

Evolution of a Station

Executing the Long Range Plan

Polar Technology Conference
US Naval Academy
Annapolis Maryland
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Summit: A Unique Location



Facts about Summit

- Originally the site of the GISP project, developed in the early 1990's
- Provides the only high latitude, high altitude research site in the northern hemisphere, access to the free troposphere and a pristine study environment
- Primarily “clean science”: atmospheric and near surface snow chemistry
- One of six NOAA baseline Observatories
- It is in an extreme environment
- Currently, year-round operation with up to 50 people in summer and 5 in winter
- **Emissions from power generation and aircraft are spoiling the very data being collected**



Summit: Long Range Planning for a long time



Model	Name	Concept
1	Business as Usual Model (AKA Do nothing)	Summit continues along as it historically has. No large upgrade projects, just sustaining existing infrastructure and replacing infrastructure at the end of its life with functional equivalent.
2	Stainless Steel Towers	Summit science is supported off of a small collection of platforms that can run autonomously for months. Routine maintenance is supported by Twin Otter and cold camp.
3	Growth Model, Observatory & Campaign (AKA Big Vision)	Summit develops permanent year round facilities and scalable seasonal facilities commensurate with historical growth patterns. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.
4	No Growth Model, Observatory & Campaign (AKA Do)	Summit develops permanent year round facilities and scalable seasonal facilities commensurate with freezing growth at current levels. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.
5	Year Round Observatory	Summit develops permanent year round facilities commensurate with supporting currently funded, year-round science only. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.
6	Scalable Campaign Summer Camp AKA (Not Summit)	Summit develops scalable seasonal facilities commensurate with currently funded, campaign science only. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.

Summit Long Range Plan (Model 5)

Pristine Atmospheric
Watch Observatory

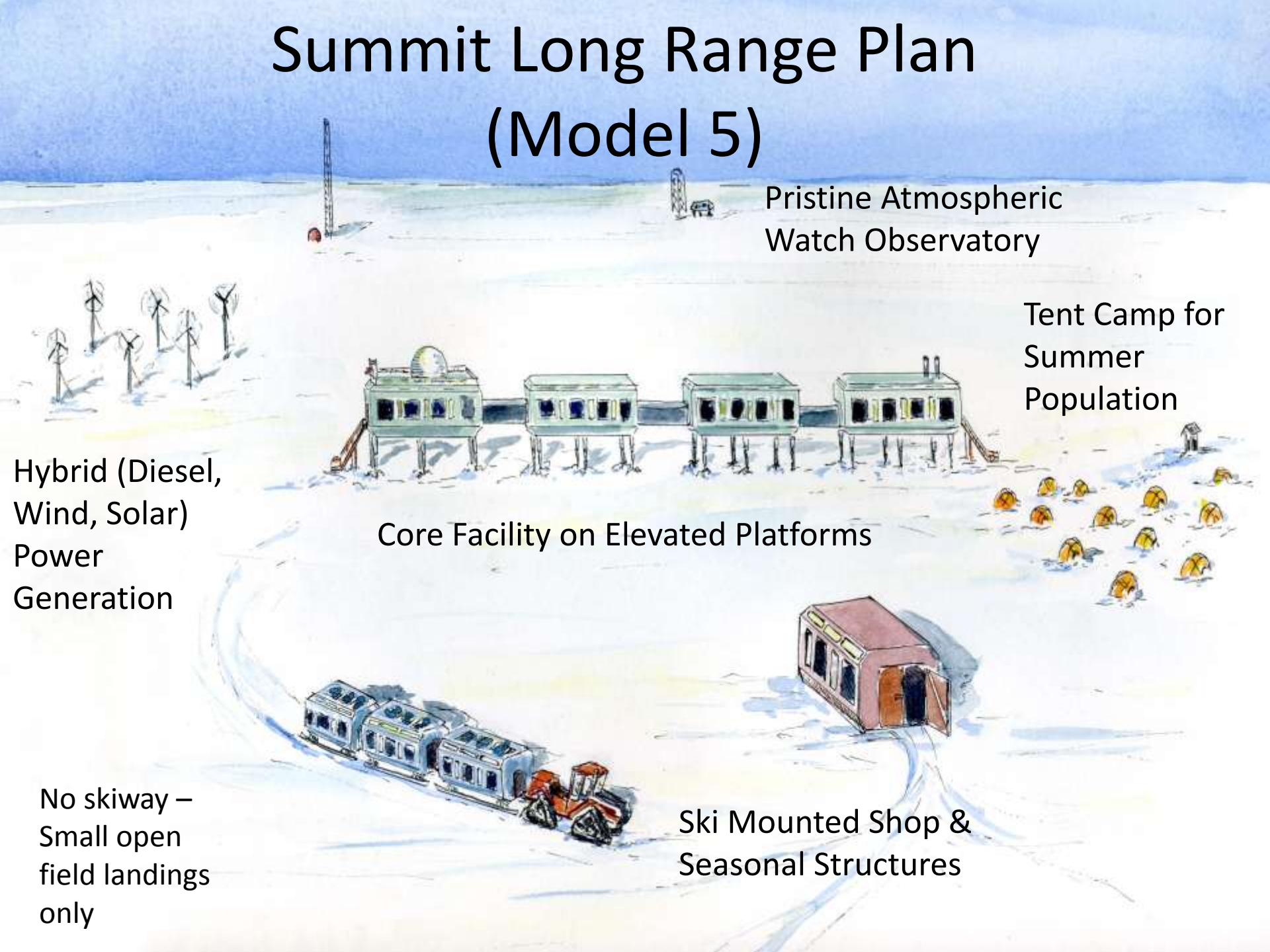
Tent Camp for
Summer
Population

Core Facility on Elevated Platforms

Ski Mounted Shop &
Seasonal Structures

No skiway –
Small open
field landings
only

Hybrid (Diesel,
Wind, Solar)
Power
Generation



Atmospheric Watch Observatory

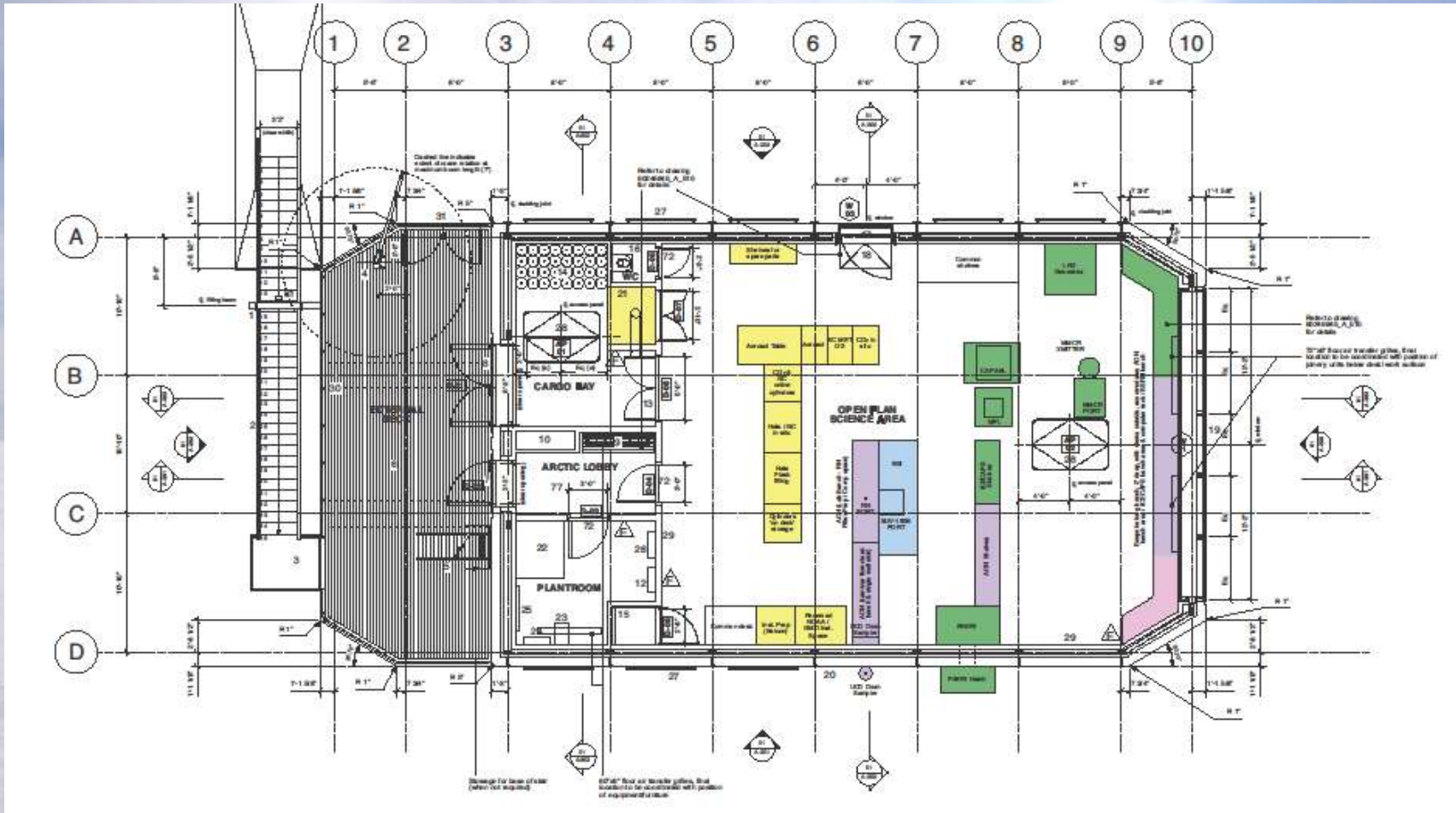


Designed in 2011 - 2012

- Halley 6 Spin off
- Energy efficient R-65 GRP cladding
- Aerodynamic to reduce drifting
- Solar
- Structural space frame: Supports weight on 2 hydraulic legs
- Rooftop science
- Assembled offsite and towed into place
- Elevating stairway
- LCCA similar to infinite leg currently on the Big House



AWO: Interior layout



Model 6: Anywhere but Summit!



- Located somewhere that isn't Summit (Not Summit)
- Allows “not clean” science to take place
- Summit then becomes a clean air site housing a year round population of 6 (Model 5)
- Idea tossed around for a couple years. Where is it? What is it?
- Enter the Telescope Project...

A Telescope at Summit? The Anchor Tenant for 'Not Summit'

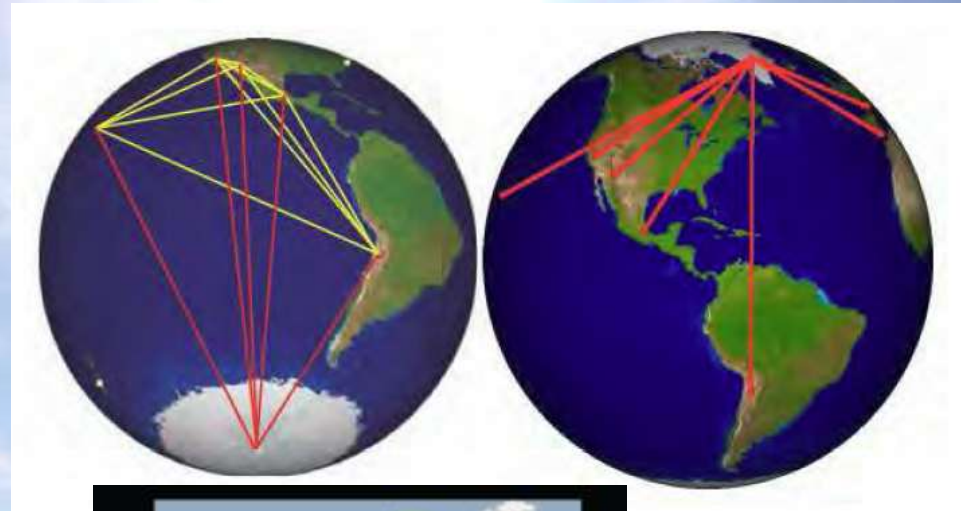


- Collaboration led by the Smithsonian Astrophysical Observatory (SAO) and the Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) from Taiwan.
- In 2011 the project was awarded a 12-meter radio telescope by the NSF. The collaboration plans to relocate the antenna to a high, dry site suitable for submillimeter and terahertz science observations.
- Site characteristics such as low water vapor, low temperatures and high altitude drove the decision to pursue a site near Summit Station

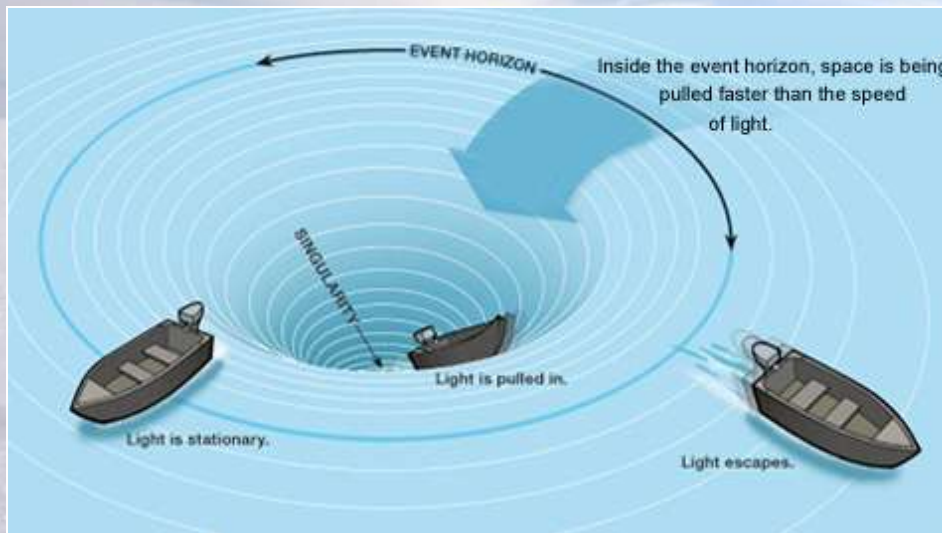
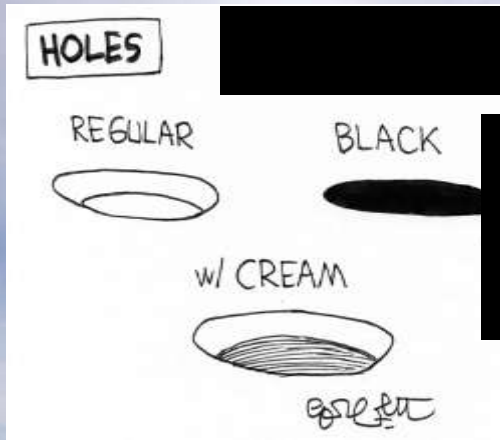


Science driver for the telescope

- Completing the Event Horizon Telescope: a global array of radio telescopes used for high resolution imaging. The further apart, the higher resolution.
- Visibility and long baseline with ALMA and SMA
- There is a push within the astrophysics community to directly image a black hole, which has never been done before.
- The two “easiest” supermassive black holes to image are the one at the center of our galaxy, Sagittarius A*, and the one in the center of the nearby galaxy M87.



What is a black hole?



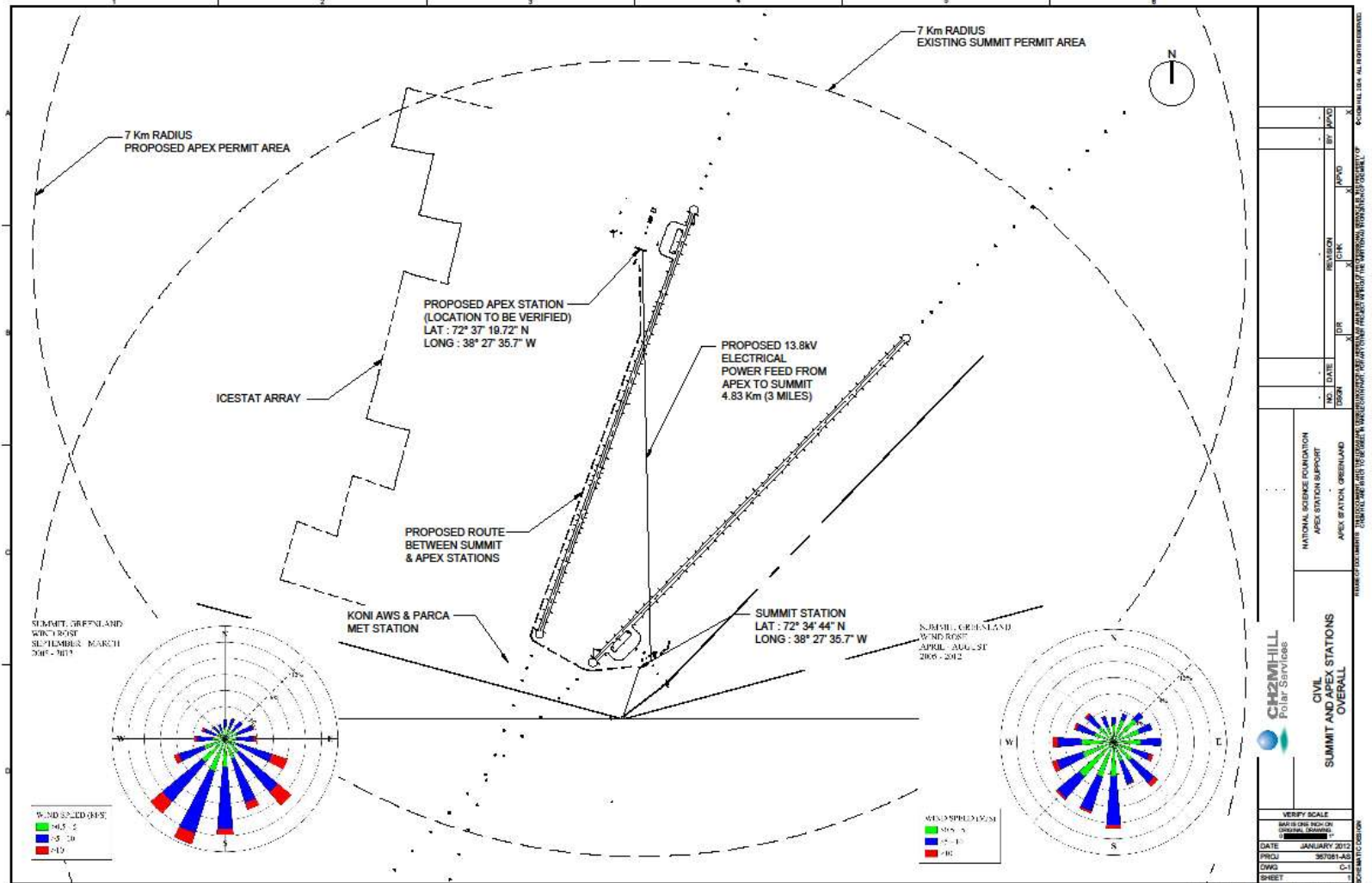
- A region in space where the gravitational field is so intense that no radiation or matter can escape because the escape velocity is greater than the speed of light.
- Wouldn't this mean that black holes are invisible? Yes. But, it is possible to image the "shadow" using an event horizon array.
- SAO and ASIAA will also make 30% of the telescope time available for other science.

'Not Summit' Becomes Isi Station



- Isi means “Eye” in Greenlandic, name suggested by Greenlandic Government
- The telescope project provides the perfect launch pad for the move to Isi. Now we know where Not Summit is!
- Located 3 miles to the north of Summit where emissions don’t spoil the data collected at Summit
- Allows some “less clean” science to take place at this unique location
- Close enough to feed power back to Summit and eliminate localized emissions there
- Similar infrastructure to the original Model 5 concept but with a few more people.

Isi/ Summit Layout



Transportation Between Isi and Summit



NASA Moon Rover

- All electric
- 6 wheel drive
- Enclosed cab

Crab walk
Pivot
20 MPH



Transportation Between Isi and Summit



Challenges? There Are Many!



- Transportation of one-off oversized cargo to the site via the Greenland Inland Traverse (GrIT)
- Constructing Isi at the same time as the Telescope
- Isi Support Infrastructure
 - Housing for 15 people year round
 - Power
 - Kitchen/ Dining
 - Lab space
- Differential settling
- 1M snow accumulation/ Yr
- Extreme temps (-76F)
- The Telescope
 - 230,000 lbs
 - 5 pieces
 - Dynamic structural and electric loads
 - Test set up in Thule
 - Snow Foundation
 - 100 ton crane
 - Dozer

Logistics chain

Thule

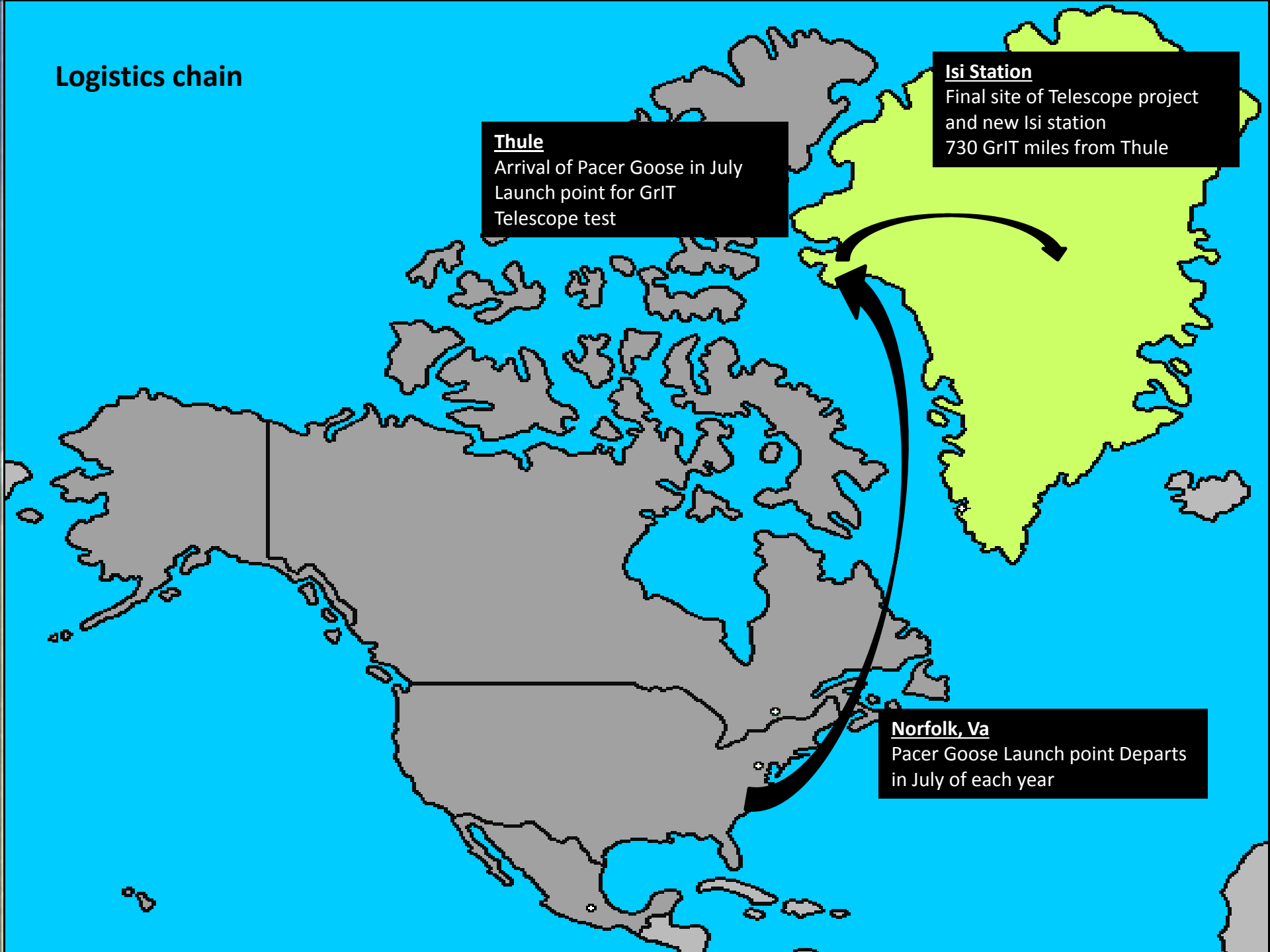
Arrival of Pacer Goose in July
Launch point for GrIT
Telescope test

Isi Station

Final site of Telescope project
and new Isi station
730 GrIT miles from Thule

Norfolk, Va

Pacer Goose Launch point
Departs in July of each year



What is GrIT? The Greenland Inland Traverse



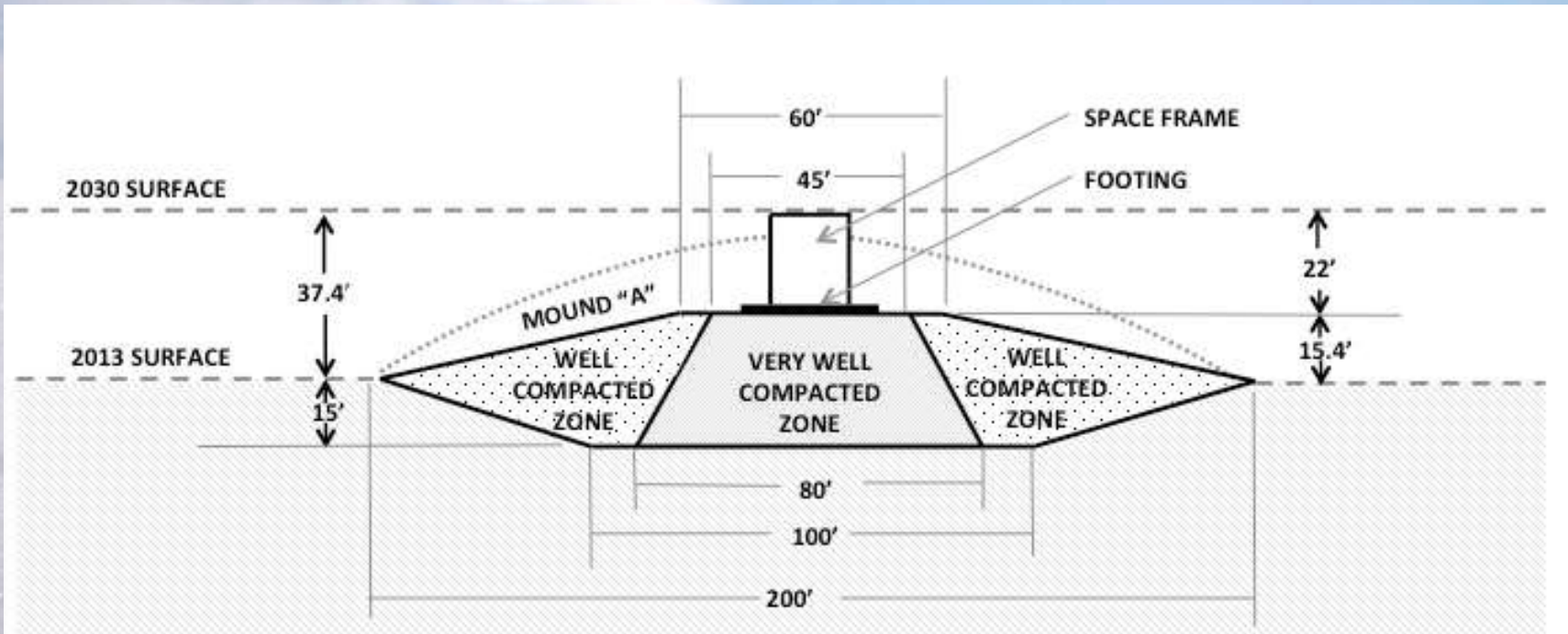


What is GrIT? The Greenland Inland Traverse



Telescope Foundation

- 15' Excavation
- 30' Compacted Snow Pad
- 22' High Support Structure
- 37' Above Existing Grade



Proposed Timeline



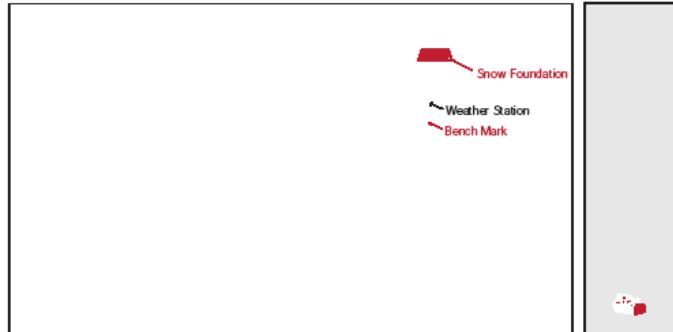
- 2014
 - Snow Foundation using new bulldozer
 - Construction of Support Camp
 - Thule Telescope test build
- 2015
 - Space Frame installation
 - Install Support Camp
 - 100 ton crane to Isi
 - Garage construction
- 2016
 - Telescope arrives at Isi/construct
 - AWO construction
- 2017
 - Living and dining facility construction
- 2018
 - Power plant construction
- 2019
 - Science Lab construction
 - Demo Summit facilities

Graphic Schedule Start 2014



Year 2013

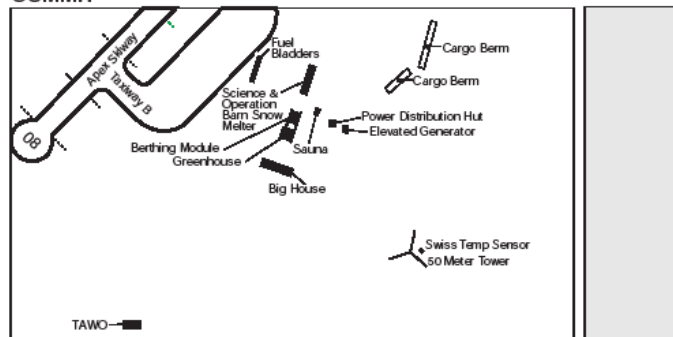
APEX



Greenland Long Range Planning Activities by Year							
Design	Procure	Fabricate	Vessel	GrIT			Construction
				Item	Lbs	Volume (R^3)	
MA1 - Living Module	AWO	AWO	Offroad Stud	D7E Dozer	Drive to Summit		Berthing Facility
MA1 - Dining Module	Support Camp	Support Camp	D7E Dozer (C-17)	Berthing Facility	25,000	5,616	Benchmark
MA1 - Power Module	Crane 1	Crane 1		Skiway Groomer	5,000	24,000	Tele Foundation
MA1 - Balloon Module	Tele Sprt Stuct	Tele Sprt Stuct		953D	35,000	1,848	
APEX Garage	Crane 2	Telescope		BH Steel Columns	30,000	800	
	Fork Lift	Crane 2		Fuel	331,200		
	Man Lift	Fork Lift					
	Tractor 5	Man Lift					
	Tractor 6	D7E Dozer					
		Tractor 5					
	Tractor 6						
Total					426,200	32,264	

Required Tractors for Single Trip: 4
 Single Trip Tractor Fleet Capacity: 495,000
 Required LC-130 Flights: 19

SUMMIT



LEGEND

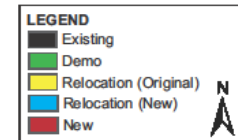
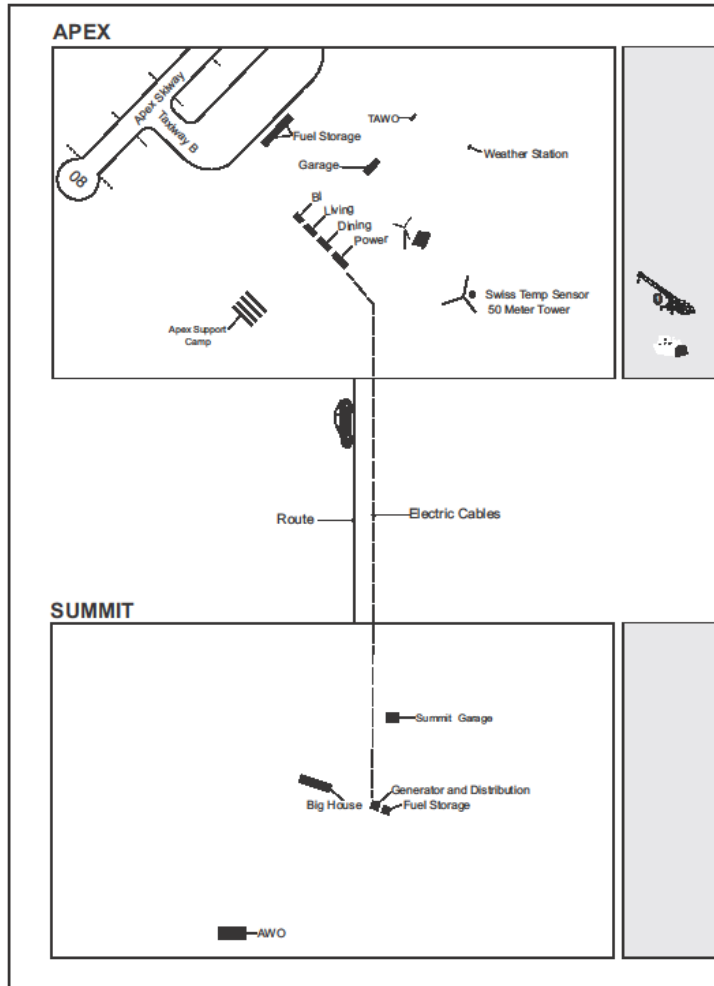
- Existing
- Demo
- Relocation (Original)
- Relocation (New)
- New



Graphic Schedule Finish



Option 2 - Final



Conclusion



- By 2020, Summit station will only support clean air and snow science via routine access from Isi station
- Isi Station will support a skiway and other science not requiring the clean area of Summit
- Costs and resources spread through phased approach
- Highly technical and complicated engineering.
- Fun! (Headaches free!)
- Opens opportunities for astrophysics/ astronomy in the arctic