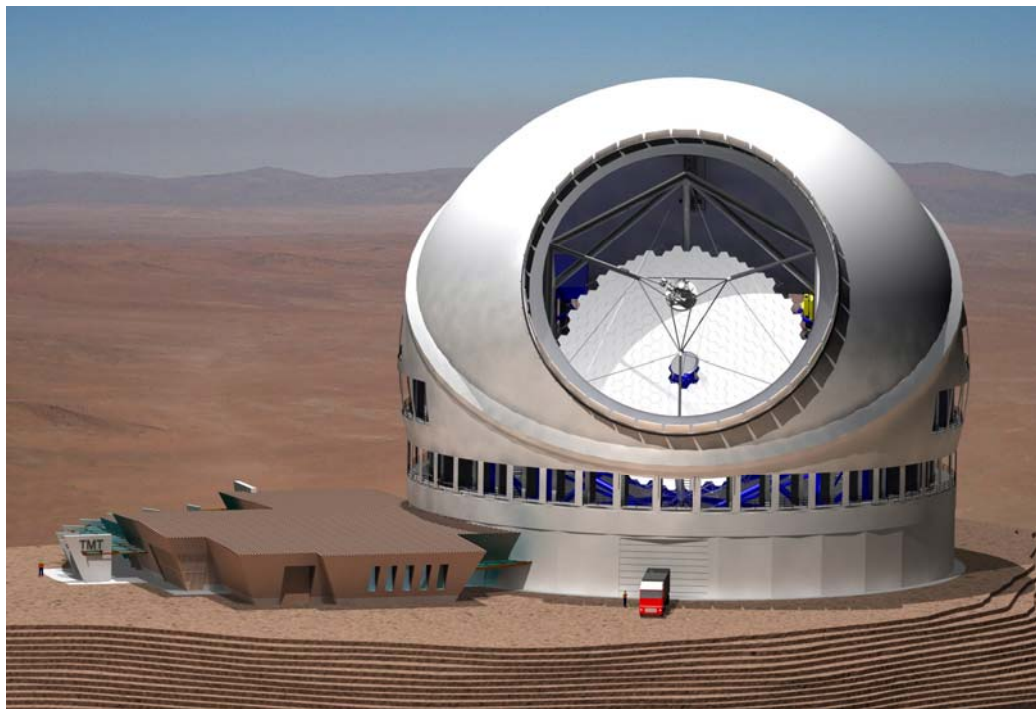




ENVIRONMENTAL IMPACT STATEMENT

PROJECT

TRANSPORT, CONSTRUCTION AND OPERATION OF THIRTY METER TELESCOPE (TMT) ON CERRO ARMAZONES, ANTOFAGASTA REGION



SANTIAGO, Mayo 2008

PREPARED BY: DATA RESEARCH



TMT.SIT.TEC.08.055.DRF01

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1. CHAPTER 1 : GENERAL BACKGROUND

1.1. COMPANY BACKGROUND

GRANTEE/OWNER:

Grantee / owner:	TMT Observatory Corporation
RUT (Chilean Tax ID):	59.139.660.9
Address:	Presidente Riesco No. 5536, office 507 – Vitacura Santiago
Phone:	3701085 – 3701086
Fax :	3709504

LEGAL REPRESENTATIVE:

Name:	Alicia Viviana Norambuena Belloni
RUT (Chilean Tax ID)	5.521-090 – K
Address:	Manuel Antonio Prieto No. 0152 Providencia Santiago
Region:	Metropolitana
Phone:	6651730
Fax:	6659201

TMT Observatory Corporation (TMT) is a nonprofit corporation under the Law of the State of California of the United States of America. One of the main purposes of TMT is to promote research in astronomy. **Annex VI** of this document specifies the legal background of the corporation, which is duly outlined under numeral 269 and dated January 21, 2008 before Notary Public Ms. Maria Gloria Acharan Toledo.

The Ministry of Foreign Affairs of Chile issued the Supreme Decree No. 196 on November 13, 2007, made public through its Official Diary on January 24, 2008. In said decree it states that TMT is subject to the same rules and enjoys the same prerogatives and opportunities as those established in the existing agreement on November 6, 1963, concluded between the Government of Chile and the European Organization for Astronomical Research in the Southern Hemisphere (ESO), in accordance with Law 17,318.

TMT Observatory Corporation is comprised by the California Institute of Technology (CALTECH), the University of California (UC) and the Association of Canadian Universities for Research in Astronomy (ACURA).

The founding members of TMT Observatory Corporation began their partnership on June 2003, with the objective of designing, building and operating an optical and infrared telescope with a primary mirror of 30 meters in diameter TMT (**Thirty Meter Telescope – Telescopio de Treinta Metros**), and to begin scientific operations by 2015. Funding of the construction is possible through a combination of public and private donations. This will make possible that a substantial amount of observation time becomes available in an open form to astronomers in the United States, Canada and Chile.

The location of the telescope, as outlined in section 1.9, is within lands granted in concession by the Ministry of National Assets to the Universidad Catolica del Norte (Northern Catholic University), by Exempt Resolution 0249 as of March 30, 2006 for a period of five years.

The management body of TMT Observatory Corporation is comprised by the TMT Board of Directors and the Scientific Advisory Committee (SAC). The TMT Board of Directors determines the main guidelines of the project to be implemented by the Principal Scientist. The SAC represents the scientific interests of partner organizations and the scientific community at large. All members of the SAC are nominated by the Board and its president changes on an annual basis through a process of rotation. The SAC president interacts with the Principal Scientist. The structure of TMT Observatory Corporation also includes an External Advisory Panel (EAP) which provides expert review of all project activities.

1.2. OBJECTIVE AND NATURE OF PROJECT

The project “**Transport, Construction and Operation of TMT Telescope (Thirty Meter Telescope) on Cerro Armazones**” has the goal of building and operating a telescope whose main mirror, unique in the world, will be 30 meters in diameter. This telescope will have instruments for conducting astronomical research at visible and infrared wavelengths. Its capability for spatial and spectral analysis exceeds, but at the same time, complements those of existing infrared optical telescopes.

In summary, the main research areas will include: finding and studying planets outside the Solar System; studying the origin of stars and galaxies. Furthermore, it will enable astronomical observations to investigate dark matter and dark energy, deemed to make up around 96% of the Universe, and until now is of unknown origin. Research conducted at TMT will be at the forefront of scientific research and will provide valuable information to understand the physical processes that shape our Universe. The size of the telescope’s mirror will provide an angular resolution three times greater than the best telescopes today, allowing the detection of smaller structures that have been observed until now. In addition, the larger area of its main mirror, along with the sensitivity of its instruments, will detect a larger amount of photons from the cosmos per unit of time. This translates into the ability to observe a greater number of astronomical objects of interest during a given period of observation. This will allow detection of objects whose emission is fainter and / or located at a greater distance from our planet. In summary, TMT represents the biggest technological challenge that has been undertaken in the development of modern astronomy and will provide valuable and unique information for the study of the Universe and understanding the physical processes taking place in it.

The project “**Transport, Construction and Operation of TMT Telescope (Thirty Meters Telescope) on Cerro Armazones**”, constitutes astronomical research activities, a type of project or activity that is not expressly contained in Article 10 of Law 19,300 and Article 3 of the rules for the Environmental Impact Assessment System / Sistema de Evaluación de Impacto Ambiental (SEIA).

In accordance with Articles 8 and 10 of Law 19,300, this project is not required to undergo SEIA. The presentation of this Environmental Impact Statement is done on a voluntary basis under the first paragraph of Article 9 of the same law.

1.3. PROJECT SITE

The project is located in the Northern part of Chile in the region of Antofagasta, Province and County of Antofagasta, Cerro Armazones, as noted in Figure 1. See attached.

More specifically, the coordinates of its location are:

Use area TMT

VERTICES	EAST	NORTH
1	377,700	7,281,600
2	380,400	7,281,600
3	380,400	7,279,500
4	377,700	7,279,500

Area: 5,670,000 m²

Telescope Facility

VERTICES	EAST	NORTH
1	379,403	7,280,547
2	379,603	7,280,547
3	379,603	7,280,147
4	379,403	7,280,147

Area: 80,000 m²

Support facilities:

VERTICE	EAST	NORTH
1	378,071	7,279,846
2	378,445	7,280,018
3	378,528	7,279,835
4	378,140	7,279,633

Area: 90,074 m²

UTM coordinates, DATUM PSAD56, Zone 19J.

Illustration #1: Location

Illustration #1B: Cartographic detail of TMT Project area

1.4. TOTAL OCCUPIED SURFACE AREA

Area used by TMT:	5,670,000 m² (567 ha)
Telescope facility	80,000 m ² (8 ha)
Support facilities:	90,074 m ² (9 ha)
Access road to the top:	45,600 m ² (4.56 ha) (5,700 meters long x 8 meters wide)
Total Area:	215,674 m² (21.56 ha)

1.5. ESTIMATED INVESTMENT

The total budget for this project is expected to reach a total of US\$750,000,000 (seven hundred fifty million dollars). The amount expected to be invested in Chile is US\$150,000,000 (one hundred fifty million dollars) during a period of 8 years.

1.6. JUSTIFICATION FOR THE SITE

As a result of a comprehensive atmospheric study conducted internationally, TMT determined that the geographic area of the Atacama Desert is one of the best places in the world to conduct research in astronomy. In particular, the Cerro Armazones located in the Cordillera de la Costa, has an ideal combination of nights with photometric quality, clear weather throughout most of the year and low atmospheric turbulence. The construction of an observatory on Cerro Armazones creates the opportunity to develop an effective partnership with other observatories in the region, such as: VLT telescope (Very Large Telescope) on Cerro Paranal and the radio interferometer ALMA (Atacama Large Millimeter Array) located in the Llano Chajnantor towards the interior of the Antofagasta region.

Like Cerro Paranal, home of the European ESO VLT, Cerro Armazones lies within what astronomers have come to call *Photon Valley*, due to exceptional weather conditions making it appropriate for observation of the Universe.

1.7. LIFETIME

The estimated lifespan of the project is 50 years, with possible extensions in time as well as expansion of facilities. Under any of these circumstances subsequent analysis of compliance to SEIA regulations will be conducted.

Construction begins: October 2008 (estimated)

Operation: July 2016-2058

End of Life: 2058-2059

1.8. EMPLOYMENT OPPORTUNITIES

During the construction phase this project will give employment to 170 people, 20 of whom will be foreigners.

Total Manpower during Construction Stage: 170 people

During the period of operation, TMT will employ approximately 100 people with long-term contracts. These employees are made up of administrative staff, engineers, technicians and support staff. It is estimated that any day there will be 40 people working at Cerro Armazones.

Total Manpower during the Stage of Operation: 100 people – in shifts of 40 people at a time.

1.9. LEGAL STATUS OF THE LAND

The campus will be located within government property; however, the Universidad Católica del Norte (Northern Catholic University) has been granted jurisdiction over the land in accordance with Exempt Resolution No. 0249, dated March 30, 2006 by the Ministry of National Assets. This campus is located in the area known as Cerro Armazones with an area of 52,700 hectares. The current concession was granted for a period of five years from the notification of award indicated. **See ILLUSTRATION #2.**

Since the year 1992, the Universidad Católica del Norte, through Exempt Resolution No. 22, was awarded the first concession on the indicated property. During this period it has developed an infrastructure complex and equipment for astronomy research. In fact, a telescope was built in collaboration with German universities. The premises have also seen the development of facilities by the University, which has built a base camp for operational staff, astronomers and students.

On top of Cerro Armazones the University, through agreements, has authorized the installation of antennas needed by the Chilean Carabineros, the Ministry of Public Works and ENTEL. It should be noted further that the summit of Cerro Armazones is referential survey monument for the Military Geographic Institute.

The Universidad Católica del Norte has also opened its facilities for TMT Corporation to conduct measurements and feasibility studies, designed to incorporate the Cerro Armazones as one of the possibilities for installation of the telescope.

The university has authorized TMT Corporation to conduct the studies according to Chilean law on the land included under the compensatory award.

On June 11, 2004, Universidad Católica del Norte and AURA Inc. signed a Mutual Cooperation Agreement that allowed them, along with the TMT, to scientifically survey the area of Cerro Armazones so as to assess the area and propose it as a site for development of Project TMT.

Moreover, Decree No. 71 of 2 May 1991 declares this site a place of Scientific Interest for mining purposes. It comprises an area of 31,200 hectares located in the vicinity of Cerro Armazones and neighboring Cerro Paranal (**Annexed Decree No. 71**). **See ILLUSTRATION #3.**

TMT Observatory Corporation is in negotiations with Universidad Católica del Norte to reach a global agreement that would allow TMT to obtain the use of the area for this project. This area is part of the land currently described and recently granted in concession to the Universidad Católica del Norte.

This Declaration of Environmental Impact is presented with the agreement of the Universidad Católica del Norte as recorded in the Supporting Letter that is attached in the **Annex VII** of the DIA.

Illustration #2: Universidad Católica del Norte Land Concession.



PHOTOGRAPH #1: View of UCN facilities (Bochum Telescope)



PHOTOGRAPH #2: View of UCN (Universidad Católica del Norte) facilities (Camp and telescope)

Illustration #3: Scientific Interest Area for mining purposes

2. CHAPTER 2: PROJECT DESCRIPTION

The project, “**Transport, Construction and Operation of Thirty Meter Telescope (TMT) on Cerro Armazones**”, is a public and private initiative under the concept of the *Giant Segmented Mirror Telescope* (GSMT). It has been identified by the National Academy of Sciences of the United States as one of the highest priorities for ground-based astronomical facilities for the first decade of the Twentieth Century.

The project is considering the construction of the facilities and infrastructure necessary for the operation of the telescope TMT (Thirty Meter Telescope), on Cerro Armazones, in the region of Antofagasta.

The future facilities correspond to:

Facilities necessary for the operation of the telescope: control center, telescope room, storage and maintenance of telescope mirrors room, electrical distribution room, hydraulic pumps room, engineering and electronic laboratory, telescope enclosure, offices and general infrastructure. These facilities will be situated on the peak of Cerro Armazones and will occupy an area of 8 ha. For the construction of these facilities it will be necessary to construct a level platform and excavations for foundations in the area.

Support facilities: maintenance area, warehouse and open area, lodging and support facilities, kitchen and dining area, toilet services, administration area, laboratory and facilities. These facilities will be situated at the base of Cerro Armazones and will occupy an area of 9 ha.

Initially the area will have access through the existing road, which will be improved.

For access to the telescope facilities area it will be necessary to build a new road from the base to the peak of Cerro Armazones. This road will have a length of 5.7 km. and a width of 8 m, with a gravel surface, and an asphalt surface on the last kilometer.

Subsequently, since an appropriate access road for the transport of the delicate instruments of the telescope is vital, a 16 km road will be constructed, starting at the junction of Route B-710, which will end at the junction of the existent access road to the base of the hill.

The telescope and its instruments will be transported in pieces from the United States and will be assembled at the project site.

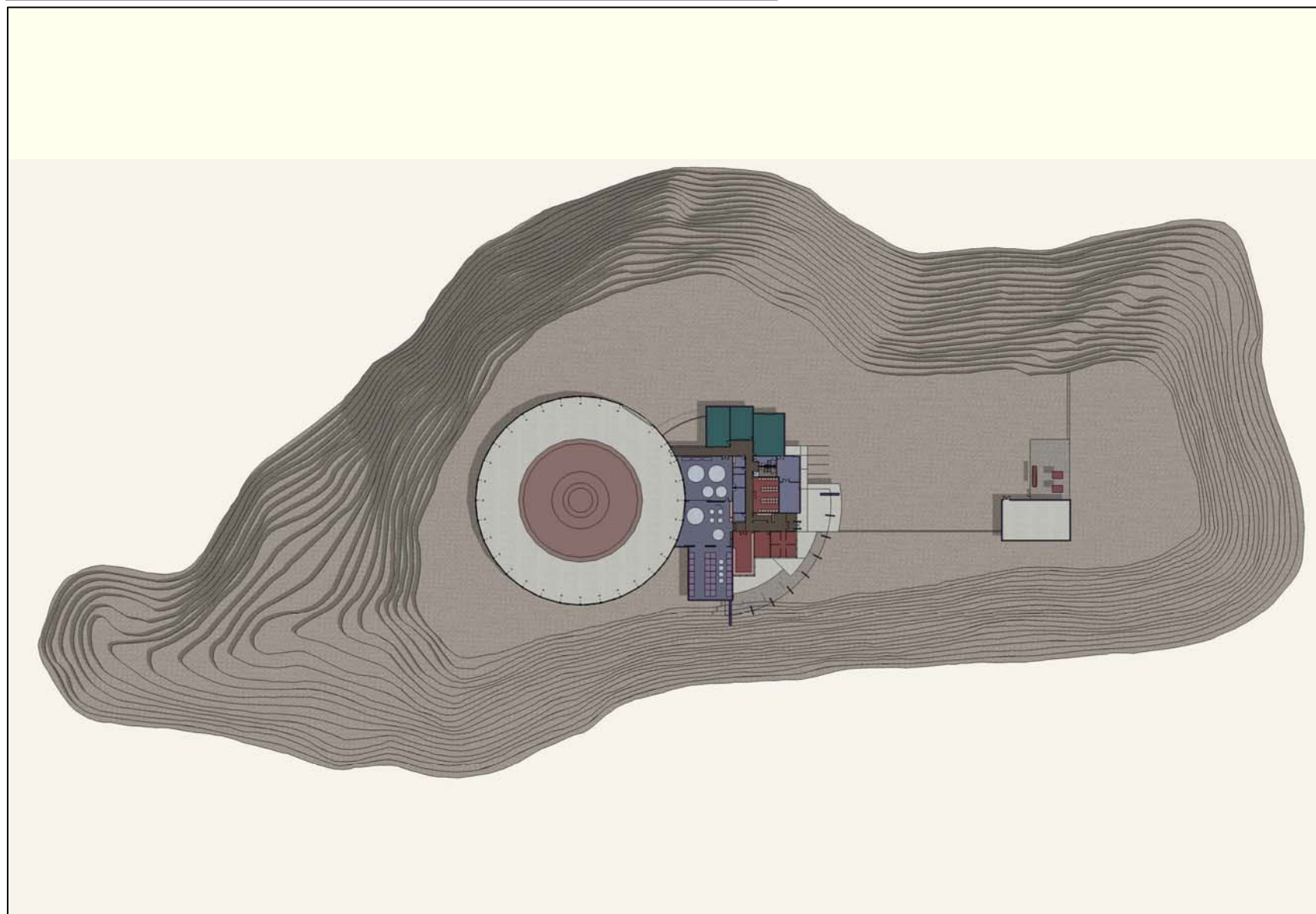


Figure 1: Aerial simulation of the TMT telescope installation on the summit of the mountain.

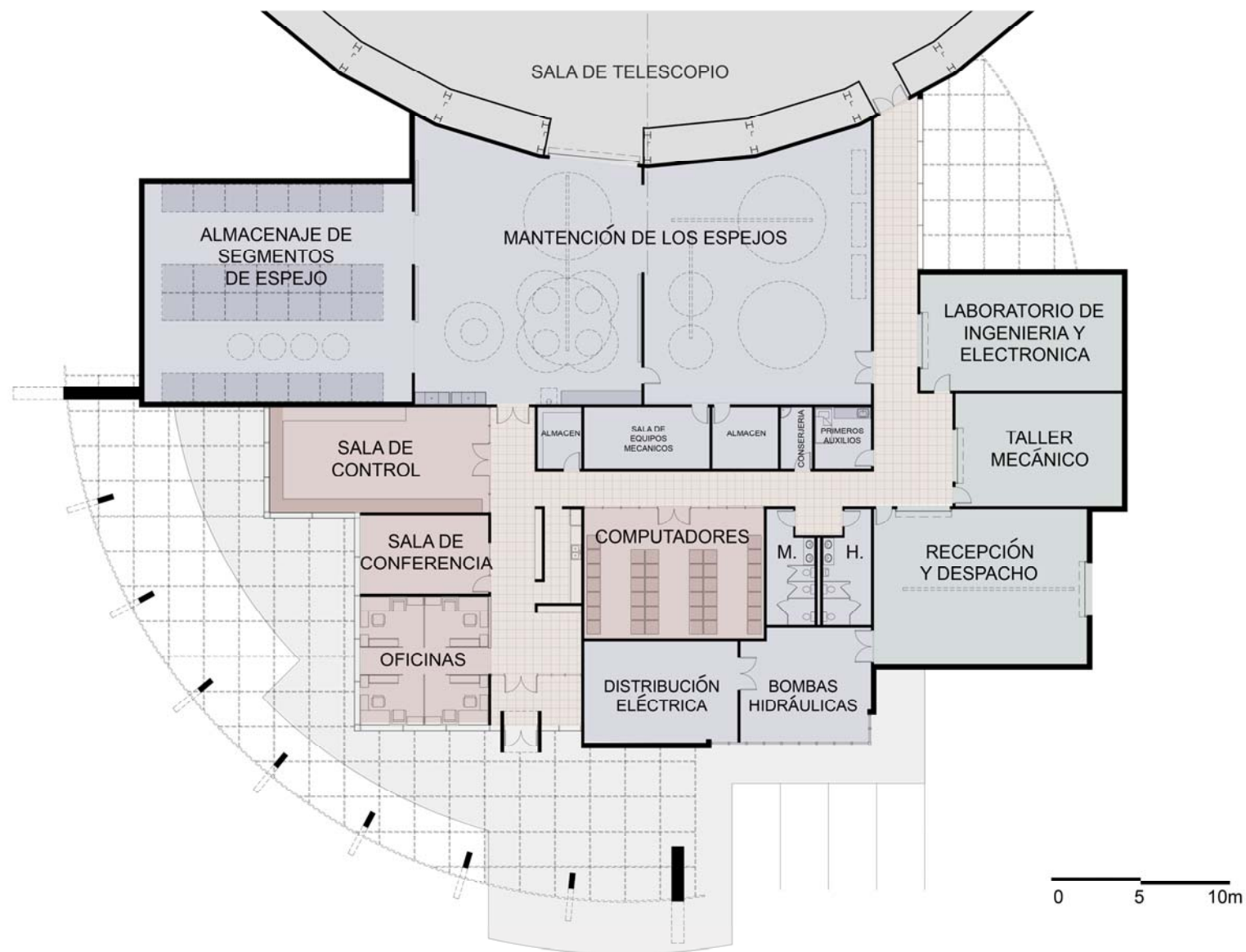


Figure 2: Architectural detail of telescope operation facilities

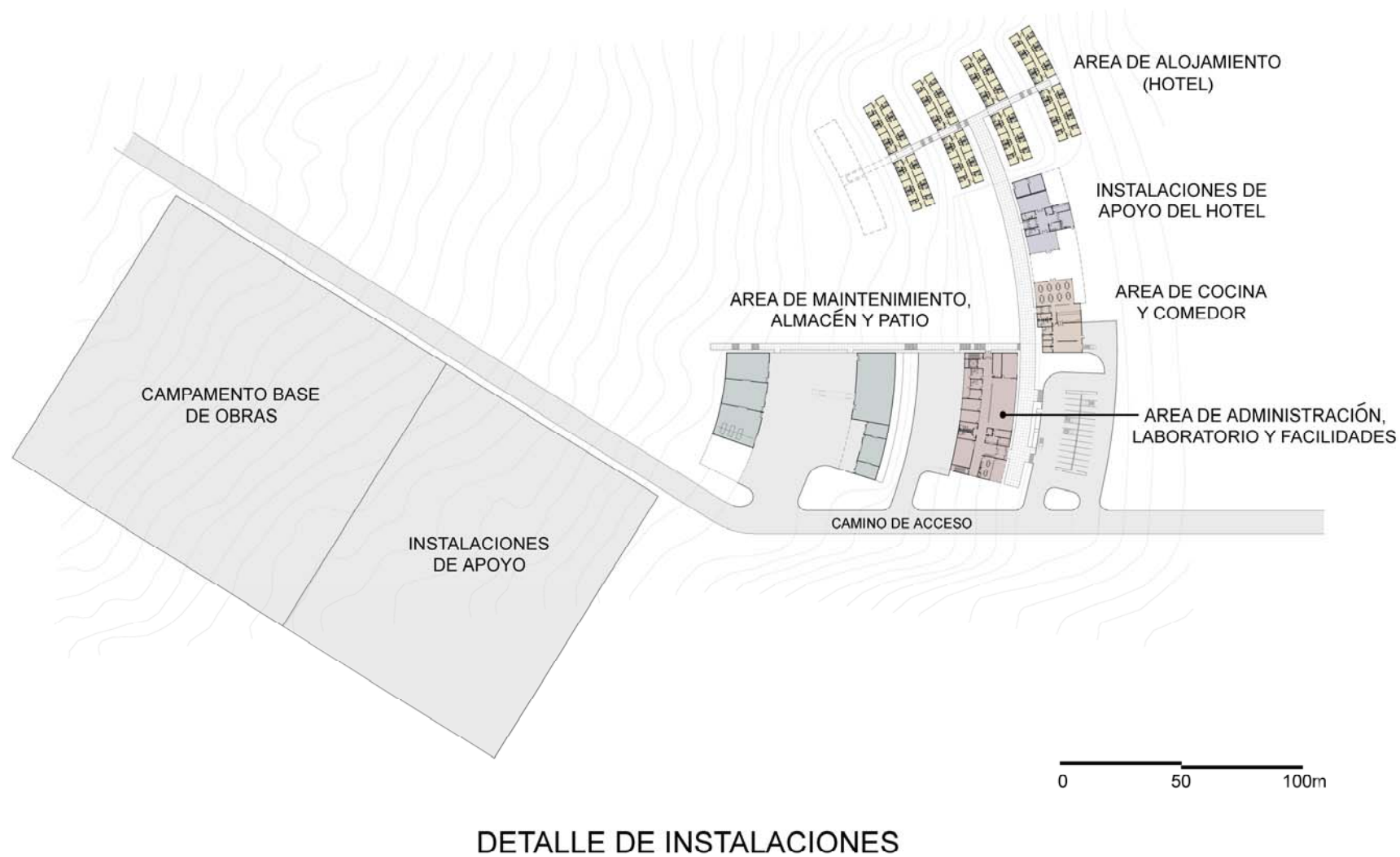


Figure 3: Architectural detail of support facilities

Characteristics of the Telescope

The Thirty Meter Telescope will be the telescope with the largest reach in the world. Its primary mirror will gather ten times more light than the ten meter Keck telescopes, situated on the top of the volcano Mauna-Kea in the island of Hawaii, presently the largest telescopes available. The telescope optics have a system of computer controlled deformable mirrors that permit the correction of the adverse effects introduced in the astronomical images by turbulence in the Earth’s atmosphere. This translates into ten times better defined and detailed images than those that can be obtained by the Hubble space telescope. TMT’s capacity for obtaining a higher quantity of photons, along with angular resolution of its primary mirror and the sensitivity of its detector instruments, will allow the TMT range to be one hundred times more sensitive than any existing telescope on the surface of the Earth or in space.

The TMT will be equipped with a group of sophisticated instruments that will analyze and register light and infrared radiation originating from distant planets (outside of the solar system), as well as stars and galaxies. By studying the spectral characteristics of light coming from these sources, astronomers can determine: its distance, chemical composition, dynamic structure and physical parameters such as temperature and density of the gas associated with these objects in the cosmos. Such studies provide a more complete understanding of the nature of these bodies. The TMT will be able to measure the parameters of dozens of these objects simultaneously, allowing high statistic confidence in the characterization of the properties of representative samples of these cosmic objects.

Presently, the TMT telescope is in the design phase, including the testing of some key components for its performance. Following the preliminary phase, the construction of the telescope will begin. The first observations could begin in the year 2016.

The primary mirror of this telescope consists of 492 individual mirrors of 1.4 meters each, arranged geometrically as a honeycomb to form a 30 meter aperture. All of these segments will be controlled by a very precise computational system in order for them to work as one single mirror.

The TMT telescope will have a place among the largest in the world, and together with the VLT (Very Large Telescope) optical telescope and the interferometer radio ALMA (Atacama Large Millimeter Array), will distinguish the Antofagasta region as the world capital of astronomy.

The telescope is complemented with eight scientific instruments, including a new system of adaptive optics specific for this telescope, which will allow it to reach the diffraction limit of the optical signals, which are affected by the turbulence of the terrestrial atmosphere. The system of adaptive optics is based on laser beams projected from a small telescope placed behind the secondary mirror on the top of the structure. These laser beams excite the sodium molecules in the terrestrial mesosphere, which in turn, emit light that is reflected towards the telescope. These reflections work as reference *artificial stars* in the upper layers of the atmosphere. The fluctuations observed in the amplitude and phase of these *artificial stars* is used to adjust the wave fronts received, thus eliminating the distortions introduced by atmospheric turbulence, which originates in changes of temperature and density amongst air masses or due to changes in the direction of the air mass flow with altitude. The 3.6 m diameter secondary mirror contains hundreds of piston-like controllers that modify the shape of the mirror to compensate for such turbulence. One of the most relevant instruments in the set of instruments planned for the TMT is the Planet Finder Instrument (PFI). It consists of a powerful detector that employs extreme adaptive optics and its objective is to be able to see extra-solar planets directly around the near stars.

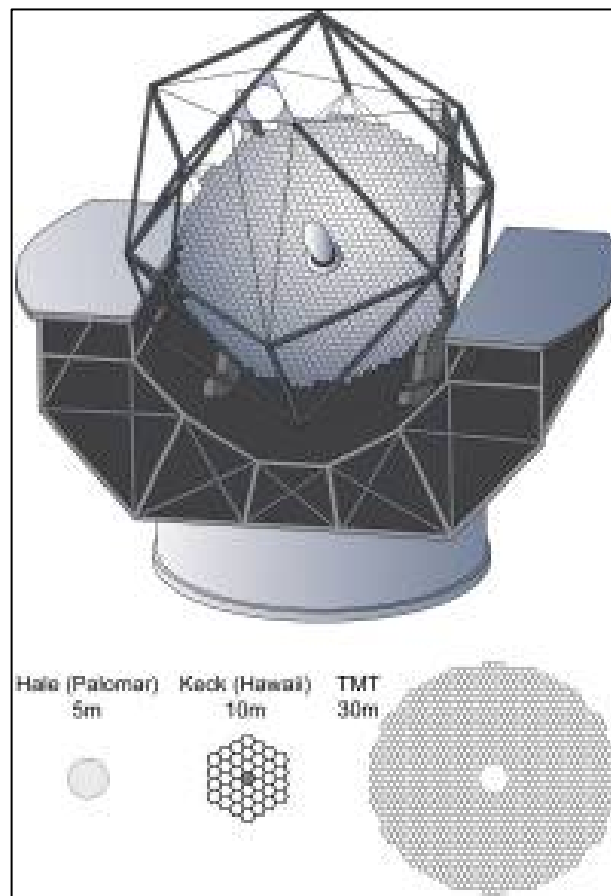


Figure 4: Comparison between the TMT telescope’s primary mirror and those of Hale y Keck telescopes.



Figure 5: Rendering of TMT and associated infrastructure

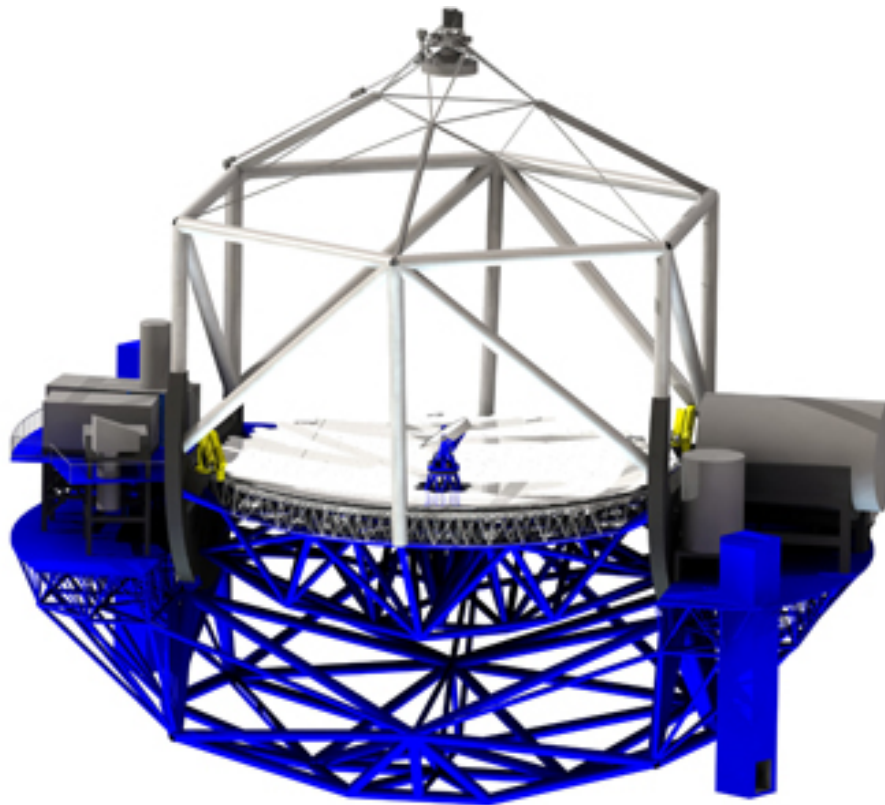


Figure 6: TMT’s mechanical structure. The telescope is meters 50 meter high y 56 meters wide.

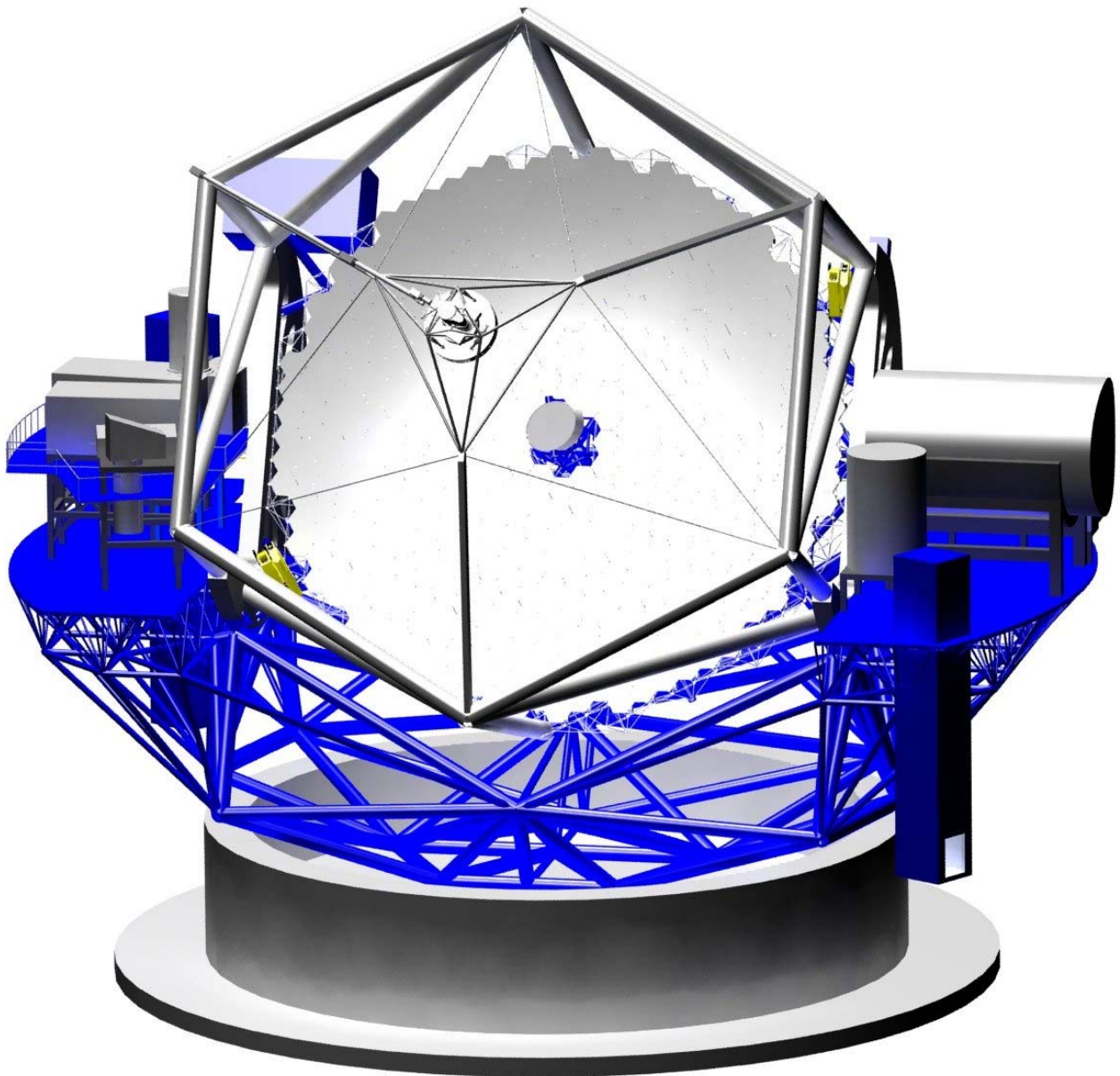


Figure 7: Diagram of the design of the TMT telescope. The telescope is mounted on a cylindrical concrete support with hydraulic bearings to allow movement.

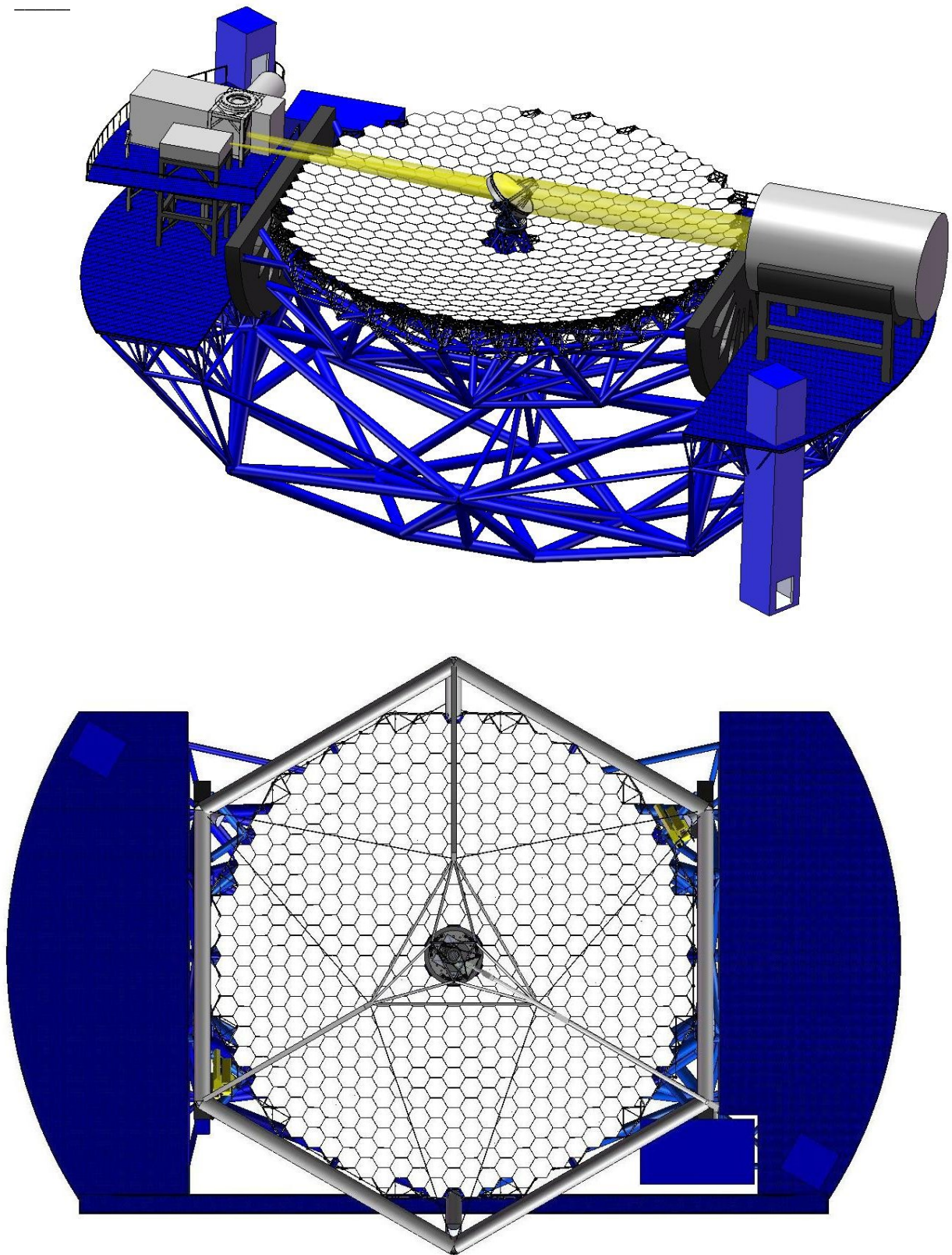


Figure 8: Rendering of TMT’s primary mirror

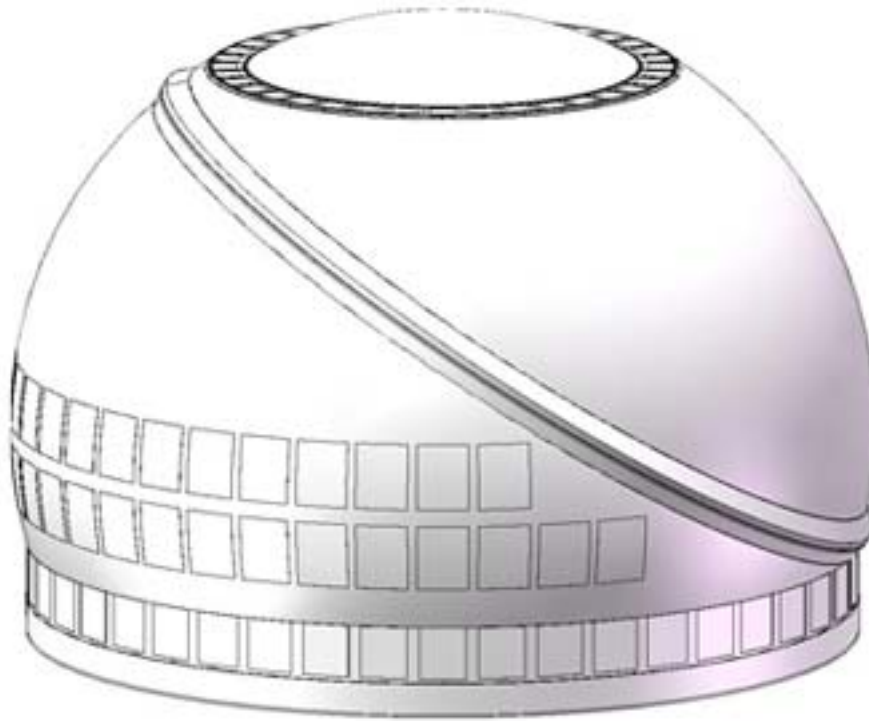


Figure 9: Rendering of TMT telescope´s Calotte enclosure

Instruments Planned for the TMT

Instrument	Spectral Resolution	Scientific Objective
Near-IR DL Spectrometer & Imager (IRIS)	≤ 4000	<ul style="list-style-type: none"> • Assembly of galaxies at large redshift. • Black Holes/Active Galactic Nucleus (AGN) / Galactic Center • Resolved stellar populations in crowded fields
Wide-Field Optical Spectrograph (WFOS)	300 – 5000	<ul style="list-style-type: none"> • High resolution spectra in galaxies at $z > 1.5$ to analyze stellar populations, measuring chemistry and energetics • Structure and composition of the intergalactic medium at redshift (Z) at range $2 < z < 6$
IMulti-IFU, near-DL, near-IR Spectrometer (IRMOS)	2000-10000	<ul style="list-style-type: none"> • Near-IR spectroscopic diagnostics of the faintest objects • JWST (James Webb Space Telescope) followup
Mid-Infrared Echelle Spectrometer & Imager (MIREs)	5000-100000	<ul style="list-style-type: none"> • Physical structure and kinematics of proto-stellar envelopes • Physical diagnostics of circumstellar proto-planetary star-disk system. Where and when are planets formed during the accretion phase.
Planet Formation Instrument (PFI) Extreme Adaptive Optics	50-300	<ul style="list-style-type: none"> • Direct detection and spectroscopic analysis of extra-solar planets
High-Resolution Optical Spectrograph (HROS) (Echelle)	30000-50000	<ul style="list-style-type: none"> • Stellar abundance studies in the local galaxy groups • Kinematic/chemical composition of the stellar medium • Characterization of the intergalactic medium up to redshift (z) -6
Wide Field Infra-Red Camera (WIRC) for Multi-Combined Adaptive Optic	5-100	<ul style="list-style-type: none"> • Astrometry in the galactic center • Stellar populations up to a distance of 10 Mpc
Near Infrared Echelle Spectrograph (NIREs) of High Resolution	5000-30000	<ul style="list-style-type: none"> • Precise radial velocities of M stars and detection of low mass planets • Analysis of the intergalactic medium up to redshift (z) 5.5

- z; redshift – in electromagnetic waves this is equivalent to the well-known “Doppler Effect” in acoustic waves. It corresponds to the apparent wavelength change of an electromagnetic signal due to the relative velocity between the Earth and the observed object. The z quantity (redshift) corresponds to the mathematical fraction formed by the change in wavelength, divided by its nominal value at rest.
- IGM – Inter-Galactic Medium
- ISM – Inter-Stellar Medium

3. CHAPTER 3: PHASES AND ACTIVITIES OF PROJECT

3.1. STUDY PHASE

a) Base Line Studies

In this phase, which has already been carried out, baseline studies for archaeology, flora, fauna and geomorphology were prepared. These are included as an integral part of this DIA.

b) Geotechnical and Access Studies

Subsequently, preliminary studies will be carried out, such as: topographic surveying for roads and for support facility areas. Also included are geotechnical studies for the analysis of mechanical properties of the soil.

3.2. CONSTRUCTION PHASE

a) Installation of the base camp

In order to begin the construction phase, the installation of a base camp will proceed. The camp is located in the same sector as the support facilities. The base camp will accommodate a total of up to 170 people, with an approximate surface of 19,250 m². The type of construction that will be used will be decided based on the commercial options available at the time of the camp's installation. The options considered include modified containers and modular manufactured construction. Accommodations will include bedrooms, bathroom facilities, cafeteria, recreation and rest areas, and administrative offices. One dormitory room will be shared by no more than four persons, and individual or shared rooms for two people, for supervisory and management personnel.

The base camp will be specifically located in the following coordinates:

EAST: 378,090
NORTH: 7,279,830
Surface area: 19,250 m²
Coordinates UTM DATUM PSAD56, ZONE 19J

b) Basic improvement of the existing road to the base of the hill

The existing road to the base of Cerro Armazones consists of a narrow strip, opened in the past before the arrival of project TMT, by a bulldozer, with no improvement to the road's surface. At the beginning of construction this route will be used to avoid any interference by vehicular traffic during construction of the new road and for security

reasons. To make access easier improvements will be made to the existing road. These include the improvement of the surface to eliminate potholes, especially in the areas where fine natural material has resulted in fine dust that impedes a safe ride. No changes will be made to the width of the road, or to its layout or surface area in general. The plan only includes maintenance that will ensure appropriate and safe traffic.

At present, in order to access the UCN observatory located at Cerro Armazones, Route B-710 is used up to the junction with Route B-750. Using this last route, after approximately 10.7 Km one arrives at the intersection with the 12 Km road to Cerro Armazones, and continues on the existing access road to the top of the hill, for a distance of 2.3 Km.

To optimize the access to the base of Cerro Armazones, basic improvements of its surface will be made in order to access the base of the hill. This work will start from the intersection of Route B-750 (Km.10.6 until the intersection with Route B-710) up to the junction with the actual road to the top of the hill. The length of the total improvement will be **11.9 Km**.

Present Road Improvement Coordinates

Intersection with Route B-750	EAST: 370,881	NORTH:7,273,122
Base of Co. Armazones	EAST: 378,858	NORTH:7,279,683

Coordinates UTM DATUM PSAD56, Zone 19J

c) Construction of the road to the top of Cerro Armazones

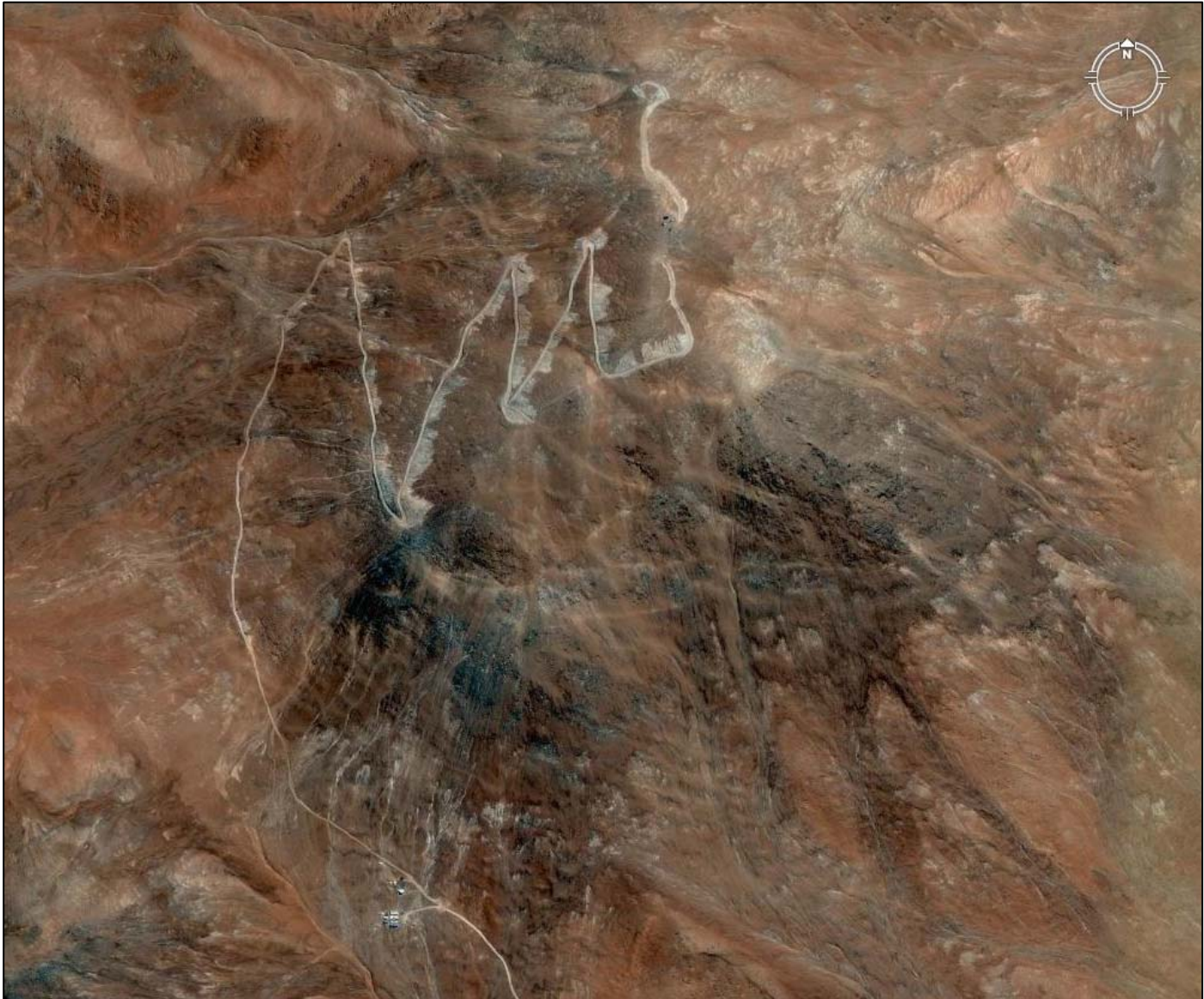
To access the top of the hill a new 5.7 Km road will be constructed from the junction of the access route described above.

In general terms, the access road will have an 8 meter width including two lanes, each 3 meters wide plus a shoulder on each side of the road. The road will be equipped with signs to ensure safe conditions. The signage will be prepared by authorized companies, following the guidelines of the Roads and Highways Department.

The last kilometer of access to the top of the hill in the design will have asphalt pavement. The engineering study will include details of this part of the project and the necessary hydrological studies in order to establish the drainage of rain water.

Both roads are shown in Illustration 4.

Illustration #4: Access Roads



PHOTOGRAPH #3: Satellite view of current access to the peak of Cerro Armazones (down below at the side of the road, the UCN facilities can be seen)

d) Construction Platform for the Telescope

In order to have a platform for the installation of the telescope’s infrastructure, it is necessary to lower the summit of Cerro Armazones by 12 meters (from its current height, 3,064 meters above sea level to its final elevation, 3,052 meters above sea level) The excavation of the platform will be executed by using explosives in a controlled manner, by specialized, properly certified personnel. A total of 72,000 m³ of rock is expected to be removed. The excavated material will be used as fill material for road construction and leveling surfaces. During this phase we also expect to work on the preliminary leveling of areas that will be used for support facilities.

e) Excavations for Foundations

During this phase we will excavate the trenches required for the foundations for the telescope and to improve, if necessary, the structure of the bedrock. For this purpose, we plan to use a reduced and focused amount of explosives. The material removed will be used as fill material on new roads or in other areas of civil engineering work.

f) Construction of Operation facilities for the Telescope

During this phase we will construct the area where the main facilities of the telescope will be situated, starting with the foundation work and ending with the installation of the rotating enclosure (or protective dome) of the telescope. At the same time, a building will be constructed on the summit to accommodate the control center and the general purpose infrastructure.

g) Construction of a new access road at the base of the mountain

It is necessary to have an adequate access road for the transportation of the delicate instruments of the telescope. The road needs to be stable, with a low slope and posing minimal risk. It is necessary to have a more efficient access road with fewer potential difficulties for the transport of the type of instruments required by the TMT. We are planning the construction of a road 16 kilometers in length, starting at the junction with Route B-710, which is administered by The Ministry of Public Works, and ending in the junction with the existing road currently used to arrive at the site at Cerro Armazones up to the observatory of the Universidad Católica del Norte.

In general terms, the access road will measure 8 meters across, and will include two lanes measuring 3 meters in width, plus a shoulder measuring one meter across on each side of the road. The road will be equipped with the signage necessary to ensure safe conditions. The signage will be prepared by authorized companies, as previously indicated by the Department of Roads according to its standards and requirements.

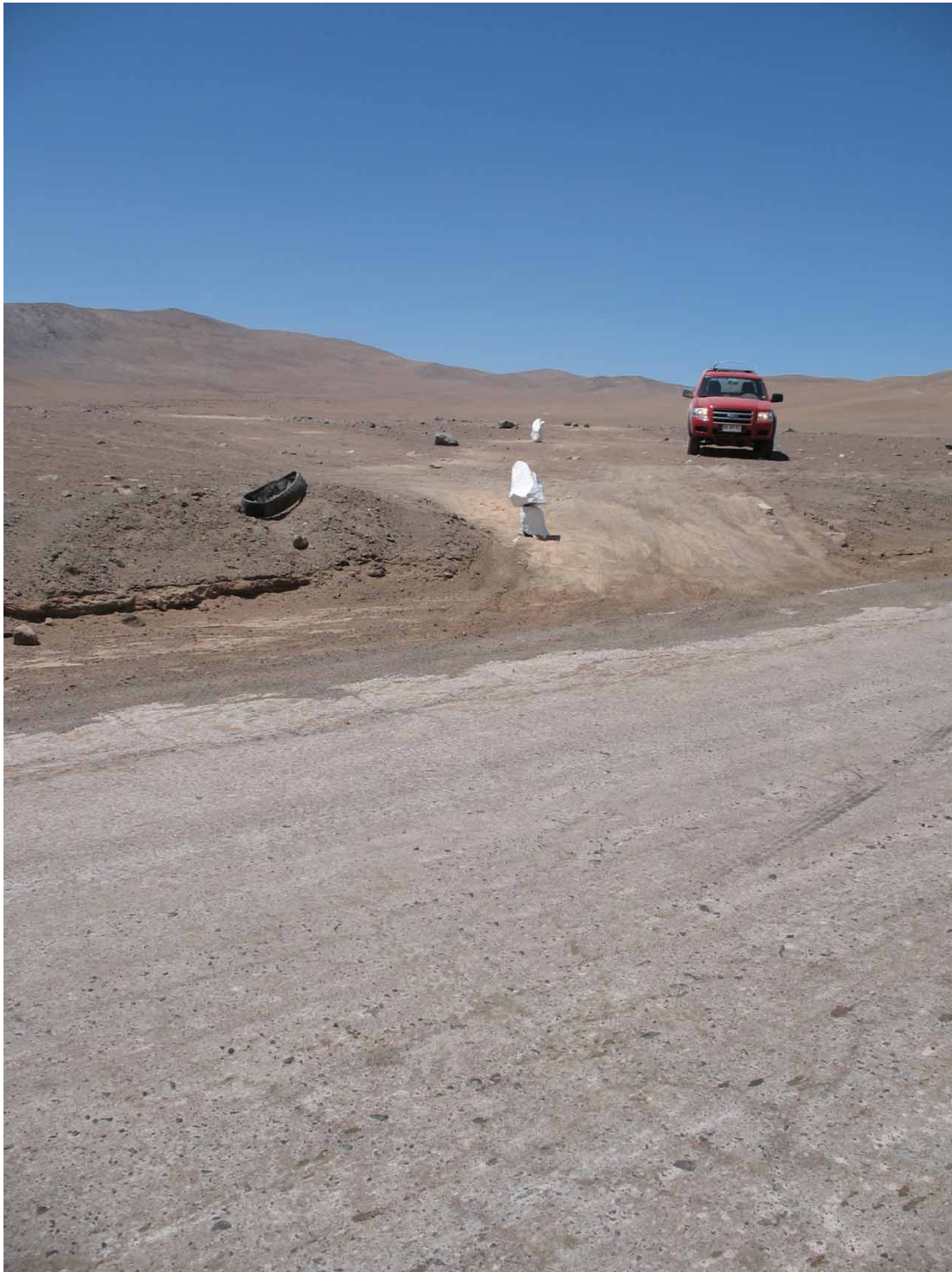
In the engineering study, which still has not been completed, we will include the details for this part of the project along with the hydrological studies necessary to determine the drainage of rain water.

For the improvement and construction of the access road at Cerro Armazones, we will comply with the current regulations and will apply for the corresponding permits.

Next, we present the following figures for the projected access roads.

Illustration #4A: Planned Road over cartography of area

Illustration #4B: Engineering Design of access road



PHOTOGRAPH #4: Junction of route B-710 with planned road. Start of planned road.

h) Construction of the Support Facilities

The construction of the support facilities will be executed in stages, starting with the installation of the power plant, warehouse, and support services in the first stage. The infrastructure for services and accommodations will be constructed at the stages of verification and testing of the telescope.

i) Completion of facilities and installation of the telescope structure

This stage includes the installation of the mechanical structure and lateral platforms of the telescope, as well as its electrical components. It includes the completion of the enclosure work and the completion of all details of the construction of the Summit Facilities.

j) Installation and Verification of the Telescope

In this stage the segments of the primary mirror are installed. The engineering testing necessary to verify the adequate functioning of all the mechanical and electrical systems and subsystems that make up the telescope, and the verification of all the accessory facilities will be carried out.

k) Transportation of the Infrastructure and Equipment

Before the start of the construction of the Support facilities and the operation of the telescope, the transportation of the infrastructure and the mechanical and optic equipment, as well as the telescope itself, will be carried out.

The transportation of all the equipment mentioned above will be completed between the years 2010 and 2013 as indicated on the timetable of activities of the attached project.

All of the infrastructure and equipment comes from North America (The United States and Canada), and will be transported by ship to the International Terminal of Antofagasta, and the Port of Angamos de Mejillones.

The majority of the equipment will be transported in standard containers measuring 20 by 40 feet in accordance with **Regulation ISO 668:1988**. The quantity of containers that will be transported each year is specified in the following chart:

Year	Quantity	Function
2010	250	Metal structure of the Telescope Enclosure
2012	220	Metal Mechanical components of the telescope
2013	70	Optic components of the Telescope mirrors
2014	60	Telescope instruments and parts of the adaptive optic system

On the other hand, oversized components will be transported in their original shipping crates and not in containers. The elements consist of:

- 2 disassembled cranes: a 300 ton track type crane, and a 200 ton hydraulic crane.
- Mechanical support cell for the primary mirror of the Telescope.

Once the elements arrive at the previously mentioned ports, they will be transported to the project site by the following routes:

Port of Antofagasta: Costanera, Route 28 to the intersection of La Negra with Route 5, to the intersection of Varillas, Route B-710, and the access road to Cerro Armazones.

Port of Angamos: Route B272 at the intersection of Route 1, to Route B 400, to the intersection with Route 5, to the intersection of Varillas, Route B-710, and the access road to Cerro Armazones.

The ground transportation will be carried out in the appropriate type of truck for each element. In the case of the transportation of oversized elements, we will comply with the permits and regulations of the Ministry of Public Works concerning the circulation of vehicles on public roads, Decree MOP No. 158 of 1980 that established the maximum cargo weight per vehicle axle, and Transit Law No. 18.290, specifically as it refers to police escorts, and coordination with public and private services of power and telephone to facilitate the transportation of this cargo and the infrastructure of power and communication along the routes.

3.2.1. CONSTRUCTION STAGE SERVICES

a) Hygienic Services

During the construction stage of the facilities, chemical toilets will be used. These will be provided by the contractor, complying with the existing regulations. TMT will extend the necessary recommendations to its contractors to assure compliance with these regulations.

In the construction stage, the initial phase consists of the installation of the waste water treatment plant that will be used with water generated in the support facilities and construction camp.

Summit Facilities

In the operation stage, hygienic services, in excess of those required by D.S. 594/99 of the Ministry of Health will be provided (two toilets and two sinks for women and two toilets, two urinals, and two sinks for men), to accommodate at least 40 people.

The bathrooms will have an storage tank for potable water with a capacity of 25,000 liters, which will be supplied from Antofagasta, by a tank truck.

The wastewater will be treated by a compact treatment plant. The wastewater will then be disinfected with chlorine, and subsequently neutralized. This same plant will be used during the operation stage.

Support Facilities

Wastewater will be treated by a treatment plant of sludge with bacteria. The wastewater will then be disinfected with bleach, and later neutralized.

b) Supply of Drinking Water

Drinking water that will be utilized in the project facilities during the construction stage, will be obtained from authorized sources in the city of Antofagasta and brought to the site in authorized tank trucks. The water will be stored in two tanks, each one 200 m³ in volume, designed specifically for this purpose, and which are considered as a necessary part of the support facilities in the construction plan.

No water will be obtained on the site.

The supply of drinking water is estimated at 300 liters per person per day (this is greater than the minimum of 100 liters per person per day required in D.S. No. 394, Article 14 of the D.S. No. 594/99 of the Ministry of Health). Based on this usage rate, the essential parameters in our estimation of the total consumption of drinking water are as follows:

Rate of Consumption: 300 liters/person/day = 0.3 m³/person/day

Estimated total number of staff members on site = 170

Total consumption of drinking water = 51 m³/day.

Total capacity of storage tanks = 400 m³

The quality, storing and distribution of water will comply with the requirements specified in Norm NCH409 and D.S. 594/99 of the Ministry of Health and its annexes. There will be a continuous control of the water quality by companies duly authorized by the sanitary authorities, in order to verify the quality of the water, conducting the chemical and bacteriological studies required. Also, the storage facilities will be built and supervised as to prevent contamination from external sources, and the level of residual chlorine will be controlled to make sure it is within safe limits.

The supply of potable water will be carried out through the Antofagasta Sanitary Services (Empresa de Servicios Sanitarios Antofagasta (ESSAN S:A.) in Spanish). This Company will certify authorized distributors to transport the water to the required location. Also, the grantee specifies that the trucks responsible for transporting potable water will have the authorization of the Seremi de Salud Antofagasta (Regional Ministerial Secretariat).

c) Waste Control

During the construction period, solid waste from construction will be collected on a daily basis by specialized personnel and stored in a secure area for this purpose. The waste will be transported weekly by a covered truck to a place approved by the sanitary authority. The organic waste will be treated separately and then transported to an authorized location.

Industrial Waste: These will be removed and disposed of in a location designated and authorized by the Municipality of Antofagasta. Eventually they will be disposed of by a specialized company (ie. Hidronor)

The company **HIDRONOR** will be in charge of the treatment and disposal of industrial waste, treating it at the company’s authorized location in Vizcaya No 260, Pudahuel, Santiago. A certificate will be issued to the grantees of elimination and/or disposal of the waste.

Solid Domestic Waste: there will be containers for temporary use at the work and construction site. Later the waste will be sent to authorized landfills in authorized vehicles.

d) Supply of Electrical Energy and Communications

During the construction stage, electrical energy supply will be provided by the contractor that TMT will subcontract.

During the construction stage, TMT employees will use low power VHF/UHF communication equipment for security and coordination reasons. Such radios will conform with all the local and national regulations in terms of operation frequency and transmission power according to the requirements of the Undersecretary of Transport and Communications.

e) Supply and Fuel Consumption

During the construction stage, the supply and storage of fuel will be provided by the contractor that TMT will subcontract. We will make sure that the contractor company complies with the appropriate regulation.

The project will comply with the current regulations from the Superintendent of Electricity and Fuel, and especially with the safety requirements established in the D.S. N 379/85 of the Ministry of Economy and the technical requirements for the installation of the storage tanks, established in Chapter II of D.E. 278/8292.

Also, there will be a station to supply fuel to vehicles for internal use, with a concrete surface to prevent filtration of fuel to the soil.

This gasoline and diesel supply station will comply with all requirements specified in D.S. N 379/85 of the Ministry of Economy, especially those indicated in section 6.2.3.1 in relation to the location of the underground tanks. Special care will be given to all pipes, fuel supply units, pumps and required safety equipment comply with the prescribed in points 6.2; 6.3; 6.5; 6.8; and 6.14 of the D.E. 278/8295.

The current regulation will be complied with by presenting a statement to the Superintendent of Electricity and Fuel (SEC) about the installation of the tanks. The supervision of the construction will be contracted with a civil engineer properly licenced before SEC. Fuel will be bought from companies properly authorized.

Estimated Consumption by Contractors:

Diesel: 4000 liters/daily, consumption of fuel by heavy machinery, based on a total of 80 hours-machinery/daily. The machinery includes bulldozers, backhoes, front-end loader and cargo trucks.

TMT Consumption

Diesel: 800 liters/daily for electricity generation to maintain the site activities. TMT (200Kwh.)

Fuel for light vehicles (mainly gasoline):

300 liters/daily, calculating 5 round trips between Antofagasta and the site daily for a total of 500 Km. daily of vehicular movement on ground. The value has been increased to cover any extra trips.

Total consumption of Diesel = 4.8 liters/daily

Total consumption of Gasoline = 300 liters/daily

f) Installations

During the construction phase we will install a base camp for workers, consisting of containers intended for dining areas, bedrooms and offices. Also, near the site at a distance that complies with the regulations, there will be an area for preparation of construction materials, and different activities including receiving and storing equipment and machinery.

3.3. OPERATION PHASE

The normal activities during the period of operation of the observatory will be strictly in relation to scientific investigation. Each night of observation various scientific programs will be executed, which require specific instruments for the scientific objectives. During the course of the day the technical and engineering personnel will work on preventive and corrective maintenance for the mechanical, electrical, electronic and computational subsystems of the telescope. Furthermore, the scientific, technical and engineering personnel that will provide direct support to the astronomical observations, will plan, prepare and program all the systems that will be used during the course of the astronomical observations of the immediate night - with first priority - and on consecutive days as a second option.

Each astronomical observation involves a specific detecting instrument depending on the investigation's objective. With the arrival of the nautical evening twilight the operators of the telescope, engineers and the night shift scientist will verify the installation of the instruments that will be used during the night, adjusting the optical and spectral desired configuration, and implement the necessary calibrations to tune each required instrument.

The astronomical observation can be done in one or two modalities, in a *service* form: in this case the proposed observations of an investigator are executed by the astronomers of the observatory, or in a *visitor* form. In this last case the observations are done by the head astronomer or an astronomer from his investigating team who will visit the telescope with the only purpose to do an astronomical observation of his interest. The scientific programs that will be executed are selected months in advance based on process of proposals, which have been evaluated by a committee that has determined the scientific merit of the proposed observations.

The normal process of an astronomical observation consists of following one or several cosmic objects of interest in the course of the night, and detect, digitalize and store the electromagnetic signal from the objects, using one or several instruments in a desired spectral range. The observations could be spectroscopic (the light that comes from the object will separate in its spectral components in a given spectral band), or the instrument's camera will be used to take pictures of the object in the desired spectral band. Each instrument used in an astronomical observatory is characterized by the spectral band that it covers, its spectral resolution and its sensitivity.

During the course of the astronomical observation the astronomer will make periodic calibrations of the instrument as well as to be able to eliminate, during the analysis of the data, the signals originating in our atmosphere (telluric spectral lines). Furthermore, the exact pointing of the telescope needs to be verified by observing every so often a stellar object which position is known exactly. The observation night will end with the dawn nautical twilight when the final calibrations are done. The data is stored for further analysis.

a) Hygiene Services

In the **operation stage** there will be hygiene services with a capacity in excess of that required by D.S.594 (with 2 toilets and 2 sinks for women, 2 toilets, 2 urinals and 2 sinks for men) to serve a minimum of 40 people.

These restrooms will have a storage tank for drinking water with a capacity of 25000 liters, supplied from Antofagasta or from another potable water source through a tank truck.

The waste water will be treated by a compact treatment plant and the water will then be processed for disinfection with chlorine and later neutralized.

b) Potable Water Supply

The potable water that will be used in the **operation stage** will correspond to water acquired from authorized sources in the city of Antofagasta and taken to the site in properly authorized tank trucks. The water will be treated and stored in specifically designed tanks for this purpose. The water will be stored in 2 tanks, of 200 cubic meters each, designed for this purpose and considered in the construction plan as part of the support facilities necessary for the operation.

No water will be extracted from the site.

The supply of drinking water has been estimated at 300 liters per person per day (this is more than the minimum of 100 liters per person per day required in article 14 of D.S N 594/99 of the Health Ministry) On the basis of use rate the essential parameters of our estimated total consumption of drinking water in the operation phase are as follows:

Rate of consumption: $300\text{liters/person/daily} = 0.3 \text{ m}^3/\text{person/daily}$

Estimated total of persons at the site: = 40

Total consumption of drinking water = $12.0 \text{ m}^3/\text{daily}$

Total capacity of storage tanks = 400 m^3

The quality, storing and distribution of water will comply with the requirements specified in Norm NCH409 and D.S. 594/99 of the Ministry of Health and its annexes. There will be a continuous control, by companies duly authorized by (SEREMI) Regional Ministerial Secretariat, in order to verify the quality of the water, conducting the chemical and bacteriological studies required. Also, the storage facilities will be built and managed as to prevent contamination from external sources, and the level of residual chlorine will be controlled to make sure it is within safe limits.

c) Waste Control

Solid waste during the operation period, will be picked up on a daily basis by specialized personnel and stored in a secure area. The waste will be transported weekly in a covered truck to a sanitary authority approved area. The organic waste will be treated separately and then transported to an authorized location. The waste water from the

cleaning of the mirror and other processes will be stored in a special tank and later taken to an authorized site for its final disposition.

d) Supply of Electrical Energy and Communications

The project will have a system of Diesel generators with a maximum capacity of 2750 KVA to generate its own electric energy. The average operational level of electric energy generation will be approximately of 1000 KVA. The generator systems will receive continuous maintenance to ensure its optimum performance, minimizing emission of gases from incomplete combustion. Oils, filters and other components that are moved during periodic maintenance will be disposed of safely with attention to the protection of the environment. The energy generation station facilities will follow the current technical requirements, and will ensure the environmental safety of the operation, minimizing the risks of fuel and/or oil spills.

The generators will receive preventive, programed and regular maintenance. This maintenance will take place according to the following program for each Diesel generator:

- Change motor oil and filter every 10 days of operation (250 hours)
- Change of antifreeze and filters every 4 months of operation (3000 hours)
- Change of fuel filters every 10 days of operation (250 hours)
- Change of air filters every 30 days of operation (720 hours)

Inspection and maintenance of electrical and mechanical systems every 3 years of operation.

All oils, air filters, antifreeze filters and replaced components, will be placed in spill proof containers and the final disposition will be done by authorized and properly certified agents (Hidronor). In the same way the liquid waste from oils and antifreeze will be placed in commercially available containers designed for this purpose and the final disposition will be done by authorized companies.

During the **construction stage**, TMT employees will use low power VHF/UHF communication equipment for security and coordination reasons. Such radios will conform with all the local and national regulations in terms of operation frequency and transmission power according to the requirements of the Undersecretary of Transport and Communications. TMT will be connected with Internet using a microwave system rented from a Chilean telecommunications company.

e) Fuel Consumption

The Diesel fuel for the generators will be stored in two double-walled steel tanks of 12,000 liters each, installed over a concrete containment pad. The concrete containment pad is designed to hold a total capacity of fuel of more than 10% to 15 of the required volume to hold rain water, as recommended by the current norms of

competent organizations in the United States and by the technical requirements of the Superintendent of Electricity and Fuels of the Republic of Chile. The fuel storage tank prevents the possibility of direct spills to the surrounding ground and later infiltration. The concrete containment pad will have a gradient to direct the contained liquids into a removal port, which allows the drainage of the accumulated liquids using a portable pump.

The project will comply with the current regulation from the Superintendent of Electricity and Fuel, with special emphasis on the safety requirements established in the D.S. N 379/85 of the Ministry of Economy and the technical requirements for the installation of the storage tanks, established in Chapter II of D.E. 278/8292.

Also, there will be a fueling station to supply fuel to vehicles for internal use, with a concrete containment pad to prevent filtration of fuel to the subsoil.

This gasoline and diesel supply station will comply with all requirements specified in D.S. N 379/85 of the Ministry of Economy, especially those indicated in section 6.2.3.1 in relation to the location of the underground tanks. Special care will be given to all pipes, fuel supply units, pumps and required safety equipment to comply with the prescribed points 6.2; 6.3; 6.5; 6.8; and 6.14 of the D.E. 278/8295.

The current regulation will be complied with by presenting a statement before the Superintendent of Electricity and Fuel (SEC) about the installation of the tanks. The supervision of the construction will be contracted with a civil engineer properly licenced before SEC.

The fuel will be obtained from properly authorized companies.

The system of generation of electrical energy has a yield of 0.07 gallons/hour/KW, estimating that a constant generation of 1000Kw./h requires diesel fuel consumption of 6720 liters (6.720 m³/day).

The estimated consumption of light vehicles is 280 liters/day.

This information gives a total fuel consumption of 7000 liters/day.

f) **Facilities and Offices**

The operation facilities include:

- **Maintenance Areas:** These areas will be dedicated to the general maintenance of the Observatory. The activities will include a wide range of needs, like minor vehicle maintenance, large mechanical equipment maintenance, from bearings and wheels that are used in the dome of the telescope, to portable air conditioning systems for offices.

- **Storage Areas:** During the construction phase a warehouse will be provided for storage of necessary components for the installation of the telescope. After the construction of the telescope is finished, the warehouse will be used to store the general supplies required for the facilities, and to store any spare parts for the telescope and its instruments.
- **Lodging Area:** Approximately 75 rooms will be constructed for personnel and visiting scientists. Each room will include a private bathroom. Support services such as laundry, recreational accommodations, cleaning area, storage of support supply for the bedrooms, will be available at an additional building.
- **Dining Area:** This facility includes a full service kitchen for necessary dining furniture. This place can provide food for 125 people and the cafeteria will sit 60 people. The kitchen area also includes space to store refrigerated, frozen and dried food. The dining area will operate in shifts.
- **Administrative Area:** Offices, conference room, reception. The main administrative installations will be located in the support facilities. They will include office space for the personnel that normally do not work at the summit installations. It also includes equipped conference rooms for the necessary video conferences for personnel meetings and a reception and waiting room area for in transit visitors.
- **Laboratory:** Consists of a large clean room (this accommodation complies with the technical requirements to minimize and avoid the particular matter in suspension). This area is intended for the assembling and testing of the different components of scientific instruments, before they are installed in the final place in the telescope. This installation is mainly intended for electronics and optomechanics.
- **Hygiene Services:** Will have a wastewater treatment plant, for waste water originating from the support facilities, mainly from the personnel and kitchen accommodations.
- **Electrical Energy Supply Plant :** The electricity will be generated on site by means of Diesel generators. These generators are described in detail in section 3.3 (d).

3.4. CLOSING AND/OR ABANDONMENT PHASE

The closing and abandonment phase will have a duration of one year and will include the dismantling of the telescope, all associated equipment, buildings and foundations. TMT will fill and compact all the area used and to leave it free from any indications of construction. The removal of the material will be done in compliance with all the environmental dispositions required for this purpose.

3.5. ACTIVITIES CHRONOGRAM

The following is a chronogram of activities for the project phases.

4. CHAPTER 4: PROJECT’S PRINCIPAL EMISSIONS, DISCHARGES AND WASTE

4.1. EMISSIONS INTO THE ATMOSPHERE

The TMT Project will generate emissions into the atmosphere during the construction phase. These emissions are from particulate matter and gases produced by the internal combustion of vehicles. However, in conformance with environmental policy and quality, the presence of particulate matter will always be under control, subject to the rules of existing laws.

4.1.1. PARTICULATE MATTER

a) Vehicles and equipment used during the construction phase

- 2 bulldozers
- 4 cargo trucks
- 1 backhoe
- 6 pickup trucks
- 1 passenger bus to transport personnel
- 1 minibus for transportation
- 2 frontend loaders
- 1 grader
- 1 100-ton crane
- 1 250-ton crane
- 1 50-ton crane
- 1 15-ton crane
- 1 forklift
- 1 small truck
- 1 hydraulic ladder
- 1 hydraulic scissor lift
- 2 tank trucks with 2 trips per day from Antofagasta
- 2 cargo trucks with 2 trips per day for supplies
- 2 trip services a day from Antofagasta
- 40 loads of pre-assembled components from the point of sale to site
- 50 loads of steel (from Antofagasta or Santiago)
- 150 loads of steel from port of Antofagasta
- 100 loads of materials from Antofagasta

b) Vehicles and infrastructure to be used during the period of operation

8 light vehicles (4 for night-shift staff, 2 for night-shift technicians, 2 spare)
3 vans (8 people)
1 small truck
1 large truck
2 pickup trucks (with one trip per day from Antofagasta)
1 van (between Antofagasta and the TMT site)
1 bus per day between Antofagasta and the TMT site
1 small bus for shift-changes
1 tank truck daily
2 trucks every week with diesel
1 truck every two weeks with gasoline
1 truck every week with coolant
1 small truck per day with supplies

The particulate matter generated by use of explosives will be minimized by scheduling them during periods of low winds.

4.1.2. Gases

There will be gas emissions from vehicles traveling through the site; however, they will be very controlled to comply with regulations of the Ministry of Transportation that requires them to have current and updated permits and technical inspections. This verifies the state of their combustion processes and thus their gas concentrations.

In the construction and operation phases, small amounts of commercially available solvents will be used routinely for facilities maintenance and with the coating of mirrors in the telescope.

4.2. DISCHARGE OF LIQUID EFFLUENT

Throughout the duration of the project there will be no effluent discharges.

In accordance with the characteristics of the project during the construction and operation stages there will be no generation of discharges of liquid industrial waste (RILES). The generation of domestic sewage in the construction phase will be removed by the trucks with appropriate permits. Chemical toilets will be used.

During the operation phase, the project will generate domestic sewage that will be processed in a treatment plant that will produce water with irrigation-quality. This water will be used to water road surfaces to reduce the particulate matter from the transit of vehicles. Any excess water will be placed in an evaporation-pool. Its characteristics are provided in the plant description as part of the requirements to obtain environmental permit # 91.

4.3. GENERATION OF SOLID WASTE

The project will generate solid waste as follows:

Domestic solid waste and comparable waste will be disposed of in a properly authorized location.

During the construction phase, solid waste will be generated from the excavations for foundations that will be made. The material extracted for the purpose of foundations will be removed and deposited at locations so that the surface can be leveled, since there are various locations with low points where is it possible to place the material, without altering the level or the landscape.

4.4. GENERATION OF NOISE

The noise generated in the construction phase by heavy machinery is not significant and will not significantly increase the noise level in the area since the site is far away from populated areas. During the operation stage no significant noise will be generated.

There will be between two to four sound detection and ranging units. These devices emit harmonic sound signals every 30 seconds and are used to measure atmospheric turbulence. The signals are directed vertically towards the atmosphere and the cone-shaped emitters have attenuators on the sides to minimize the lateral propagation of sound. These sound signals will be audible in certain parts of the summit but will not be audible inside buildings or areas away from the summit. These devices are used routinely in virtually all observatories and high-tech weather and meteorological stations.

4.5. GENERATION OF FORMS OF ENERGY AND/OR ELECTROMAGNETIC RADIATION

There will be a system of diesel-powered generators for generation of electricity. This system will receive continuous maintenance to ensure optimal operation, so as to minimize the emission of incomplete combustion gases. All parts, filters and oil removed during maintenance will be disposed of with care and according to environmental protection guidelines. The facilities of this equipment will follow safety and environmental guidelines to decrease the risk of oil and diesel spills.

Near the end of the construction phase, TMT will begin to emit laser beams at night in order to measure atmospheric turbulence. This will continue during the operation phase in a routine manner. There will be a passive detection system to ensure airplanes will not be illuminated by laser lights. Additionally, all safety measures will be taken to ensure that laser light beams will not hit personnel within or near the vicinity of the TMT. The safety systems are based on proven technology, protocols and control processes developed for observatories in Mauna Kea (Hawaii, USA) and Cerro Pachon (Chile). Laser emission systems have become standard in astronomical observatories in Chile and around the world.

TMT will use automated visible wavelength cameras to detect aircraft, and automate the infrared camera as a security system. Additional security systems will protect against (i) the exposure of staff and instrumentation to lasers within the observatory, (ii) accidental illumination of artificial satellites in orbit, (iii) laser interference with nearby Astronomical observatories.

Permits will be obtained from the Directorate of Civil Aviation to operate the laser emitting systems. Additionally, any regulations and instructions provided in the process will be followed.

In relation to the rules applicable in Chile for the operation of lasers in space, currently there is no legal background on the subject. The Directorate of Civil Aviation is working with Part 6, Chapter 8 of document FAA No. 7400 2E from that institution.

All prior coordination in using the laser system must be done with the Directorate of Civil Aviation Control Center.

Laser emission periods will be restricted while there is air traffic in the area.

The TMT Corporation shall inform the General Directorate of Civil Aviation (DGAC), at least two-months in advance, the schedule that corresponds to the use of the laser light system. TMT will also coordinate activities with the appropriate Control Center six hours prior to the start of operation so that the DGCA may include information in the Aviation Note (NOTAM). TMT will also notify when the activity ends as well as any changes in the laser system.

The laser beam will be temporarily turned off when required by the Control Center of DGAC. TMT will wait for a new authorization in order to continue with the operation. This does not replace have a system of human observers that will observe the sky and prevent the laser propagation into air traffic.

There will be no additional forms of energy, radiation or vibrations of significance.

4.6. MEASURES TO ENSURE PHOTOMETRIC QUALITY OF THE NIGHT SKY

In astronomy, the photometric sky quality is a valuable resource for scientific research. This consists of the ability to observe the electromagnetic radiation from cosmic sources without being affected by light sources of anthropogenic origin which are reflected in the various layers of the atmosphere, increasing artificially the emission level of the atmosphere.

The *photometric sky quality* resource has been preserved in regions II, III and IV of Chile through the emission standards for the regulation of Light Pollution in the DS No. 686 of 1998 from the Ministry of Economic Development and Reconstruction. Chile recognizes the photometric sky quality in its northern region as a valuable environmental and cultural heritage that makes it possible to develop research in astronomy and which needs to be preserved by avoiding light pollution. The regulation was published in the Official Journal on 02 August 1999.

The TMT project is particularly sensitive in this respect since its main goal is to conduct astronomical research. During the construction and operation phases, TMT will take all necessary measures to prevent artificial light emissions, so as to preserve the photometric sky quality. These measures include:

- Inform, train and supervise all staff to prevent the emission of light to the exterior during the nighttime.
- Employ technical measures and give recommendations to all staff, which ensures that all windows in the observatory have blackout curtains that are completely closed at night. In this manner light inside buildings will be blocked to the exterior.
- We will take necessary measures for the exterior lighting for walkways with the use of phosphorescent material. Any necessary outside lights will be limited in height close to the ground level with reflective panels that will direct all light towards the ground. Light bulbs used will follow the recommendation in the DS No. 686: low-pressure sodium and low power.
- Vehicular transit will be kept to a minimum during the night. Should there be any traffic, this will be limited to a speed of 20 Km/h while only allowing the use of low-beam lights and tail-lights.
- During the construction phase activities at night will be kept to a minimum while taking measures to ensure all needed lighting is kept on the surface to prevent it from spreading into the atmosphere.

5. CHAPTER 5: FRAMEWORK FOR ASSESSMENT OF PROJECT OR ACTIVITY AS TO VERIFY WHETHER IT REQUIRES SUBMISSION OF AN ENVIRONMENTAL IMPACT STUDY

In this chapter, the framework is presenting for warranting and justifying the present project's compliance with the SEIA through a Declaration of Environmental Impact and not by means of an Environmental Impact Study. With this objective in mind, we have taken into account the project's interactions with all of the environmental factors present in the affected area through an analysis of Articles 5 through 11 of the SEIA Regulation.

In compliance with Article 4 and following the Title II Regulation, the owner must present a Study of Environmental Impact if the project or activity causes or presents any of the following effects, characteristics or circumstances:

5.1. HEALTH RISK FOR THE POPULATION DUE TO THE QUANTITY AND QUALITY OF THE EFFLUENTS, EMISSIONS OR WASTE GENERATED OR PRODUCED.

Article 5 of the Regulation of the Environmental Impact Evaluation System (SEIA) declares that: “The owner must present a Study of Environmental Impact if the project or activity causes or presents a health risk for the population due to the quantity or quality of the effluents, emissions, or residues that it generates or produces.” In order to assess if it causes or presents a risk as referred to in the previous paragraph, we must consider the following factors:

a. The established regulations for environmental quality and emissions. In the absence of such regulations, the indications in Article 7 of the Regulations will be utilized.

Given the characteristics of the project, the absence of regular and/or significant sources of emissions and liquid waste into the environment, it is not expected to significantly modify the environmental concentrations of the contaminants regulated by the primary laws governing environmental quality. The dust emissions of the project are temporary, sporadic, and minimal; and come mostly from the occasional traffic of vehicles on dirt roads and the processes of extraction. It is important to consider that in the sector in which the project is located, there is no human population.

b. The composition, potential danger, quantity and concentration of the liquid effluents and atmospheric emissions.

The liquid waste products generated by the project consist of the waste from chemical toilets during the construction stage. These will be removed by a company which specializes in waste removal and disposed of in a manner authorized by the Sanitary Authority.

The project will not generate atmospheric emissions coming from fixed sources. The only atmospheric emissions are those generated by the occasional traffic of vehicles driving on dirt roads.

These will not cause adverse effects on the population because of their composition, potential danger, quantity, or concentration of liquid effluents and atmospheric emissions.

c. The frequency, duration, and location of the liquid effluents and atmospheric emissions.

During the construction, operation, and shutdown stages of the project, no liquid effluent discharges will be introduced into any receiving waters.

The liquid waste coming from the bathrooms will be removed by companies specializing in liquid waste removal and disposed of in authorized areas.

The atmospheric emissions produced during the construction stage are those generated by the operation of the bulldozer and other heavy machinery for the preparation of the land and construction of the support facilities infrastructure and the platform for the telescope facility. There is no human population living in the area of the project.

During the operation stage, the atmospheric emissions will come mainly from the occasional traffic of smaller vehicles on dirt roads.

During the shutdown stage, the atmospheric emissions will come from a bulldozer utilized in the rehabilitation of the land.

d. The composition, potential danger and quantity of solid wastes.

The solid wastes that will be generated by the project are associated with the maintenance of machinery, leftover materials, and human activity (domestic solid waste) consisting of:

Used oils and lubricants. These are generated as a result of changing the machinery oil, which will be stored in containers or drums and will eventually be taken care of by a company specializing in the handling and removal of dangerous waste products.

Domestic solid waste. This is composed of organic material produced in the kitchen.

Non-hazardous solid waste. This consists of waste such as paper, cardboard boxes, wood, packing materials, used office materials, etc.

The organic waste coming from the kitchen is estimated to be 62.5 kg/day, including grease and oil, which will be collected by a filtration system, to later be temporarily disposed of in appropriate containers as per the regulations.

These will not cause adverse effects to the population due to their composition, potential danger, or quantity of the solid wastes.

e. The frequency, duration, and location of solid waste management.

Solid waste generated by the project is associated with the maintenance of machinery, leftover materials, and human activity (domestic solid waste).

Used oils and lubricants. These refer to the replacement of machinery oil, which will be stored in receptacles and oil drums and will eventually be taken care of by a company specializing in the handling and removal of dangerous waste products.

Domestic solid waste. This is composed of organic material produced in the kitchen.

Non-hazardous solid waste. This consists of waste such as paper, cardboard boxes, wood, packing materials, used office materials, etc.

All waste will be temporarily stored in compliance with all the environmental regulations and will be periodically transported and disposed of in an authorized area.

These will not cause adverse effects on the population due to the frequency, duration, or location of solid waste management.

f. The difference between the estimated noise levels emitted by the project or activity and the background noise level typical of areas in which there is a permanent human population.

The noise emissions are associated with the construction stage because of the operation of heavy machinery and occasional traffic on the access roads to the project. In the area of the project there is no permanent human population. In any case, we will comply with the applicable regulations concerning the environmental conditions in the work place.

g. The forms of energy, radiation or vibration generated by the project or activity.

The construction and operation of the project will not generate forms of energy, radiation, or vibration which pose health risks to people.

Concerning the end of the construction stage, TMT will start to emit lasers during the night to measure atmospheric turbulence. These emissions will continue throughout the operation. We will install a system to detect aircraft to make sure that these will not be

adversely affected by the lasers. We will take all of the security measures to make sure that the lasers will not adversely affect personnel working in or around the TMT. These laser security systems are based on well-tested technologies developed for observatories in Mauna Kea (Hawaii, USA) and Cerro Pachón (Chile).

TMT will use automatic cameras to scan the sky in order to detect aircraft and will utilize automatic infrared cameras as a security system. Additional security systems will protect against: (i) exposure of personnel and team to laser beams inside the observatory; (ii) accidental illumination of artificial satellites in orbit; and (iii) laser interference with nearby astronomical observatories.

We will solicit the appropriate permit to operate the laser system from the Department of Civil Aeronautics and will comply with their regulations.

h. The effects of the combination and/or known interactions of the contaminants emitted or generated by the project or activity.

The construction and operation of the project will not generate or emit contaminants that could potentially combine or interact with each other to produce synergetic effects.

Conclusions of the analysis under Article 5: Based on what has been presented here, it is concluded the project does not pose any risk to the health of the population due to the quality and quantity of waste, emissions, or residues that it generates or produces.

5.2. ADVERSE EFFECTS ON THE RENEWABLE NATURAL RESOURCES, INCLUDING SOIL, WATER AND AIR.

Article 6 of the Regulations of the Environmental Impact Evaluation System establishes that: “The owner must present a Study of Environmental Impact if the project or activity generates or presents significant adverse effects on the quantity or quality of renewable natural resources, including soil, water, and air. For the purpose of evaluating if the project could potentially cause the previously mentioned adverse effects, letters a) through q) of the article are considered in the following.

a. The established secondary regulations concerning environmental quality and existing emissions. In the absence of such regulations, the indications in Article 7 of the Regulations will be utilized.

The project will neither generate nor discharge effluents, nor significant atmospheric emissions that are regulated by secondary laws for environmental quality.

b. The composition, potential danger, quantity and concentration of the liquid effluents and atmospheric emissions.

The liquid wastes generated by the project are not hazardous and consist of sludges generated by the chemical toilet in the construction stage. These will be removed by a company specializing in waste removal and deposited in places authorized by the Sanitary Authority.

The project will not generate atmospheric emissions from fixed sources. The only atmospheric emissions are those generated by occasional traffic of vehicles on dirt roads.

c. The frequency, duration, and location of the liquid effluents and atmospheric emissions.

During the construction, operation, and shutdown of the project, no liquid effluent discharges will be introduced into any receiving waters.

The liquid waste coming from the chemical toilets will be removed by companies specializing in liquid waste removal and disposed of in authorized areas.

The atmospheric emissions produced during the construction stage are those generated by the operation of the bulldozer and other heavy machinery for the preparation of the land and construction of the support facilities infrastructure and the platform for the telescope facility.

During the operation stage, the atmospheric emissions will come mainly from the occasional traffic of smaller vehicles on dirt roads.

During the shutdown stage, the atmospheric emissions will come from a bulldozer utilized for the restoration of the land.

d. The composition, potential danger, and quantity of solid wastes.

The solid wastes that will be generated by the project are associated with the maintenance of machinery, leftover materials, and human activity (domestic solid waste) consisting of:

Used oils and lubricants. These are generated as a result of changing the machinery oil, which will be stored in containers or drums and will eventually be taken care of by a company specializing in the handling and removal of hazardous waste products.

Domestic solid waste. This is composed of organic material produced in the kitchen.

Non-hazardous solid waste. This consists of waste such as: paper, cardboard boxes, wood, packing materials, used office materials, etc.

These will not cause adverse effects on the population because of the composition, danger, or quantity of the solid wastes.

e. The frequency, duration, and location of solid waste management.

Solid waste generated by the project is related to maintenance of machinery, leftover materials, and human activity (domestic solid waste).

Used oils and lubricants. These refer to the replacement of machinery oil, which will be stored in receptacles and oil drums and will eventually be taken care of by a company specialized in handling and removing hazardous waste products.

Domestic solid waste. This is composed of organic material produced in the kitchen.

Non-hazardous solid waste. This consists of waste such as: paper, cardboard boxes, wood, packing materials, used office materials, etc.

These will not cause adverse effects on the population because of the frequency, duration, or location of solid waste management.

f. The difference between the estimated noise levels emitted by the project or activity and the background noise level typical of areas with a high concentration native fauna habitats significant for their nesting, reproduction, or feeding.

The noise emissions are associated with the construction stage because of the operation of heavy machinery and occasional traffic on the access roads to the project.

The project will take place in an area where there are no native fauna habitats important for their nesting, reproduction, or feeding, as listed in the Environmental Baseline of Animals.

g. The forms of energy, radiation or vibration generated by the project or activity.

The construction and operation of the project will not generate forms of energy, radiation, or vibration which pose health risks to people.

Near the end of the construction stage, TMT will start to emit lasers during the night to measure atmospheric turbulence. These emissions will continue throughout the operations phase. A system to detect aircraft will be installed to ensure that these will not be adversely affected by the lasers. We will take all security measures to make sure that the lasers will not adversely affect personnel working in or around the TMT. These laser security systems are based on well-tested technologies developed for observatories in Mauna Kea (Hawaii, USA) and Cerro Pachón (Chile).

TMT will use automatic cameras to scan the sky in order to detect aircraft and will utilize automatic infrared cameras as a security system. Additional security systems will protect against: (i) exposure of personnel and team to laser beams inside the observatory, (ii) accidental illumination of artificial satellites in orbit, and (iii) laser interference with nearby astronomical observatories.

We are soliciting the appropriate permit to operate the laser system from the Department of Civil Aeronautics and will comply with their regulations.

h. The effects of the combination and/or known interactions of the contaminants emitted or generated by the project or activity.

The construction and operation of the project will not generate or emit contaminants that could potentially combine or interact with each other to produce synergetic effects.

i. The relationship between the generated emission of contaminants and the environmental quality of the renewable natural resources.

The project will not generate atmospheric emissions coming from fixed sources. The only atmospheric emissions are those generated by the occasional traffic of vehicles driving on dirt roads.

Similarly, no liquid effluent discharges will be introduced into any receiving waters.

As a result, due to the small quantity and short duration of the atmospheric emissions and the lack of liquid waste discharge, the project will not affect the environmental quality of renewable natural resources.

j. The capacity for dilution, dispersion, self-purification, assimilation, and regeneration of renewable natural resources present in the area affected by the project or activity.

The project will not generate or emit contaminants that could affect the environmental quality of renewable natural resources. As such, it will not affect the capacity for dilution, dispersion, self-purification, assimilation, and regeneration of renewable natural resources present in the area affected by the project or activity.

k. The quantity and surface area of native vegetation affected and/or exploited, as well as the way in which it is affected and/or exploited.

The project does not interfere with or exploit native vegetation. The project takes place in an area where there is no native vegetation, as listed in the Environmental Baseline of Plants and Vegetation.

l. The quantity of wild animal life affected and/or exploited, as well as the way in which it is affected and/or exploited.

The project does not interfere with or exploit wild animal life.

m. The conservation status of animal and plant species which may be removed, exploited, altered, or handled, as indicated on the national list of endangered, vulnerable, rare, or insufficiently known species.

The project does not remove, exploit, alter, or handle plant or animal species whose conservation status is indicated on the national list as endangered, vulnerable, rare, or insufficiently known. The project takes place in an area where there is no plant or animal life with a conservation status as listed in the Environmental Baseline of Plants and Animals.

n. The volume, quantity, and/or surface area, as they apply to water resources which may be affected or exploited in:

n.1) fertile plains and/or high altitude wetlands located in regions I and II that could be affected by the rising or falling of groundwater levels.

The project does not include the extraction of groundwater or surface water, or the interference with any fertile plains or high altitude wetlands.

n.2) wetland areas that could be affected by the rising or falling of groundwater or surface water levels.

The project will not affect any wetlands, nor interfere with the movement of groundwater that could affect this type of system.

n.3) subterranean bodies of water that contain millennial waters and/or fossil water.

The project does not include the extraction of subterranean water of any kind.

n.4) one hydrographic basin or sub-basin transferred into another; or

This does not apply to this project. The project will not interfere with or exploit water resources of systems of hydrographic basins or sub-basins.

n.5) lakes or lagoons that are subject to level fluctuations

This does not apply to the present project. There are no bodies of water in the area of the project which are subject to level fluctuations.

o. The alterations that could be caused to other natural and/or manmade elements of the environment by the introduction of species of plants or animals into national territory, such as the introduction or use of genetically modified organisms, or other similar technologies.

The project does not involve the introduction of any species of plants or animals into national territory, nor does it employ any genetically modified organisms or other similar technologies.

p. Surface soil that is susceptible to loss or degradation by erosion, compaction, or pollution.

The project does include alteration of the surface soil for the purpose of installing the infrastructure and telescope. Surfaces will be restored at the end of the project.

q. The biological diversity present in the area of the project or activity, and its capacity for regeneration.

The project will not affect the biological diversity or its capacity for regeneration.

Conclusions of the analysis under Article 6: Based on what is presented here, given the characteristics of the project, the lack of contaminants that could affect the environmental quality of the area, and the environmental considerations that were taken into account in the definition of the areas of use; the project will not cause adverse effects on the renewable natural resources of the area.

5.3. RESETTLEMENT OF HUMAN COMMUNITIES OR SIGNIFICANT ALTERATION OF LIFE SYSTEMS AND CUSTOMS OF HUMAN GROUPS

Article 8 of the Regulations of the Environmental Impact Evaluation System (SEIA) establishes that: “The owner must present a Study of Environmental Impact if the project or activity causes resettlement of human communities or significant alteration to their cultural customs and ways of life.” For the purpose of evaluating if the project or activity may cause resettlement of human communities, the following criteria has been considered:

a. Geographic characteristics, consisting of the distribution of human groups in the area and the spatial structure of their relationships, considering the density and spatial distribution of the population, the area of the land, possession status, and lines of communication and transportation.

The project is located far from any human settlement, so it will not cause any of the changes in the density index and/or spatial distribution index of human populations.

b. Demographic characteristics, consisting of the breakdown of the local populations by age, sex, line of business, occupational category, and migratory status, considering the rural population structure, the portion of the population that is economically active, the level of education; and other statistics involving age, sex, line of business, occupational status, and migratory status.

By its nature and location, the project will not cause any significant demographic or socioeconomic changes in any human populations. Therefore, it will not cause adverse effects by generating increases or important changes in the demographic indexes, consisting of the breakdown of the local population by age, sex, line of business, occupational category, or migratory status, considering the rural population structure, the portion of the population that is economically active, the level of education, and other statistics involving age, sex, line of business, occupational status, and migratory status.

c. Anthropological characteristics, consisting of ethnicity, and cultural phenomena such as religious ceremonies, pilgrimages, processions, celebrations, festivals, tournaments, fairs, and markets.

The project will not cause any changes in the anthropological characteristics of the inhabitants of the area.

There are no human communities in the area of the project that have traditions, communal interests or feelings of attachment towards the land. The population in the area is considered to be a rotating population, since they work in shifts at the observatory facilities of the Universidad Católica del Norte, and travel from their workplaces to their homes within the national territory or abroad.

d. Socio-economic characteristics, consisting of employment and unemployment levels; and the dependence on the extraction of natural resources by the human population, as individuals or as a group.

The project does not involve interference or exploitation of natural resources by third parties in any of its stages, nor does it restrict the access to these resources in any way or cause a negative impact on the socioeconomic status of any population.

Therefore, the project will not cause adverse effects on the socioeconomic status of any population, considering employment and unemployment levels; and the dependence on

the extraction of natural resources by the human population, as individuals or as a group.

e. Characteristics of basic social wellbeing, relative to the access of human societies to goods, equipment, or services, such as housing, transportation, energy, health, education, or sanitation.

Given the nature and location of the project, these concerns will not be an obstacle. There will be no interference with basic services or equipment to any human group. Therefore, the project will not cause adverse effects on the access of any population, community, or human society to basic services and equipment.

Conclusions of the analysis under Article 8: Based on what we have presented here, there are no human communities in the area that would be affected by the project.

5.4. SITE NEAR TO SYSTEMS THAT ARE PROTECTED AND OF ENVIRONMENTAL VALUE OF THE TERRITORY

Article 9 of the Regulation of the Environmental Impact Evaluation System (SEIA) establishes that: “The owner must present a Study of Environmental Impact if the project or activity is located in proximity to populations, resources, or protected areas which could be affected, as well as the environmental value of the territory in which it is located.” For the purpose of evaluating if the project or activity is located in proximity to populations, resources, or protected areas which could be affected, the following criteria have been considered:

a. The extent or duration of the intervention or location of the project in or around areas inhabited by populations protected by special laws.

The project does not intervene in areas inhabited by populations protected by special laws.

b. The extent or duration of the intervention or location of the project in or around areas where there are formally protected resources.

The project will be located in an area where there are no formally protected resources.

c. The extent or duration of the intervention or placement of the project in or around areas that are under official protection.

The project does not intervene in areas under official protection, in accordance with Article 2 letter a) of the Regulations: protected areas: any portion of the territory that is geographically bounded and established by act of a public authority, placed under official protection with the intention of ensuring biological diversity, preservation of nature, and conservation of environmental heritage.

The project is located in an area placed under official protection as a Place of Scientific Interest for Mining Purposes, according to Decree No. 71 of May 2, 1991 by the Ministry of Mining. Given the scientific nature of the project, this protection allows for its development and, at the same time, protects it from the potentially adverse effects of entities that may wish to develop mining projects in the area.

Conclusions of the analysis under Article 9: Based on what is presented here, the project will not affect areas placed under official protection.

5.5. SIGNIFICANT ALTERATION OF LANDSCAPE OR SIGNIFICANT TOURIST VALUE

Article 10 of the Regulation of the Environmental Impact Evaluation System (SEIA) establishes that: “The owner must present an Environmental Impact Study if the project or activity causes significant alteration, in terms of magnitude or duration, to the scenic or tourist value of the area.” For the purpose of evaluating if the project generates or alters, in terms of magnitude or duration, the value of the landscape or tourist appeal, we have considered the following criteria set down in the DS 95/01.

a. The duration or extent to which the project obstructs the visibility in areas with scenic value.

The region in which the project is located, the Coastal Mountain Range, is composed of rocks that date from the Paleozoic up to sediments from the Quaternary with a large number from the Jurassic and Cretaceous periods. Taken together, the latter make up approximately 80% of this unit. The project will not alter regions with landscape value.

b. The duration or extent to which environmental resources or elements are altered in areas with scenic or tourist value.

Due to the characteristics of the region of the project, the scenic or tourist value is not considered to be altered. From the point of view of the tourist, the project will be a contribution to astronomy infrastructure already in place in the area.

c. The duration or extent to which the project obstructs access to environmental resources or elements in areas with scenic or tourist value.

The project will not obstruct access to environmental resources or elements in regions with scenic or tourist value.

d. The intervention or placement of the project in an area declared as a National Center of Interest for Tourists according to Law Decree No. 1,224 of 1975.

The placement of the project does not correspond to an area declared as a National Center of Interest for Tourists according to Law Decree No. 1,224 of 1975.

Conclusions of the analysis under Article 10: Based on what is presented here, we conclude that the project will not cause any changes in the scenic or tourist value of the area.

5.6. ALTERATION OF THE CULTURAL HERITAGE

Article 11 of the Regulations of the Environmental Impact Evaluation System (SEIA) establishes that: “The owner must present a Study of Environmental Impact if the project or activity causes the alteration of monuments, sites with anthropological, archeological, historical, or general value pertaining to cultural heritage. For the purpose of evaluating if the project alters sites pertaining to cultural heritage, the following criteria set down in DS 95/01 have been considered:

a. The proximity to a National Monument as defined by Law 17.288.

The project will not affect sites with anthropological, archaeological, historical or of cultural heritage. According to the study of the archeological baseline, the project is not located in proximity to any National Monument as defined by Law 17,288.

b. The extent to which the project may permanently remove, destroy, excavate, relocate, damage, or modify any National Monument as defined by Law 17,288.

The project will not in any way remove, destroy, excavate, relocate, damage, or modify any National Monument as defined by Law 17.288.

c. The extent to which the project will permanently modify or deteriorate structures or sites that pertain to cultural heritage because of their style of construction, their antiquity, their scientific value, their historical context, or their unique character.

The project will not cause the permanent deterioration or modification of any sites that pertain to cultural heritage because of their style of construction, their antiquity, their scientific value, their historical context, or their unique character.

d. The proximity to places or sites in which any society, community, or human group may participate in expressions of its culture or folklore.

The project is not located in proximity to places or sites in which any society, community, or human group participates in expressions of its culture or folklore. According to the Environmental Baseline of Heritage and Archeology, there are no monuments or sites with anthropological, historical, or general value pertaining to cultural heritage in the area of the project.

In the construction stage, the project will provide Archeological Monitoring, so that in the case of the discovery of any element of archeological value, we will be in compliance with the existing regulations with respect to the protection and/or rescue of those elements.

Conclusion of Analysis under Article 11: Based on what has been presented here, we conclude that the project will not affect sites with anthropological, archeological, historical, and/or general value pertaining to cultural heritage.

5.7. CONCLUSION OF THE ANALYSIS

As we have already indicated, the project has been designed so as to avoid potentially affecting the value of all environmental components, which was accomplished by completing the previous studies that permitted us to determine the areas that are vulnerable to intervention. As a consequence, due to the fact that the project will not produce any of the effects, characteristics, or circumstances cited in Article 11 of Law 19.300 and detailed in Articles 5, 6, 8, 9, 10, and 11 of Title II of the Regulations of the Environmental Impact Evaluation System, it is estimated, from the voluntary submission of the details of the present project to the Environmental Impact Evaluation System through a presentation of a Declaration of Environmental Impact (DIA), that all is in compliance with Article 4 of the SEIA Regulations.

6. CHAPTER 6: BACKGROUND FOR ASSESSING THE COMPLIANCE WITH THE GOVERNING ENVIRONMENTAL REGULATIONS AND LEGAL FRAMEWORK

The present chapter explains the contents required by article 18 of Law 19.300 and article 15 of Supreme Decree number 95/01 of the Ministry General Secretariat of the Presidency of the Republic, Regulation of Environmental Impact Evaluation System (SEIA in Spanish), that is, the necessary background to determine whether the impact of this project complies with the governing environmental norms. Therefore, this chapter includes the identification and analysis of the environmental regulation, the implementation of the obligations contained in the norms, and sectoral permits identified as applicable to the project.

The project will comply with all of the legal regulations pertaining to environment and sectoral permits to allow for accurate implementation.

- According to the plan, the regulation currently in force is implemented as it relates to the protection of the Air resource.
- According to the plan, the regulation currently in force is implemented as it relates to the Water Resource.
- According to the plan, the regulation currently in force is implemented as it relates to the disposal of solid residue.
- According to the plan, the regulation currently in force is implemented as it relates to Noise.
- The project is supported by a person in charge of environmental issues. The telescope (TMT) Operation’s division will seek advice from specialized external resources when required, and will be responsible for environmental issues in the organization.
- At the end of the project’s lifetime, and in order to ensure a safe abandonment of the facilities, measures will be taken for the removal of the whole structure and foundation bases in order to leave the area in optimal conditions. The material will be transported and stored in places authorized for this purpose. It is important to point out that the abandonment of the project will happen only due to forces outside of their control, with a possibility of using the facilities for future astronomy projects.
- The project plans to implement archaeological environmental monitoring during the construction phase.

- Access control: A security control has been planned that includes radio communications in order to prevent entrance of unauthorized persons in the area.
- A strict control of all air conditioning units will be established. Freon will not be used as a cooling element, or any fluorocarbon-based product that could affect the ozone layer.
- The current legislation with respect to the transmission of communication signals will be implemented.

BACKGROUND ASSESSMENT FOR COMPLIANCE OF THE ENVIRONMENTAL CURRENT REGULATION

6.1. GENERAL REGULATION

The general regulation implemented by the project is as follows:

6.1.1. Political Constitution of the Republic of Chile

Article 19 No. 8 of the Political Constitution of the Republic of Chile guarantees to all persons the right to live in an environment free of contamination.

The implementation of this Environmental Impact Declaration and its submission to SEIA (Environmental Impact Evaluation System) contribute to the implementation of the above mentioned constitutional guarantee.

The project enters the Environmental Impact Evaluation System voluntarily, as a way to express its willingness to comply with the protection of the environment and the current legislation. The project complies with the current environmental regulation in order to insure an environment free of contamination and/or adverse alteration.

6.1.2. Base Law for the Environment

The Base Law for the Environment explains and defines the right to live in an environment free of contamination, establishing the acceptable and lawful margins of alteration to the environment that do not represent a violation to this right. It also establishes the Environmental Impact Evaluation System (SEIA) as a tool for preventive control to which projects susceptible to produce important effects on the environment must submit in order for interested parties to undergo a scientific-technical evaluation that upon favorable results will allow it to obtain all the permits, authorizations and necessary approval to carry out such projects.

In this case there are no elements that require the presentation of an Environmental Impact Study. For this reason, a Declaration of Environmental Impact is presented in order to ensure the project’s compliance with all the legal norms and regulations applicable according to article 10. The said project is not described in letters a) to f), and therefore is entered into the Environmental Impact Evaluation System voluntarily.

6.1.3. Regulation of the Environmental Impact Evaluation System, Supreme Decree No 95/01 of the Ministry General Secretariat of the Presidency

This regulation made it compulsory for all projects listed in article 10 of Base Law for the Environment to enter into the Environmental Impact Evaluation System, or SEIA.

In what pertains to this project, the regulation explains and gives specific guidelines about which projects enter the SEIA, and establishes criteria to decide at what point the effects of a project make it necessary to present an Environmental Impact Evaluation (EIA in Spanish), or an Environmental Impact Statement (DIA in Spanish). It also explains which should be the basic contents in an EIA and a DIA, establishing procedures for process and evaluation, defining the types of environmental permits originating with the approval of EIA or DIA.

Since the project is not subject to the Environmental Impact Statement System according to Article 10 of the General Base Law for the Environment, the grantee submits voluntarily through this Environmental Impact Statement, therefore complying with the current regulations.

6.2. SPECIFIC REGULATION

The project complies with the following specific environmental regulation.

6.2.1. Air

a. Norm: DS No 59/98 of the Ministry General Secretariat of the Presidency of the Republic, shall establish the primary norm for breathable particulate matter (MP10), modified by DS No 45, 2001, of the Ministry General Secretariat of the Presidency of the Republic, published in the official newspaper on August 11, 2001.

Subject

It establishes the primary quality norm for breathable particulate matter (MP10) in 150 micrograms of concentrations of 24 hours, and regulates the overseeing and preventing events of critical contamination in all the Chilean territory.

Connection to the activity

The main emissions of breathable particulate matter (PM10) will be produced by the traffic of trucks on dirt road. However, they will represent minor problems, since these roads will be moistened and watered down each time they are in use.

Activity compliance

During the construction phase the atmospheric emissions of particulate matter will be generated by construction activities and traffic of vehicles driving on dirt roads.

During the operations phase only low significance MP10 emissions will be generated, due mainly to sporadic vehicular traffic.

Because of the limited production of emissions, the distance between the sources and the receptors, and the mitigation measures to be implemented, it is possible to conclude that the project will comply with the primary quality norm for breathable particulate matter (MP10).

Supervision

Regional Ministry Secretariat of Health, Region II

b. **Norm:** DS 144/61 of the Ministry of Health, establishes norms to prevent emissions or atmospheric contaminants of any nature.

Subject

Establishes that gases, vapors, smoke, dust, emissions of any nature produced in any factory or workplace, shall be collected or eliminated so as not to cause danger, damages or inconvenience to the human population.

Connection to the activity

The project will produce dust due to the traffic of trucks on dirt road. However, they will represent minor problems, since these roads will be irrigated every time they are used.

Activity compliance

To comply with this regulation the roads will be irrigated every time they are used in the project area.

Supervision

Regional Ministry Secretariat of Health, Region II

c. Norm: Resolution No 1215, 1978, Department of Environmental Programs, Ministry of Health, establishes basic health norms to prevent and control atmospheric contamination.

Subject

Establishes basic health norms to prevent and control atmospheric contamination. Moreover, it sets primary air quality norms for carbon monoxide, ozone and hydrogen dioxide.

Connection to the activity

The project will produce dust due to the traffic of trucks on dirt road. However, they will represent minor problems, since these roads will be irrigated every time they are used.

Activity compliance

The project will comply with the norms of air quality.

For the combustion equipment for heating or hot water services, the project will depend on the approval of Regional Ministry Service Secretariat of Health, Region II.

The Staff that operates the combustion services will be issued a certificate of competency from the National Health Service.

Supervision

Regional Ministry Secretariat of Health, Region II

d. Norm: DS No 4/94 establishes norms for emissions of contaminants to motorized vehicles, and sets the control procedures. DS No 103, 2000, of the Ministry of Transport and Telecommunications, establishes Emission Norm for non-Metallic Hydrocarbons for Light and Medium Vehicles.

Subject

These Decrees contain the contaminants emission standards that apply to motorized vehicles, whether they are light vehicles for the transport of passengers, or cargo. This Decree also contains the norms to be followed by the authority when supervising for compliance.

Connection to the activity

The project will produce dust due to the traffic of trucks on dirt road. However, they will represent minor problems, since these roads will be irrigated every time they are used.

Activity compliance

The project shall comply and demand from subcontractors the compliance of the emissions of contaminants norms for all vehicles.

Supervision

Chilean police, fiscal and municipal inspectors

6.2.2. Noise

a. Norm: DS 146/97 of the Ministry General Secretariat of the Presidency, that establishes annoying sounds from stationary sources.

Subject

Article No. 5 establishes that in rural areas the levels of weighted sound pressure obtained from the emission of a stationary source, measured at the place of the receptor, shall not be superior to background noise in 10 dBA or more. In rural areas, the sound pressure levels obtained from a stationary source emitting the noise, measured at the place of the receptor, shall not be superior to background noise in 10 dBA or more.

In addition, article No. 1 in connection with workplaces establishes that the maximum limits established in DS 594/99 of the Ministry of Health will be applied.

Connection to the activity

The project will generate sound mainly due to the operation of machinery used during the construction phase.

Activity compliance

The sound generated will affect the radius of influence of the surroundings of the equipment operation. There is no population potentially affected.

The noise generated during the construction phase will come from the machinery used to move dirt, facilities for the work, transport, loading and unloading, and the development of the construction work as such. There are no housing or populated centers in this sector; therefore, there will be no population affected. In the operation phase no significant noise will be generated.

Supervision

6.2.3. Solid waste

a. Norm: DS 594/99 of the Ministry of Health and its modification DS 201 published in the official newspaper

Subject

Article 19 stipulates that in every case, whether the final treatment and/or disposal of the industrial waste happens inside or outside of the industrial property, the company, before the start of the said activities, shall present a declaration to the health authorities of the quantity and quality of the industrial waste generated, clearly differentiating the hazardous industrial waste.

Finally, article 17 states that the accumulation, treatment and final disposal of industrial waste inside of the industrial property, place or workplace, must have the proper health authorization.

Connection to the activity

The project will generate dangerous and non-dangerous industrial waste.

Activity compliance

The site for the collection of solid wastes is located inside the area surveyed for the support facilities. This area consists of open terrain, free of vegetation and without flow or deposits of surface water. We will construct a concrete surface surrounded by metal grating for the storage area. The perimeter of the concrete surface will be elevated so as to contain and limit any possible leakage. The surrounding metal grate will discourage access by unauthorized personnel. Solid wastes will be collected in covered steel containers as a means of preventing spillage.

Supervision

Regional Ministry Secretariat of Health, Region II

b. Norm: DS 148 of the Ministry of Health published in the official newspaper on June 16, 2004. It approves the Health Regulation on Management of Hazardous Waste.

Subject

The regulation establishes the basic health and safety conditions to which the generation, holding, storing, transport, treatment, re-utilization, recycling, final disposal and other forms of elimination of hazardous waste must submit.

Connection to the activity

During the construction phase the project will generate a low amount of used oil from machinery maintenance.

Activity compliance

The storage container will be located in a special area fitted according to article 33 of DS 148. It will be labeled according to NCh 2190 Of.03, and will be handed over to a company authorized for the management of hazardous waste.

We are soliciting a health authorization for the accumulation, treatment and final disposal of industrial waste.

Supervision

Regional Ministry Secretariat of Health, Region II

6.2.4. Liquid Waste

a. **Norm:** DFL 725 of the Ministry of Health; Health Code, published in the official newspaper on January 31, 1968. It regulates the treatment or the final disposal of liquid waste.

Subject

Article 73 of the Health Code prohibits the discharging of wastewater on rivers or ponds, or on any other place or body of water used to provide drinking water for human consumption, for watering or for a resort, without being treated according to the regulations.

Connection to the activity

The project will generate wastewater and sewage sludge.

Activity compliance

During the construction phase the project will generate liquid effluents corresponding to the wastewater from human use of chemical toilets authorized by health officials, and the liquid waste will be removed for its disposal by a company with the corresponding permit of the Sanitary Authority.

During the operations phase, the project will generate wastewater that originates primarily in the hygienic facilities in common areas, residential bathrooms, including

discharge from toilets, lavatories, and showers. This category also includes wastewater coming from the kitchen, such as from food preparation and dish washing.

These discharges do not involve the use of chemicals except for those used in washing dishes and those that are required for kitchen sanitation, so as to maintain an area for safe and hygienic food preparation.

Supervision

Regional Ministry Secretariat of Health, Region II

b. Norm: DS 594/99 of the Ministry of Health and its modification DS 201 published in the official newspaper on April 29, 2000. It approves the Regulation on Health and Environmental Conditions in the workplace.

Subject

Article 18 stipulates that the accumulation treatment and disposal of the industrial waste inside of the industrial property, place or workplace, must have the proper health authorization.

Connection to the activity

The project will generate wastewater, as a product of human activity.

Activity compliance

There will be chemical toilets installed at the workplace, maintained by a specialized company.

During the operations phase a treatment plant for sewage will be included. Here we consider the treatment plant based on an estimated 200 liters of wastewater generated, per person, per day. This production estimate of 200 liters per person, per day includes the use of baths and hygienic facilities by each person, plus the estimation of the wastewater generated in the kitchen by all personnel. Considering a staff of 125 people on the site at any given time, the plant is designed to treat up to 25,000 liters of wastewater each day.

Supervision

Regional Ministry Secretariat of Health, Region II

6.2.5. Archaeology

Norm: Law 17288, Law of National Monuments, published in the official newspaper on February 4, 1970.

Subject

Law 17288 article 26, in its Regulation in article 23, declares that “All persons, natural or legal, who, in making excavations at any site in the national territory, for any reason, should find sites, ruins, items of historical, anthropological, archaeological or paleontological character, are under obligation to report it immediately to the Governor of the Province, who will make the police responsible for its security until the Council takes over.

Connection to the activity

In the area of the project’s intervention there are no archaeological sites.

Activity compliance

During the construction phase the project will provide Archeological Monitoring, in the case that during the removal of soil, they should find ruins, sites, items of historical, anthropological, archaeological or paleontological character, the discovery shall be reported to the Governor of the Province, according to Article 26 of Law of National Monuments and Article 23 of the Regulation of Law No. 17288.

Supervision

Council of National Monuments

6.2.6. Water Supply

Norm: DS 594/99 of the Ministry of Health published in the official newspaper on April 29th, 2000, approves the regulation on health and environmental basic conditions at the workplace.

Subject

Norm DS 594/99 establishes the following:

Article 13: Whatever the supply systems should be, potable water must comply with the physical, chemical, radioactive and bacteriological requisites established in the current regulations on the subject.

Article 14: Every working place having their own supply system, with a project previously approved by health authorities, must maintain a minimum amount of 100 liters of water per person per day, which must comply with the requisites established in article 13 of this regulation.

Article 15: In temporary worksites or camps with no potable water service, the company shall keep a drinking water supply equal in quality and quantity to the requirements established in articles 13 and 14 of this regulation, per worker and for each member of his family.

The health authority shall authorize a lesser quantity of potable water, which by no means can be less than 30 liters per day per worker and for each member of his family.

In the event that water will be stored in tanks, these must comply with appropriate health conditions. This potable water must be completely replaced if needed, with daily testing, making sure the residual chlorine complies with the proper water quality norms. Any kind of contamination or infiltration of any agent that can cause deterioration of the minimum requisites expected by the current norms will be prevented. The distribution of water to the consumers must be done through piping networkss, with tap water outlets in good working conditions.

Connection to the activity

During the construction and the operations phase the project will require potable water for the workers’ consumption.

Activity compliance

The project will be supplied with bottled drinking water purchased from authorized providers in the region. This water will also comply with the requisites established in Chilean Norm NCH 409, Drinking Water Requisites.

Workplaces will provide potable water for human consumption and basic personal hygiene needs, for individual and collective use. The facilities, appliances, and complementary devices of potable water services will comply with the current legal dispositions on the subject.

Potable water must comply with the physical, chemical, radioactive and bacteriological requisites established in the current regulations on the subject.

The project will maintain a minimum amount of 100 liters of water per person per day.

In the event that water will be stored in tanks, these must comply with appropriate health conditions. This drinking water must be completely replaced if needed, with daily testing, making sure the residual chlorine complies with the proper water quality norms. Any kind of contamination or infiltration of any agent that can cause deterioration of the minimum requisites expected by the current norms will be prevented. The distribution of water to

those who will consume it must be done through pipes with tap water outlets in good working conditions.

Supervision

Regional Ministry Secretariat of Health, Region II

6.2.7. Hunting

Norm: Law 19472, Hunting Law, published in the official newspaper on September 27, 1996. Hunting Law Regulation.

Subject

It prohibits, in all of the national territory, the hunting or capture of wildlife specimens listed as species in danger of extinction, vulnerable, unique and hardly known, and of specimens listed as beneficial for the forestry, farming and livestock development, maintenance of natural ecosystems or those that present reduced population densities.

Connection to the activity

There is no fauna in the area of the project

Activity compliance

In case of sighting of fauna species, the staff is forbidden from capturing or hunting any specimen, as well as from destructing dens or nests during the construction, operation and withdrawal phases of the project.

Supervision

Agricultural and Livestock Service

6.2.8. Hygiene and Safety

Norm: Health Code

Subject

Article 77 explains that the regulation shall include norms like the ones referring to:

Article 82. The regulation shall include norms like the ones referring to:

a) the hygiene and safety conditions that the workplaces must offer: equipment, machinery, facilities, materials and any other element, so as to efficiently protect life, health and well-being of workers and employees and the population in general;

- b) the health and protection measures that must be adopted during extraction, elaboration and manipulation of substances produced or used in the places where human work is being done;
- c) the hygiene and safety conditions the personal protection equipment must meet, as well as mandatory use.

Connection to the activity

The project will have workplaces operating under these norms and where machinery and equipment will be used.

Activity compliance

The project will comply with:

- a) the hygiene and safety conditions that the workplaces must offer: equipment, machinery, facilities, materials and any other element, so as to efficiently protect life, health and wellbeing of workers and employees;
- b) the health and protection measures that must be adopted during extraction, elaboration and manipulation of substances produced or used in the places where human work is being done;
- c) the hygiene and safety conditions the personal protection equipment must meet, as well as mandatory use.

Supervision

Regional Ministry Secretariat of Health, Region II – Municipality of Antofagasta

6.2.9. Transport

a. Norm: DS No 298, of the Ministry of Transport and Telecommunications, Regulates Transport of Hazardous Cargo Through Streets and Roads, published in the official newspaper on February 11, 1995.

Subject

It contains norms applicable to transport of substances and products that because of their characteristics might be hazardous or because they represent risks for the health of persons, public safety or the environment, without interfering with the specific regulation on each particular product.

Connection to the activity

During the construction phase the project will transport hazardous cargo.

Activity compliance

Considering hazardous substances those defined in the Chilean Official Norms NCh 2120/1 to 9.Of89.

During operations of loading, transport, unloading, change and cleaning, vehicles will carry the signs referred to in the Chilean Official Norm NCh 2190 Of93, easily visible from the front, behind or from the sides of the vehicles.

The vehicles will comply with the specifications of cargo, conditioning, loading and unloading, and manipulation.

The vehicles will comply with the requirements of circulation and parking.

Supervision

Ministry Transport and Telecommunications

b. Norm: D.F.L. No 850 of the Ministry of Public Works, sets the revised, coordinated and system-organized text of Law No. 15840, of 1964 and D.F.L. No. 206, of 1960 (D.O. 25.02.1998).

Subject

Use of public roads

Connection to the activity

The project will do basic maintenance work of a road that connects with a public road and will build an access road to connect with a public road.

Activity compliance

The project will request the necessary permits for the roads.

Supervision

Ministry of Public Works, Roads Department

c. Norm: DS No. 158, 1980, of the Ministry of Transport and Telecommunications

Subject

It sets the maximum weight for vehicles permitted on public roads.

Connection to the activity

The project will include movement of vehicles on public roads.

Activity compliance

Vehicles will work with a total gross weight for vehicles traveling on public roads. Length of vehicle less than 13 meters, 39 tons of total gross weight; length of vehicle between 13 and 15 meters, 42 tons of total gross weight; and length of vehicle more than 15 meters, 45 tons of total gross weight.

Also, the requirement of limits of weight per axle and relation of total gross weight as applied to distance of wheels for traveling on public roads will be: simple axle, simple wheels, limit of 7 tons; simple axle, double wheels, limit of 11 tons; double axle, simple wheels, limit of 14 tons; simple axle, simple and double wheels, limit of 16 tons; double axle, double wheels, limit of 18 tons; triple axle, simple wheels, limit of 19 tons; triple axle, double 2 wheels + 1 simple, limit of 23 tons; and triple axle, double wheels, limit of 25 tons.

Supervision

Ministry of Public Works, Roads Department

6.2.10. Contamination of Light

Norm: DS No 686, 1998 of the Ministry of Economy, Public Works and Reconstruction, Norm of Emission for the Regulation of Light Contamination (1998)

Subject

Taking in consideration that the skies in Regions II, III and IV in our country make up for a valuable environmental and cultural heritage for the activity of astronomic observation, this norm is established, published in the Official Newspaper on August 2, 1999.

The objective for this norm is to prevent the contamination of light of the night skies of regions I, II and III, so as to protect the astronomic quality of said skies through the regulation of light emissions. We hope to preserve the current quality of the skies and prevent future deterioration.

Connection to the activity

The project requires the compliance of the regulation for its implementation.

Activity compliance

The project requires the compliance of the regulation for its implementation; therefore, it will not produce contamination of light on any of its phases.

- Inform, train and supervise all staff to prevent the emission of light in the exteriors during the period of observation at night.
- Employ technical measures and give recommendations to all staff, which ensures that all windows in the observatory have curtains that cover them entirely. In this manner light inside buildings will not leak to the exterior.
- We will take necessary measures for the exterior lighting of corridors with the use of phosphorescent material. Any necessary outside lights will be limited in height close to the ground level with reflective panels that will direct all light towards the ground. Light bulbs used will follow the recommendation in the DS No. 686: low-pressure sodium and low power.
- Keep vehicular transit to a minimum during the night. Should there be any traffic, this will be limited to a speed of 20 Km/h while only allowing the use of low-beam lights and tail-lights.
- During the construction phase activities at night will be kept to a minimum while taking measures to ensure all needed lighting is kept on the surface to prevent it from spreading into the atmosphere.

Supervision

Regional Government of Electricity and Fuels

6.2.11. Telecommunications

Norm: Law No 18168 15/09/1982 of the Ministry of Transport and Telecommunications, Undersecretary of Telecommunications

Subject

Regulation of telecommunications services

Connection to the activity

The project will use communication equipment.

Activity compliance

In reference to this law, communication will be understood as all manner of transmission, emission or reception of signs, signals, writings, images, sounds or

information of any nature, by physical, radio electricity, optical means or other electromagnetic systems.

Before the beginning of services, the Undersecretary of Telecommunications will be informed for the corresponding authorizations.

Supervision

Undersecretary of Telecommunications

7. CHAPTER 7. ENVIRONMENTAL PERMITS

In this chapter, we identify and explain the environmental permits relevant to the project in accordance with the stipulations in Title VII of the SEIA by-laws.

In agreement with Title VII of the Regulations, the project requires the following environmental permits.

7.1. ENVIRONMENTAL PERMIT ARTICLE 91

Article 91: Permits for the construction, modification and expansion of any public or private work designated for the evaluation, treatment, or disposal of drainage or wastewater of any kind, referring to Article 71, letter b) of the D.F.L. No. 725/67 of the Sanitary Code. The requirements for granting the permit and the formal and technical contents necessary to authorize its implementation, are those that are indicated in the present article.

In the operation stage, the project will include a Wastewater Treatment Plant with the following characteristics:

Wastewater Treatment Plant

1. Physicochemical Characteristics of the Inflow

The wastewater has its origin primarily in the hygienic facilities in common areas, residential bathrooms, including discharge from toilets, lavatories, and showers. This category also includes wastewater coming from the kitchen, such as from food preparation and dish washing.

These discharges do not involve the use of chemicals except for those used in washing dishes and those that are required for kitchen sanitation, so as to maintain an area for safe and hygienic food preparation.

In the case of the summit facilities, the wastewater comes primarily from the hygienic facilities, including discharge from the toilets and sinks.

According to the potential supplier of this wastewater treatment plant, the characteristics are:

BOD₅: 250 ppm (amount of oxygen needed to degrade the organic matter)

Solids in suspension: 250 ppm

pH: 6.0 to 9.0

2. Volume of Sewage Water to be treated

Water generated in the Support Facilities:

Here we consider the treatment plant based on an estimated 200 liters of wastewater generated, per person, per day. This production estimate of 200 liters per person, per day includes the use of baths and hygienic facilities by each person, plus the estimation of the wastewater generated in the kitchen by all personnel. Considering a staff of 40 people on the site at any given time (and considering that the plant could support the volume produced by a maximum staff of 125 people), the plant is designed to treat up to 25,000 liters of wastewater each day.

Summit Facilities:

The maximum volume of wastewater this section is expected to generate is 60 liters per person, per day. Considering a maximum summit staff of 40 people, the plant is designed to treat up to 2,400 liters/day from this section.

3. Physicochemical and Microbiological analysis of the wastewater discharge.

A potential supplier of this wastewater treatment plant has measured the following characteristics of the waste matter:

BOD5 <30 ppm

Solids in suspension <30 ppm

pH: 6.0 to 9.0

4. Characterization and Manipulation of the Sludge generated in the wastewater treatment plant

The sewage sludge generated is neutral and can be disposed of in a landfill, or utilized as fertilizers. The accumulated residues from the treatment plant will be removed once every 6 to 12 months, depending on the frequency of use.

5. Disposal of Treated Wastewater

The crew is expected to generate a volume of 8,000 liters of treated wastewater, part of which will be used for the irrigation of the roads, since the daily volume of treated wastewater is too little for any other use.

7.2. ENVIRONMENTAL PERMIT ARTICLE 93

Article 93: Permits for the construction, modification, and expansion of any treatment plant for garbage or waste of any kind; or for the installation of any sites designated for the accumulation, selection, industrialization, commerce, or final disposal of garbage or waste of any kind, referring to Articles 79 and 80 of the DFL, No. 725/67 of the Sanitary Code. The requirements for granting the permit, and the formal and technical contents necessary to authorize its implementation, are those that are indicated in the present article.

Temporary Storage of Solid Wastes

1. Location and characteristics of the site: The site for the collection of solid wastes is located inside the area surveyed for the support facilities. This area consists of open terrain, free of vegetation and without flow or deposits of surface water. The coordinates are (PSAD56) 7.279.830 N; 378.090 E.

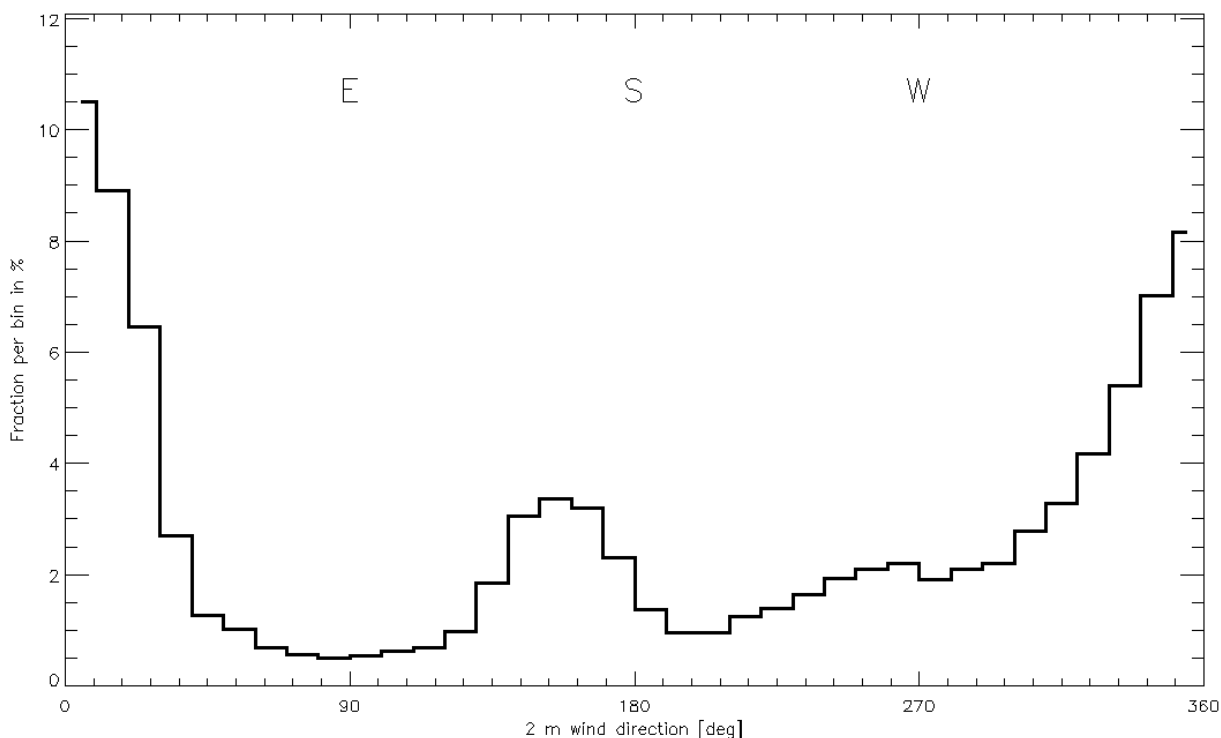
According to the geomorphologic study that accompanies this report, the area where the support facilities are located is described as “typical alluvial, colluvial, and fluvial sedimentary rock fragment sequences at the foot of the mountain: conglomerates, sandstone, and siltstone (Upper Miocene – Pliocene).”

2. Qualitative and Quantitative Analysis of the Solid Waste: It is estimated that the daily generation of solid waste will be 125 kg/day. This total is composed of: 50% organic material from the kitchen and 50% waste products such as paper, cardboard boxes, wood, packing materials, used office materials, etc.

3. Projected Works: A cement surface surrounded by metal grating will be constructed for the temporary storage of waste products.

4. Predominant Winds: The attached diagram shows the distribution of wind directions based on completed studies.

The analysis of the wind direction shows the following distribution: 80% of the time from the north, 10% from the south southeast, and 10% from other directions.



Wind direction at 2 meters above the ground surface.

5. Hydrological and Hydrogeological Characteristics: The location has little precipitation. There are no permanent, or even occasional, superficial streams.

6. Risk Prevention Plan and Accident Control plans, security measures, and measures for the control of fire, leakage, and waste spillage.

- a) We will develop a written procedure that details the correct manner of handling and storing waste materials. This procedure will be developed in cooperation with the company responsible for the removal, transport and storage of the waste.
- b) The collection zone will be separated from any facility where there is a risk of fire. In particular, there will be no areas designated for welding in the immediate vicinity.
- c) Fire extinguishers will be available in the facilities and the staff will be trained in their correct use.
- d) Waste products will be stored in steel containers as a way of minimizing the risk of leakage, spillage, and fire.
- e) Access to the collection zone will be limited to authorized personnel.

7. Characteristics of the Storage Area:

We will construct a concrete surface surrounded by metal grating for the storage area. The perimeter of the concrete surface will be elevated so as to contain and limit any possible leakage. The surrounding metal grate will discourage access by unauthorized personnel.

8. Establishment of types of storage, such as receptacles or containers. Only commercially available receptacles or containers that are designed for this purpose will be used. Solid wastes will be collected in covered steel containers as a means of preventing spillage.

Temporary Storage of Hazardous Industrial Waste

The metal structures will arrive already factory painted, treated with anticorrosive agents, and galvanized. However, during the installation period it will be necessary to paint or retouch parts of these structures in those areas where assembly or welding is done. In this case, dangerous industrial wastes may be produced as by-products of the paints and solvents.

Quantity of hazardous waste products in paint and solvents:

Less than 20 cans of paint (gallon sized)
Less than 10 cans of solvent (gallon sized)

On the other hand, the process of maintaining the diesel generators for the duration of the project produces small quantities of the hazardous liquid residues contained in oils and antifreeze coming from spare parts, and solid wastes consisting of the “rags” used to clean the generator filters (10 kg/month).

The maintenance of the heavy machinery during the construction stage will generate hazardous oily liquid residues, which is estimated to be a maximum quantity of 100 liters/month.

The hazardous residues are in group B-2, in accordance with the D.S. No. 148/2003, which can safely be temporarily stored in a common area.

The temporary storage area for these residues will measure 100 m² and will be located within the support facilities, relatively close to the storage area for non-hazardous residues.

The features of the temporary storage area and the storage containers that will be utilized will be in compliance with D.S. No. 48/2003 for this type of residue.

It is worth noting that the quantities of hazardous residues that will be generated are much less than what is specified in the preceding regulations.

7.3. ENVIRONMENTAL PERMIT ARTICLE 96

Article 96: Permits to subdivide and urbanize rural land in order to augment industrial activity with housing, provide resources to a rural sector, or to set up a spa or tourist campsite; or for industrial, equipment, tourism and housing construction outside city limits, referring to the third and fourth subsections of article 55 of the DFL No. 458/75 of the ministry of housing and urban development. The requirements for granting the permit and the formal and technical contents necessary to authorize its implementation, are those that are indicated in the present article.

DFL No. 458/75 Ministry of Housing and Urban Development

Article 55 – *Outside the city limits as established in the Regulatory Plans, it will not be permitted to open new streets or subdivide property to form settlements, or to erect buildings, with the exception of those that are necessary for farming or for housing for the owners of the farm property and their workers, or for the construction of public housing units under Law 19859 or housing under Article No. 1 up to a value of 1,000 Unidades de Fomento, the requirements for which D.O. 31.01.2003 takes into account in order to obtain aid from the State.*

It is up to the Regional Secretary of Housing and Urban Development to make sure that the non-agricultural subdivisions and buildings in rural areas do not give rise to new urban centers outside the regional urban planning establishment.

With that objective in mind, when it is necessary to subdivide and urbanize rural land in order to augment industrial activity with housing, provide resources to a rural sector, or to set up a spa or tourist campsite, or for the construction of public housing units under Law 19859 or housing under Article No. 2 up to a value of 1,000 Unidades de Fomento, the requirements for which D.O. 31.01.2003 takes into account in order to obtain aid from the State, the authorization granted by the Regional Secretary of the Ministry of Agriculture will require a prior favorable report from the Regional Secretary of the Ministry of Housing and Urban Development. This report will indicate the grade of urbanization that will be permitted for this land division under Law 19859, as established by Articles No. 3 and 4 of the General Ordinance of Urban Development and Construction. D.O. 31.01.2003. Also, industrial, equipment, tourism and housing construction outside of city limits will require, prior to the approval of the Office of the Director of Municipal Works, a favorable report from the Regional Secretary of the Ministry of Housing and Urban Development, and from the corresponding Agricultural Service.

The project is considering the erection of facilities in a rural zone declared as a Site of Scientific Interest for Mining Purposes (Document No. 71 of May 2, 1991). The project is considering the construction of the facilities for the operation of the TMT telescope; treating it as a **project of a scientific nature**. We are soliciting an Article 96 permit.

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- Environmental Measures and/or conditions that avoid the loss and degradation of the soil: in this zone there is a substrate with very little vertical development and with very little agricultural value. We will demarcate the area of intervention with the intention of limiting the required area to what is strictly necessary.
 - Effects of new urban centers outside the regional urban planning establishment: The project will not generate new urban centers outside the regional urban planning establishment, given that all of the facilities will be designed and constructed for the exclusive intention of serving the scientific project, with a plan for abandonment intended to return the land to its pre-project condition to the greatest extent possible. Given the distance from populated areas, and the altitude of the facilities, it is unlikely that they will become urban centers. Also, the personnel will work in shifts, so that during their rest periods they will return to their places of residence.
 - The support facilities will include necessary equipment in accordance to their specific functions. That is to say, we will make arrangements for dormitories, recreation areas, a dining area, administration office, a computer lab, laboratory, warehouse, etc. For that reason, they will be quite independent of the existing community services.
 - Additionally, we will impose the following requirements and conditions for occupation of the facilities:
 - Avoid areas that may generate high visual impact.
 - Avoid steep slopes or in ravines. In this zone there is a substrate with very little vertical development and with very little agricultural value.
 - The site must be located where it will not significantly alter the original shape of the terrain and where it will not alter the future course of surface water.
 - The surrounding area and the access roads must be maintained free of waste and in perfect condition for transit.
 - We will avoid the unnecessary sprawl of buildings and the like, concentrating within previously defined limits. We will demarcate the area with the intent of limiting the required area to what is strictly necessary.

8. CHAPTER 8: VOLUNTARY ENVIRONMENTAL COMMITMENTS

The project’s grantee will implement voluntary environmental commitments not enforced by the current legislation.

- The TMT project includes a meteorological and weather monitoring station. These data will be available to interested institutions.
- Also, the TMT project, collaborating with the Universidad Católica del Norte, foresees the creation of technological development, scientific and academic programs that will benefit the region and the country. Discussion on this subject is currently ongoing between the two organizations.

9. CHAPTER 9: ADDITIONAL BACKGROUND

The Owner complement the preceeding documenation with the following information:

ANNEX I: Decree No. 71 of May 2, 1991, that declares a Place of Scientific Interest for mining purposes for the lands around Cerro Armazones.

ANNEX II: Archaeological Report

ANNEX III: Flora and Fauna Report

ANNEX IV: Geormorphology Report

ANNEX V: Technical Report for the Design and Operation of TMT

ANNEX VI: Legal Background. Copies of the legal documenation that accredits the Owner and Owner’s Representative for the project.

ANNEX VII: Letter of Backing from UCN

The following is a summary of the Biological and Social-cultural aspects of the Base Line Studies presented in the corresponding Annexes. [Note: This text is not translated. See translations of the Baseline Studies.]

MEDIO BIÓTICO

9.1. FLORA

De acuerdo a estudio de línea de base de flora y fauna que se adjunta en anexo, en el área de influencia del proyecto no se han identificado especies de flora que se encuentran en las siguientes categorías: extinguida en su distribución natural, en peligro, vulnerable, rara, o insuficientemente conocida.

Según Luebert y Pliscoff (2006), el cerro Armazones se ubica en la formación vegetal de Desierto y otras áreas con vegetación escasa. Ella se refiere a formaciones vegetales dominadas por formas de vida diversas, pero que presentan coberturas bajas o nulas, de manera que el paisaje está dominado por terrenos descubiertos de vegetación.

Según Gajardo (1994), el sector se encuentra ubicado en la sub-región del Desierto Absoluto, dentro del cual se distingue la formación vegetal de Desierto Estepario de las Sierras Costeras. Este piso vegetacional corresponde a macizos montañosos, con altitudes de hasta 3.000 m de altitud. De alguna forma recibe influencias favorables para el desarrollo de la vida, ya sea por la latitud o bien por la cercanía al océano. Aún así, no existe información comprobable sobre la presencia de alguna comunidad vegetal.

Las formaciones vegetales presentes en el área de estudio corresponden a las siguientes:

- *Adesmia atacamensis* y *Calandrinia salsoloides*: corresponde a especies que habitan mayormente quebradas y cursos de agua intermitentes. Categoría de conservación: fuera de peligro.
- *Cistanthe arancioana* y *Nolana sessiliflora*: corresponde especies que se desarrollan en promontorios y afloramientos rocosos.

Si bien existen especies que habitan el área de estudio, cabe mencionar que cerca del 82% del área en estudio corresponde a superficies desprovistas de vegetación. Como se señala en los antecedentes generales, los autores que han estudiado la zona mencionan la casi nula cobertura de flora en esta sección del desierto.

Aún así, existen especies que habitan las inmediaciones del cerro Armazones. El 18% del área de influencia corresponde a ambientes de quebrada o cursos de agua intermitentes, donde son capaces de desarrollarse las especies *adesmia atacamensis* y *calandrinia salsoloides*). Estos ambientes son propicios para la colonización de ambas especies, en la mayoría de los casos ellas se encuentran juntas.

La densidad de cobertura no sobrepasa el 5%, por lo que en este hábitat la mayor parte del suelo se encuentra desnudo. La *adesmia atacamensis* es dominante en cuanto a cobertura.

La vitalidad de la *adesmia atacamensis* y *calandrinia salsoloides* encontrados en terreno varía de individuos muertos a vegetación en buen estado para un mismo sector. Aún así, es posible encontrar sólo especies muertas en la ladera de solana del cerro que se encuentra al suroeste de Armazones, y en sectores de mucha pendiente en laderas de umbría.

Sólo el 0,6% de la superficie total en estudio está colonizada por las especies *cistanthe arancioana* y *nolana sessiliflora*. Ellas se desarrollan exclusivamente en ambientes rocosos, por lo que su hábitat es muy reducido en el área de estudio. Se encuentran entre los 2.700 y 2.800 m de altitud en la ladera norte del cerro Armazones. Su cobertura es superior al de la formación anteriormente descrita, aunque no sobrepasa el 10% de cobertura. Es posible encontrar tanto especies vitales como individuos muertos.

9.2. FAUNA

De acuerdo a estudio de línea de base de flora y fauna que se adjunta en anexo, en el área de influencia del proyecto no se han identificado especies de fauna que se encuentran en las siguientes categorías: Extinguida en su distribución natural, en peligro, vulnerable, rara, o insuficientemente conocida.

En el área de estudio, se encontró un total de 3 especies de vertebrados, de los cuales 1 corresponde al grupo de los micromamíferos y 2 especies de aves.

Respecto de mamíferos mayores, al igual que el grupo de reptiles, no fueron avistados ni se observaron rastros.

Con respecto a las aves encontradas en terreno, ambas especies (*Geositta marítima* y *metriopelia melanoptera melanoptera*) fueron avistadas en el campamento, en la base del cerro. Ninguna especie fue avistada en el recorrido de los transectos.

Sólo la especie *geositta marítima* fue avistada en la cima de Armazones.

Si bien se hace mención sólo de fauna vertebrada, es importante mencionar la presencia de algunos insectos en el área de estudio. Se encontraron dos especies del orden Orthoptera, que corresponden a langostas y saltamontes. Se trata de insectos comunes, que en su estado adulto pueden ser alados o ápteros.

Estos insectos son un indicador de la presencia de otro tipo de animales como aves y micromamíferos, pues forman parte de la cadena alimenticia de ellos y permiten su desarrollo en el área de estudio.

De las tres especies detectadas, dos se catalogan como especies beneficiosas para la actividad silvoagropecuaria (*Geositta marítima* y *Metriopelia melanoptera melanoptera*) y una como especie con densidades poblacionales reducidas (*Phyllotis darwini*).

Las especies de aves encontradas corresponden a especies migratorias, mientras que el *Phyllotis darwini* es una especie de distribución nacional que no tiene problemas de conservación. Por ello no es necesario un plan de manejo ambiental.

9.3. GEOMORPHOLOGY

De acuerdo al estudio de línea de base geomorfológica que se adjunta en anexo, se tienen los siguientes antecedentes:

El área de estudio de acuerdo a su topografía y evolución morfológica forma parte de la macro unidad Cordillera de la Costa. Ella está compuesta por rocas que datan desde el Paleozoico hasta sedimentos del Cuaternario, con un predominio apreciable de edades Jurasicas y Cretácicas. En su conjunto, estas últimas constituyen aproximadamente el 80% de esta unidad.

La tectónica, reflejada en los movimientos sísmicos constantes en la zona, además de darle su impronta a la cadena costera, actúa permanentemente sobre su morfología, transformándose en una constante que debe ser considerada al momento de intervenir el área de estudio.

La principal causa de los grandes procesos de erosión, transporte y sedimentación que configuran la morfodinámica del área en estudio, corresponde a los fenómenos climáticos pleistocénicos, denominados Periodos Pluviales, que una vez culminados han pasado por una etapa de transición climática hacia la aridez. Esta dinámica climática, con todos los agentes erosivos del medio que ello implica, conduce a considerar al paisaje actual como fósil o heredado.

En la actualidad, el área de estudio presenta uno de los climas más áridos del planeta, aún así se presentan algunos eventos pluviales de alta intensidad y corta duración, los cuales configuran la morfodinámica de las formas heredadas. Otro elemento importante a considerar dentro de los elementos climáticos corresponde a la cantidad de insolación que recibe la roca durante el día, dada la importante amplitud térmica diaria que afecta las áreas desérticas, que desencadena procesos de meteorización mecánica sobre los clastos, alterando constantemente el paisaje.

El área de estudio se presenta como una zona geomorfológicamente muy estable, con presencia de una red hídrica de carácter intermitente, la que favorece el desagüe de las cuencas locales en condiciones de presencia de precipitaciones.

En función de las formaciones superficiales, el área se caracteriza por ser un relieve heredado de condiciones climáticas pasadas, caracterizadas por la presencia de mayor cantidad de precipitaciones. Actualmente el principal agente modelador del relieve corresponde a la actividad sísmica. Un segundo agente modelador que complementa al anterior, corresponde a la acción de las escasas pero intensas precipitaciones de origen frontal que se desarrollan en el desierto interior de la Región de Antofagasta.

La acción de éstos agentes moderadores, se ve facilitada por la presencia de la termoclastia, que actúa como proceso permanente de disgregación del material superficial. Ésta se encarga de descomponer la roca madre en clastos de menor tamaño.

El área de estudio está regida primordialmente por la acción que la fuerza gravitatoria sostiene sobre las formaciones superficiales. En ella es posible distinguir 4 tipos de Inestabilidad Morfodinámica en base a la intensidad de los diferentes procesos modeladores. De este modo en los sectores de menor pendiente no se desarrollan procesos, a su vez se desarrollan procesos de mínima inestabilidad morfodinámica en la mayoría de la superficie, sin existir un patrón en su distribución, sin embargo se podría concluir que están asociados a los sectores bajos de las quebradas (talwegs). Por su parte en los Interfluvios de las laderas, se dan procesos de alta intensidad. Orientados hacia el Sur, en ambos cerros existen afloramientos rocosos donde se desencadenan procesos de alta inestabilidad morfodinámica. En el camino proyectado se desencadenan intercaladamente procesos de nula y baja inestabilidad morfodinámica.

En cuanto a la Inestabilidad Morfodinámica potencial es posible distinguir tres tipos de sectores: inactivos, activos y potenciales. Se concluye que el área de estudio, especialmente los cerros, son sectores potencialmente activos bajo la ocurrencia de precipitaciones dada la presencia de las quebradas, que son los lugares por donde se desarrolla el modelado de las formas geomorfológicas, por su parte bajo sismos de alta magnitud, los sectores de los afloramientos rocosos se tornan potencialmente peligrosos dada la posibilidad de la caída de bloques de gran tamaño. Por otra parte los sectores de las laderas que han sido intervenidos con maquinarias, se tornan vulnerables ante la acción de los factores desencadenantes dado que se ha alterado la capa superficial de tales laderas, dejando expuesta la roca madre a los efectos de las precipitaciones. Otro efecto potencial de la intervención de maquinarias sobre las laderas se asocia a los taludes de los terraplenes del camino hacia la cima de Cerro Armazones, que podrían provocar el derrumbe de estos mismos bajo condiciones de saturación hídrica.

9.4. SOCIAL Y CULTURAL ENVIRONMENT

El proyecto se localiza alejado de localidades pobladas y fuera de zonas consideradas patrimonio histórico o cultural, según los registros del Consejo de Monumentos Nacionales. De acuerdo al estudio de línea de base arqueológica que se adjunta en anexo, se tienen los siguientes antecedentes:

El estudio de Sitios Arqueológicos realizado no registra sitios arqueológicos en el área inmediata al Proyecto. Los antecedentes que existen para la zona incluyen la presencia de sitios fundamentalmente costeros, representando una economía marítima y de recolección litoraleña.

El recorrido de la base del cerro no cuenta con restos con valor patrimonial. La cumbre y su actual camino de acceso resultan sumamente verticales y tampoco tiene restos con valor patrimonial. Se revisó infructuosamente y con especial cuidado la posible presencia de algún tipo de lugar de culto, dado que se trata de la cumbre más alta de la zona.

Dada la altísima visibilidad de los volúmenes en superficie, se contó con un amplio radio de prospección visual en el recorrido del camino de acceso al cerro. Se revisaron todas las áreas sospechosas de ser estructuras de piedra, talleres líticos, huellas antiguas o piedras soporte de petroglifos. No se encontró más que rocas y lasca naturales, sin modificar, en un sustrato de limo tipo “chusca”.

En síntesis, no se cuenta con antecedentes de hallazgos con valor patrimonial en el área de estudio. Esto se debe a un patrón de asentamiento prehistórico que prefiere la conjunción de recursos en el litoral, específicamente junto a vertientes de agua dulce.

Es probable que portezuelos y otras quebradas hayan sido utilizadas como vía de paso entre el interior de la costa, especialmente en tiempos históricos. En este sentido, las huellas históricas tampoco parecen haber utilizado el área de estudio, tal vez debido a su extrema aridez. Tampoco se encontraron restos de acciones rituales en la cumbre, a la manera que sí se practicó en el sector circumpuneño.

Tanto la revisión de antecedentes como la visita al terreno del proyecto, permiten descartar la presencia de restos visibles con valor patrimonial. Del mismo modo, resulta de baja probabilidad el hallazgo de restos de este tipo en el subsuelo del terreno.

Dadas estas circunstancias, las únicas medidas de mitigación adicionales a este estudio deberán estar relacionadas con las obras a realizar, a saber:

Monitoreo arqueológico. Durante la realización de excavaciones o movimientos de tierra para el Proyecto, deberá contarse con la presencia de un arqueólogo en terreno a fin de supervisar las obras. El “Arqueólogo Presente”, tendrá la función de evaluar la presencia de restos arqueológicos en las faenas, instruir al personal e implementar planes de salvataje para la debida recuperación de dichos restos (Art. 20, Reglamento de Ley 17.288).

10. POWER OF ATTORNEY, SIGNING OF THE STATEMENT, AND OATH

10.1. POWER OF ATTORNEY

I submit this Environmental Impact Statement in representation of the TMT Observatory Corporation, as written in the power of attorney specified in Annex VI, granted to the undersigned before a Notary Public in the city of Santa Barbara, California, USA, which, duly authenticated, is officially recorded under Number 270, dated on January 21st, 2008, before Ms. Maria Gloria Acharán Toledo, Notary Public in Santiago, Chile.

Alicia Norambuena Belloni
RUT (Chilean Tax ID) 5.521.090-K
Legal Representative
TMT Observatory Corporation

10.2. SIGNING OF THE STATEMENT AND OATH

In the representation in which I appear, I sign this statement, and declare under oath that, on the bases of the submitted documents, the project, “Transport, Construction and Operation of Thirty Meter Telescope TMT on Cerro Armazones, Antofagasta Region, complies with the applicable current environmental regulation.”

In accordance with the foregoing and with that established in Law No. 19.300 on General Bases for the Environment and in the Environmental Impact Evaluation System Regulation, appearing in representation of TMT Observatory Corporation, I declare under oath that, on the bases of the submitted documents, we will comply with the applicable current environmental regulation associated to the execution of the project **“Transport, Construction and Operation of Thirty Meter Telescope TMT on Cerro Armazones, Antofagasta Region.”**

In light of the foregoing, I ask the Regional Environmental Commission, Region of Antofagasta, to consider the Environmental Impact Statement contained in this document submitted, and to accept it for processing.

Alicia Norambuena Belloni
RUT (Chilean Tax ID) 5.521.090-K
Legal Representative
TMT Observatory Corporation