THE ANTARCTIC TREK

An Architectural Typology for Evading the Climatic Dangers of the Arctic

Undergraduate Architecture Thesis
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0 SETTING THE STAGE

"Glittering white, shining blue, raven black ... the land looks like a fairytale. Pinnacle after pinnacle, peak after peak—crevassed, wild as any land on our globe, it lies, unseen and untrodden. It is a wonderful feeling to travel along it."

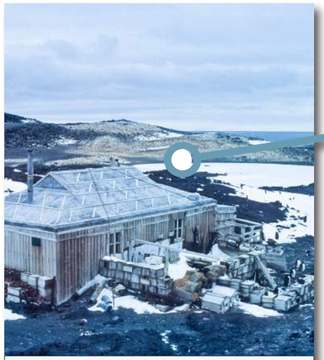
–

"I may say that this is the greatest factor: the way in which the expedition is equipped, the way in which every difficulty is foreseen, and precautions taken for meeting or avoiding it. Victory awaits him who has everything in order— luck, people call it. Defeat is certain for him who has neglected to take the necessary precautions in time, this is called bad luck."

–Roald Amundsen,
Antarctic Explorer, Discoverer of the Geographic South Pole

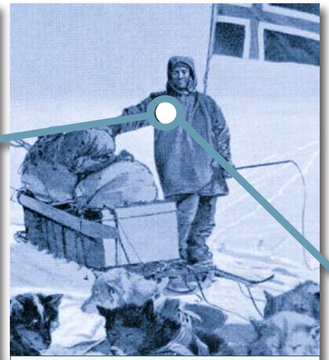
"We were like men who had been fired off in rockets to take up life on another planet. We were in a lifeless, and almost featureless world. However snug and comfortable we might make ourselves, we could not escape from our isolation. We were now face to face with raw nature so grim and stark, that our lives could be snuffed out in a matter of minutes. Every day would bring us new problems to solve and our ingenuity would be taxed over and over again. And all this to carry out a somewhat difficult fragment of the worldwide scientific program of the International Geophysical Year.'

–Paul Siple,
Construction Manager of Original South Pole Station



1909

Shackleton's Hut was constructed in the McMurdo Sound and served as the starting point for his unsuccessful expedition to the South Pole. McMurdo Station was later constructed in close proximity.



December 1911

Roald Amundsen's expedition becomes the first men to discover Earth's South Pole.

January 1912

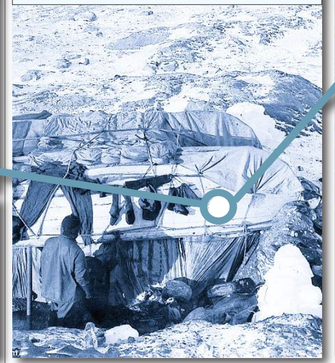
Robert Scott's expedition becomes the second discoverers of the South Pole, missing Amundsen's mark by just a month. The entirety of Scott's expedition perishes as Autumn weathers took a turn for the worse. Pictured here is their mass grave.

January 1915

Ernest Shackleton's *Endurance* voyage runs aground and, after having used the ship for shelter, it is finally crushed by the ice sheet in October.

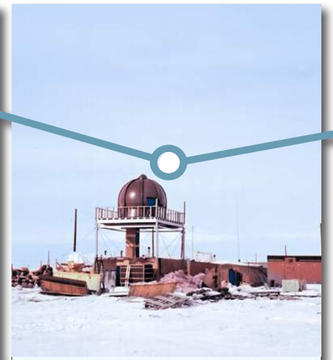
March 1916

Shackleton's crew builds temporary structures on shifting ice flows, hoping they will drift to safety.



December 1955

McMurdo Station, the United States' logistics hub on the continent, is opened. All flights to the South Pole make a layover stop here.



January 1956

The U.S. Navy Seabees construct the first station at the South Pole. The Station has since been lost to the compounding of snow accumulation.

December 1, 1959

The Antarctic Treaty is signed, barring all signees from exploitation of the continent and establishing a sole commitment to scientific observation.

0.3 SETTING THE STAGE

"I think part of the appeal of Antarctica is experiencing some sort of power, the forces of the natural world."

–Jon Krakauer
American Writer, Mountaineer, Survived Disastrous Mt. Everest Summit Expedition

October 1965

A crevasse east of Halley Station swallows an arctic tractor, whose occupants were killed in the 100 foot plunge.

1967

Halley II station replaces its predecessor. The first Station had a lifetime of 12 years, showing the transient reality of Arctic architecture.

1968

Halley I is abandoned after its submergence in ice. 12 years of operation is hardly impressive, but such is life in Antarctica.

December 1986

An LC-130 cargo flight crash lands in Central Antarctica as a fuel tank dislodged and destroyed a propellor. Nature, as it is oft to do, obscures it in time.

a History of Futility and Catastrophe to Discovery and Invention 0.4

"We are all adventurers here, I suppose, and wild doings in wild countries appeal to us as nothing else could do. It is good to know that there remain wild corners of this dreadfully civilised world."

–Robert Falcon Scott,
Ill-fated Explorer, Leader of Second Expedition to Discover the South Pole

1992

Halley V becomes fully operational. Its pioneering design of hydraulic columns that raise the building away from voracious appetites of rising snow grants the Station a longer lifetime than its predecessors.

February 2012

An electric generator caught fire and burnt down roughly 70% of the Comandante Ferraz Station. Even with a coastal location, fighting the fire proved difficult and killed two firefighters.

April 2018

Halley VI takes advantage of its mobility, migrating 23 km as a fissure threatened to break its host ice shelf off into the Sea.

January 2020

Following the destruction of its predecessor to fire in 2012, the new Comandante Ferraz Station was completed.

1 DEFINING A THESIS STATEMENT

Antarctica deserves an identity, in built form, characterized by the struggles overcame and harmony with its arctic climate. Architectural and infrastructural features will allow the Arctic Research Station to carve into relentless oncoming winds, harness power from climatic sources to entirely sustain itself, rise vertically above creeping snow, and relocate at the will of its tenants to conduct observations in new biomes.

a Design Intervention to a Precarious Architectural Issue 1.2

From the ramshackle wooden shelters of the Antarctic trailblazers in the early 20th century to the metallic engineering marvels of modernity, the quick assembly of small, tight structures and bare necessities for survival were emphasized as Antarctic Research Stations had to counter the harsh climate. Yet, architectural expression, scientific accessibility, and sustainability were all forgotten.

At the South Pole—the heart of a continent dedicated to the sciences— I will establish a design typology for the Antarctic which requires features of sustainable energy generation and mobility. Able to migrate across the Arctic Plateau, Stations can escape the long-term climatic dangers to sedentary structures[1 & 2] as well as provide its occupants with new architectural comforts, locations, and perspectives to study.

1 — Ernest Shackleton's Band of Antarctic Trailblazers Huddled around Gramophone

2 — Ernest Shackleton's Hut

3 — Halley II Station's Access Points were entirely buried, forcing abandonment

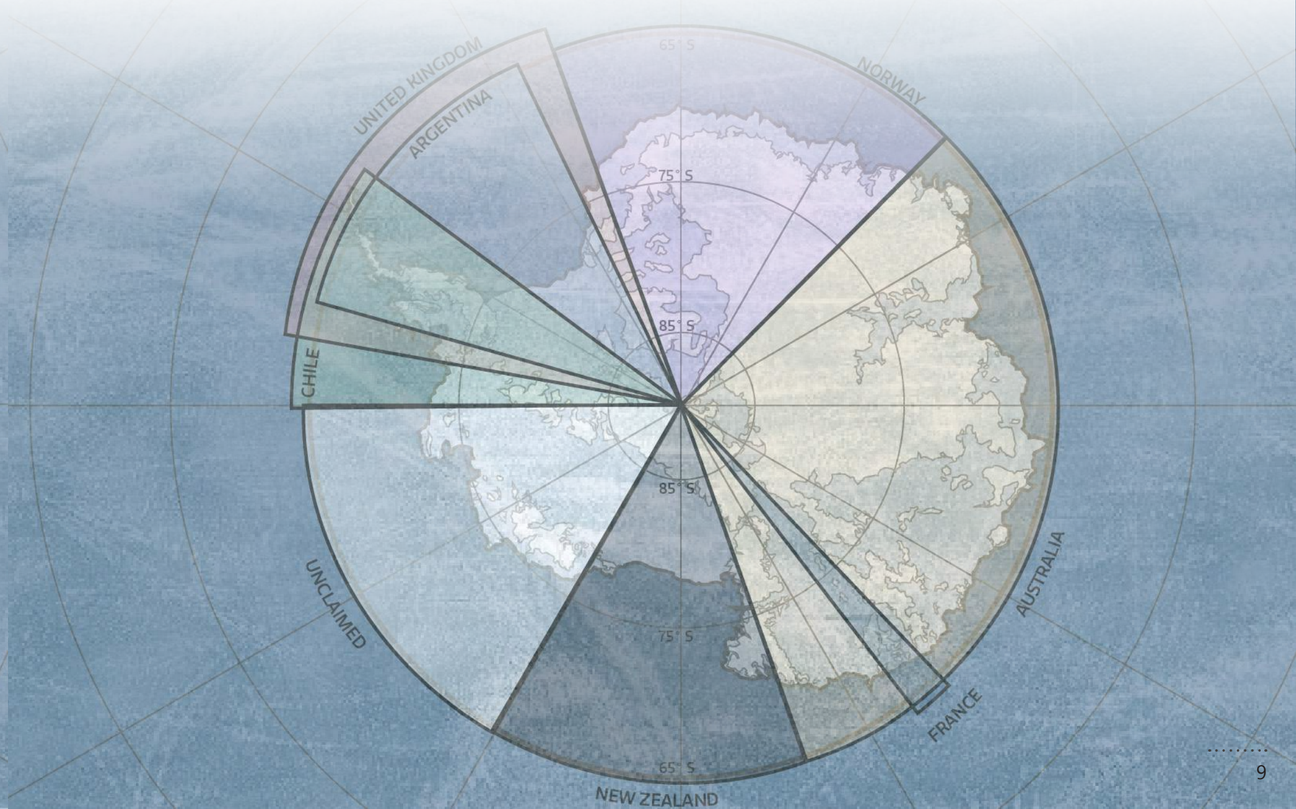
4 — Unable to rise above the rising snow, Halley III was buried, and has fractured into the Ocean

2 ILLUSTRATING AN ‘INHOSPITABLE’ ENVIRONMENT

Much of Antarctica’s land mass isn’t even land in a traditional sense, but rather migrating ice sheets whose bedrock exists below sea level. If, and when, these ice sheets melt, the area they occupied will become one with the Arctic Sea.

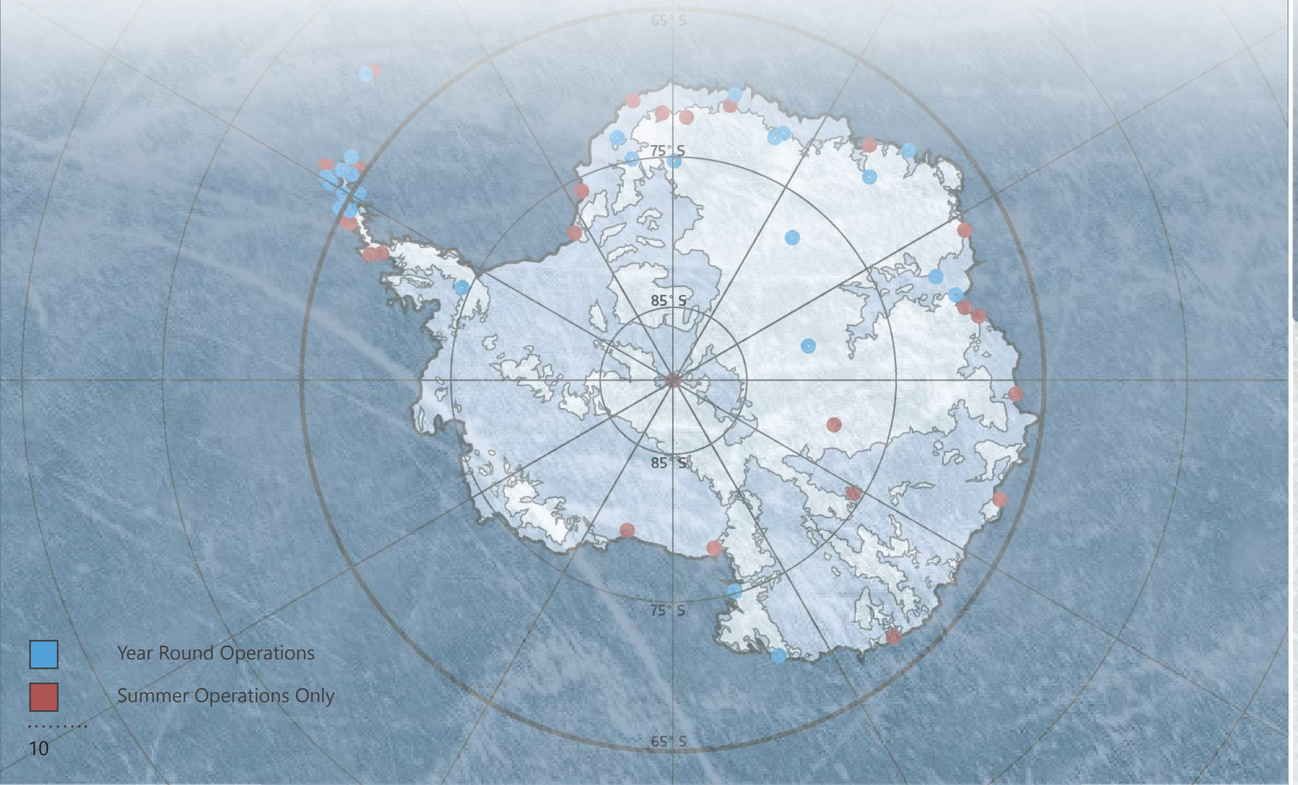
a Terrifyingly Primal, Pristine, and Otherwordly Land 2.2

Notwithstanding Antarctica’s geographic isolation and lack of permanent society, the continent is still subject to the territorial dominion of global superpowers and nations in the Southern hemisphere’s polar regions. Pictured are the radial-shaped divsions.



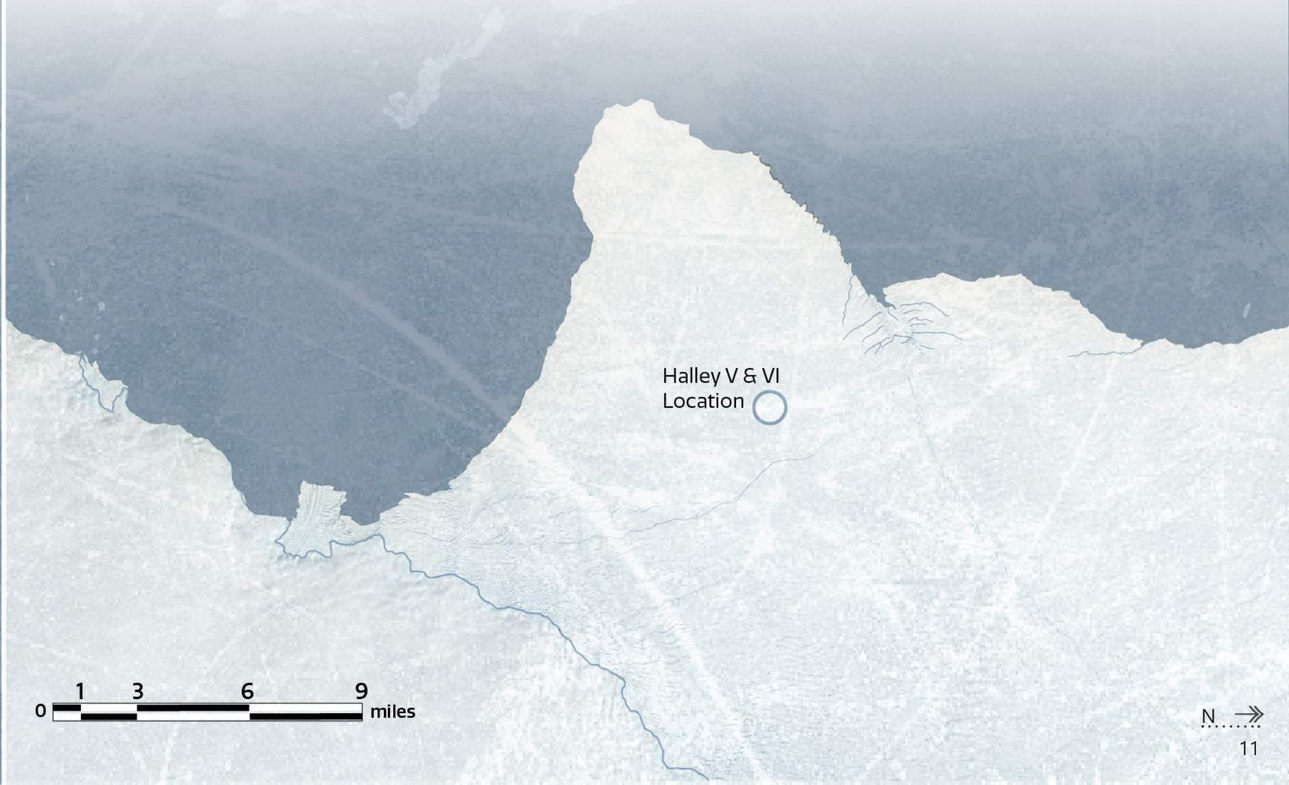
2.3 ILLUSTRATING AN ‘INHOSPITABLE’ ENVIRONMENT

Winter in the Arctic is frigid, inhospitably windy, and most precariously—entirely dark, save for Aurora light. Thus, stations must be abandoned or entirely self-sufficient for the season.



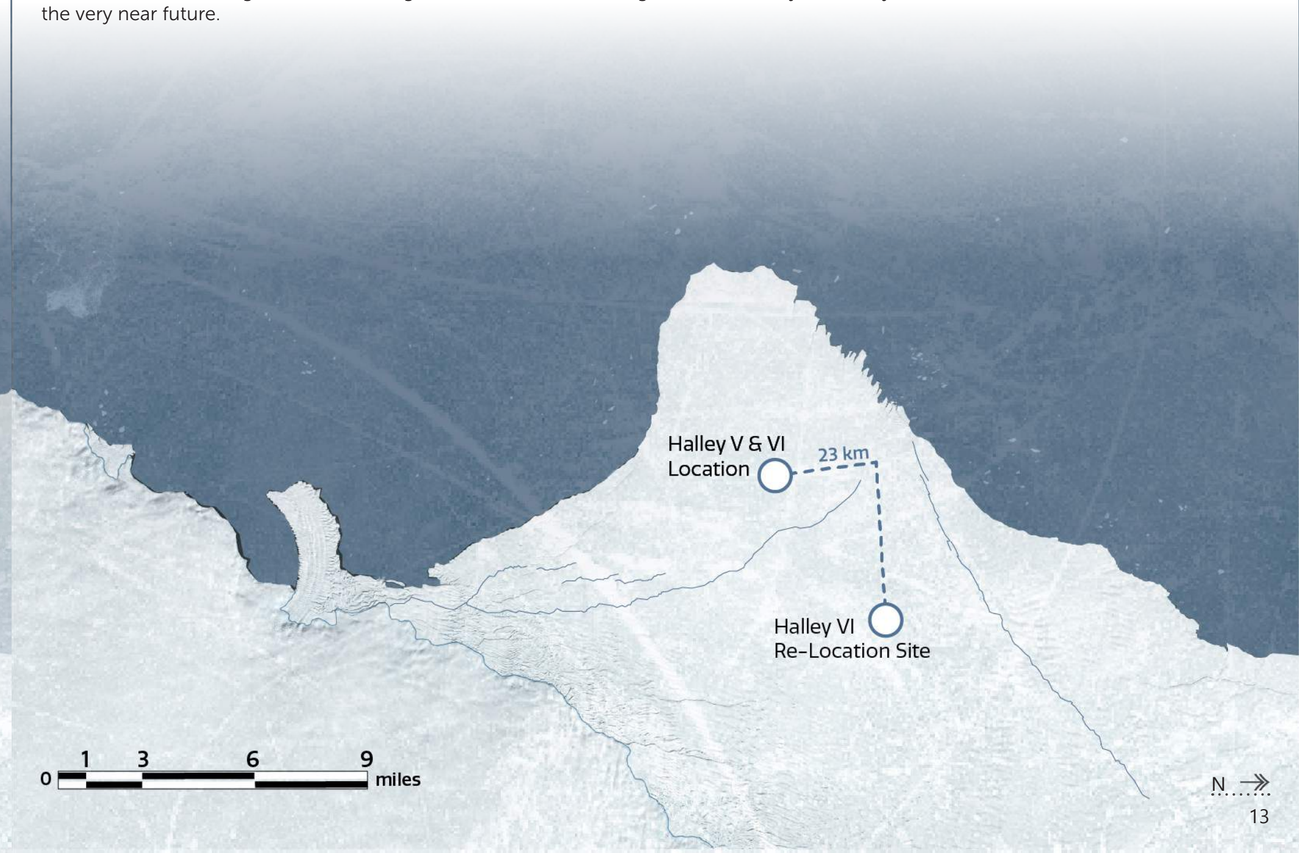
a Terrifyingly Primal, Pristine, and Otherwordly Land 2.4

The Brunt Ice Shelf in Eastern Antarctica is steadily traveling away from the Antarctic Bedrock, sacrificing its structural integrity. Fissures in the ice converge, breaking large swathes off into the ocean in the form of icebergs. Below is the coastline in 1986.



The coast of the Brunt Ice Shelf from 1986 compared to its appearance in 2018.

As of 2021, the two large fissures converged and created an iceberg. If not for Halley VI’s ability to flee, it would be lost at sea in the very near future.



ILLUSTRATING AN ‘INHOSPITABLE’ ENVIRONMENT

Coastal mountains and squalls, inland whiteouts and winds, and frozen sea surfaces all stand in the way of pedestrian and vehicular movement.

1 — Intense Coastal Katabatic Winds

2 — Intense Whiteout Conditions

3 — Uphill Trek from Coastal Landing

4 — Bow of Icebreaker Ship Confronts Ice Field

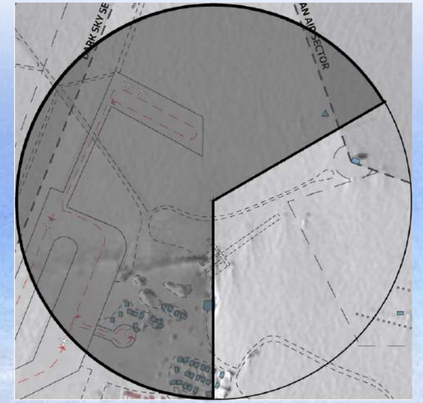
Architecture and infrastructure—often thought as a comfortable refuge from the elements—are at the mercy of nature. Buildings and vehicles are in danger from the very land they occupy.

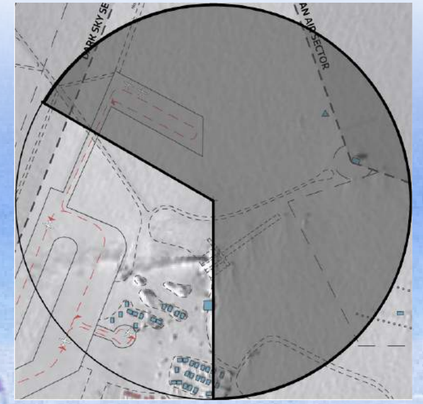
5 — Low Visibility and Frozen Facades

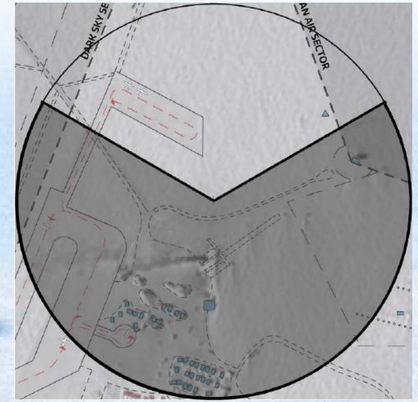
6 — Muskeg Vehicle Dangles over Crevasse

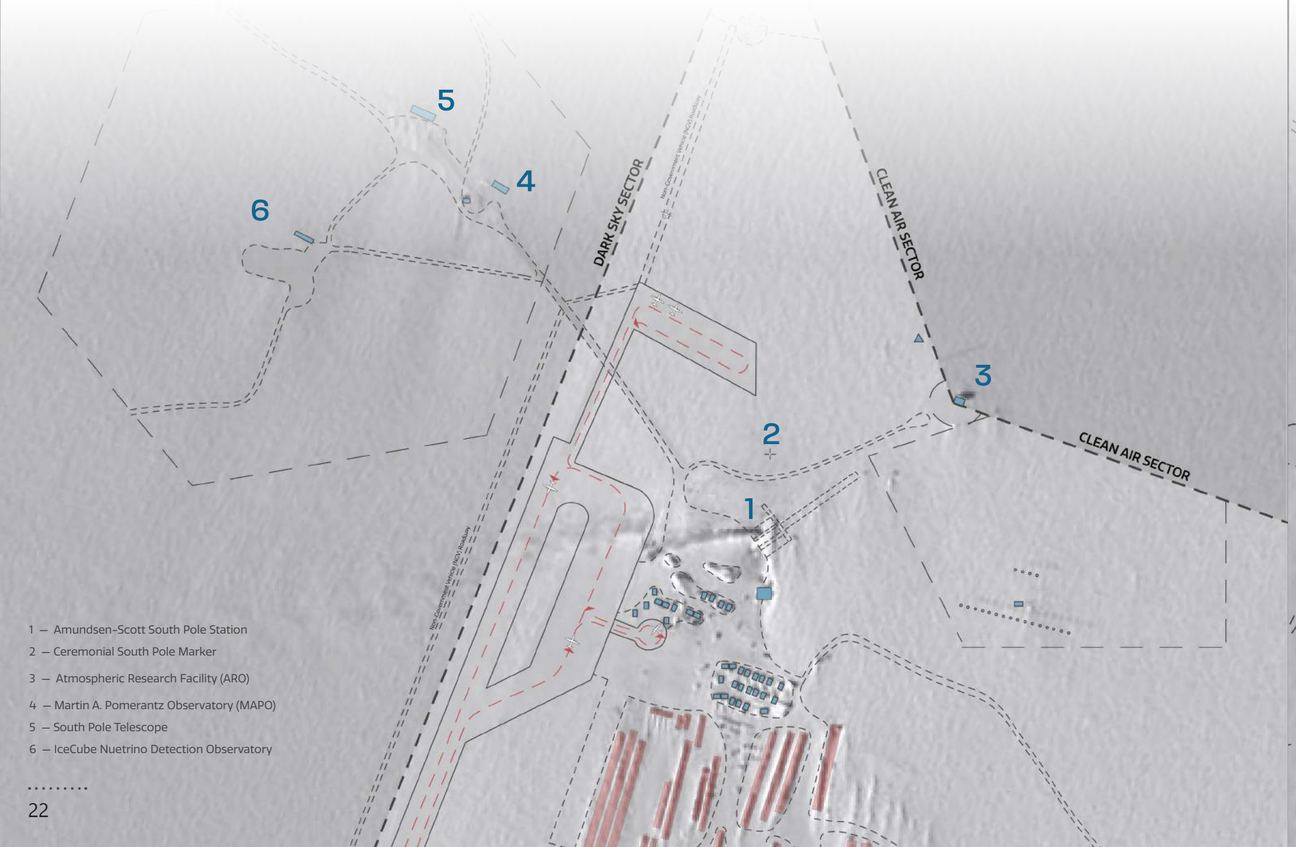
7 — Whale Oil Silos Knocked Off-Kilter by High Winds

8 — LC-130 Teeters over Crevasse

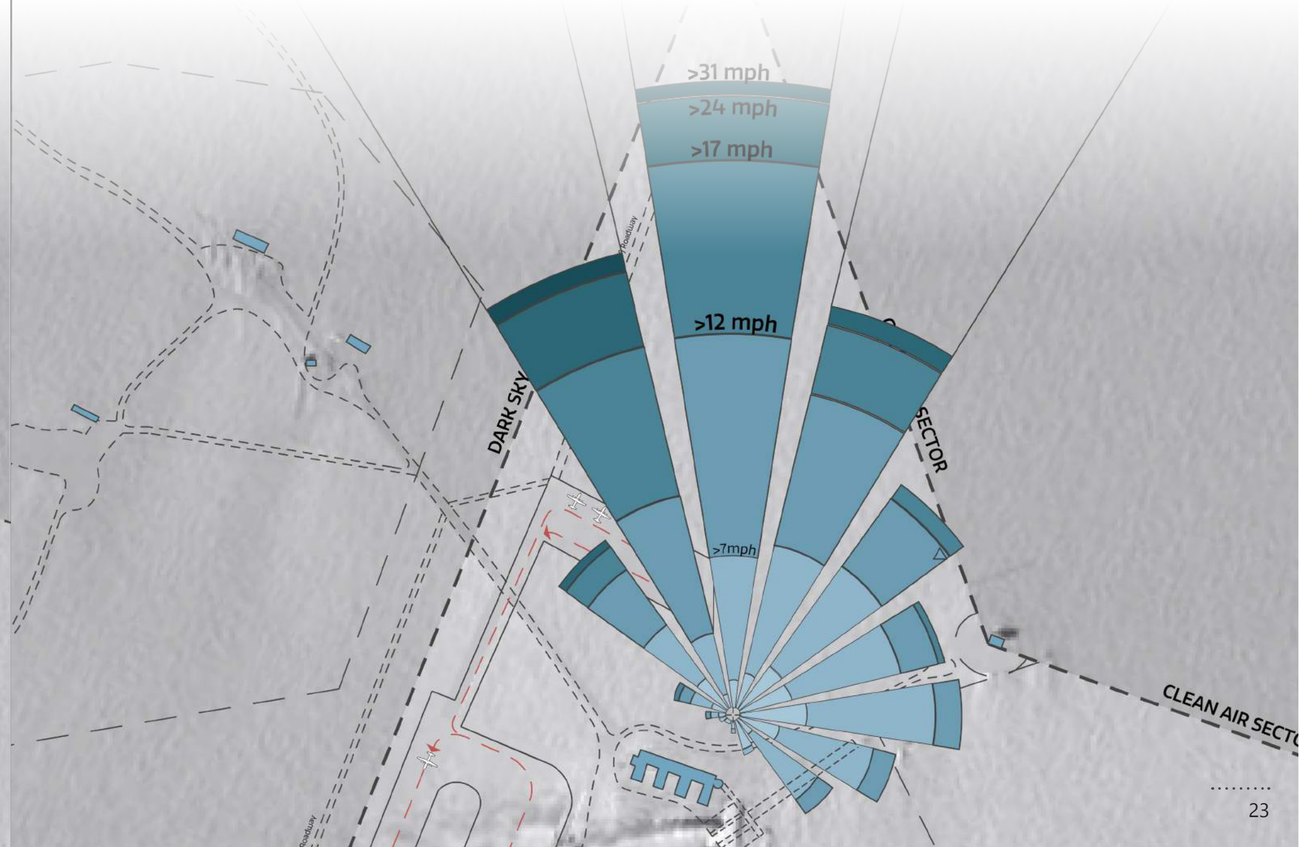





DARK SKY SE
AN AIR SECTOR



1 — Amundsen-Scott South Pole Station
2 — Ceremonial South Pole Marker
3 — Atmospheric Research Facility (ARO)
4 — Martin A. Pomerantz Observatory (MAPO)
5 — South Pole Telescope
6 — IceCube Nuetrino Detection Observatory



SITE ANALYSIS AND ZONING

Housing the majority of scientific-related laboratories and equipment, the central region of the South Pole complex is by far the most trafficked and dense. Here, emissions and light pollution from vehicles and structures are acceptable.

1 — Amundsen-Scott South Pole Station + Summer Field Camp - Ferraro Choi Architects - 2008

2 — Ceremonial South Pole Marker + Nations With Vested Interests In Antarctica

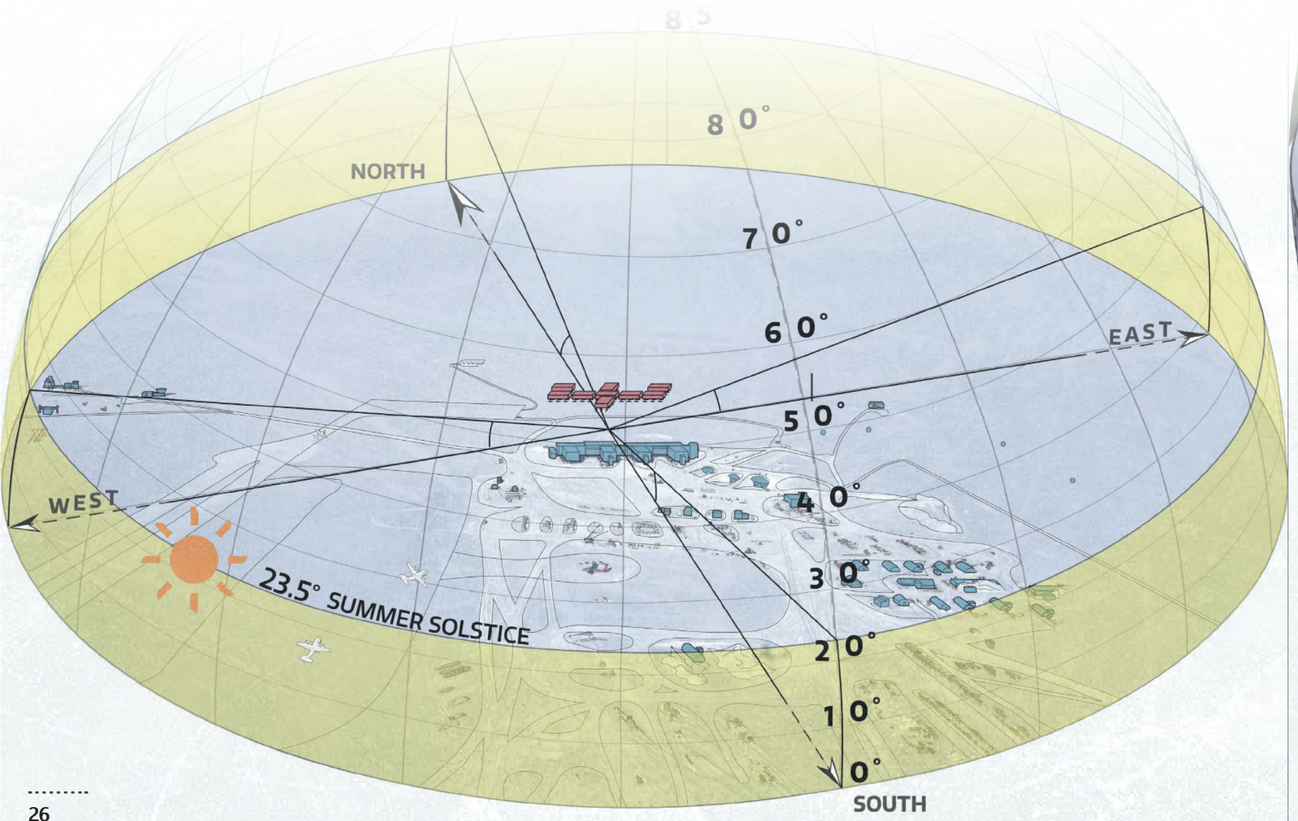
3 — Atmospheric Research Facility (ARO) - Meteorology Observatory

The Dark Sky Sector is as the name suggests—a region of incredibly dark skies free from the disruptions of light pollution. The construction of any non-astronomical observatories are prohibited to maintain the unrivaled clarity of cosmological imaging in this location.

4 — Martin A. Pomerantz Observatory (MAPO) - Infrared-Wavelength Observatory

5 — South Pole Telescope - Radio-Wavelength Observatory

6 — IceCube Nuetrino Detection Observatory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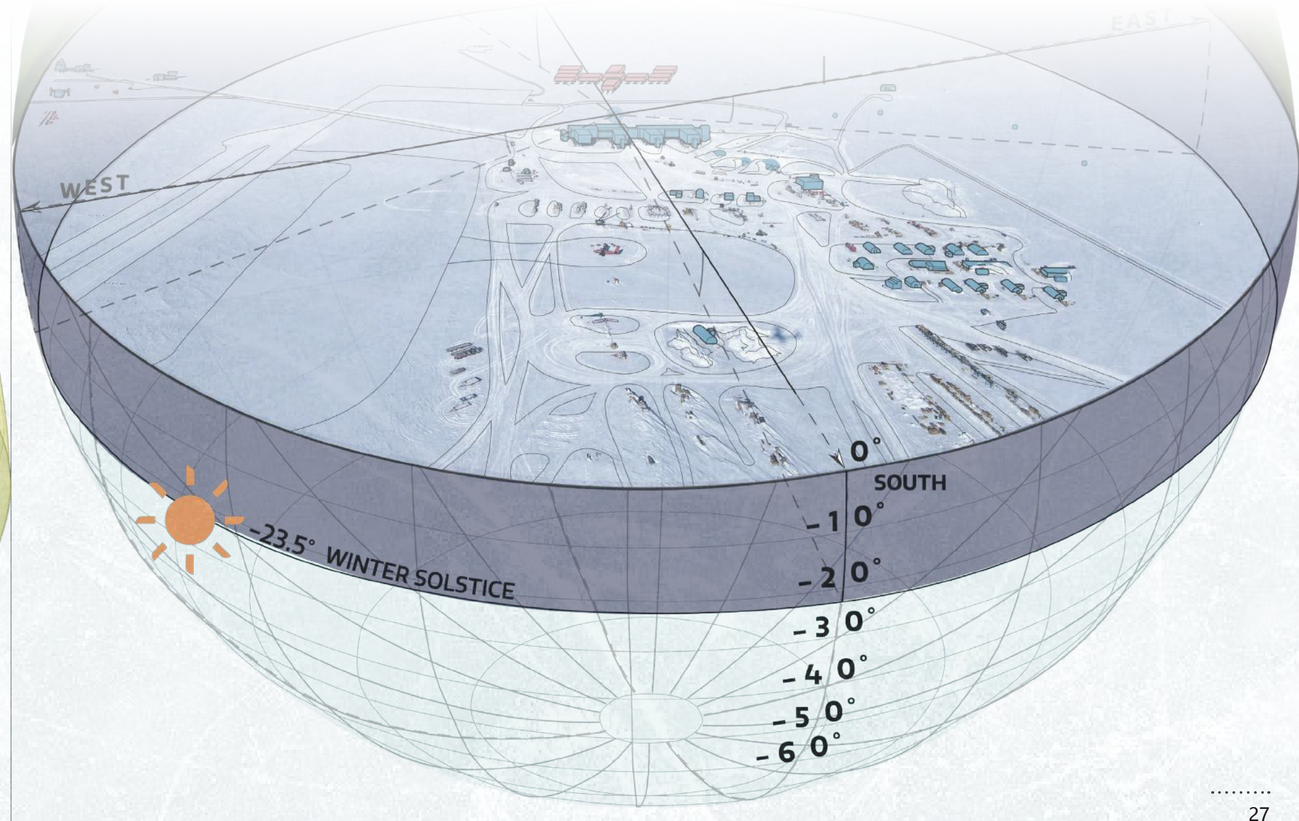
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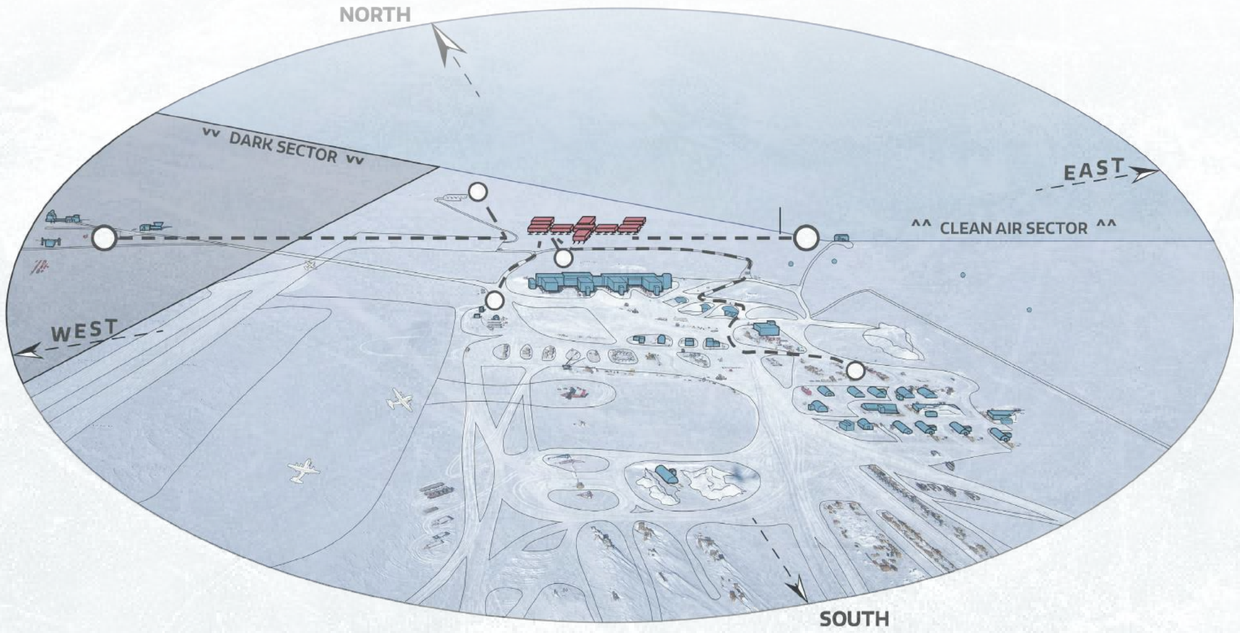
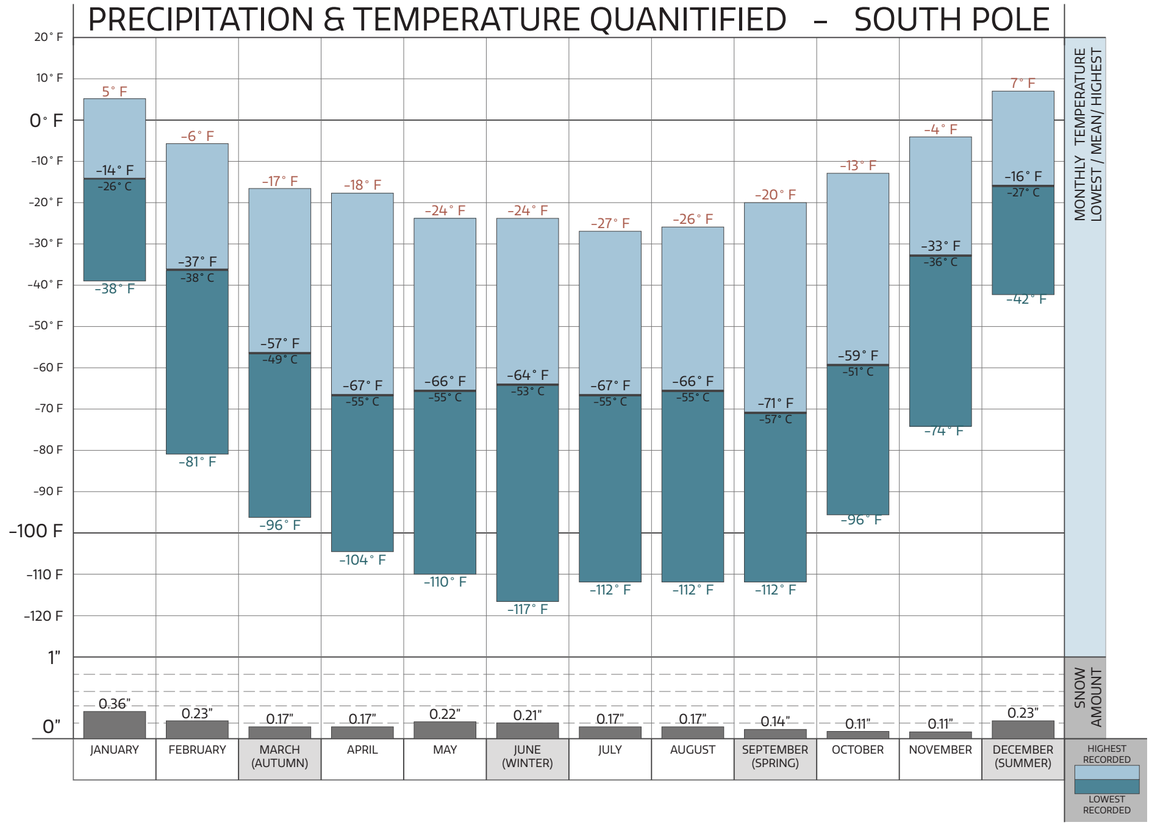

NORTH
vv DARK SECTOR vv
EAST
^^ CLEAN AIR SECTOR ^^
WEST
SOUTH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0.11"
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SNOW AMOUNT
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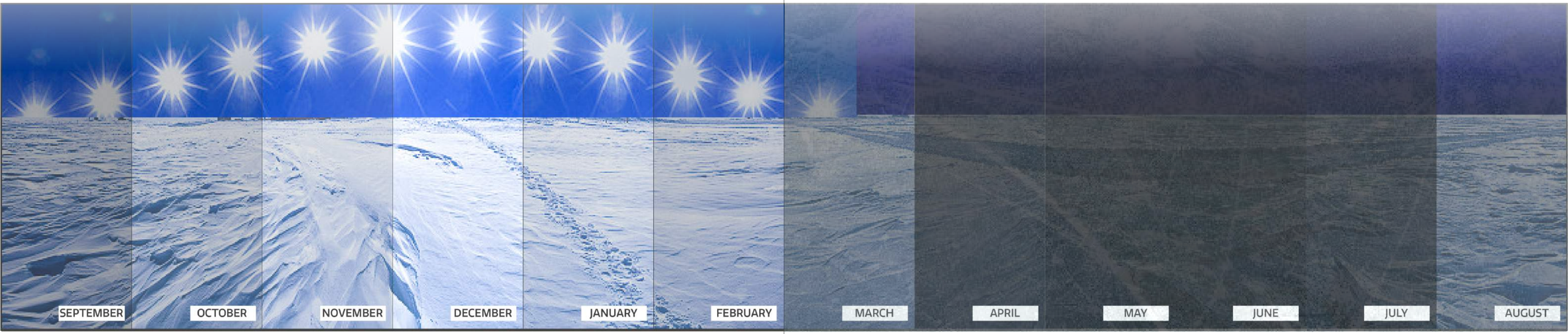
FEBRUARY
MARCH (AUTUMN)
APRIL
MAY
JUNE (WINTER)
JULY
AUGUST
SEPTEMBER (SPRING)
OCTOBER
NOVEMBER
DECEMBER (SUMMER)
HIGHEST RECORDED
LOWEST RECORDED


SEPTEMBER
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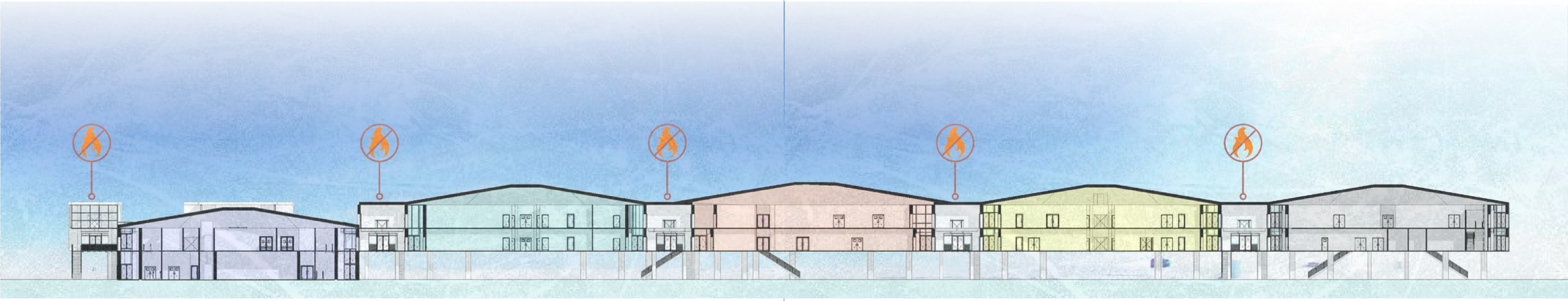

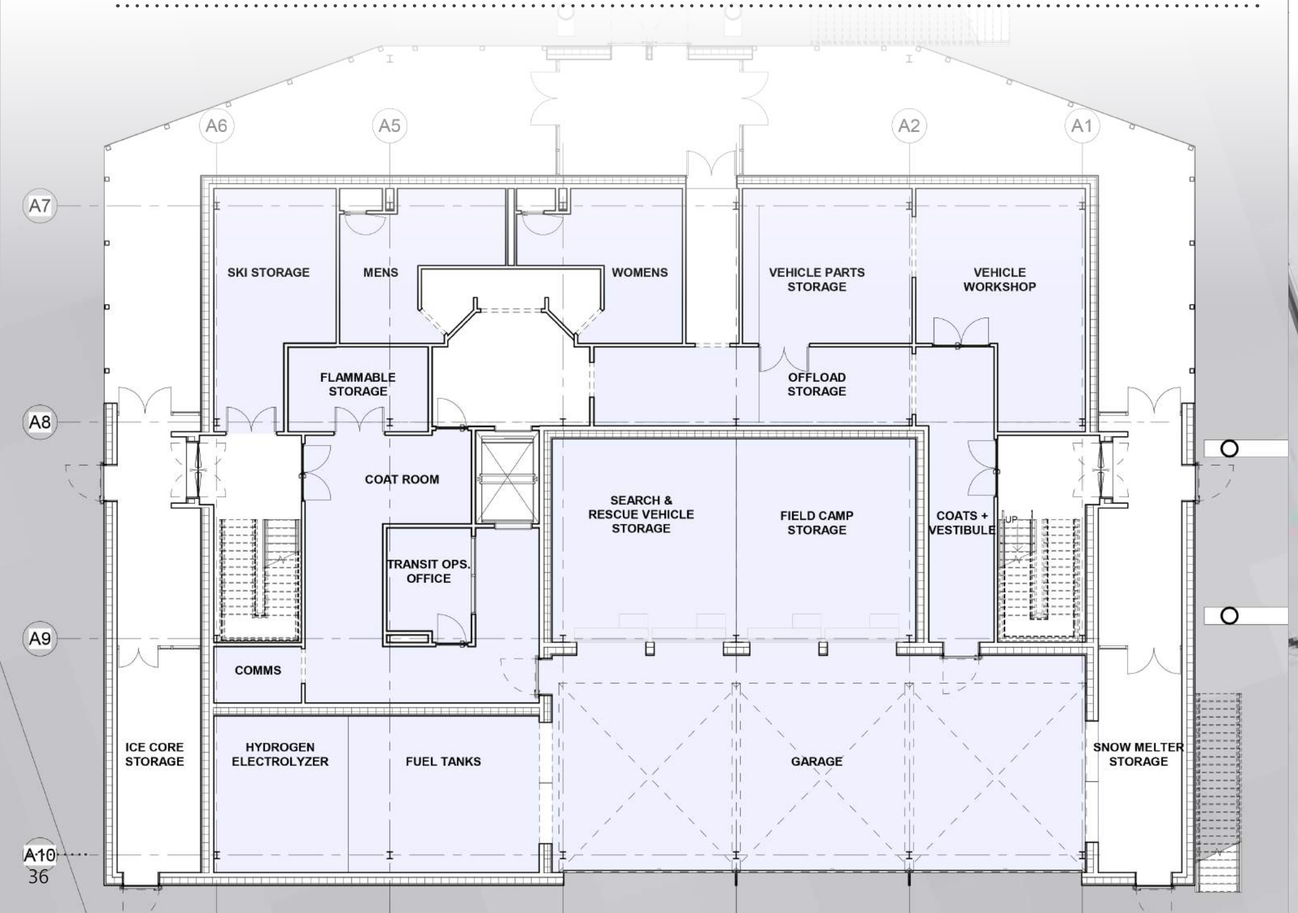
A6
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A10
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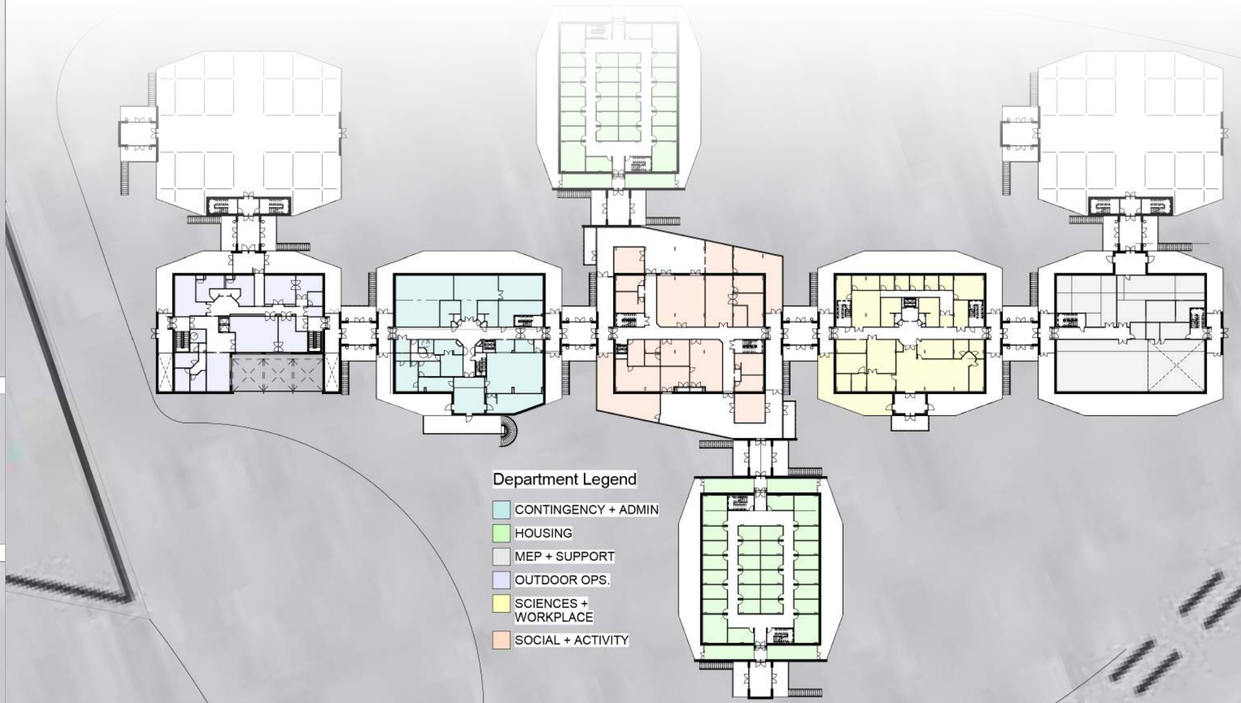
MENS
WOMENS
VEHICLE PARTS STORAGE
VEHICLE WORKSHOP
FLAMMABLE STORAGE
OFFLOAD STORAGE
COAT ROOM
SEARCH & RESCUE VEHICLE STORAGE
FIELD CAMP STORAGE
COATS + VESTIBULE
UP
TRANSIT OPS. OFFICE
COMMS
ICE CORE STORAGE
HYDROGEN ELECTROLYZER
FUEL TANKS
GARAGE
SNOW MELTER STORAGE


Department Legend
CONTINGENCY + ADMIN
HOUSING
MEP + SUPPORT
OUTDOOR OPS.
SCIENCES + WORKPLACE
SOCIAL + ACTIVITY


A6
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A10
RECYCLING
MENS
WOMENS
STEEL FABRICATION
WELDING AND METALLURGY
3D PRINTING
DUST COLLECTION
ADMIN W.C.
CARPENTRY WORKSHOP
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BREAK ROOM
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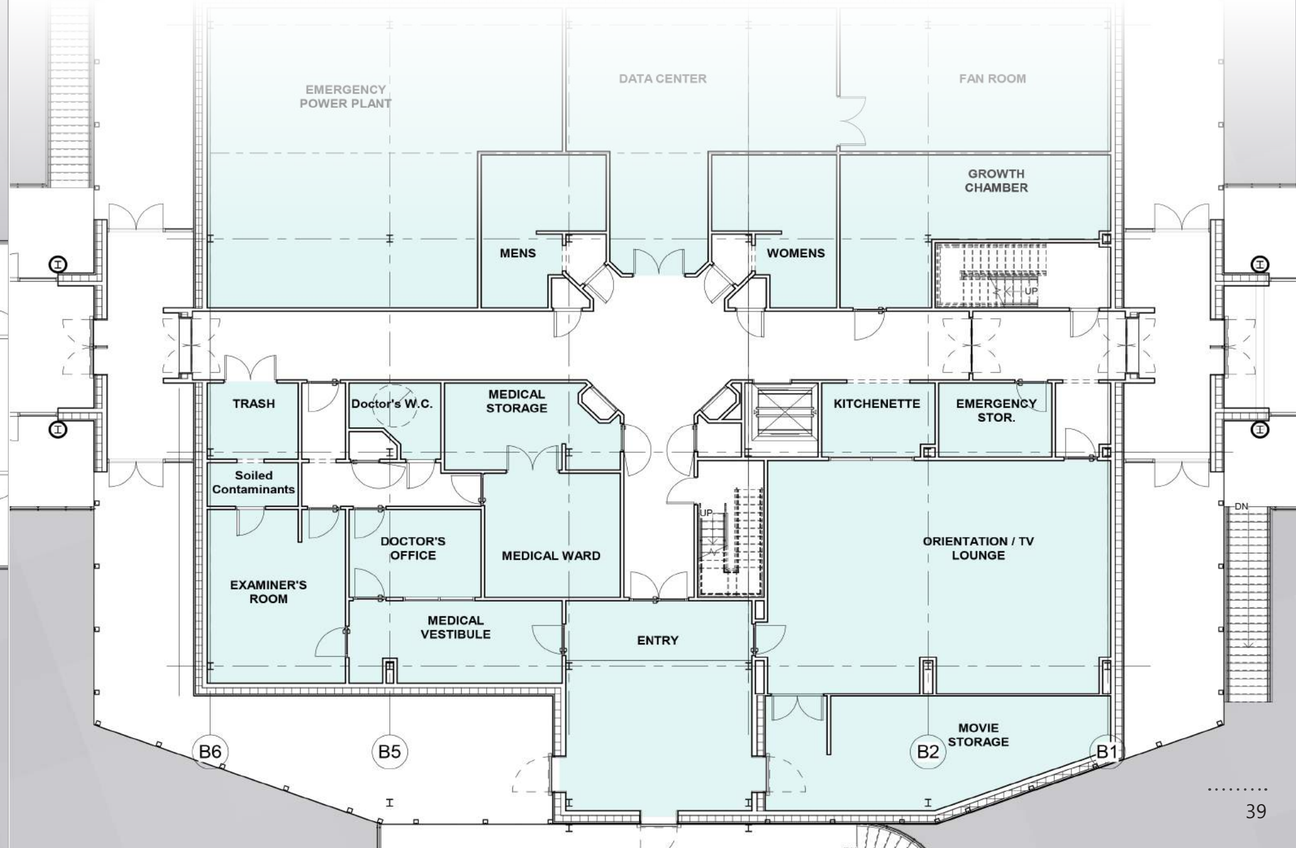
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DATA CENTER
FAN ROOM
GROWTH CHAMBER
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TRASH
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MEDICAL STORAGE
KITCHENETTE
EMERGENCY STOR.
Soiled Contaminants
DOCTOR'S OFFICE
MEDICAL WARD
UP
ORIENTATION / TV LOUNGE
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EXAMINER'S ROOM
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MOVIE STORAGE
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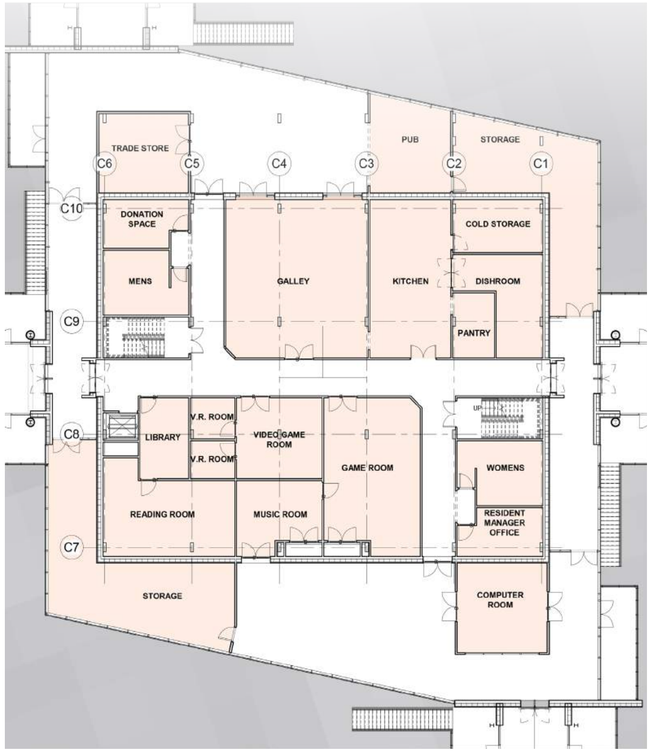
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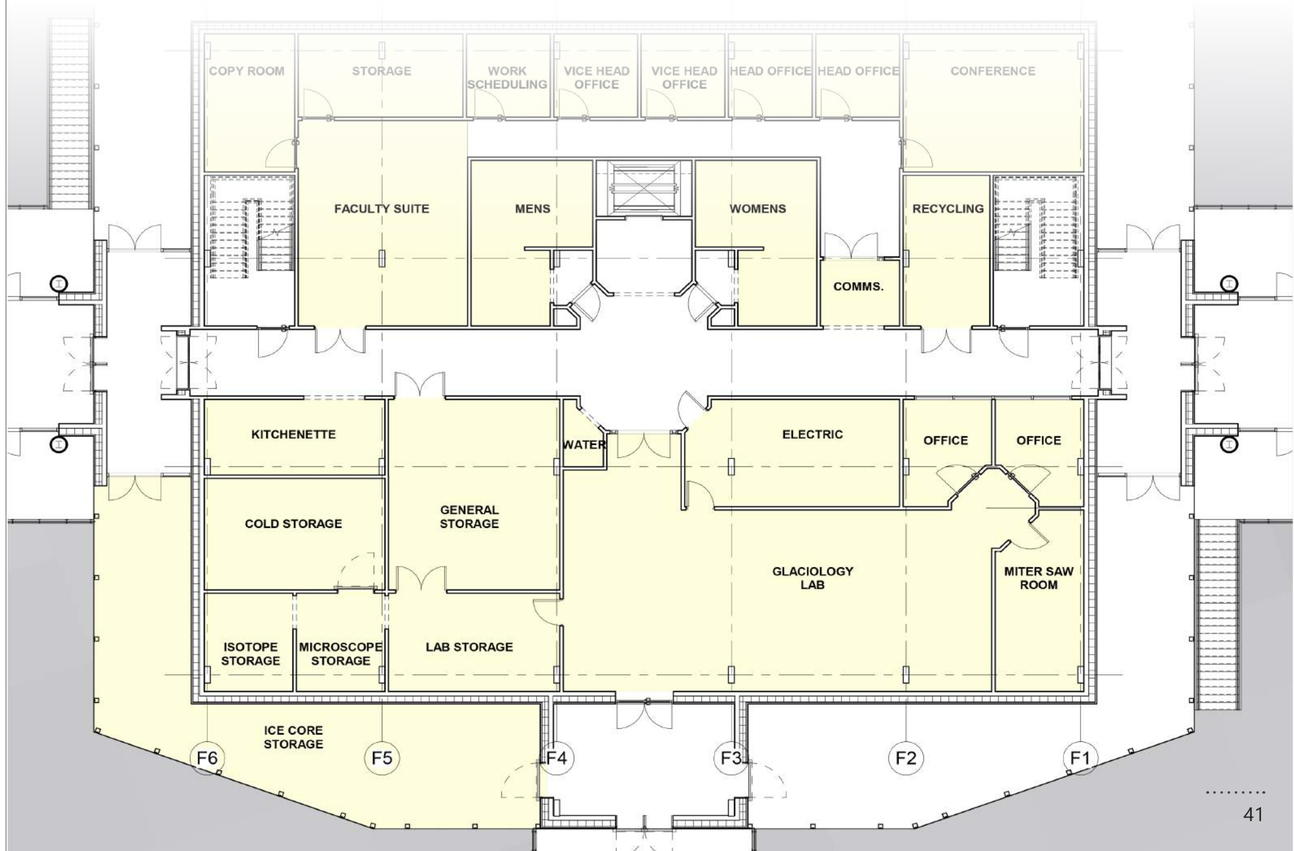
DONATION SPACE
COLD STORAGE
MENS
GALLEY
KITCHEN
DISHROOM
C9
PANTRY
C8
V.R. ROOM
LIBRARY
V.R. ROOM
VIDEO GAME ROOM
GAME ROOM
WOMENS
READING ROOM
MUSIC ROOM
RESIDENT MANAGER OFFICE
C7
STORAGE
COMPUTER ROOM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STORAGE
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VICE HEAD OFFICE
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FACULTY SUITE
MENS
WOMENS
RECYCLING
COMMS.
KITCHENETTE
WATER
ELECTRIC
OFFICE
OFFICE
COLD STORAGE
GENERAL STORAGE
GLACIOLOGY LAB
MITER SAW ROOM
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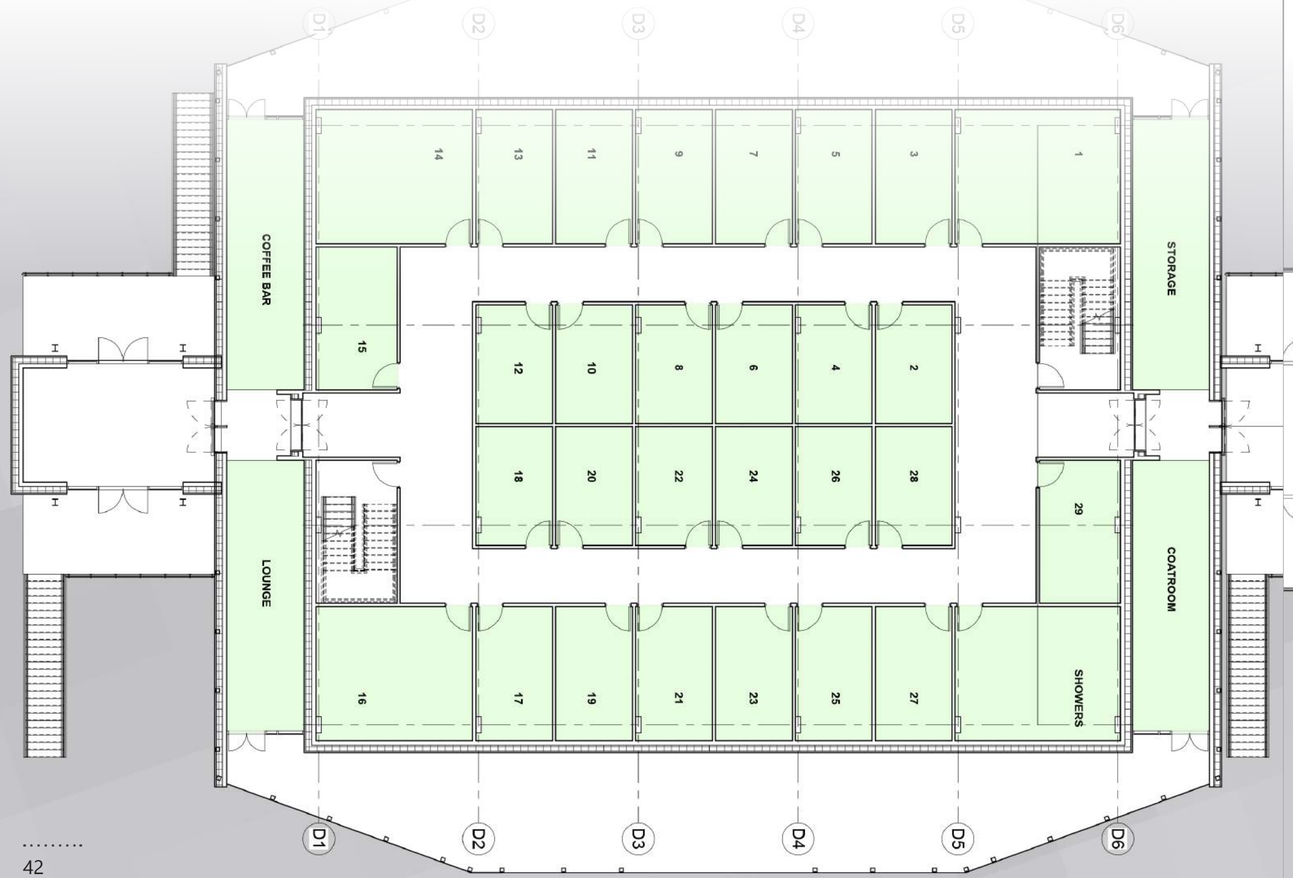
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LOUNGE
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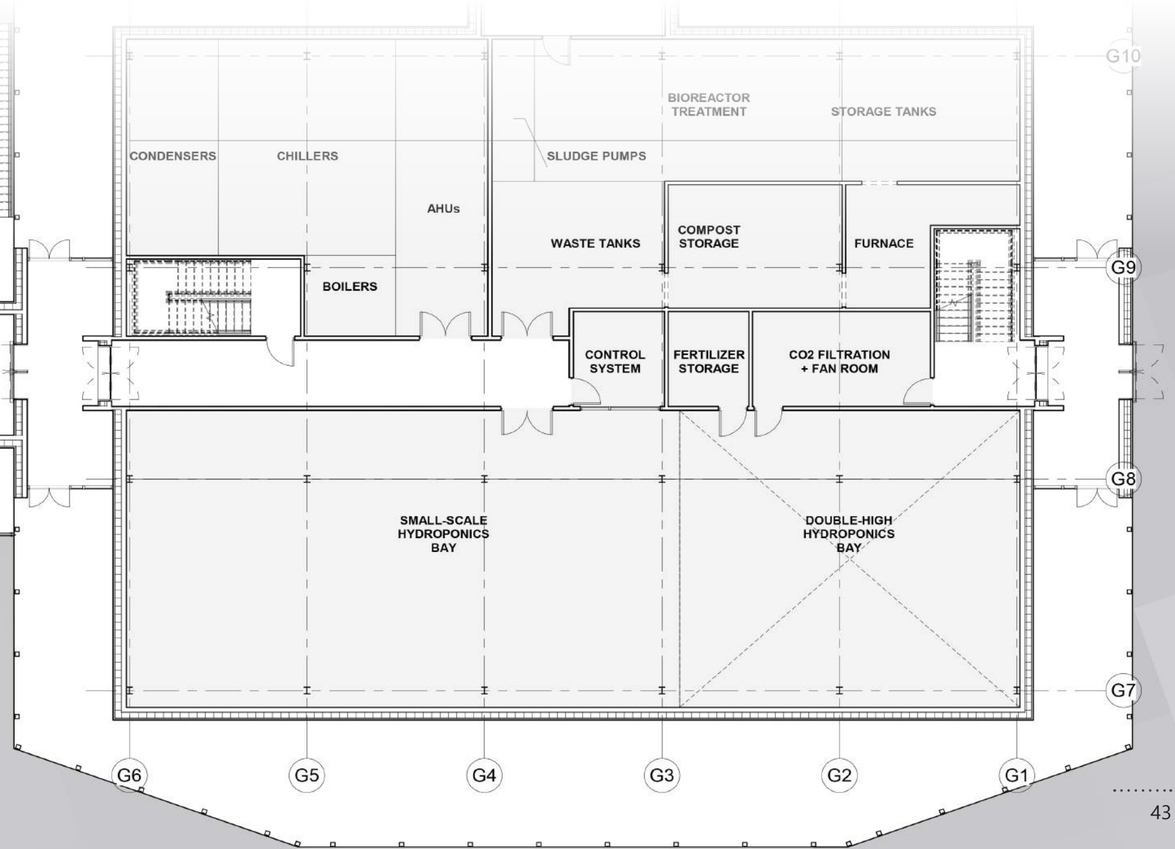
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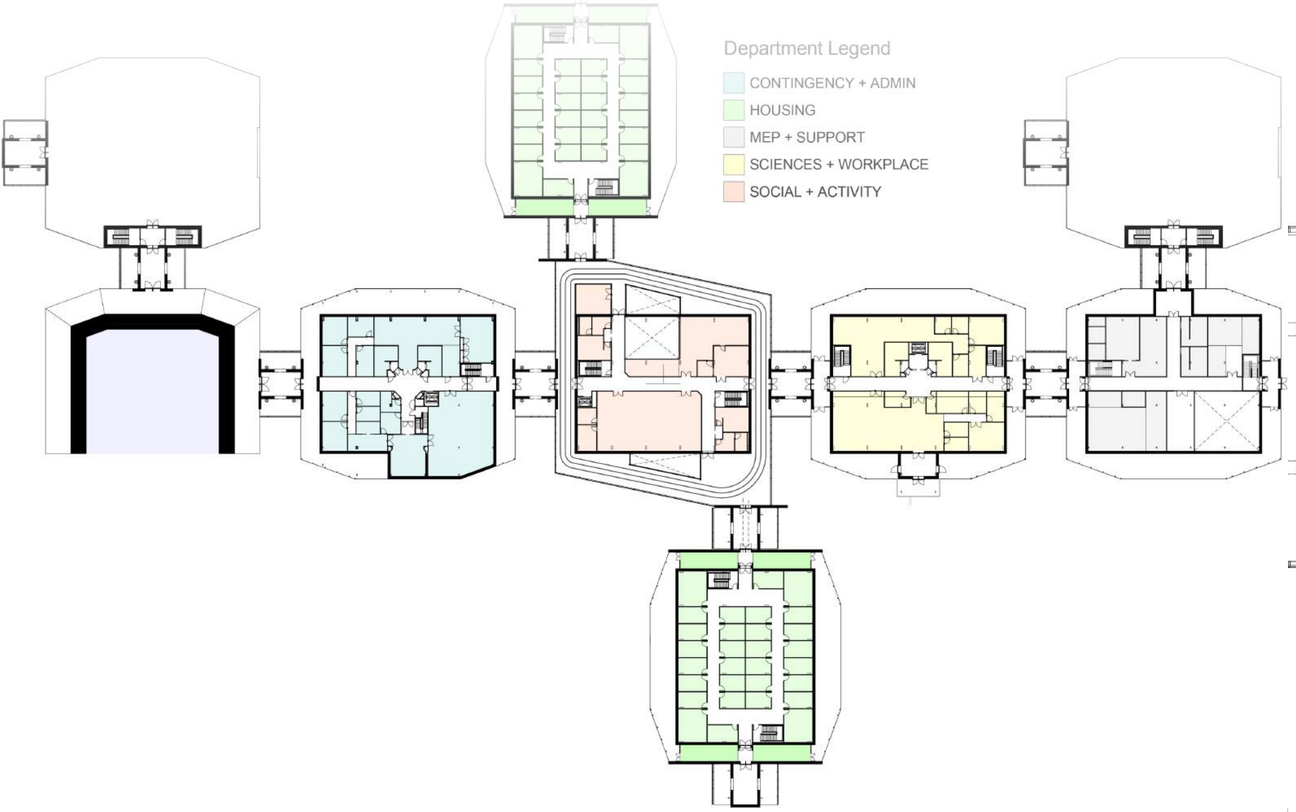
G1
BIOREACTOR TREATMENT
STORAGE TANKS
CONDENSERS
CHILLERS
AHUs
SLUDGE PUMPS
WASTE TANKS
COMPOST STORAGE
FURNACE
BOILERS
CONTROL SYSTEM
FERTILIZER STORAGE
CO2 FILTRATION + FAN ROOM
SMALL-SCALE HYDROPONICS BAY
DOUBLE-HIGH HYDROPONICS BAY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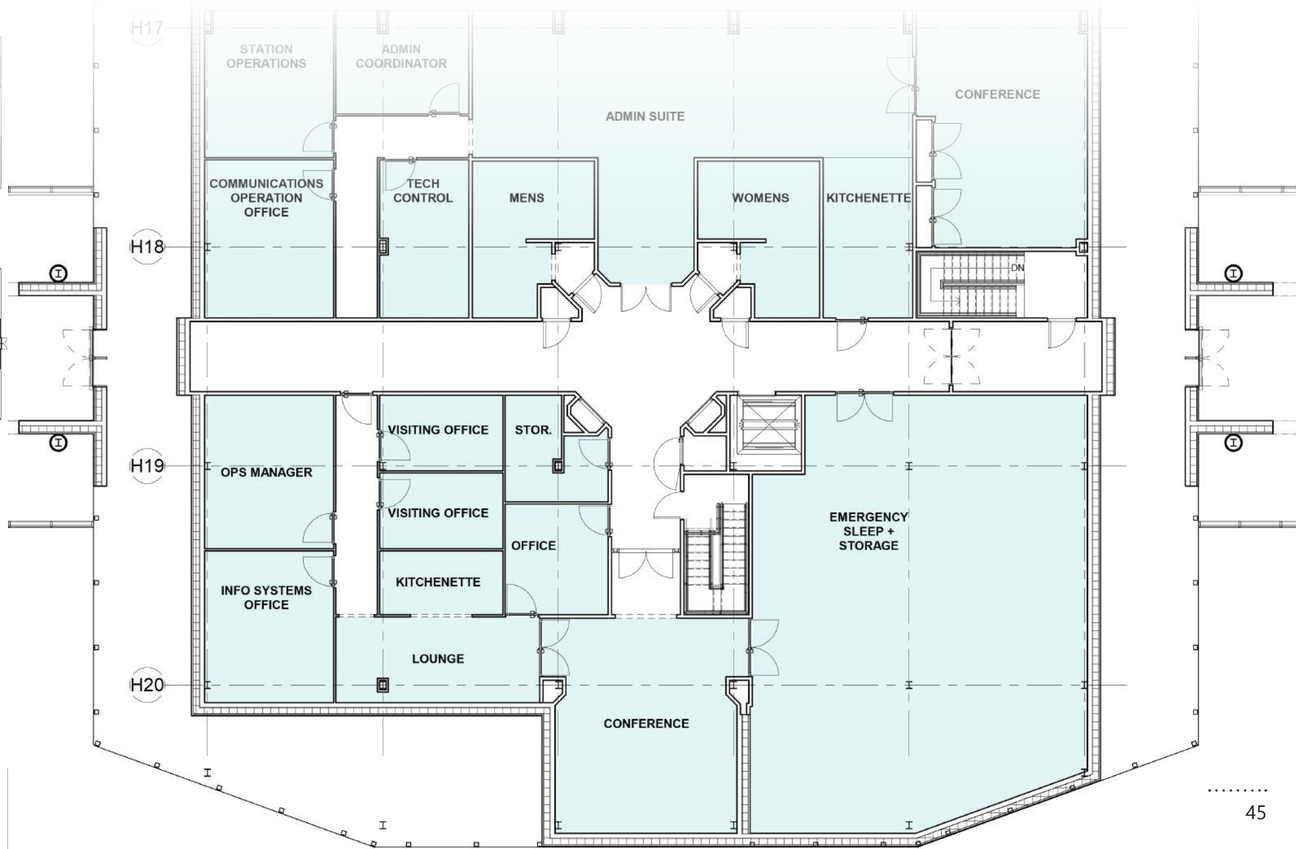
CONTINGENCY + ADMIN
HOUSING
MEP + SUPPORT
SCIENCES + WORKPLACE
SOCIAL + ACTIVITY


H17
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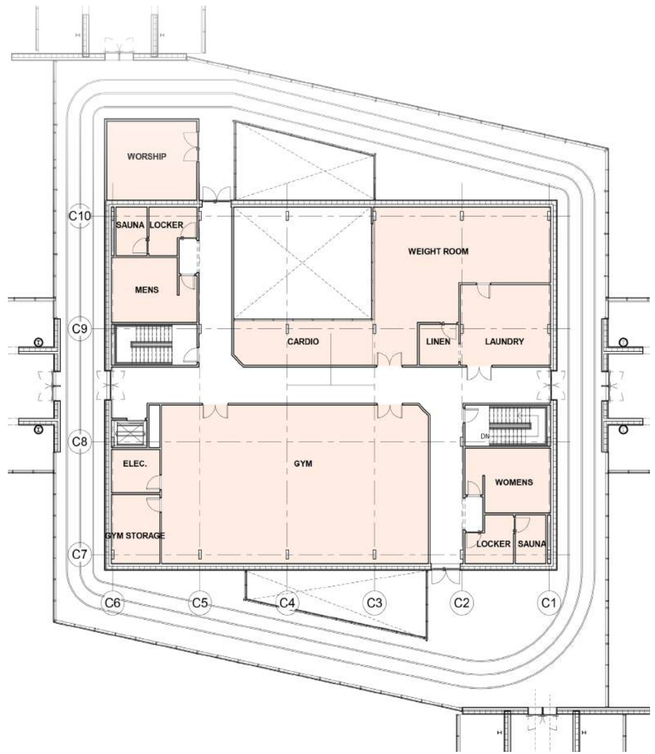
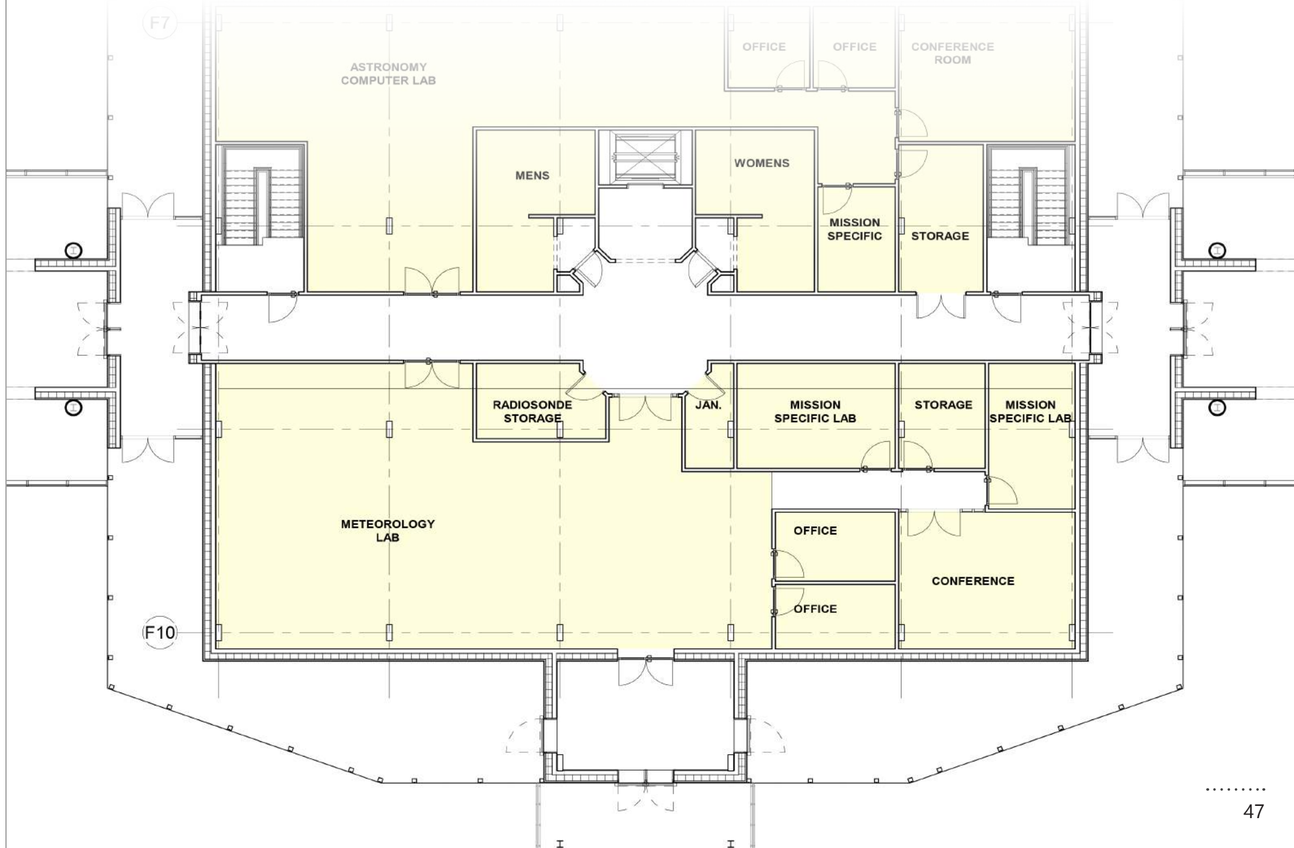
ADMIN SUITE
CONFERENCE
COMMUNICATIONS OPERATION OFFICE
TECH CONTROL
MENS
WOMENS
KITCHENETTE
DN
VISITING OFFICE
STOR.
OPS MANAGER
VISITING OFFICE
OFFICE
EMERGENCY SLEEP + STORAGE
INFO SYSTEMS OFFICE
KITCHENETTE
LOUNGE
CONFERENCE


WORSHIP
C10
SAUNA
LOCKER
MENS
WEIGHT ROOM
C9
CARDIO
LINEN
LAUNDRY
C8
ELEC.
GYM
DN
WOMENS
GYM STORAGE
LOCKER
SAUNA
C7
C6
C5
C4
C3
C2
C1


F7
ASTRONOMY COMPUTER LAB
OFFICE
OFFICE
CONFERENCE ROOM
MENS
WOMENS
MISSION SPECIFIC
STORAGE
RADIOSONDE STORAGE
JAN.
MISSION SPECIFIC LAB
STORAGE
MISSION SPECIFIC LAB
METEOROLOGY LAB
OFFICE
CONFERENCE
OFFICE
F10


E7
E8
E9
E10
COATROOM
HEATED STORAGE
SHOWERS
115
113
111
109
107
105
103
116
114
112
110
108
106
104
89
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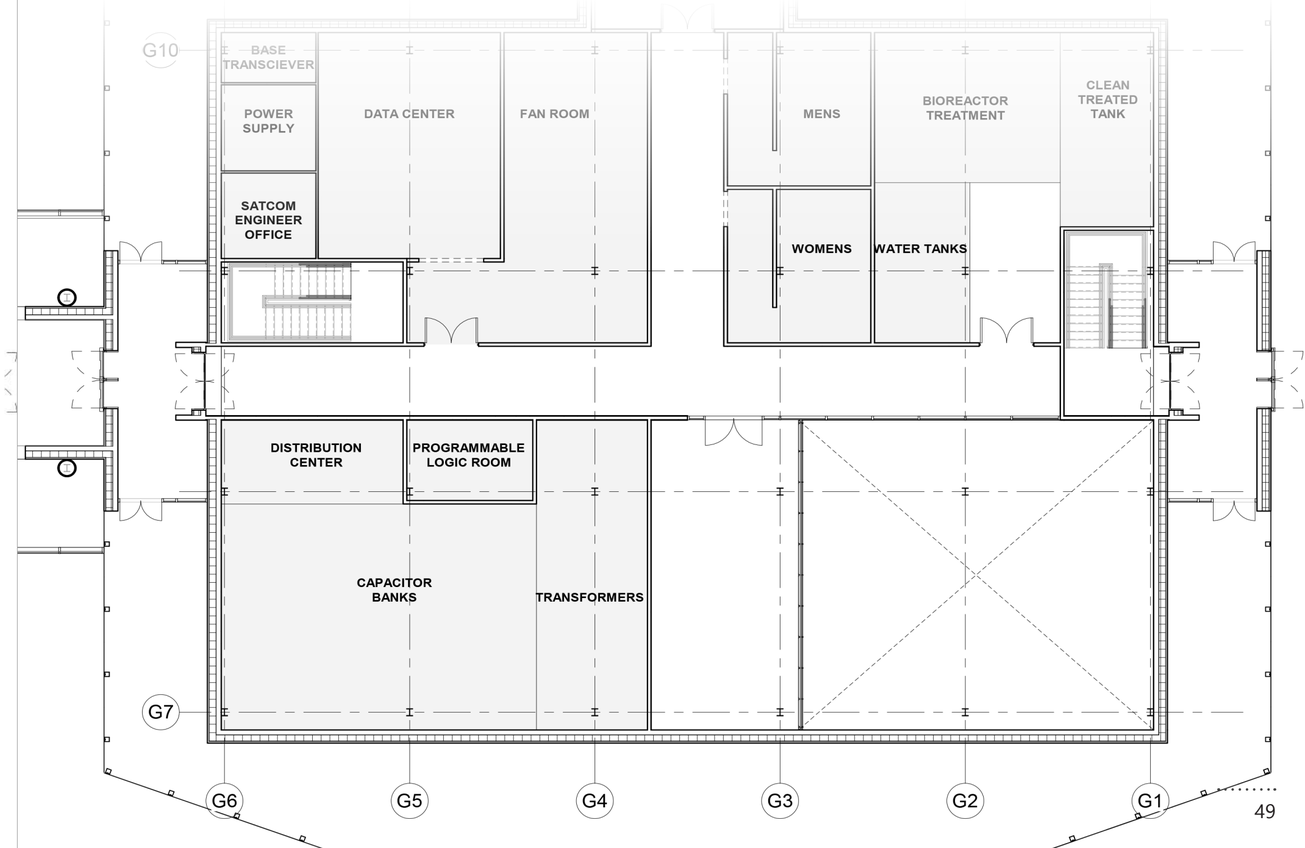
100
102
88
90
91
93
95
97
99
101
DN
LOUNGE
COFFEE BAR


G10
BASE TRANSCIEVER
POWER SUPPLY
SATCOM ENGINEER OFFICE
DATA CENTER
FAN ROOM
MENS
WOMENS
BIOREACTOR TREATMENT
WATER TANKS
CLEAN TREATED TANK
DISTRIBUTION CENTER
PROGRAMMABLE LOGIC ROOM
CAPACITOR BANKS
TRANSFORMERS
G7
G6
G5
G4
G3
G2
G1

THE ANTARCTIC TREK

An Architectural Typology for Evading the Climatic Dangers of the Arctic

Undergraduate Architecture Thesis
Spring 2021, Penn State University
Michael Hafer