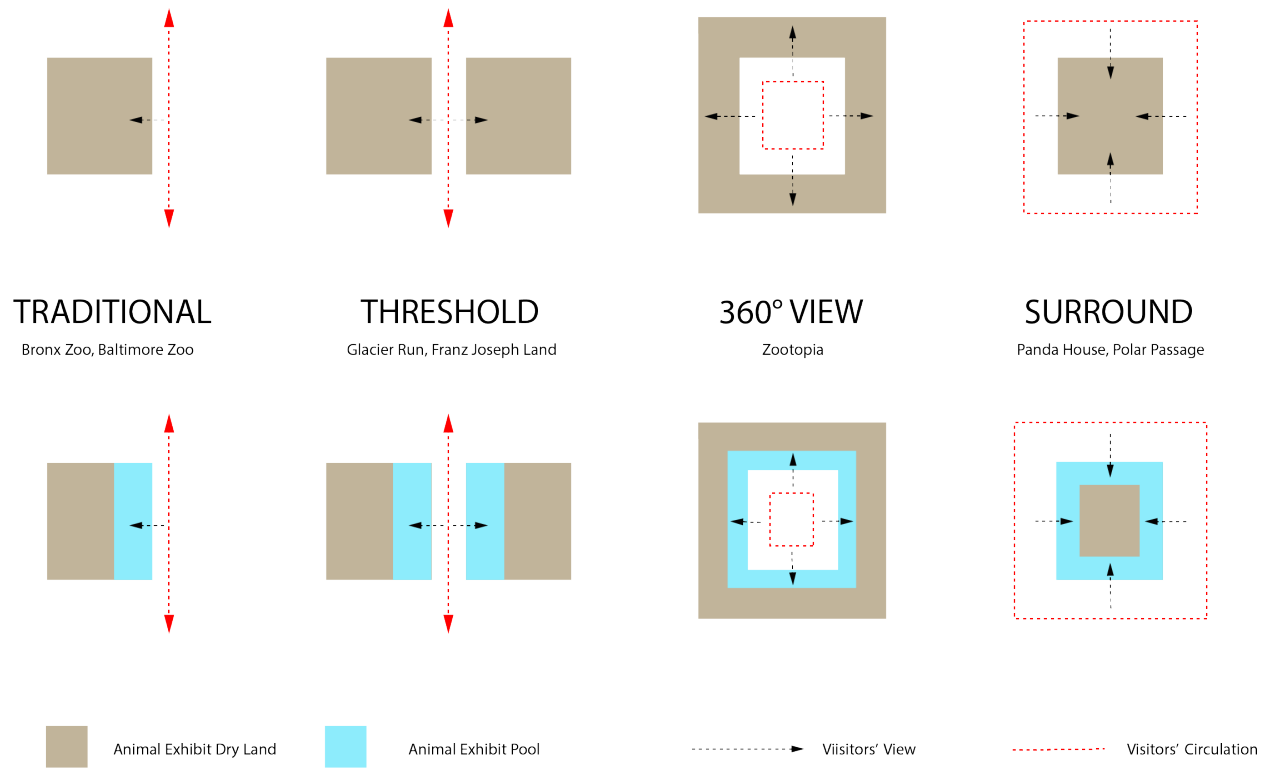


Figure 55. Animal and Visitor Relationships Based on Precedents (Source: Author)

Chapter 8: Program

A habitat enclosure is designed for three different user groups – the zoo keepers, the visitors, and the animals.

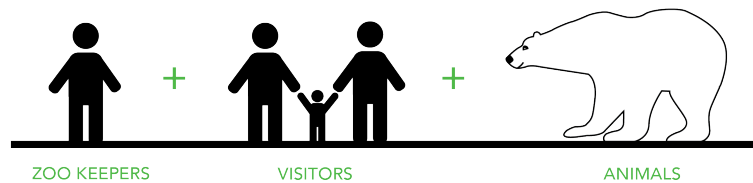


Figure 56. Habitat Enclosure Users (Source: Author)

Balancing the needs of all users can be quite challenging. Designers often find themselves favoring one user group over the other. In current habitat enclosure designs, the visitor is often considered more than the actual animal or the zoo keeper. Zoos want to attract visitors so that they can raise awareness and funds for conservation. Without the visitors, the survival of zoos and the animal are stake. However, there is great irony in this because designing for the visitor sometimes can compromises the habitat design and the animal's well-being.

In order to raise awareness for conservation and educate the public, the habitat enclosure needs to be designed as accurately as possible.

Program Goal

The goal of the program is to create an accurate habitat enclosure that acts as an educational tool to help visitors understand the effects of climate change on the arctic animals. The accurate habitat enclosure will also improve the well-being of the polar bear and be helpful to the zookeepers and staff.

Designing for Animal Needs

When determining the program for the animal, two things must be taken into consideration.

1. The Animal's Natural Environment (addressed in an earlier chapter)
2. Animal Captivity Code and Regulations

This project is designed for two main species animals – the polar bear and the seal. The habitat enclosure will also have fish for the seal to create as much of a natural cycle as possible.

The Polar Bear

The official standard for polar bear habitat design is the Polar Bear Care Manual, completed in 2009.⁷⁴ The following standards must also be taken into consideration:

- USDA Animal Welfare Act (USDA AWA)
- Marine Mammal Protection Act (MMPA 2007)
- Manitoba 'Polar Bear Protection Act' (PBPA, 2002)

The habitat will be designed for two or more polar bears. The habitat will also have enough space for 2 cubs if necessary. There are slight variations between the AZA, USDA and PBPA on some size requirements and are noted below.

Dry resting and social activity area – at least 5,400 ft²

- 400 ft² (USDA)
- 5,400 ft² (AZA)

Off Area Dry Land

- 807 ft² (PBPA)

Temporary Holding Area

⁷⁴ Polar Bear and Care Manual, "POLAR BEAR (*Ursus Maritimus*) CARE MANUAL CREATED BY THE AZA Polar Bear Species Survival Plan ®" (n.d.): 1–95.

- 13ft x 9.8ft x 8.2ft (PBPA)

Pool of Water

- Surface area - 96 ft² (USDA) or 760 ft² (PBPA)
- Minimum horizontal distance – 8 feet (USDA)
- Minimum depth – 5 feet (USDA)
 - Deep end at least 9 feet (PBPA)
- Must be irregularly shaped
- Temperature – 55-70°F

Maternity Den

- 6 feet deep x 6 feet wide x 5ft high (at least) (USDA)
- 8.2 feet x 8.2 feet x 8.2 feet (PBPA)

These are the minimum code requirements for a polar bear. However, based on precedents, these numbers may be well exceeded.

The Ringed Seal

The seal and polar bear both live in the same natural environment and therefore the analysis done on the polar bear can be applied to the seal. The only difference is that the seal requires their own seal lair for birthing. However, it is still important to look at specific seal habitat requirements.

The ringed seal does not have an AZA care manual. In fact, no marine mammal has an AZA care manual except for the polar bear. Therefore, the USDA APHIS standards should be consulted for seal and other marine mammal habitat minimums. Marine Animal requirements can be found in Chapter 1, Subchapter A, Part 3, Subpart E. The ringed seal is considered a group II pinniped. (pg. 120). Ringed seals are also considered solitary animals so no more than two seals will be necessary for the habitat enclosure. However, if the seals are consumed by the polar bear when the habitat enclosure is closed to the visitor, then more seals will be required.

Dry resting area required for seal

- 56 ft² (USDA Calculations)

Pool of Water

- Surface area of pool of Water – 56 ft² (USDA) (Same or greater than resting area required)
- Pool depth: Must be at least 3 feet or half the length of the longest pinniped (USDA)
- Min. Horizontal distance – 6.6ft (1.5 times the length of seal – 4.4ft) (USDA)

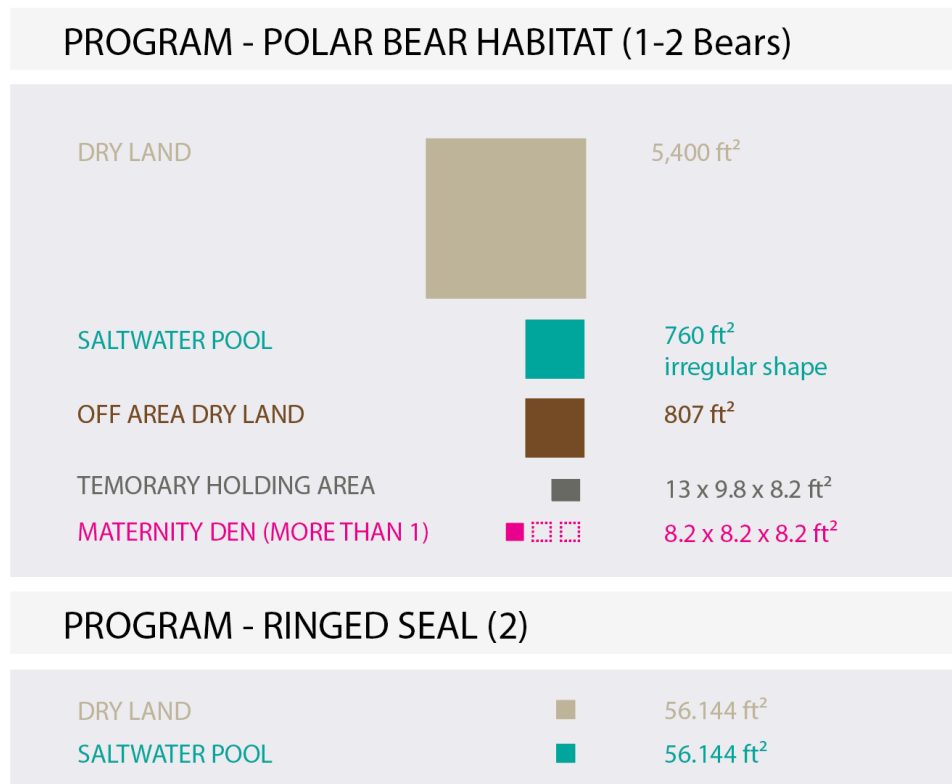


Figure 57. Programmatic Design for Seals and Polar Bears (Source: Author)

To determine the program, this thesis examined the natural environment, the polar bear code requirements, as well as polar bear habitat enclosure precedents. Most precedents designed well above the minimum square footage requirements set by the AZA, USDA or PBPA. Franz Josef Land and Glacier Run, both designed after 2009 had more than three times the minimum requirement for dry resting outdoor space (15,000 ft² and 18,000 ft² respectively). Their off area

dry land are both above the 807 ft² dry land area required space (1,614 ft² and 7,534 ft² respectively). The amount of water sufficient for both the seal and polar bear according to the standards are about 816 ft² surface area in total. Franz Joseph Land had about 4,800 ft² of water surface area. Franz Joseph Land also had 166,000 total volumetric gallons of water while Glacier Run had around 88,000 gallons. Franz Joseph Land was designed for 3 polar bears.

The ideal number of polar bears in this habitat enclosure is 4-8. By having 4-8 polar bears, the visitors will be able to better ensure a view of the animal. This large number of polar bears will also make a larger and more memorable statement to the viewers if there are more polar bears roaming around the enclosure. A factor of 4 was applied to the code requirements for any communal polar bear space or seal space (since the code is designed for 1-2 polar bears and 1-2 seals and the thesis wants to design for 4-8 polar bears and 4-8 seals.)

Dry Resting or Social Activity Area or “Exhibit Area” – 5,781 ft²

Either an indoor or outdoor “area of the ex situ habitat where a polar bear may be viewed by the public and is considered the bears’ primary living space.” (PBPA, 2002)

(For 1-2 polar bears, 5,400 ft² of outdoor dry resting space is required according to the Polar Bear Care Manual. 1650 ft² additional space is required for each additional polar bear.)

This also needs to factor in the seal’s dry space which is 56 ft² per every 2 seals.

Off Area Dry Land or “Management Area” – 2,019 ft²

An area of the ex situ habitat where public viewing of the polar bear is not permitted.

(For 1-2 polar bears, 807 ft² of off area dry land is required according to the Polar Bear Care Manual. 269 ft² additional space is required for each additional polar bear. If this enclosure were to house 8 polar bears, according to the standards, it would need 2,421 ft². So, the number proposed for the exhibit area exceeds the code.)

Temporary Holding Area – 150 ft²

Individual space for each polar bear where they can retreat when maintenance work or cleaning needs to be done within the habitat enclosure

(According to the polar bear code, the temporary holding space should be about 127 ft² and each polar bear must have their own.)

Transfer Area - 113 ft²

A space between the off-exhibit area and the loading area where the animal can be temporarily contained for each of transfer between the two spaces.

Outdoor Pool of Water – 845 ft² surface area

Body of water where the polar bears and seals can swim. This body of water is necessary to feed both the polar bears and the seals.

(According to the polar bear code, 1-2 polar bears need a body of water with an area of 760 ft². A seal needs a body of water with an area of about 56 ft².)

Indoor Pool of Water – 347 ft² surface area

Maternity Den – 136 ft²

An area separate from other management areas where pregnant female polar bears can birth their young.

(According to the polar bear code, each maternity den should be about 67 ft². Every polar bear does not need a maternity den, however, there should be many to choose from if a polar bear is pregnant. This exhibit has two maternity dens.)

Designing for Visitor Needs

First and foremost, the visitor needs space to view and understand the polar bear and its arctic environment. It also might be convenient for the visitors to have a café/restaurant and restroom area within the enclosure. Visitors may also enjoy a gift shop where they can purchase their own plush polar bear or reminder of their experience. Many of the program square footages were based on the nearby dimensions of the Smithsonian African American Museum of History Museum. This museum is closer in scale to the habitat enclosure than the other Smithsonian Museums.

Viewing Areas

Space where the visitor can see the polar bear and/or the seal. Viewing areas can either be above or below the animal.

Café/Restaurant – 2,879 ft²

Space where the visitor can purchase a quick snack or beverage or stay for an extended meal.

Kitchen for the Restaurant – 1,293 ft²**Gift Shop – 3,760 ft²**

Store that sells polar bear merchandise. All proceeds either go to Polar Bear Conservation, the Smithsonian, or the National Park Service.

Designing for the Zookeeper Needs

Part of the research for this project was to talk with architect and zoo specialist, Sue Chin, at the Bronx Zoo and architect, Wayne Chang, at CLR Design in Philadelphia, PA. They both pointed out that there are specific requirements for the polar bear habitat in the Polar Bear Care Manual. However, there are no such requirements detailing the required for the zoo keepers. Both Chin and Chang explained that the zoo staff and veterinarians will give their input as to which spaces they would like in the final design.

This habitat enclosure is unique because it is not within a larger zoo. Therefore, all necessary programmatic elements that would be found in a zoo and shared amongst several animals, must all be incorporated into the design. Part of the thesis will determine which spaces are necessary for the proper care of the polar bear in a stand-alone habitat enclosure.

Food Storage – 76 ft²

Refrigerators and freezers (or chilled and/or iced coolers for under 12 hours) must be used for perishable food. Supplies of food must be stored in facilities that adequately protect such supplies from deterioration, spoilage (harmful microbial growth), and vermin or other contamination. (USDA)

Food Preparation Area or “Kitchen”– 100 ft²

A space where the food can be prepared for the animals.

Employee Washroom Facilities

Washroom facilities containing basins, sinks, and, as appropriate, showers, must be provided and conveniently located to maintain cleanliness among employees, attendants, and volunteers. These facilities must be cleaned and sanitized daily. (USDA)

Keeper Office – 155 ft²

Monitoring room where the surveillance cameras are. This is also a space where the keepers can conduct any research that they have.

Keeper Kitchen – 155 ft²

A space where the keepers and zoo staff can make their own food. The space will have a refrigerator, microwave, communal table, a sink, and cabinet space.

Storage – 155 ft²

A space for storing tools to take care of the animals as well as the staff.

Designing for Building Needs**Loading Area – about 336 ft² for each building**

There is an area in each building where goods can be dropped off such as animal food/supplies, ingredients and supplies for the café, and merchandise for the gift shop. This is also an area where trash can be picked up.

Mechanical - about 600 ft² for each building**Storage – about 1000 ft² for each building**

There should be a storage space in the animal area, the keeper area, the café, near the bathrooms and the gift shop.

Water Filtration and power supply – 3023 ft²

Reliable and adequate sources of water and electric power must be provided by the facility housing marine mammals. (USDA)

Chapter 9. Design Conclusion

The ultimate design consisted of a memorial, a polar bear habitat, and a museum, in which visitors would visit in sequential order. The monument acts as the “shock factor” and helps visitors understand sea level rise and climate change. The visitor ramps down a series of switchback spaces. At each level of the switchback, the water feature stream becomes heavier and heavier until it turns into a waterfall at the end of the memorial. After experiencing the memorial, the visitor will start to understand that sea level rise is a major concern. At each stage of the monument, there are also quotes which allow the visitor to understand the polar bear population is dwindling.

After the visitor experiences the monument, they cross a bridge over Constitution Gardens pond and arrive at the gem building, an open-air structure design solely for viewing the polar bear and seal relationship. If the visitor can understand the polar bear and seal relationship, and how important sea ice is to the survival of the polar bear, then maybe they can understand climate change a little better. In the wild, polar bears hunt seals. However, in this exhibit, the polar bear and seals can see each other

but they cannot access one another. It simply gives the illusion that they are in the same space.

After experiencing this seal and polar bear relationship, the visitor can retreat back to land and can enter the museum or the gift shop. The museum helps to further explain the effects that climate change has on polar bears and other animals. The museum can also help to explain how the visitor can help to reverse climate change, through many sustainable practices. The visitor can also travel to the gift shop and buy a souvenir polar bear or purchase solar panels for their home.

In addition to the monument, polar bear habitat, gift shop and museum, this design also consists of a café, keeper staff areas, and off exhibit areas for the polar bear where it can retreat from the public eye.

Since this thesis was about climate change awareness, the thesis had to incorporate sustainable tactics. The roofs were angled towards the south to penetrate the solar panels and the skylights for natural daylighting. The building also took advantage of a living machine system, which filtered black water from the buildings through a landscape feature and then back into the building. The design also incorporated the addition of coniferous

trees around the perimeter of the Constitution Pond to allow the area to feel more like the taiga area, which is made up of deciduous trees. There was also minimal regrading on the site, and the design took advantage of the natural topography of the site.

In conclusion, this design explores how architecture can help to raise awareness about architecture. Something like this design could be seen on the national mall in D.C. in order to educate the many visitors from all over the world. Many designers are already starting to think about how memorials, zoos, and museums can play a role and it will be exciting to see these spaces take form in the future.



Figure 58. Thesis Storyline – Shock, Awe, Educate (Source: Author)

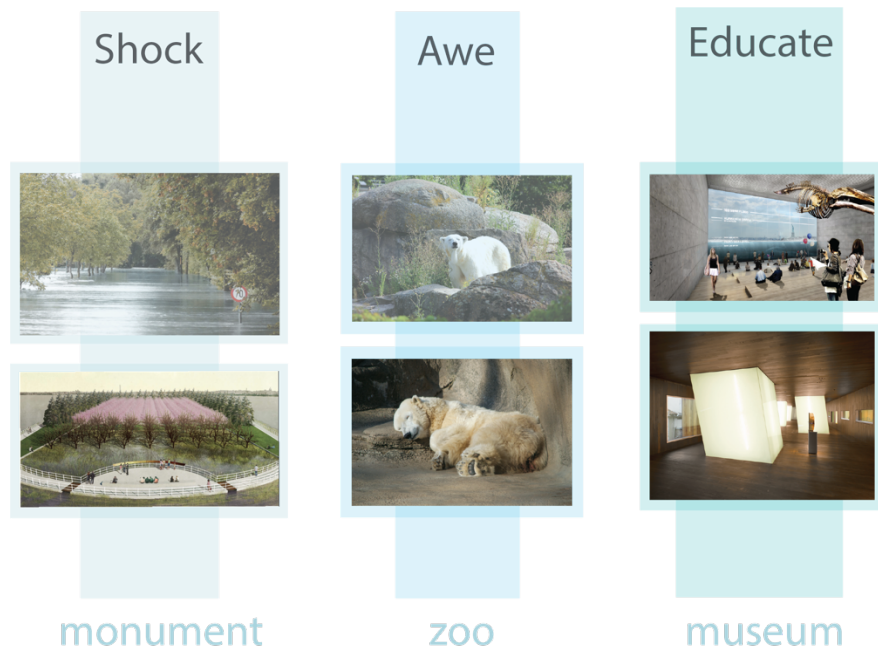


Figure 59. Thesis Storyline – Programmatic Alignment (Source: Author)

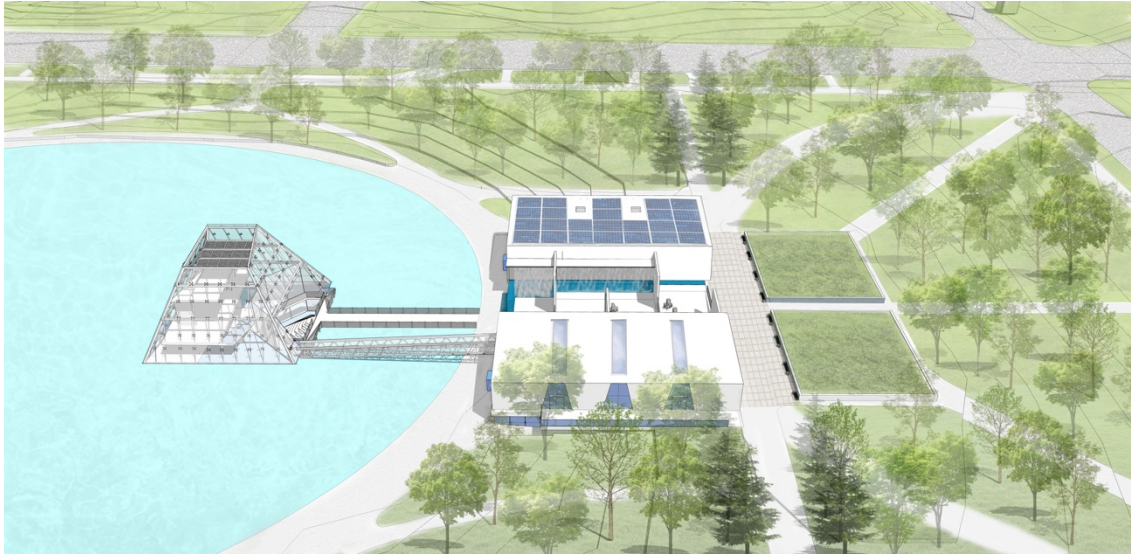


Figure 60. Aerial View (Source: Author)

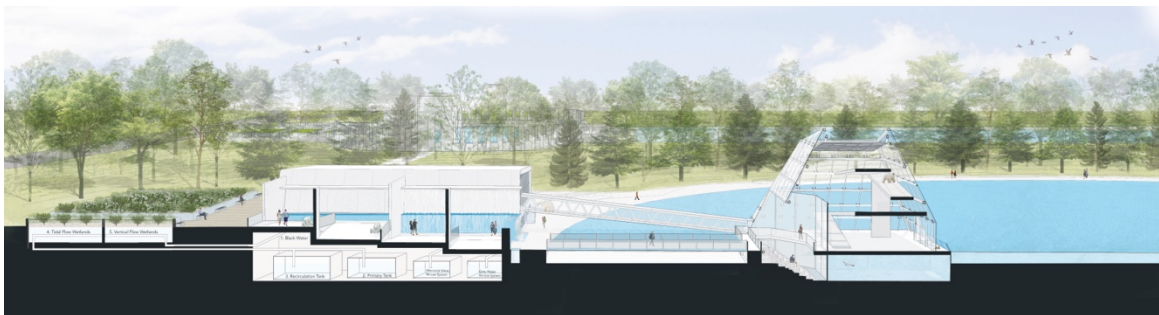


Figure 61. Section Perspective (Source: Author)



Figure 62. North Elevation (Source: Author)



Figure 63. East Elevation – View from Signer’s Island (Source: Author)

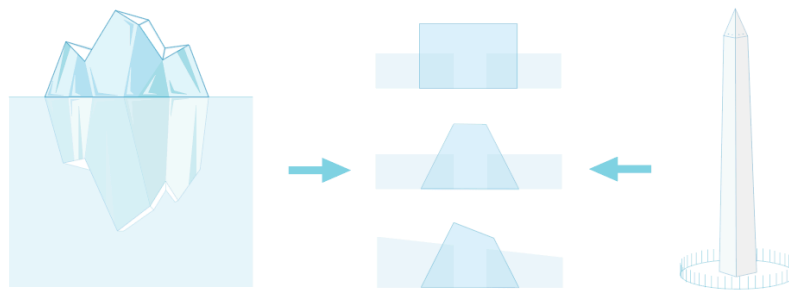


Figure 64. Design Form Inspiration (Source: Author)

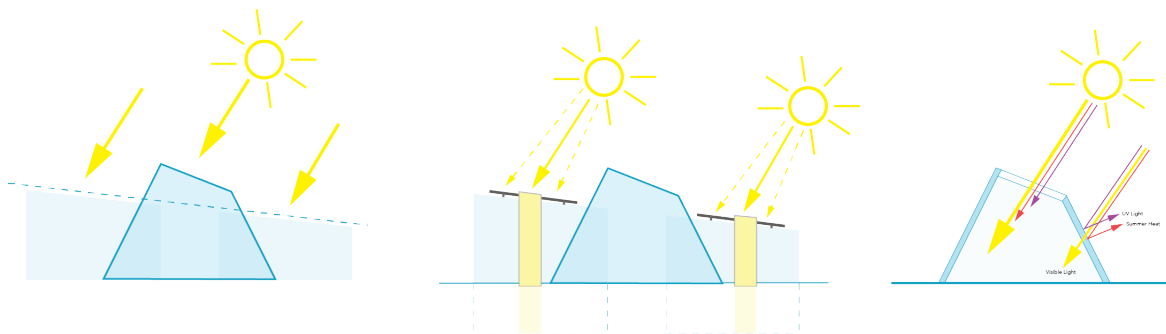


Figure 65. Southern Building Orientation (Source: Author)

Approach



Figure 66. South Elevation – View from WWII Memorial (Source: Author)



Figure 67. East Elevation – View from Washington Monument (Source: Author)

1. Memorial

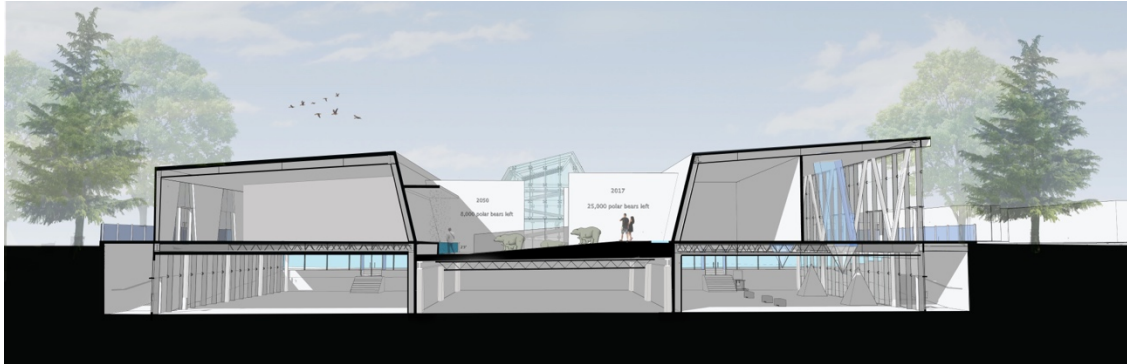


Figure 68. Monument – 2017 – 25,000 Polar Bears Left (Source: Author)

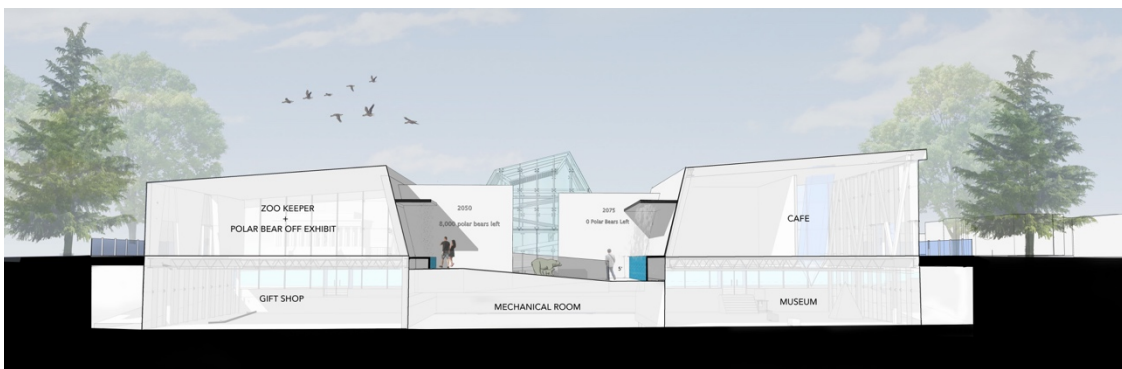


Figure 69. Monument – 2050 – 9,000 Polar Bears Left (Source: Author)

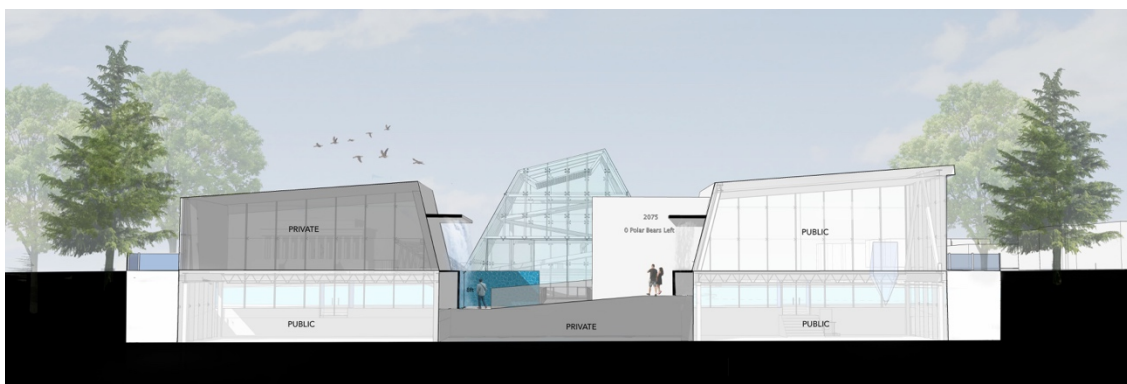


Figure 70. Monument – 2075 – 0 Polar Bears Left (Source: Author)

2. Zoo

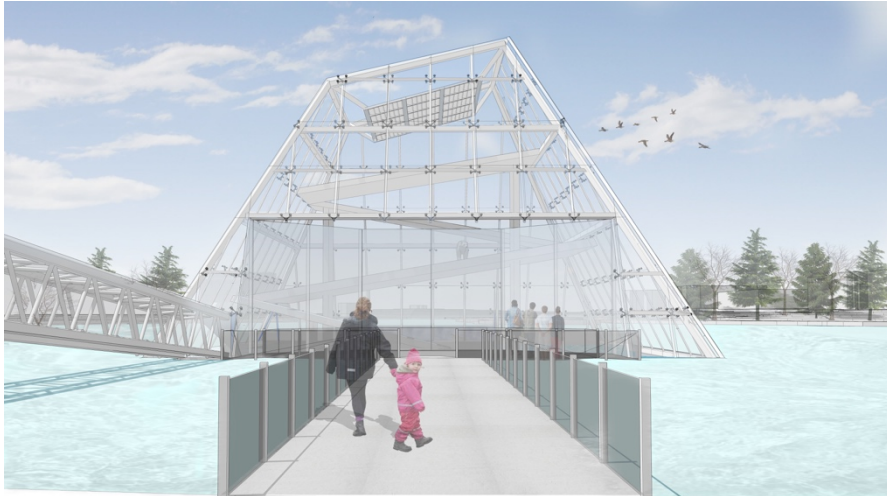


Figure 71. Zoo – The Gem (Source: Author)



Figure 72. Seal, Polar Bear and Visitor Relationship (Source: Author)

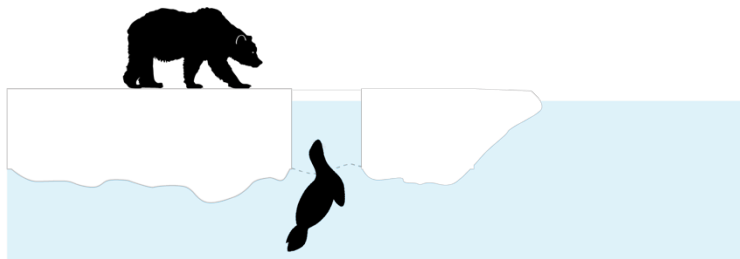


Figure 73. Polar Bear and Seal Natural Relationship (Source: Author)

3. Museum



Figure 74. Museum (Source: Author)

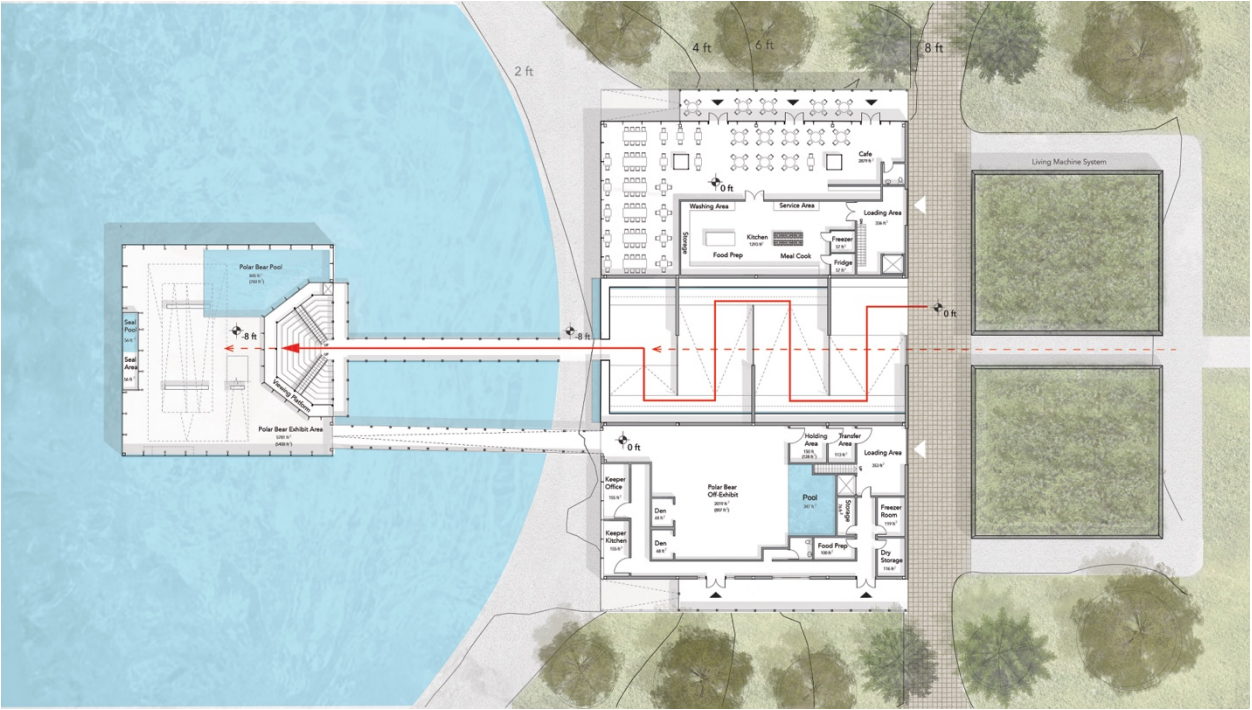


Figure 75. Ground Level Floor Plans (Source: Author)

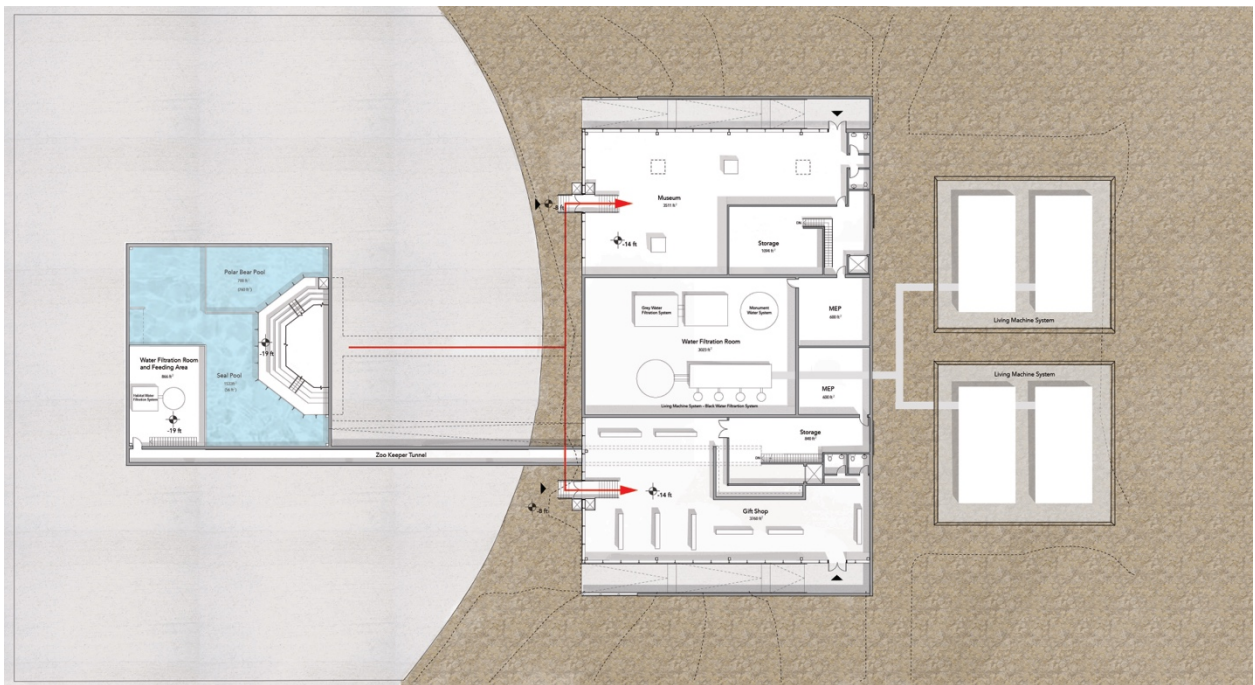


Figure 76. Subterranean Floor Plans (Source: Author)

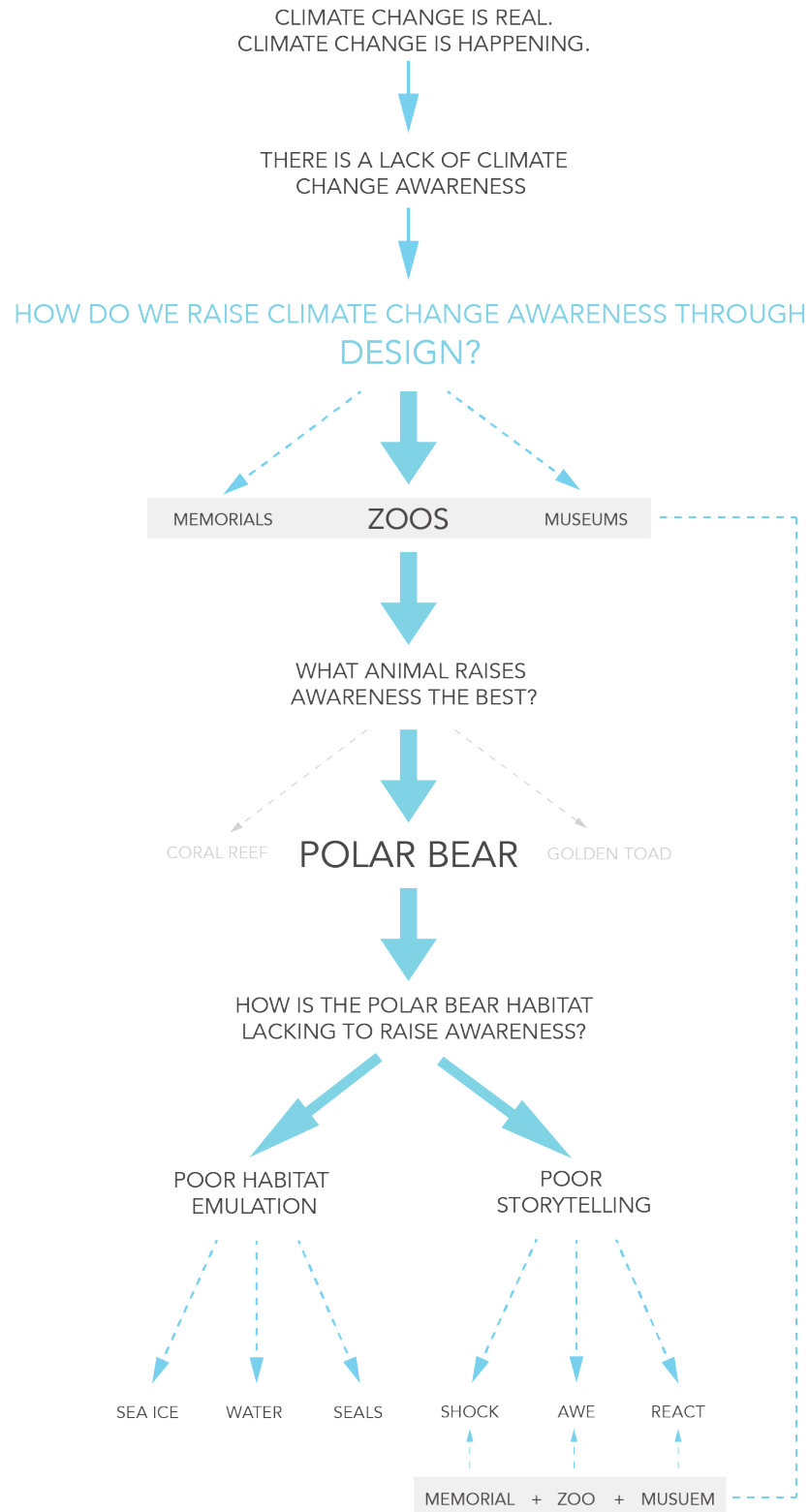


Figure 77. Story Flow Chart (Source: Author)

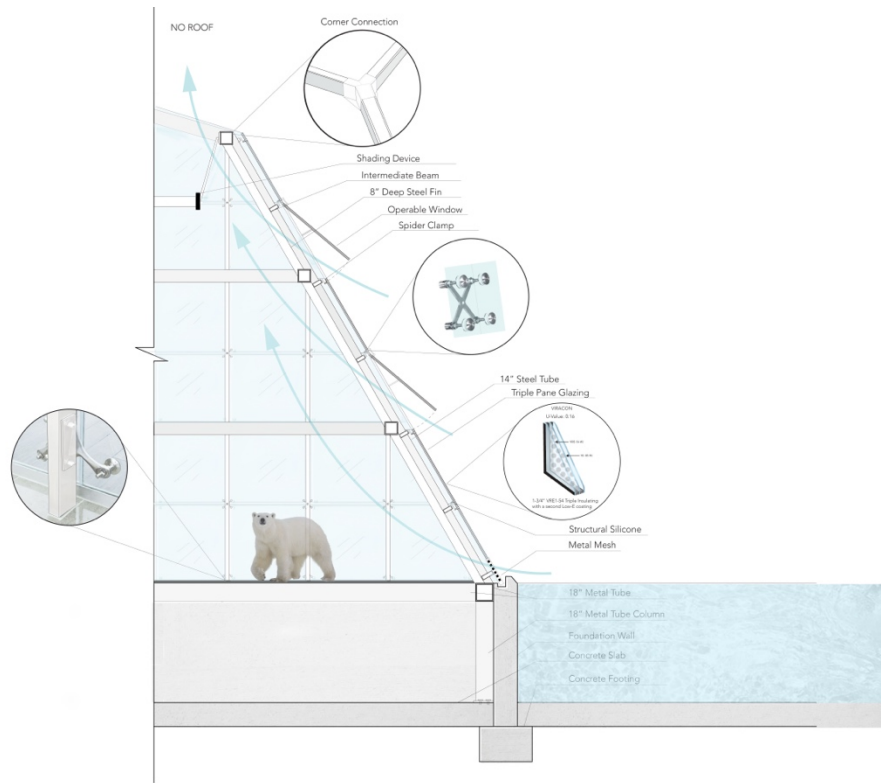


Figure 78. Gem Wall Section (Source: Author)

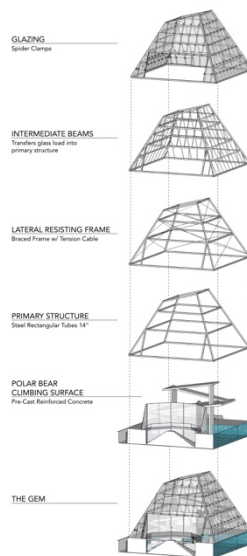


Figure 79. Gem Exploded Structure Diagram (Source: Author)

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