

Manager as part of its on-going efforts to fulfill its long-term commitment to preserve and protect the natural resources found within the MKSR. He is responsible for all the natural resource programs on the mountain, including developing programs and identifying collaborative partnerships that will help OMKM best achieve its overall goal to manage and protect lands managed by the University. WDT Klasner at 1; (Nagata) Tr. 12/8/16 at 38:1-19.

203. OMKM is continually in the process of removing fireweed and other invasive species from the Hale Pōhaku area road and summit areas. Rangers remove fireweed when they find it along the road and summit areas. In 2012, OMKM created a volunteer program to remove fireweed and other invasive weeds. To date, the program has engaged over 1,000 volunteers, who collectively have worked over 7,000 hours, removed over 1,500 bags of invasive weeds, and planted several hundred Mauna Kea Silversword plants. WDT Klasner at 5.
204. OMKM is working on restoring native vegetation, focusing on common native species, such as māmane, aweoweo, and puakala. OMKM is working with both botanists and entomologists to understand and restore the basic habitat of some of the rarer species. Tr. 12/6/16 at 72:14-73:7.
205. The testimony of Nelson Ho, a witness for Opposing Intervenor Sleightholm, focused on what he believes has been a misplaced emphasis upon astronomy over environmental and cultural resources, as well as past issues relating to the management of the mountain and the politics affecting said management. Ho has been involved in the controversy on the mountain since 1995. He believes the TMT should be built but not on Mauna Kea. *See generally* Ex. J-8 (Amended WDT Ho). Nelson Ho acknowledged that the follow-up to the 1998 State Auditor's Report indicated that most of the auditor's concerns were addressed. Tr. 2/22/17 at 32:12-38:14, 102:21-103:7.
206. The annual reports to the BLNR, beginning in 2010 to the most recent 2016, cite the management accomplishments that OMKM has done over the years. The 2016 report states that most of the CMP management actions have been implemented or are in progress. Many of the actions are described as "ongoing" as they are long term, continuing land management responsibilities. All of the reports provide details on the implementation status with explanations for individual CMP management actions. The 2016 report includes details on the cumulative annual progression of the implementation status from 2010. Ex. A-22. In addition, the U.S. Fish and Wildlife Service references OMKM's efforts and the adoption of the CMP and sub-plans and a procedure for formal review of projects all contribute to the protection and conservation of the wēkiu bug as such were reasons for removing the wēkiu bug from the candidate species list under the Federal Endangered Species Act. Ex. A-134a at 66377.

II. THE PROPOSED PROJECT

A. HISTORY OF THE TMT PROJECT

207. Edward C. Stone ("**Dr. Stone**") is the Executive director of TMT International

Observatory, LLC. He received his Ph.D. in physics at the University of Chicago before joining the staff of Caltech as a research fellow in 1967. In 1976, he was named professor of physics and Chairperson of the Division of Physics, Mathematics, and Astronomy from 1983 to 1988. He has served as vice president for Astronomical Facilities from 1988 to 1990 and as director of Jet Propulsion Laboratory in Pasadena, California from 1991 to 2001. In the late 1980s through 2009, he served as chairperson and vice chairperson of the Board of Directors of the California Association for Research in Astronomy, which has been responsible for building and operating the W.M. Keck Observatory with its two ten-meter telescopes on Mauna Kea, Hawai'i. WDT of Edward C. Stone, Ex. C-1

208. According to Dr. Stone: "TMT is just the next step in the 400-year-old journey of discovery of the universe. The journey first began in 1610 when Galileo turned his newly developed telescope on the planet Jupiter and saw that there were moons orbiting the planet.

At the time everything was assumed to be orbiting the earth. The earth being the center of the universe. We now know that that was completely wrong. And that was the first major step in this journey of discovery that continues.

Today, the latest step in the journey is what's on Mauna Kea, that is the Subaru Telescope, the Gemini Telescope, the two Keck 10-meter telescopes are the current generation of seeing the most distant objects in the famous objects that have been seen, and have made discoveries using the telescopes on Mauna Kea.

For instance, there's been discovered that there is a giant – a massive hole at the center of the Milky Way Galaxy, four million suns of mass are in that black hole.

And another that was a prize winning discovery. Another prize winning discovery is that the universe is expanding at an accelerating rate indicating there's some form of dark energy, and it's called dark energy because we can't see it. We don't know what it is, but there is no doubt that there is something pushing the universe apart at an increasing rate.

Why do we need still another generation? We need it in order to see the very first stars that formed in the universe 13.4 billion years ago. We believe that's when the first stars were created, and there was first starlight, but it's very faint because it's very far away.

And we also know there are lots of planets orbiting other stars in our own Milky Way Galaxy. And there many planets orbiting the stars, but they're very faint because they're small. And so again, we need to collect even more light than the mighty telescopes on Mauna Kea do today. And that's where the in Thirty Meter Telescope comes in. It's mirror is three times the diameter of the Keck mirror. Thirty meters, that's 98 feet compared to the ten meter Keck telescopes. That factor of three, though, and that diameter means nine times more light is collected because that's nine times more area, and that light is focused on a spot on the camera of 1/9th the area. So it's 81 times brighter with the Thirty Meter Telescope than it is with the Keck, which is currently the best in the world.

That factor of 81 should allow us to see the first stars and galaxies as they formed great distances from here, and to study the other worlds orbiting nearby stars in our own Milky Way Galaxy.

One night on a thirty meter telescope would take 81 nights on the Keck telescopes and would never be done, that's just too much time. And so there's another great leap in the journey." Vol. 18, Tr. 12-19-16 at 6:17-9:2.

209. The National Academy of Sciences recommended that "there is a priority for a 30-meter segmented mirror telescope in the year 2000." (Dr. Stone) Tr. 12/19/16 at 9:3-6.
210. In 2003, Caltech and the University of California formed the TMT Corporation, a California non-profit public benefit corporation, for the purpose of fostering astronomy through the building and operation of a thirty meter telescope. (Dr. Stone) Tr. 12/19/16 at 9:6-12, 11:15-24.
211. The proposed location for the TMT Project at the 13N site was based on "guidelines for siting a next-generation telescope (such as the TMT) in Area E as set forth in the Master Plan. (Dr. McLaren) Tr. 11/02/16 at 163:9-11; Ex. A-1/R-1 at 1-6 & n.5; Page A-4 & Figure A-1 of App. A to Ex. B of Ex. A-1/R-1; Ex. A-48 at IX-37 to IX-39. Site testing of the "seeing" conditions, such as turbulence and the impact on image quality at this site was conducted from 2003 through 2008. The results of the testing showed that this site is a world class site and possibly the best site in the world for an optical infrared telescope using adaptive optics. (Dr. Sanders) Tr. 01/04/17 at 30:16-31:7; Ex. A-3/R-3 at 2-11.
212. In 2008, the TMT Corporation in consultation with the University began assessing the development of the TMT Project in a location identified as "Area E" on the Northern Plateau of the summit of Mauna Kea. Pursuant to Chapter 343 of the Hawai'i Revised Statutes, the University commenced environmental scoping activities for the TMT Project. WDT Hayes at 2; Tr. 10/25/16 at 118:14-23.
213. Advertisements were placed in the local papers notifying interested persons and organizations that an Environmental Impact Statement Preparation Notice/Environmental Assessment ("**EISPN/EA**") for the TMT Project was forthcoming. Interested persons and organizations – specifically including Petitioners KAHEA, MKAH, and Neves – were sent advance copies of the EISPN/EA. WDT Hayes at 2.
214. On September 23, 2008, an EISPN/EA for the TMT Project was officially published. The publication was announced that day by the State of Hawai'i Department of Health's Office of Environmental Quality Control ("**OEQC**") in the *Environmental Notice*. Public scoping meetings were held throughout the State in October 2008. WDT Hayes at 2; Tr. 10/25/16 at 118:17-23.
215. On May 23, 2009, the Draft Environmental Impact Statement ("**DEIS**") for the TMT Project was published in the *Environmental Notice*. KAHEA, MKAH, and Neves submitted written comments on the DEIS. Ward submitted written comments on the

DEIS on behalf of the Sierra Club's Hawai'i Chapter. WDT Hayes at 2-3; Ex. A-76; Ex. A-77; Ex. A-78; Ex. A-80; Exs. A-82 to A-85; Exs. A-88 to A-91; Tr. 2/13/17 at 203:1- 203:11.

216. The TMT Project's Final EIS ("FEIS"), which was prepared following the review of comments received during the DEIS review period, was issued on May 8, 2010. WDT Hayes at 2; Exs. A-2/R-2 to A-6/R-6.
217. On April 21, 2010, the MKMB reviewed the FEIS and recommended that the UH Hilo Chancellor approve and sign it; that occurred on April 26, 2010. Ex. A-61; Ex. A-102. The Governor of the State of Hawai'i accepted the TMT FEIS on May 19, 2010. WDT Nagata at 10-11; WDT Hayes at 2; Tr. 10/25/16 at 118:24-119:1; Ex. A-52; Ex. A-62 at 2-6; Ex. A-6/R-6.
218. The time to legally challenge the formal acceptance of the FEIS is set out in HRS § 343-7; to wit:

§ 343-7 Limitation of actions. (a) Any judicial proceeding, the subject of which is the lack of assessment required under section 343-5, shall be initiated within one hundred twenty days of the agency's decision to carry out or approve the action, or, if a proposed action is undertaken without a formal determination by the agency that a statement is or is not required, a judicial proceeding shall be instituted within one hundred twenty days after the proposed action is started. The council or office, any agency responsible for approval of the action or the applicant shall be adjudged an aggrieved party for the purposes of bringing judicial action under this subsection. Others, by court action, may be adjudged aggrieved.

(b) Any judicial proceeding, the subject of which is the determination that a statement is required for a proposed action, shall be initiated within sixty days after the public has been informed of such determination pursuant to section 343-3. Any judicial proceeding, the subject of which is the determination that a statement is not required for a proposed action, shall be initiated within thirty days after the public has been informed of such determination pursuant to section 343-3. The council or the applicant shall be adjudged an aggrieved party for the purposes of bringing judicial action under this subsection. Others, by court action, may be adjudged aggrieved.

(c) Any judicial proceeding, the subject of which is the acceptance of an environmental impact statement required under section 343-5, shall be initiated within sixty days after the public has been informed pursuant to section 343-3 of the acceptance of such statement. The council shall be adjudged an aggrieved party for the purpose of bringing judicial action under this subsection. Affected agencies and persons who provided written comment to such statement during the designated review period shall be adjudged aggrieved parties for the purpose of bringing judicial action under this subsection; provided that the contestable issues shall be limited to issues identified and discussed in the written comment.

219. None of the Petitioners challenged the approval of the FEIS. There were no challenges to the TMT Project's FEIS ever filed. Tr. 10/25/16 at 119:1, 131:15-17; Tr. 2/13/17 at 171:4-171:10.
220. Cruz, a rebuttal witness called by KAHEA and one of the authors of a preliminary draft of the Cultural Impact Assessment ("**Preliminary Draft CIA**"), claimed that the DEIS did not comply with HRS Chapter 343 because his recommendation that project proponents should strongly consider no further development atop Mauna Kea was not included in the Draft CIA that was attached to the DEIS. Tr. 2/28/17 at 123:24-124:1.
221. The Executive Summary in the beginning part of the DEIS specifically identifies and discusses a no action alternative to the building of the TMT Project. Ex. A-148a at S-9; *see also* Ex. A-148. The no action alternative is also identified and discussed in other parts of the DEIS. Ex. A-148a at 1-2, 4-5 through 4-7.
222. On May 19, 2010, MKMB reviewed the project, including TMT's scientific potential, project design, impacts (both positive and negative), and mitigation measures described in the TMT FEIS. MKMB, with input from Kahu Kū Mauna, recommended to the UH Hilo Chancellor that she submit a recommendation to the University President and the BOR to approve the TMT Project. The BOR approved the TMT Project on June 28, 2010. WDT Nagata at 11; Ex. A-52; Ex. A-64.
223. Following the approval of the project by the BOR, the University prepared a CDUA for submittal to the DLNR. On September 1, 2010, the MKMB reviewed the CDUA, recommended that the UH Hilo Chancellor accept it, and requested the University President to designate UH Hilo as the appropriate agency within the University to submit the CDUA to the DLNR. The University President accepted this recommendation, and the UH Hilo Chancellor submitted the CDUA to the DLNR on September 2, 2010. Ex. A-1; WDT Nagata at 11; Ex. A-52; Ex. A-65; A-47.

B. FORMATION OF TIO

224. TIO was formed on May 6, 2014 as a Delaware limited liability company. (Dr. Stone) Tr. 12/19/16 at 11:16-19; Ex. C-2 (WDT Dr. Sanders) at 1. TIO is a not-for-profit entity and an exempt organization under IRS regulations. TIO is comprised of the University of California, Caltech and governmental institutions from China, Japan, India and Canada. Ex. C-2 (WDT Dr. Sanders) at 1. Over time, TMT Corporation's role in the project has been reduced and transitioned to TIO. Tr. 1/4/17 at 77:11-20.
225. Upon its formation on May 6, 2014, TIO succeeded the TMT Corporation as the owner of the TMT Project. (Dr. Stone) Tr. 12/19/16 at 13:15-20. TIO was formed so that the voting power (and telescope observing time) could vary amongst the members and be proportionate to their respective contributions to the TMT Project. (Dr. Stone) Tr. 12/19/16 at 10:9-20. In comparison, the TMT Corporation, a California corporation, did not allow for such unequal voting power. The TMT Corporation only allowed each member to have the same voting power. (Dr. Stone) Tr. 12/19/16 at 10:3-14.

C. SUBLEASE BETWEEN THE UNIVERSITY AND TIO

226. On July 28, 2014, the University executed a written sublease ("**TIO Sublease**") for a portion of the UH Management Area to TIO. Ex. B.02f. Under the TIO Sublease, TIO agreed to pay rent on a graduated schedule that will eventually be approximately \$1 million per year in about eight to ten years. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 39:17-23; B.02f at 4-5. The TIO Sublease also requires TIO to decommission, remove its improvements, and restore the site at the end of the useful life of the proposed TMT Observatory, or in the event the General Lease between the University and BLNR is not extended or renewed. Ex. B.02f at 5-6, 8; Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 38:3-11, 165:21-25; Vol. 21, Tr. 01/04/17 at 70:6-11.
227. The Flores-Case 'Ohana introduced the TIO Sublease and moved it into evidence in this proceeding as Ex. B.02f. It was received into evidence on April 20, 2017 as part of Minute Order No. 44.

D. CONSULTATION FOR THE PROPOSED PROJECT

228. Advertisements were placed in local newspapers notifying interested parties that the EISPN/EA for the TMT Project was forthcoming. KAHEA, MKAH, and Neves were among the individuals sent advanced copies of the EISPN/EA. WDT Hayes at 2.
229. Advertisements were also placed to solicit participation and input from lineal descendants in the cultural consultation process, as contemplated by the CRMP. Vol. 7; Vol 12, (Baybayan) Tr. 11/02/16 at 134:2-24; Vol. 15, Tr. 12/12/16 at 44:21-45:4.
230. As part of the preparation of the development of a burial treatment plan for burials that may be found in the UH Management Area, in 2012, public burial notices were placed in the newspapers and in OHA's monthly publication, Ka Wai Ola. The advertisements sought individuals with knowledge about the identity and history of the burials on Mauna Kea and the appropriate treatment of unmarked burials. Ex. A-138, Appendix B. In 2004, burial notices were also placed in newspapers pertaining to the burial treatment plan for the Keck Outriggers Telescope project. Ex. A-11 at 4-47.
231. On May 8, 2010, the FEIS was published. WDT Hayes at 2. Approximately 780 Federal, State, and County agencies, organizations and individuals were on the mailing list for FEIS. Ex. A-5/R-5 at A-1 to A-10. Amongst those sent copies of the FEIS were: MKAH, Fergerstrom, Temple of Lono, KAHEA, Sierra Club, and ROOK I. *Id.* Other organizations and individuals who were mailed copies of the FEIS included Keomailani Von Gogh, Townsend, Nelson Ho, and Richard Ha. *Id.*
232. The State Historic Preservation Division ("**SHPD**") of DLNR and OHA were consulted on which groups and individuals should be contacted for consultation on the CIA. Vol. 8, Tr. 11/15/16 at 53:4-13. Approximately 64 individuals and organizations were contacted for consultation on the CIA for the TMT FEIS, including Flores, Ching, Neves, MKAH, Pisciotta, Fergerstrom, Kakalia, Kanaele, and KAHEA. Ex. A-5/R-5, App. D at 85-102; Vol. 8, Tr. 11/15/16 at 50:21-52:9; *see also* Vol. 34, Tr. 2/13/17 at 141:3-141:9, 141:16-142:14. Of those 64 organizations or individuals contacted, 25 responded and 18 people

- were interviewed. Vol. 8, Tr. 11/15/16 at 50:21-51:10. Baybayan and Dr. Aluli Meyer were also consulted as part of the CIA. *Id.* SHPD and OHA provided comments on the CIA in writing. Ex. A-5/R-5, App. D. at ix-xi, 103-04; Vol. 15, Tr. 12/12/16 at 45:5-45:17. Though Flores was sent information about consultation, he did not respond or otherwise participate in that process. Vol. 32, (Flores) Tr. 1/30/17 at 222:3-22; Ex. A-131.
233. Pisciotta testified that she made comments on behalf of MKAH, Neves, and Ching in 2009 that were included in the EIS process. Vol. 34, Tr. 2/13/17 at 170:20-171:3. She also testified that she participated in the scoping meeting for the TMT EIS, reviewed the TMT DEIS and commented extensively twice. Vol. 34, Tr. 2/13/17 at 203:1-203:11; Ex. C-43. Pisciotta acknowledged that she is aware that there is a time period to challenge an EIS that is approved by the Governor and that she did not challenge the FEIS for the TMT Project during this period. Vol. 34, Tr. 2/13/17 at 171:4-171:10.
234. Ruth Aloua, a witness called by Petitioner Flores-Case ‘Ohana, acknowledged that the consultation efforts described in Section 2.3 of Appendix G to the FEIS (the Archaeological Inventory Survey ("**AI**S") for the Mauna Kea Summit Area) can be considered consultation as defined in HAR Chapter 13-276. Vol. 36, Tr. 2/15/17 at 82:18-21; Ex. A-132.
235. On September 2, 2010, the CDUA was submitted to DLNR. Ex. A-1/R-1; Ex. A-7/R-; Ex. A-8/R-8; Ex. A-23. On October 23, 2010, a notice of the application was published in OEQC’s *Environmental Notice*. Ex. A-7/R-7 at 22. Copies of the CDUA were made available for review at the Hawai‘i State Library, and the Kailua-Kona and Thelma Parker Public Libraries, as well as on OCCL’s website. *Id.*
236. Written comments on the CDUA were submitted by a number of agencies, organizations, and individuals, including comments on behalf of KAHEA (represented by its then-executive director, Miwa Tamanaha, and Townsend), MKAH (represented by Pisciotta), Neves (claiming to represent ROOK I), Sierra Club Hawai‘i (represented by Ward), Ching, and the Flores-Case ‘Ohana. Ex. A-8/R-8 at 187-204, 207-08, 219-21, 239-43.
237. Extensive public hearings on the CDUA were held in Hilo and Kona. The hearings were noticed in the paper of record. Ex. A-7/R-7 at 37. The hearing in Hilo was held on December 2, 2010 at the Hawai‘i County Council Room, 25 Aupuni Street in Hilo. Approximately 125 members of the public attended the Hilo meeting, with 51 persons providing oral testimony. *Id.* The Kona hearing was held on December 3, 2010 at the Natural Energy Laboratory in Kona. Ex. A-7/R-7 at 22. Approximately 78 persons attended the Kona meeting, with 33 members providing oral testimony. *Id.*
238. MKAH, Neves, Ward, and Ching offered live testimony at the Hilo hearing on December 2, 2010. MKAH, Ward, Ching, and the Flores-Case ‘Ohana testified at the Kona hearing on December 3, 2010. Ex. A-7/R-7 at 37-43. R. Ha and Baybayan testified in support of the TMT Project at both the hearings in Hilo and Kona. Ex. A-7/R-7 at 40, 43.
239. Additional public meetings about the project were held and open to the public through

- MKMB and Kahu Kū Mauna meetings. Vol. 13, Tr. 12/6/16 at 37:5-37:22; Vol. 14, (Nagata) Tr. 12/8/16 at 74:8- 74:9.
240. Kahu Kū Mauna provided input on the TMT Project to MKMB. On May 19, 2010, Ed Stevens, on behalf of Kahu Kū Mauna, read a statement saying that the Council had reservations about the TMT project, but after considerable deliberations they felt that their reservations were not sufficient to stand against the project since the TMT Project had demonstrated an intention to provide responsible tenancy that strives to meet the standards established by OMKM, which made the project less objectionable. Ex. A-62 at 4; Vol. 41, Tr. 2/27/17 at 155:7-165:23; Ex. A-146 at 6.
241. Tajon, a witness for Kakalia and a member of Kahu Kū Mauna, testified that in his experience the astronomy community has truly expressed its interest in understanding and respecting the traditional Hawaiian faith. Vol. 41, Tr. 2/27/17 at 12:2-7; *see* Ex. A-144a.
242. Consideration of traditional and contemporary cultural and religious practices, and the impacts thereto, were specifically included in the CIA for the FEIS. Ex. A-5/R-5, App. D; Vol. 8, Tr. 11/15/16 at 28:12-23, 45:2-47:7.
243. Dr. Hasinger testified that he personally consulted with various native Hawaiian practitioners throughout the CDUA process. Vol. 5, Tr. 10/27/16 at 81:18-83:9; 91:16-93:2.
244. Despite asking for more consultation in this process, Prof. Jonathan Osorio testified that building the telescope is a deal breaker and that in this situation, compromise is impossible because either the telescope will be built or it will not be built. Tr. 01/12/17 at 89:21-25, 116:20-25. Accordingly, no amount of consultation or mitigation would be satisfactory.
245. Spies testified that those opposed to the TMT Project will stand against any project on Mauna Kea no matter what. Vol. 25b, Tr. 01/12/17 at 179:24-180:2.
246. Prof. Johnson, witness for William Freitas, testified that he does not disagree with the CDUA's characterization of its goals to protect historic and cultural resources up to the point that it was published, but stated that the religious life of the mountain has been catalyzed, magnified and intensified since the time of the CDUA, which in his opinion, warrants review and revisions to the CDUA and the EIS with particular attention to consultation. Vol. 37, (Prof. Johnson) Tr. 02/16/17 at 17:1-17. Prof. Johnson testified that this contested case hearing is part of the consultation process and that he admires this process as a form of ongoing consultation. Vol. 37, (Prof. Johnson) Tr. 02/16/17 at 88:10-16.
247. Despite initially claiming that he was not consulted, Ching admitted during cross-examination that he was interviewed for the TMT Project. Vol. 31, Tr. 1/26/17 at 187:3-21, 226:24-227:20, 229:9-230:19, 238:15-240:10. The FEIS lists Ching as one of the individuals consulted and contains a written record of his views. Ex. A-5/R-5, App. D at A-5 (TMT EIS Vol. 3 at A-5). The CIA states that Ching was interviewed on three

separate occasions. Ex. A-5, App. D at 92. A full summary of the interviews with Ching is included as part of the CIA. Ex. A-5, App. D, § 7.13 at 169-71.

248. Nobriga testified that the Temple was never consulted about the TMT Project. However, comments captured in the TMT FEIS (Ex. A-4, Chapter 8) indicate that the Temple of Lono was consulted and a comment letter was received from Fergerstrom, who claimed to be the representative of the Temple, and considered as part of that cultural review process. Vol. 43, Tr. 3/1/17 at 23:1-14, 67:1-68:1; Ex. A-4, Chapter 8. Fergerstrom admitted that he was a member of the Temple and that the record speaks for itself as to whether the Temple was consulted. Vol. 28, Tr. 1/23/17 at 243:19-20.
249. Dr. Aluli Meyer testified that in her opinion, the University did its best in understanding and responding to cultural concerns, but ultimately did not make appropriate consultation efforts. Vol. 31, Tr. 1/26/17 at 34:1-35:2. Dr. Aluli Meyer testified that she had not read the CDUA and implied that she had not read any of the documents and studies related to the TMT Project. Vol. 31, Tr. 1/26/17 at 35:3-5.
250. Kanaele was extensively interviewed and consulted during the CIA process. Ex. A5, App. D, § 7.4 at 113-118. He testified that he read most of the FEIS, Kanaele was not aware that the CIA included a specific and separate section on his extensive interview and consultation. Vol. 44, Tr. 3/2/17 at 33:2-34:6.
251. Certain individuals, including parties to this proceeding, have actively boycotted the University's ongoing consultation efforts. For example, in 2015, the University held public open houses on the EISPN for the new master lease. Case, along with other members of the Flores-Case 'Ohana, Pisciotta, Ching, Ward, and Neves actively called for a boycott of the process. Ex. A-129; Vol. 25, Tr. 1/11/17 at 212:3- 219:22.

E. PROJECT DESCRIPTION

252. The TMT Observatory will be located in the 525-acre Astronomy Precinct within the MKSR on Mauna Kea. The Astronomy Precinct is already home to eight optical and/or infrared observatories and three submillimeter observatories. Ex. C-2 (WDT Dr. Sanders) at 2.
253. In 1964, an unpaved, 4-wheel drive Mauna Kea Access Jeep Trail was established to facilitate astronomy testing in the northwest slope area, and in particular at a location designated "13N." There are small foundations remaining on the site from that astronomical testing. Vol. 6, Tr. 10/31/16 at 132:10-133:6. The Mauna Kea Access Road extends near to the summit and loops along the Pu'u Kea, Pu'u Hau'oki, and an unnamed pu'u cinder cones to reach the existing observatories. The 4.6-mile segment of the Mauna Kea Access Road just past Hale Pōhaku is unpaved. The road is paved again above 11,600 feet. The existing observatories have mostly short paved or unpaved driveways off the main road. The unpaved SMA service roadways are the most extensive roads other than the main Mauna Kea Access Road. One branch of the SMA road extends toward Area E. Where the SMA road ends, the unpaved 4-wheel drive trail extends into and runs through the middle of Area E to the 13N site, where it ends. Ex. A-

1/R-1 at 3-4; Ex. A-3/R-3 at 3-165, 3-208 to 3-209.

254. Currently, utility services exist along the Mauna Kea Access Road Loop to a point near the intersection of the Mauna Kea Access Road Loop and the SMA building. There are electrical transformers at the Hale Pōhaku Substation, which is located approximately 2,000 feet southwest of the main headquarters building at Hale Pōhaku and about 1,000 feet from Mauna Kea Access Road. Utility lines run overhead from Saddle Road to near Hale Pōhaku and then underground from there to the summit area. There are conduits located approximately 50 feet west of the Mauna Kea Access Road for most of the distance to the summit area; one portion of the power line alignment follows a former access road alignment that is now within the NAR. Pull boxes are located approximately every 300 feet along the conduit. Ex. A-1/R-1 at 1-11 to 1-14; Ex. A-3/R-3 at 3-208 to 3-209.
255. The design guidelines from the Master Plan were conceptual and were incorporated into the design of the TMT Observatory. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 257:23-258:2. The proposed design for the TMT Observatory is based on balancing the technical requirements of the observatory and the goal of minimizing adverse impacts of the project. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 18:2-23:1, 258:8-262:5. The TMT Observatory design is therefore consistent with and in compliance with the 2000 Master Plan. Vol. 21, Tr. 01/04/17 at 14:2-10.
256. The TMT Project consists of the following components:
- a. **"TMT Observatory"** refers to the components of the TMT Project located at a site designated as "13N" within Area E on the upper elevations of Mauna Kea, but below the summit. The TMT Observatory generally consists of the 30-meter telescope, instruments, dome, attached building, and parking.
 - b. The **"Access Way"** refers to the road and other infrastructure improvements that will be provided to access and operate the TMT Observatory. Improvements in the Access Way will generally include a surface roadway and underground utilities.
 - c. **"Hale Pōhaku work"** refers to Hawai'i Electric and Light Company ("**HELCO**") upgrades to existing electrical transformers at the HELCO substation located near the University's Mid-Level Support Facility known as Hale Pōhaku. The new transformers will replace the existing ones on a 1:1 basis, and the fenced substation compound will not be expanded.
 - d. **"Headquarters"** refers to the facility located in Hilo to manage activities at and support operation of the TMT Observatory. This includes an office building with a parking area.

Ex. C-2 (WDT Dr. Sanders) at 1-2; Vol. 3, Tr. 10/25/16 at 132:13-133:17.

257. The TMT Observatory will be the first optical/infrared observatory of its size to integrate Adaptive Optics ("**AO**") into its original design. AO systems correct for the image

distortion that is caused by the atmosphere. The TMT AO system will project up to eight laser beams into the atmosphere to create an asterism, or group, of "guide stars" that are used to determine the atmospheric distortion of the visible and infrared light from distant objects and thus allow the telescope system to correct for it. The TMT AO system will generate each of these eight beams using a 25-watt laser; the laser light will appear yellow (0.589 microns – the sodium D2 line). The TMT AO system removes distortion caused by the atmosphere to create a very sharp image of celestial objects, allowing, for example, for highly accurate position measurements for moving objects. Ex. C-2 (WDT Dr. Sanders) at 4; (Dr. Sanders) Tr. 1/3/17 at 243:15-245:19.

258. The TMT Observatory dome housing the telescope will be a Calotte-type enclosure with the following characteristics: (1) total height of roughly 180 feet above the current ground surface, with an exterior radius of 108 feet; (2) the dome shutter will be 102.5 feet in diameter and it will retract inside the dome when opened; (3) the dome will rotate on two planes, a horizontal plane and a second plane at 32.5 degrees to the horizontal plane. By rotating on both planes simultaneously, the dome will allow viewing of the sky from vertical to roughly 25 degrees above the horizon; and (4) the Calotte dome base, cap, and shutter structures will appear rounded and smooth and have a reflective aluminum-like exterior coating. This reflective aluminum-like coating was chosen to minimize the visual impacts of the dome; throughout the majority of the day, this coating will reflect the surroundings of the TMT Observatory. Ex. C-2 (WDT Dr. Sanders) at 5; Vol. 3, Tr. 10/25/16 at 125:8-17, 133:21-134:3; Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 102:9-103:23. Ex. C-3.
259. The TMT dimensions complies with those set forth in the Master Plan because the 130 feet height limit in the Master Plan applies to facilities on the summit ridge, not the northwest slope in Area E. Vol.8, Tr. 11/15/16 at 196:6- 197:1; Ex. A-48 at XI-5.
260. The TMT design complies with the Master Plan because it calls for non-reflective to be used "as much as possible . . . to minimize glare and visibility from distant areas." Ex. A-48 at XI-6. As discussed above, TMT was designed to have a reflective coating in order to reduce visibility from distant areas. WDT White at 11; WDT Hayes at 20; Ex. A-3/R-3 at 3- 103; Ex. A-1/R-1 at 7-13; Tr. 10/25/16 at 125:8-17. Accordingly, the design is consistent with the 2000 Master Plan's objective of reducing visibility of structures on Mauna Kea.
261. A support building will be attached to the TMT Observatory dome. The building will have a roof area of approximately 21,000 square feet, a total interior floor area of roughly 18,000 square feet, a flat roof, and be lava-colored. The support building will include the following spaces: (1) mirror coating and staging area; (2) laboratory and shop spaces, including a computer room, engineering and electronics laboratories, and mechanical shop; (3) utility spaces including electrical services, chillers, a generator, pumps for fire suppression and other non-potable water needs, restrooms, and fluid dynamic bearing pumps that control the movement of the telescope; (4) administration space, including offices and a kitchenette; and (5) visitor and public spaces, consisting of a lobby, restroom, and viewing platform. Ex. C-2 (WDT Dr. Sanders) at 6.

262. A roughly 6,000 square foot exterior equipment area on the north side of the support building will include: two electrical transformers and electrical service switchboards; three 5,000-gallon underground storage tanks (one for water storage, one for domestic waste storage, and one double-walled for chemical waste storage); a 25,000-gallon underground storage tank for water storage as part of the fire suppression system; and one double-walled 2,000-gallon above-ground storage tank for diesel fuel to power the emergency generator. *Id.* at 6.
263. Up to 140 people will operate and maintain the Observatory. An average of 24 employees will work at the TMT Observatory during daytime operations, with a minimum of 15 persons and a maximum of 43 persons possible depending on activities. Fewer persons will be present at night. During darkness, typically 2 to 3 operators (but occasionally as many as 6) will be present at the TMT Observatory. Observers and support astronomers will view remotely from the Headquarters. All other members of the staff will work at the Headquarters. *Id.* at 11.
264. The parking area for TMT Observatory staff and delivery vehicles will be unpaved and located outside of the support facility. A guard rail will be placed along the top of the slope on the north and west sides of the graded area where there will be a drop-off. *Id.* at 7.
265. TIO does not anticipate constructing a construction camp. Workers will either be housed at Hale Pōhaku using the dormitories or transported from lower altitudes to the project site through a rideshare program. TIO anticipates that most of the construction workers will be local residents. (Dr. Sanders) Tr. 1/3/17 at 43:23-44:19.
266. The footprint of the TMT Observatory dome, support building, parking area, and area disturbed during construction will be roughly five acres. A half-acre portion of this has previously been disturbed by the existing 4-wheel drive road and site testing equipment; the original disturbance occurred during site testing in the 1960s, and site testing was also performed in this area for the TMT Project in the 2000s. Ex. C-2 (WDT Dr. Sanders) at 7. Additional areas (outside of the TMT Project site, the access way, and Hale Pōhaku) will be temporarily utilized for construction. Tr. 01/04/17 at 17:16-18:6; 36:3-15. The total construction acreage footprint for the TMT Project (including the TMT Project site, access way, Batch Plant, underground utilities, and use of the facilities at Hale Pōhaku) is approximately 12.5 acres. Tr. 01/04/17 at 50:11-51:3.
267. The deepest part of the foundation will be approximately 21 or 21.5 feet below the ground. Tr. 01/04/17 at 56:21-57:6.
268. The TMT Access Way will include a road and utility services to the TMT Observatory from existing services. Currently, utility services exist along the Mauna Kea Access Road Loop to a point near the intersection of the Mauna Kea Loop Road and the SMA road. The proposed Access Way will start at that point and extend to the TMT Observatory following either the existing 4-wheel drive road or the wider roads that serve the SMA facility. The Access Way that the TMT Project has proposed is limited to a single lane (reduced from a previous design of two lanes) over the southernmost portion

of the Access Way (i.e., the portion that crosses Pu‘u Hau‘oki and through the SMA); the remainder is two lanes. The vast majority of the Access Way route follows and goes over an existing single-lane, 4-wheel drive road that was previously developed for access to and testing of the 13N site in the 1960s. A portion of the route was graded during construction of the SMA facility as well. Construction will not require a widening of the access roads. Ex. C-2 (WDT Dr. Sanders) at 8; Tr. 10/25/16 at 134:4-135:8, 178; (Dr. Sanders) Tr. 1/3/17 at 46:21-25.

269. The switch boxes needed to extend electrical power and communication service to the TMT Observatory will be placed above ground next to the existing ones across the road from the SMA facility. To the extent possible, utilities from that point northward to the TMT Observatory site will be placed beneath the road to reduce the footprint of disturbance, with pull boxes located to the side of the road in already disturbed locations where possible. Ex. C-2 (WDT Dr. Sanders) at 8; Tr. 10/25/16 at 178:11-13.
270. Various elements have been incorporated into the Access Way design to minimize the visual impacts of the Access Way, including: (1) coloring the pavement of the Access Way so that it blends with the surrounding environment; (2) limiting the Access Way to a single lane in certain areas; and (3) minimizing the visual impacts of the Access Way guardrail so that it blends with the surrounding environment. Ex. C-2 (WDT Dr. Sanders) at 8.
271. Two transformers within the HELCO substation will be upgraded by the local electrical utility company. The HELCO substation is located across Mauna Kea Access Road from Hale Pōhaku. The new transformers will be placed in the same location as the existing transformers and the existing fenced substation compound will not be expanded. *Id.*; Tr. 10/25/16 at 135:16-136:4.
272. In addition, HELCO will upgrade the electrical service from the transformer compound near Hale Pōhaku to the existing utility boxes across the road from the SMA building to support the TMT Observatory’s power requirements. This will be done by removing the existing conducting wire and placing a new electric conducting wire in existing underground conduits. Ex. C-2 (WDT Dr. Sanders) at 8; *see also* Ex. A-3/R-3 at 2-26.
273. During construction, additional areas will temporarily be utilized and/or disturbed. Base yards required for the construction of the telescope and observatory will include the following:
 - a. Port Staging Area: An existing warehouse and/or yard near the port where the TMT Project components are received.
 - b. Batch Plant Staging Area: A roughly 4-acre area northwest of where the Mauna Kea Access Road forks near the summit that will primarily be used for storing bulk materials and a concrete batch plant, as this area has been used in the past during construction of other observatories.
 - c. TMT Observatory and Headquarters sites: The areas within the TMT Observatory and Headquarters sites not occupied by structures will also be

utilized as staging areas during construction of those facilities.

Id. at 10.

274. The CDUA for the TMT Project does not request subdivision approval, and UH Hilo does not intend to request or utilize subdivision of land as part of the Project. Ex. A-1; Ex. C-6 (WDT Callies) at 9.
275. TIO will pay rent as set forth in the TIO Sublease. Tr. 11/15/16 at 65:4-7; (Dr. Stone) Tr. 12/19/16 at 39:17-23; Ex. B.02f at 5-6.

F. THE UNIQUE COMBINATION OF CONDITIONS THAT MAKES MAUNA KEA A PREMIER LOCATION FOR ASTRONOMICAL OBSERVATORIES

276. TIO identified Mauna Kea as the preferred site for the TMT Observatory after an extensive worldwide study to evaluate potential locations. Mauna Kea was and remains TIO's preferred site for several reasons. Ex. C-2 (WDT Dr. Sanders) at 10.
277. Mauna Kea possesses a rare combination of many natural resources that, taken together, make it an outstanding location for astronomical research, including the TMT Project. Mauna Kea has:
- a. generally little to no cloud cover;
 - b. a stable atmosphere;
 - c. low mean temperature and temperature variability;
 - d. low humidity;
 - e. low light pollution; and
 - f. a location at a favorable latitude.

See WDT Dr. Hasinger at 1; Vol. 5, Tr. 10/27/16 at 88:15-89:13. Tr. 1/5/17 at 105:18-106:6.

278. In addition to its advantageous combination of natural resources, the presence of other astronomical facilities in close proximity creates the opportunity for many scientific synergies between the TMT Observatory and those facilities. Smaller optical/infrared observatories can provide observation targets for the TMT Observatory and carry out supporting science programs that do not require the large light-gathering power and fine diffraction limit of the TMT Observatory. Facilities that observe at radio wavelengths would also be able to provide targets for TMT observations and collect supporting complementary scientific information. These synergies increase productivity in conducting science when compared to a single observatory operating independently. Observatories that share common partners are more likely to collaborate and go to greater lengths to work together, including designing and installing complementary suites of

instruments on individual telescopes. *See* Vol. 5, Tr. 10/27/16 at 116:1-119:12.

G. THE SCIENTIFIC VALUE OF THE TMT OBSERVATORY

279. Astronomy is one of the oldest of the sciences and its contributions to humankind are immeasurable. Many benefits of astronomy impact our daily lives. Among its many contributions, astronomical research has been the basis of timekeeping, navigation, and climate science. For example, quantum mechanics, which is the basis for computers and electronics, was discovered in astronomy. The physics of climate change was originally discovered through observations of the atmosphere on Venus. Vol. 5, Tr. 10/27/16 at 18:8-19:4. Various tools developed for astronomical research have also been the basis of many "spin-off" technologies such as Global Positioning Satellite ("GPS") systems and transition bifocal lenses. *See* Vol. 5, Tr. 10/27/16 at 18:12-20:2, 341:13-21; WDT Dr. Hasinger at 4.
280. Observatories on Mauna Kea were involved in the majority of astronomical breakthroughs in the last 50 years. The yearly number of scientific publications from Mauna Kea observatories is greater than that from the Hubble Space Telescope or the European Southern Telescope. Observatories on Haleakalā are currently providing the world's best early-warning system for dangerous asteroids. TMT would be able to provide more detailed information about their orbits, composition, and ultimately the danger they pose. This would aid in predicting the path of the asteroid, and potentially aid in preventing an asteroid from impacting the Earth. Although there are telescopes planned for locations in the southern hemisphere that would have similar capabilities, those telescopes could not view asteroids approaching from the north, where TMT, being located in the northern hemisphere, could. WDT Dr. Hasinger at 3-4; Vol. 5, Tr. 10/27/16 at 29:4- 30:5; Vol. 22, Tr. 1/5/17 at 201:19-202:12.
281. Astronomy on Mauna Kea has also led to the Mauna Kea Weather Center ("MKWC"), which was originally created to provide excellent custom forecasts for the observatories. However, MKWC recently adapted its computer programs to predict the dispersion of vog from the Kilauea volcano. This is a valuable service to the Hawai'i community at no cost. WDT Dr. Hasinger at 4. Similarly, 20 years ago, the Mauna Kea observatories contributed \$2 million to help expedite the installation of fiber-optics communications infrastructure on Hawai'i Island, and today, astronomy is leading the big data efforts in the State. WDT Dr. Hasinger at 4.
282. Modern astronomy was a key component in the revival of Hawaiian navigation. Nainoa Thompson and others used modern celestial maps at the Bishop Museum to reconstruct the Hawaiian star lines. Vol. 5, Tr. 10/27/16 at 181:14-182:11.
283. Without the development of the TMT project, many of the services could lose funding that is necessary for continued availability. Vol. 5, Tr. 10/27/16 at 167-168.
284. The TMT Project will allow Hawai'i to maintain its leading position in generating new knowledge about the universe and help to produce a new generation of leaders in science, technology and education. WDT Dr. Hasinger at 1; Vol. 5, Tr. 10/27/16 at 16:3-11,

192:13-194:4.

285. The addition of TMT is needed because it has capabilities that are unique from the existing telescopes. Telescopes commonly work together like instruments in a symphony, and more often than not, multiple telescopes work in unison to produce scientific discoveries. In this context, the TMT "instrument" would be a new and unique addition to the "symphony" of telescopes on Mauna Kea, which will open a completely new area of discovery that could not otherwise be reached. Vol. 5, Tr. 10/27/16 at 15:18-16:2.
286. The light collection power of TMT's larger aperture will be about ten times bigger than that of the largest telescopes today. The size of the aperture, combined with the excellent atmospheric conditions above Mauna Kea will yield about ten times sharper images than the Hubble Space Telescope. The mirror on the James Webb space telescope is only 6.5 meters, and the angular resolution is inferior to that planned for TMT. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 73:10-19. With the larger aperture and higher resolution, the stars will be 81 times brighter at TMT than at Keck, which is currently the best in the world. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 8:9-9:2, 15:1-16:17. In other words, one night at TMT is equivalent to 81 nights at Keck. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 15:6-7.
287. TMT's advanced capabilities will allow it to observe any class of astronomical objects much further than current telescopes. TMT will be sensitive enough to see things formed billions of year ago that could never be seen using Keck. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 8:9-9:2, 14:15-15:25. TMT's reach will enable it to essentially look back in time, which will enable astronomers to answer fundamental questions regarding the origins of the universe. TMT will enable discoveries about the nature and origins of the physical world, from the first formation of galaxies in the distant past and distant regions of the Universe to the formation of planets and planetary systems today in our Milky Way Galaxy. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 15:23-16:6. TMT may also aid in the quest to find and study Earth-like planets. WDT Dr. Hasinger at 2.
288. The United States has been the leader in astronomy research for the last 150 years, and locating the TMT Observatory in Hawai'i will maintain the nation's leadership in astronomy research, discovery, and innovation. For the past forty years, the State of Hawai'i, the University, and Mauna Kea have been at the forefront of terrestrial astronomy. The TMT Observatory will help to maintain this leadership by leveraging the capacity of the existing observatories on Mauna Kea, including the Keck Observatory, Subaru and the CFHT. The University will have approximately 7.5% of the observing time at TMT. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 45:12-17. While these observatories are world-leading observatories today, their future scientific productivity will be enhanced by co-location with a next generation observatory, such as the TMT Observatory. Ex. C-1 at 3; A-70.
289. Certain Petitioners and Opposing Intervenors dispute the scientific value or tangible benefits of the TMT Observatory. Petitioner Kealoha Pisciotta describes her history with Mauna Kea as three-fold: "I have a history of cultural and religious practice, I worked for the observatories for more than 12 years and I have been advocating for greater

protections of Mauna Kea for more than a decade." WDT of Ms. K. Kealoha Pisciotta, Ex. B.01a.

290. Pisciotta testified that in her opinion the benefits of astronomy are purely academic and the knowledge gained from astronomy will do nothing to change the lives of the people of Hawai'i. Ex. B.01a (WDT Pisciotta) at 5-6. Pisciotta opined that astronomy is not solving the cure for hunger, cancer or HIV, protecting our biodiversity by protecting rare, threatened or endangered species, providing people with clean water, reducing our energy consumption or inventing new forms of energy. WDT Pisciotta at 6.

H. ECONOMIC BENEFITS OF THE TMT OBSERVATORY

291. Astronomy has historically been an economic driver to the local community, as well as the state. After the devastating tsunami of 1960, the observatory on Mauna Kea and the IfA were founded with the explicit goal of producing educational opportunities to Hawai'i students, and to promote economic growth. A study by the University of Hawai'i Economic Research Organization ("**UHERO**") shows that in 2012 alone, astronomy had a total economic impact of \$168 million (with approximately \$91 million attributed to Hawai'i County), a job creation impact of 1,400, and generated State taxes of \$8.2 million. The TMT project will further contribute to these economic benefits. WDT Dr. Hasinger at 3; Ex. A-33 at 3.
292. Astronomy provides close to 1,000 quality jobs in clean high-tech activities that offer employment opportunities in science, technology, engineering, and mathematics ("**STEM**") fields to local youth. These opportunities are not limited to astronomers, as most jobs are technical and administrative. The workforce currently has more than 50% local employees, but efforts are being made to increase this number because it is much better and more efficient to hire local residents instead of mainland residents, who typically leave after a few years of employment. WDT Dr. Hasinger at 4; Vol. 5, Tr. 10/27/16 at 17:1-16, 390:16-391:9.
293. Additionally, astronomy has resulted in spin-off industries. For example, IfA innovation has spun off new Hawai'i businesses working in remote sensing and new technologies for solar power. Vol. 5, Tr. 10/27/16 at 19:11-13.
294. In addition to paying rent as set forth in the TIO Sublease, a staff of up to 140 employees is planned to work on the TMT Project in Hawai'i during operations. Many of the positions require specialized skills in computing, optical-mechanical engineering, and other technical areas. The availability of a local workforce with the requisite skills is a very strong plus for a site. The unique technical systems that comprise the Observatory make it desirable to have long-term employees. Thus, locating the TMT Observatory on Mauna Kea is favored in that the availability of housing, quality schools and medical care, and opportunities for spousal employment are important factors in attracting and retaining long-term employees. Ex. C-2 (WDT Dr. Sanders) at 11.

I. TMT PROJECT CONSTRUCTION ACTIVITIES

295. The TMT Observatory construction crew will average 50 to 60 crew members through

the life of construction; during certain phases, a crew of more than 100 will be working at the site. Construction is expected to take place six days a week, 10 hours a day; however, some special operations or construction phases will require longer work hours. It is also expected that winter weather conditions at the TMT Observatory site will interrupt construction at times. Ex. C-2 (WDT Dr. Sanders) at 11.

296. During construction of the TMT Project, as it has been used in the past for the construction of other observatories, the Batch Plant Staging Area will be used primarily for storing bulk materials and as a concrete batch plant. Roughly four acres of the Batch Plant Staging Area will be used by TMT construction activities. TMT construction activities at the Batch Plant will be done in compliance with all existing laws and regulations. Upon completion of construction of the TMT Observatory, the Batch Plant Staging Area will be partially restored. *Id.* at 10; Vol. 3, Tr. 10/25/16 at 136:5-24; Ex. A-1/R-1 at 1-13.
297. During all operations with heavy equipment, the TMT construction manager will monitor the weather and decide when any shutdowns will be necessary. Vol. 21, Tr. 01/04/17 at 35:19- 36:2. Crane operators will monitor all safety procedures and will be trained on proper operating methods. Vol. 21, Tr. 01/04/17 at 36:2-42:24.
298. Tests will then be conducted and adjustments to the telescope and instruments made for a period of time to gain optimum efficiency and viewing. Ex. C-2 (WDT Dr. Sanders) at 11. The first scientific results using the TMT Observatory are expected, at the earliest, in 2024. During the life of the TMT Observatory, astronomical observations will be made by scientists from around the world.
299. No explosives will be used and no blasting will be done to construct the TMT Project. Vol. 21, Vol. 21, Tr. 01/04/17 at 45:2-6.

J. EDUCATIONAL AND EMPLOYMENT OPPORTUNITIES

i. The Need for Educational Opportunities

300. The creation of educational and employment opportunities is an important and relevant factor in considering the CDUA permit.
301. PUEO was formed by native Hawaiians who support the pursuit of educational opportunities for the children of Hawai'i. They intervened in this contested case proceeding to express their views that the TMT Project will greatly enhance the educational opportunities for Hawai'i's children. WDT Ha at 1-3; Tr. 2/15/17 at 196:3-197:25; Tr. 2/21/16 at 161:12-22, 21:12-15.
302. The testimony of PUEO members established that there is a need for educational opportunities in Hawai'i, specifically on Hawai'i Island. Warfield, the president of PUEO, testified as to his substantial experience working with children on Hawai'i Island through public outreach programs. Warfield's testimony evidenced the lack of educational opportunities for children on Hawai'i Island. WDT Warfield at 1; Vol. 36, Tr. 2/15/17 at 207:8-17, 214:3-215:14. Warfield also spoke of instances where native

Hawaiian children have expressed interest in astronomy, but were discouraged from pursuing this interest due to a lack of educational opportunities, as well as a lack of support from the local community. Vol. 36, Tr. 2/15/17 at 200:13-202:11, 230:14-231:3, Vol. 38, Tr. 2/21/17 at 260:4-261:15. PUEO's goal is to protect and foster such interest through educational opportunities, such as those provided by the TMT Project. WDT Warfield at 1; Vol. 36, Tr. 2/15/17 at 200:13-202:11.

303. Warfield testified that Hawaiian culture and modern science can co-exist, as evidenced by his current efforts in the community. Warfield works to provide educational opportunities on Hawai'i Island, while at the same time fostering positive self-esteem and cultural identity in native Hawaiian children. WDT Warfield at 1.
304. PUEO members Richard Ha, Elroy Osorio, and Brown, also testified as to the need for educational opportunities in Hawai'i. Collectively, they assert that if TMT is not built, educational opportunities may be lost, thereby injuring the children of Hawai'i. WDT Ha at 1-3; WDT E. Osorio at 1-3; WDT W. Brown at 1-3; Vol. 38, Tr. 2/21/17 at 162:10-14, 179:9-15; 242:24-243:22.
305. PUEO Members support the TMT Project and its potential educational and community benefits, despite backlash from those who oppose the TMT Project. *See* Ex. C-48; Vol. 38, Tr. 2/21/17 at 210:17-212:12.
306. The testimony of PUEO members supports the idea that the TMT Project will present educational opportunities for the children of Hawai'i. Additionally, the testimony of PUEO members established that there are native Hawaiian children who are interested in the field of astronomy, but who lack the resources and support to pursue such interests.

ii. Native Hawaiians and Astronomy

307. King David Kalākaua was deeply interested in astronomy. During his trip around the world in 1881, he visited the site of the first permanently occupied mountaintop astronomical observatory, the Lick Observatory on Mount Hamilton, in California, which was under construction. Earlier, in 1880, he had written to Captain R. S. Floyd, President of Lick Trustees, "I must thank you sincerely for the pamphlet you sent me of the 'Lick Observatory Trust.' Something of this kind is needed here very much but we have so few people who take interest in scientific matters..." Ex. A-7 at p. 54.

King Kalākaua also wrote: "It will afford me unfeigned satisfaction if my kingdom can add its quota toward the successful accomplishment of the most important astronomical observation of the present century and assist, however humbly, the enlightened nations of the earth in these costly enterprises." Ex. A-48 (2000 MKSR Master Plan, cover)

308. Paul Coleman ("**Dr. Coleman**") is a native Hawaiian who holds a Ph.D. in Physics. He was called as a witness by TIO. Here is Dr. Coleman's story:

"My Hawaiian 'ohana comes from three main groups who were in Kohala, Hawai'i; Makua and Kahana, O'ahu; and Ka'anapali, Maui. If we follow my maternal line, we can trace back to Mele Makini (4th great tutu) who was related to Kalakaua and

Liliuokalani. Coincidentally, she married the Chinese entrepreneur and businessman Hu Pak Sing, who for a time owned one of the sugar mills on Hawai'i, owned the ahupua'a containing Kahana valley, and was the first association president of the Manoa Chinese Cemetery. As an astrophysicist who specializes in cosmology, this connection to the Kalakaua line afforded to me through tutu Mele, connects me to the Kumulipo and therefore back to the Big Bang! So for me, using the TMT which will allow us to look back in time as far as possible, is in the Hawaiian sense, literally investigating my ancestors.

When I graduated from St. Louis High School, there were two things I wanted to do – play football and study theoretical general relativity – the physics that Einstein invented. I knew that I would have to say goodbye to Hawai'i as there was no option to do both here at the level I wanted. I went to the University of Notre Dame to accomplish both those goals.

I graduated with a BS in physics and a few broken fingers. Notre Dame won two national championships in football while I was there (no thanks to me). Next, I applied to the graduate program at the University of Pittsburgh where one of the true geniuses of Relativity (Professor Ezra "Ted" Newman) was a faculty member. He advised me that since I was a Hawaiian, perhaps I could shift my interests slightly to astrophysics and physical cosmology. He knew that new telescopes were being built on Maunakea and thought that this might give me the chance to go back home. He also confided in me that if he were just starting out in physics, as I was, he would do exactly this. Ted is one of the smartest men I have ever met – so of course I took his advice.

After earning my PhD in physics, I began applying for jobs back home in Hawai'i. The Institute for Astronomy was moving along and becoming one of the best astronomy institutes in the world – this meant that I would have to do pretty well also in order to be considered for any jobs back home. There were six telescopes on Maunakea at that time and one of them (the James Clerk Maxwell Telescope – JCMT) was the only telescope in the world which could answer a problem in extragalactic astrophysics that I was interested in. Access to telescopes on Maunakea depends on your affiliation. If you are a member of an institute which has guaranteed time, you may apply for that time. You will, of course, have to beat the competition by having a highly rated observing proposal.

I didn't get either of the jobs I applied for in Hawai'i back then, but I was hired as an Institute Postdoc at the University of Groningen in the Netherlands. What was originally supposed to be only a 2 year job turned into a permanent position which I left after 8 years. During those years, I unsuccessfully applied for jobs in Hawai'i many, many times. As the years went by, my record of my work and experience, papers published, etc. got better and better.

Fortunately, the Netherlands is one of the partner countries in the UK telescopes on Maunakea which meant that I could also apply for time for those telescopes. I used to joke that I had to go almost to the other side of the Earth in order to be able to use the telescopes in Hawai'i because the competition for telescope time was so tough. Since coming home to the IfA, the competition has gotten much less. I only have to compete

with the 40 plus astronomers here for telescope time – instead of the thousands in the rest of the world. Every second of time on Maunakea is used and I find it almost laughable when I hear people say that we don't use the time allocated for us. If they only knew how precious telescope time is on Maunakea (with typical oversubscription factors of five to ten – meaning that as many as ten different projects are applying for the same time on the telescope that you are)." WDT of Paul Coleman, pages 1-2; Ex. C-17, pages 1-2.

309. Dr. Coleman testified that he is aware of only four native Hawaiians in the world who currently hold astronomy degrees. Vol. 22, Tr. 1/5/17 at 97, 126:10-11. The TMT Project will allow the University to continue its astronomy outreach and teaching efforts, and aid in the quest to produce "home grown" astronomers. Ex. C-17 at 3.
310. The effort to produce "home grown" astronomers is important because astronomy is an essential part of the identity of the Hawaiian people. In fact, the defining characteristic of a Hawaiian is rooted in astronomy. The mastery of astronomy, and its application – long distance voyaging – is what separates Hawaiians from their Polynesian brothers and sisters. Embracing modern astronomy would represent Hawaiians coming full circle from being masters of astronomy in the past, to being masters of astronomy in the future. In Dr. Coleman's words: "I find this very appealing since I know that the defining characteristic of a Hawaiian is astronomy. Our mastery of astronomy, and its application – long distance voyaging – is the one thing that separates us Hawaiians from our other Polynesian brothers. It represents coming full circle from being masters of astronomy in the past to being the masters of astronomy in the future." Ex. C-17 at 3; Vol. 22, Tr. 1/5/17 at 92:10-17.
311. Outreach programs have been implemented by the observatory operators, including TIO, that are particularly effective in sparking interest in Hawai'i's youth for all types of STEM-related fields, not just astronomy. Every year the Journey Through the Universe program, a national program that focuses on science as a human endeavor, reaches over 7,000 elementary, middle, and high school students and is now well into its second decade. The HI-Star program trains local high school kids to participate in science fairs and go on to university careers in STEM fields. HI-Star alumni have received almost half a million dollars in prized fellowships and stipends, and have won local and national science fairs. The Akamai program provides internships, many of them for Native Hawaiians, in observatories and high-tech companies for jobs not just in astronomy, but across many industries. The Akamai program is designed to allow people to gain experience with different companies and different jobs. Vol. 5, Tr. 10/27/16 at 69:21-70:7. Akamai has a retention rate of close to 80% in STEM jobs, meaning 80% of the students are actually gaining employment at places where they apply. Vol. 5, Tr. 10/27/16 at 13:19-23.
312. The astronomy programs in the University System (undergraduate and graduate) are some of the finest and most attractive in the country. WDT Dr. Hasinger at 4-5; Tr. 10/27/16 at 12:2-14:4. University students currently have access to several of the existing telescopes on Mauna Kea. Tr. 01/12/17 at 55:15-20. The observatories recently added another element which is the Mauna Kea Scholars Program, where high school and middle school students can get viewing time on the telescopes for their projects. Tr.

10/27/16 at 12:25-13:3.

313. The University currently incorporates elements of Hawaiian navigation and astronomy into its outreach efforts. Tr. 10/27/16 at 110:7-111:21.
314. Heather Kaluna ("**Dr. Kaluna**"), a witness called by TIO, is a Native Hawaiian from the Big Island of Hawai'i who received her Ph.D in Astronomy in 2015. Here is her story:

"In 2002, I graduated from Pahoa High School and spent my first semester of college at the University of Hawai'i Manoa in the fall of 2002. After taking a pair of astronomy and physics courses that semester, I immediately fell in love with astronomy decided to pursue the astronomy degree at the University of Hawai'i at Hilo (which was the only place in the islands that offered an undergraduate degree at that time), and transferred the next semester. During my time at UH Hilo, I was an intern for the Panoramic Survey Telescope and Rapid Response System (PanSTARRS) project and was tasked with leading public outreach efforts and educating the community about near-Earth asteroids. In the summer of 2007, I was also an Akamai intern at the University of California, Santa Cruz where I investigated far away galaxies and their companions. I also served as an intern under Dr. Marianne Takamiya for the Keaholoa STEM program, and studied the structures of galaxies. The Keaholoa STEM program was designed to provide research and training opportunities for minority students and also educated participants on local cultural perspectives. I received my Bachelors of Arts in Physics and Mathematics in the spring of 2008.

In 2008, I was accepted into the astronomy program at UH Manoa (IfA), where I spent seven years studying water on asteroids and trying to understand a possible source of Earth's water. Having such a strong connection to the ocean, I was very passionate about studying the evolution of water in our solar system. As a graduate student I conducted many observations using the UH 2.2m, Subaru, Keck, Gemini and IRTF telescopes. I applied for and utilized time that was appropriated to UH by each of the observatories. I completed my dissertation and received my PhD in 2015. I am now in a post-doctoral fellow at the Hawai'i Institute of Geophysics and Planetology. I am working with Paul Lucey on research conducted with the AEOS telescope on Haleakalā as well as data collected with NASA's Dawn spacecraft of the asteroids Vesta and Ceres." WDT of Dr. Heather Kaluna, page 1; Ex. C-8, page 1.

i. Community Benefits Package

315. The TMT Project has committed to a Community Benefits Package ("**CBP**"). A portion of the CBP funding commenced in 2014 upon the start of the TMT Project construction and was committed to continue throughout the TMT Observatory's presence, so long as the original CDUP was not invalidated or construction was not stayed by court order. However, even though the original CDUP has been invalidated, TIO has continued the CBP. As part of the CBP, TIO has provided \$1 million annually during such period to the THINK Fund; the dollar amount is adjusted annually using an appropriate inflation index. The funding is divided; \$750,000 is distributed through the Hawai'i Community Foundation and \$250,000 through the Pauahi Foundation. To date, TIO has remitted

\$630,000 to the Pauahi Foundation, and \$1.8 million to the Hawai‘i Community Foundation, a total of approximately \$2.5 million. Ex. C-2 (WDT Dr. Sanders) at 13-14.

316. The \$2.5 million remitted to date has funded over sixty scholarships and \$100,000 in small grants for classroom projects for twenty-seven classrooms. The THINK Fund was the originator and initial contributor to the STEM Grant Learning Partnership program, giving \$400,000 in the first two years for this endeavor. Programs supported focus on key elements of building a strong STEM education system. Education initiatives are focused on K-5, 6-8, 9-12, and college. The program includes support for students to visit Imiloa Astronomy Center and the Mauna Kea observatories. *Id.* at 14. The CBP addresses concerns regarding providing educational opportunities and lack of resources, which were expressed by some members of the Native Hawaiian community. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 214:15-23.
317. The CBP helps to reduce the impact to cultural resources at the project site because it provides an understanding to the community about the values of Mauna Kea and science. Vol. 12, (Nees) Tr. 12/05/16 at 22:20-23:15.
318. The Hawai‘i Community Foundation and the Pauahi Foundation decide which local organizations receive THINK Fund monies. TIO does not make this decision. Vol. 36, Tr. 2/15/17 at 237:2-8; Vol. 20, Tr. 1/3/16 at 58:8-11.

iv. Workforce Pipeline Program

319. The TMT Project is committed to partnering with UH Hilo, Hawai‘i Community College ("**HawCC**"), and the Department of Education ("**DOE**") to help develop, implement, and sustain a comprehensive, proactive, results-oriented Workforce Pipeline Program ("**WPP**") that will lead to a highly qualified pool of local workers who could be considered for hiring into most job classes and salary levels. Special emphasis will be given to those programs aimed at preparing local residents for science, engineering, and technical positions commanding higher wages. Therefore, there will be a significant component in the WPP for higher education on the Island of Hawai‘i. Ex. C-2 (WDT Dr. Sanders) at 14.
320. In addition, the TMT Project is participating in a County of Hawai‘i Workforce Investment Board initiative with the Mauna Kea Observatories. The purpose of this initiative is to explore opportunities for marshaling existing community resources to introduce focused programs within the Hawai‘i Island community to provide the observatories with a broader and stronger qualified local labor pool, as candidates for careers in the local astronomy enterprise. *Id.*
321. Key elements of the WPP include:
 - (1) initiation of a TMT Project workforce committee including members from UH Hilo, HawCC, DOE, and Hawai‘i Island workforce development groups;
 - (2) identification of specific TMT Project job requirements that UH Hilo, HawCC, and DOE can use to create education and training programs, and ongoing support

for the identified programs;

- (3) earmarking of funds in the TMT Project's annual operations budget which can be used to support workforce development programs at suitable educational institutions;
- (4) TMT Project support for development and implementation of education and training programs, including at least 4 internships per semester, apprenticeships, and at least 10 summer jobs for students;
- (5) creation of a partnership between UH Hilo and the TMT Project's partner organizations, such as Caltech, the University of California system, and Canadian universities to attract and develop top talent;
- (6) support of, and active participation in, ongoing efforts to strengthen STEM education in Hawai'i Island K-12 schools and informal learning organizations; and
- (7) focusing the WPP program on long-term investments to strengthen the current STEM skills infrastructure, programs, and curricula at UH Hilo, HawCC, and Big Island K-12 education organizations, especially those serving lower income and first-generation college attending populations.

Id. at 13-14.

K. TMT PROJECT MITIGATION MEASURES

322. Mitigation of impacts has been a fundamental component of the TMT Project from its inception and at all times thereafter. The TMT Project has already implemented and is committed to implementing a number of measures that are intended to mitigate the impacts of the Project. A comprehensive recitation of these measures can be found in the TMT FEIS, TMT CDUA and TMT Management Plan appended to the CDUA. Exs. A-1/R-1, A-3/R-3, A-4/R-4 and A-5/R-5.
323. The use of mitigation measures is a universally recognized and widely adopted means of lessening otherwise adverse impacts in land use projects. Ex. C-6 (WDT Callies) at 8.
324. The TMT Observatory has been sited at the 13N site, within Area E, north of and below the summit ridge. One of the principal reasons this location was chosen is to mitigate impacts on cultural and historic resources, viewplanes, and biological resources. As a direct result of locating the TMT Observatory at its chosen site, and although the TMT Observatory will be the largest dome and tallest built on Mauna Kea, as well as a new visual impact on the Northern Plateau, it: (1) will not be visible from culturally sensitive locations, such as the summit of Kūkahau'ula, Lake Waiau, and Pu'u Līlīnoe; (2) is more than 200 feet from known historic properties; (3) will not be visible from Hilo and the southern portion of Hawai'i Island, including the Kona areas; and (4) is outside of the wēkiu bug's preferred habitat. Ex. C-2 (WDT Dr. Sanders) at 15; Vol. 21, Tr. 01/04/17 at 79:3-13; WDT Nagata at 9-10; Ex. A-48 at IX-37 to IX-39; Ex. A-68; Ex. A-69; Vol.

14, (Nagata) Tr. 12/8/16 at 34:24-35:4. Open space on the Northern Plateau would largely be preserved. Vol. 21, Tr. 01/04/17 at 79:14-80:12.

325. Petitioners contend that the location of the TMT Project on the Northern Plateau should not be considered a mitigation measure. *See, e.g.*, Ex. B.02a at 15-17; Ex. B.01a at 16; Ex. B.13a at 4; Vol. 24, Tr. 1/10/17 at 41:1-21; Vol. 27, Tr. 1/19/17 at 226:9-226:13, 226:9-226:13; Vol. 31, Tr. 1/26/17 at 138:3-19; Vol. 32, (Flores) Tr. 1/30/17 at 86:3-87:8.
326. Candace Lei Fujikane ("**Prof. Fujikane**"), a witness called by KAHEA, is an Associate Professor of English at the University of Hawai'i at Mānoa where she has taught since 1995. Here is her story:

"I received a BA in English from UH Mānoa in 1990, and a Ph.D. in English from UC Berkeley in 1996. I am the Cultural Studies Concentration Advisor for the UH English Graduate Program, and I teach undergraduate and graduate foundations courses in literary and cultural studies, as well as classes on the literatures and mo'olelo (stories/histories) of Hawai'i, land struggles in Hawai'i and indigenous and critical cartography in Hawai'i. As an English professor, I teach the mo'olelo of Mauna a Wākea in my undergraduate courses and graduate seminars on the literatures of Hawai'i and literary and cultural studies. We trace the English translations back to the original Hawaiian texts in 'ōlelo Hawai'i, comparing the different versions and mapping them on the land.

I have published work on the mo'olelo (stories/histories) of Māui in Wai'anae, and my book manuscript examines indigenous and critical cartography in Hawai'i. I have been a board member of KAHEA: The Hawaiian Environmental Alliance since 2012.

I am also a member of Huaka'i i Nā 'Āina Mauna, a group led by Clarence Kūkauakahi Ching that has been walking the mountain lands since 2003. I have walked with Kū and others on the ancient kuamo'o (trails) of Mauna a Wākea since 2012. We have followed the path of Kāneikawaiola on Mauna a Wākea from Waiau down to the springs of Houpokāne, Waihūakāne, and Lilinoe, and we have walked Pōhakuloa at Pu'u Ke'eke'e where the other springs Waiki'i, Anaohiku, and Kīpahe'ewai are said to have spread out from Mauna a Wākea to Hualalai, all the lands connected by the waters of Mauna a Wākea. This continuous path of water is recorded in the mo'olelo of Kamiki. We have walked the 'Umikoa-Ka'ula Trail from Pu'u Līlinoe to Pu'u Mākanaka, walking on the lands between Pu'u Poepoe, Pu'u Ala, Pu'u Hoaka, and Pu'u Māhoe. We have walked to the rim of Pu'u Kanakaleonui. We have also walked across the northern plateau, the proposed site of the TMT." WDT of Candace Fujikane, page 1. Ex. B.13a., page 1.

327. Prof. Fujikane opined that locating the TMT Project on the Northern Plateau should not be considered a mitigation measure because there was no room for the TMT Project on the summit anyway. Vol. 23, Tr. 1/9/17 at 225:25- 226:7.
328. Hayes testified that the TMT Project could have been considered for the summit. *See* Vol. 3, Tr. 10/25/16 at 209:21- 210:7. Further, the Master Plan specified Area E as a preferred location for a next generation large telescope because of the minimum impact on existing facilities, wēkiu bug habitat, archaeological sites, and viewplanes while

providing suitable observation viewing conditions. Ex. C-2 (WDT Dr. Sanders) at 4.

329. Applicants assert that the Project location on the Northern Plateau was chosen in large part to avoid the most culturally sensitive areas of the summit ridge region, and supports the finding that the location of the TMT Project was intended to be, and is, a significant mitigation measure. Ex. C-2 (WDT Dr. Sanders) at 15; WDT Nagata at 9-10; Ex. A-48 at IX-37 to IX-39.

330. The TMT Access Way's physical and visual impacts have been directly mitigated by:

- (1) designing the Access Way to reduce the potential for both physical and visual impacts to the historic properties and potential impacts to natural resources known to be in the vicinity;
- (2) limiting the southern 750-foot long portion of the Access Way to a single lane even though such a configuration is not desirable from an operational standpoint;
- (3) aligning most of the Access Way to follow an existing single-lane, 4-wheel drive road that was built in the 1960s for access and testing of the 13N site;
- (4) paving the portion of the Access Way within the boundaries of Kūkahau'ula on the flank of Pu'u Hau'oki to reduce dust;
- (5) coloring the pavement and guardrail a reddish color that blends with the surrounding area; and
- (6) placing the utilities to the TMT Observatory within the Access Way and beneath the paved roadway instead of on a different or parallel alignment that would cause more ground disturbance.

Ex. C-2 (WDT Dr. Sanders) at 15-16; Vol. 3, Vol. 3, Tr. 10/25/16 at 134:4-135:8; Ex. C-3.

331. The option selected for the placement of the TMT Access Way was the one recommended by SHPD of the DLNR to minimize adverse effects on Kūkahau'ula. Page 3-9 of Ex. B to Ex. A-1/R-1.

332. The TMT Observatory has been designed to mitigate its visual impact by:

- (1) reducing the size of the dome through the use of a Calotte-type dome;
- (2) designing the telescope to be much shorter than usual given its mirror size;
- (3) designing the dome to fit very tightly around the telescope;
- (4) finishing the dome with a reflective aluminum-like surface, which during the day reflects the sky and reduces the visibility of the structure; and
- (5) finishing the support building and fixed structure exterior with a lava color.

- Ex. C-2 (WDT Dr. Sanders) at 19-21; Vol. 3, Tr. 10/25/16 at 124:24-125:17, 133:5-134:3.
333. While the design mitigation measures reduce certain costs, they also increase both cost and technical risk in other areas. The mitigation measures also will make maintenance of the observatory more difficult. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 70:11-71:16. For example, if the TMT telescope used the same f/1.75 design as the Keck Observatory, then the dome would be 256 ft. high and 261 ft. wide. To reduce the dome size, TMT will use an f/1 design so that the telescope will be shorter. Such a design requires more expensive mirrors, is harder to maintain, and creates more technical risk. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 18:2-19:25. The result is a dome that is 180 feet high. For reference, the Magellan Telescope, which has a smaller mirror measuring 24 meters in diameter, is 200 ft. high. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 21:24- 22:5; Ex. C-23.
334. The TMT Project will camouflage certain HELCO electrical pull-boxes and other utility boxes that are visually distracting or intrusive at the summit of Mauna Kea and other key locations visible from other portions of Kūkahau‘ūla. The method of camouflage will be determined through consultation with Kahu Kū Mauna and may include one of the following options: (1) painting the covers to match the surrounding natural colors; and (2) affixing stones and cinders from the vicinity to the exposed utility box. Ex. C-2 (WDT Dr. Sanders) at 17; Page A-9 of App. A of Exhibit B to Ex. A-1/R-1.
335. A zero-discharge self-contained wastewater system will be installed at the TMT Observatory. All wastewater generated at the TMT Observatory will be transported off-site to an approved treatment facility for treatment and disposal. The discharge of wastewater within the summit region has been identified as an impact on cultural resources and is one of the reasons for this mitigation measure. Ex. C-2 (WDT Dr. Sanders) at 21.
336. There will be three 5,000-gallon Underground Storage Tanks ("UST") to the northwest of the support building; one each for potable water, wastewater and chemical waste. There will also be a 25,000-gallon UST for fire suppression, and an above ground tank for diesel fuel for the emergency generators. Vol. 21, Tr. 01/04/17 at 84:8-15.
337. The TMT Project will install water efficient fixtures and implement water saving practices to reduce the demand for freshwater resources. Ex. C-2 (WDT Dr. Sanders) at 22.
338. The TMT Project, including its USTs, is designed to survive conceivable seismic disturbances. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 79:10-15.
339. The TMT Project will implement a Waste Minimization Plan ("WMP") and institute an annual WMP audit, which will include an examination of: (1) waste produced by the TMT Project and how that waste could be reduced, reused, or recycled; (2) water use by the TMT Project and how that use could be reduced; and (3) energy use by the TMT Project and how that could be reduced. Ex. C-2 (WDT Dr. Sanders) at 22.
340. The TMT Project will recycle solid and non-hazardous waste materials and reuse them to

the extent possible. *Id.*

341. The TMT Project will implement a Materials Storage/Waste Management Plan, including a Spill Prevention and Response Plan. This plan will require: (1) daily inspections of equipment handling hazardous materials; (2) mandatory training of all personnel handling hazardous materials and wastes; (3) regular inspections by a Safety and Health Officer; (4) that all solid waste be collected in secured and covered storage containers; and (5) that all waste be transported down the mountain for proper disposal at an off-site facility. *Id.*
342. The TMT Project will implement a mandatory Ride-Sharing Program for TMT Observatory employees to travel beyond Hale Pōhaku. Ex. A-1/R-1 at 4-25. This program will reduce the number of vehicle trips to the summit and, in turn, will also reduce the amount of noise and dust generated by vehicles. Ex. A-1/R-1 at Table 2.1, pp. 4-25 to 4-26.
343. At the conclusion of construction of the TMT Observatory, a portion of the Batch Plant Staging Area will be restored. Page A-9 of App. A to Ex. B of Ex. A-1/R-1; Vol. 12, (Nees) Tr. 12/05/16 at 62:10-15.
344. The TMT Project will fund the restoration of the closed access road on Pu‘u Poli‘ahu in accordance with plans already submitted by the IfA and approved by the DLNR. Ex. C-2 (WDT Dr. Sanders) at 16-17; Page A-9 of App. A to Ex. B of Ex. A-1/R-1.
345. The TMT Project will support, through financial contributions and utilization of its outreach office, the development of educational exhibits related to Mauna Kea. The exhibits will: (1) be developed in coordination with OMKM and UH Hilo’s ‘Imiloa Astronomy Center (“**Imiloa**”); (2) address the cultural, natural, and historic resources of Mauna Kea; (3) be developed for use at the Mauna Kea Visitor Information Station (“**VIS**”), ‘Imiloa, TMT Project facilities, and other appropriate locations; and (4) include informational materials that explore the connection between Hawaiian culture and astronomy. Ex. C-2 (WDT Dr. Sanders) at 16
346. The CMP requires that all users on the mountain receive an orientation prior to going up the mountain for the first time and MKMB policy requires that all users receive that orientation at least every three years. Vol. 13, Tr. 12/6/16 at 88:13-90:7. Since the orientation began in 2013, 1,537 people have attended the orientation and, beginning in 2016, those who took the orientation in 2013 have begun their renewal process. Ex. A-22. The current focus is to incorporate contractors and vendors and ensure all observatory staff have taken the orientation within the past three years. WDT Klasner at 7.
347. The TMT Project will institute a Cultural and Natural Resources Training Program that all TMT Project staff and all construction workers will be required to attend annually. The training is approximately 1-hour and is considered sufficient to convey a sense of the need to be respectful to cultural and natural resources. Vol. 21, Tr. 01/04/17 at 63:14-22; 65:25- 66:5. The content of the training program will be determined by OMKM. The

program is intended to educate attendees on the sensitive natural, cultural, archaeological, and historic resources of Mauna Kea, the cultural practices exercised on Mauna Kea, and the measures to prevent potential impact to such resources. Ex. C-2 (WDT Dr. Sanders) at 16; Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 210:23-211:1, 212:2-11. Workers who have not taken the training will not be allowed to work on Mauna Kea. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 212:12-16.

348. Kū Hinahinakūikahakai Kahakalau, a witness called by the Flores-Case `Ohana, is "a native Hawaiian educator, researcher, scholar, composer and recognized expert in Hawaiian language and culture." WDT of Kū Kahakalau; Ex. B.06a. Here is her story:

"I am Dr. Kū Hinahinakūikahakai Kahakalau. I was born in Honolulu, but have lived in Kukuihaele on Hawai‘i Island since 1991. My grandfather was William Keahonui Kahakalau. He was pure Hawaiian, born and raised in Kalihi, a native speaker of the Hawaiian language, and a talented Hawaiian musicians, entertainer and teacher. My Hawaiian family comes from the islands of Maui, Moloka‘i, O‘ahu and Hawai‘i Island.

I am a native Hawaiian educator, researcher, scholar, composer and recognized expert in Hawaiian language and culture. I hold a Bachelor’s in Secondary Education and a Professional Diploma in Hawaiian Language, and a Master’s Degree in European Languages and Literature (focusing on German literature about Hawai‘i). Moreover, I am the first person in the world to earn a Ph.D. in Indigenous Education. I have over 30 years of experience teaching Hawaiian language, history and cultural studies to learners of all ages and levels, in and outside of the classroom. I have developed and implemented multiple educational pilots and spent over two decades researching the impact of Hawaiian-focused education on native learners. I have lectured all over the world on diverse aspects of Hawaiian language and culture revitalization through culturally-driven models of education. I am also an active community leader, serving on multiple non-profit boards, representing Hāmākua for eight (8) years on the Hawai‘i Island Burial Council and currently serving as Chairperson of the Hawai‘i County Board of Ethics.

I began to pursue my academic study of everything Hawaiian in 1981 at Kapi‘olani Community College (KCC). I literally took every college class with the word "Hawai‘i" offered then at KCC and later at UH Mānoa. More importantly, I spent countless hours learning from esteemed kūpuna, many of whom were mānaleo, or native speakers, from Ni‘ihau to Ka‘ū about our language, our values, our daily practices and protocols, and our traditional ways, including our spiritual practices. In fact, my husband and I base our personal family practices on the mana‘o shared with us by highly knowledgeable kūpuna and cultural experts over the past three decades. In addition to kūpuna teachings, our practices are informed by primary sources like Malo’s Hawaiian Antiquities, which we have studied extensively individually and in various high level groups.

As cultural practitioners, our family regularly engages in Hawaiian ceremonies and protocol and we have raised our two daughters in these traditions, which include daily family protocols, healing rituals, monthly ceremonies based on the moon cycle, multiple yearly makahiki and other ceremonies like house blessings, graduations etc. We have

shared these practices with interested learners from youth to elders, and spearheaded a Hale Mua for kāne and a Hale Papa for wahine, focusing on our roles and responsibilities as kāne and wahine.

I am currently Program Director for Organizational Capacity at INPEACE, a Hawaiian nonprofit organization headquartered in Kapolei, as well as CEO of Kū-A-Kanaka, a native Hawaiian social enterprise providing Hawaiian language and culture products and services, educational consulting and research and evaluation for Hawaiian-focused and other Indigenous programs. I am also the founder and former director of Kanu o ka 'Āina New Century Public Charter School, Hālau Wānana Indigenous Center for Higher Learning, Mālamapōki'i Early Childhood Program, the Kanu o ka 'Āina Learning 'Ohana and Kauhale 'Ōiwi o Pu'ukapu, all located in Waimea on Hawai'i Island. This family of programs is grounded in a Pedagogy of Aloha, which I developed as part of my doctoral research in Indigenous Education. This Pedagogy is also known as Education with Aloha, or EA and has been documented to bring about significant, positive changes for Hawaiian K-12 students. Specifically, providing not just Hawaiians, but all who are interested, a solid grounding in native Hawaiian language, culture and traditions has shown increased socio-emotional well-being (e.g., identity, self-efficacy, social relationships), increased math and reading test scores, particularly for those with low socio-emotional development, significant increases in graduation and college going rates, impressive student and parent satisfaction, significant decreases in absenteeism, and an exceptional commitment to being responsible 21st century global citizens, evidenced by helping others, protecting the environment and making the world a better place.

Over the years, I have received many awards including the Order of Princess Pauahi from the Kamehameha Schools. This is the highest and most distinguished award given to those whose extraordinary lifetime contributions have positively impacted the Hawaiian community and who exemplify the values and vision of the Princess Bernice Pauahi Bishop." WDT of Kū Kahakalau at pages 1-2; Ex. B.06a. at pages 1-2.

349. Dr. Kahakalau is opposed to the construction of the TMT on Mauna Kea. WDT of Kū Kahakalau at page 2; Ex. B.06a. at page 2. She is critical of the Cultural and Natural Resources Training Program because she believes that an annual training is inadequate for any employee to gain an understanding and respect for any cultural and religious practices, and/or sensitivity to the negative impacts on cultural resources. Ex. B.06a (WDT Dr. Kahakalau) at 5. Dr. Kahakalau testified that: "Well, again, my personal belief is that there is no place for the TMT or any other observatories on top of Mauna Kea, and that they need to not be built and be decommissioned ASAP. So that is – that's my belief, that this is not the place to build anything. If you want to get buried up there and your Ohana wants to put you up there, you know, that is a personal decision. But for me, it's that there is no place for TMT up in the wao akua, any wao akua, in this case its Mauna Kea." Vol. 23, Tr. 1/9/17 at 195:8-195:17. Dr. Kahakalau's opinion is that the building of the TMT on Mauna Kea is non-negotiable, no matter what evidence is presented. Vol. 23, Tr. 1/9/17 at 116:22-117:6.
350. Dr. Kū Kahakalau criticized the TMT Project's proposed educational contributions, stating that for native Hawaiians, something is only educational if it follows their value

system. Tr. 1/9/17 at 33:25-34:5.

351. In addition to those mitigation measures at the project-level, the University has also proposed area-wide mitigation measures, including formally and legally binding itself to the commitment that this is the last new area on the mountain where a telescope project will be contemplated or sought, and has committed to decommission the Caltech Submillimeter Observatory, Hoku Ke‘a, and the United Kingdom Infra-red Telescope by the time TMT is operational. Exhibit A-39; WDT Dr. McLaren at 3-4; *see also* Ex. A-13. These actions go beyond simply addressing the impact of the TMT Project in a vacuum. They will substantially mitigate existing area adverse impacts of the astronomy sites on Mauna Kea as a whole and therefore on claimed impacts to native Hawaiian traditional and customary rights. Ex. C-6 (WDT Callies) at 8.

L. TMT PROJECT DECOMMISSIONING

352. At the end of the TMT Observatory’s useful life, the TMT Observatory and the portion of the Access Way exclusively used to access the TMT Observatory will be dismantled and the site restored in compliance with the Decommissioning Plan. TMT will take approximately 3-4 years to decommission. Vol. 7, Tr. 11/2/16 at 201:16-20. Deconstruction and site restoration efforts will be managed by TMT Project staff with oversight by OMKM. TIO is committed to adequately fund decommissioning. Ex. C-2 (WDT Dr. Sanders) at 11- 12; Vol. 7, (Dr. McLaren) Tr. 11/02/16 at 233:8-17. Even if the General Lease, which expires in 2033, is not extended, TIO members have committed to providing the funds needed for decommissioning of the TMT Observatory and portion of the Access Way exclusively used to access the TMT Observatory. Vol. 18, (Dr. Stone) Tr. 12/19/16 at 120:7-121:2, 178:7-179:6; Vol. 7, (Dr. McLaren) Tr. 11/02/16 at 201:16-20.
353. Excess landscape materials removed from the site during construction will be stored at the Batch Plant so that they can be used to restore the TMT Project site as best as possible upon decommissioning. Vol. 21, Tr. 01/04/17 at 58:16-24.
354. In compliance with the Decommissioning Plan, TMT Project staff will develop a Site Restoration Plan ("**SRP**") that will present specific targets for site restoration and describe the methodology for restoring disturbed areas after the demolition/construction activities described in the Site Deconstruction and Removal Plan ("**SDRP**") for the TMT Project are completed. Under the Decommissioning Plan, the two primary objectives of site restoration are: (1) restoring the look and feel of the summit prior to construction of the observatories; and (2) providing habitat for the aeolian arthropod fauna. Ex. C-2 (WDT Dr. Sanders) at 12; Ex. A-13 at 22-26.
355. The level of restoration to be performed and the potential impact of the restoration activities on natural and cultural resources will be carefully evaluated in the SRP and in consultation with OMKM and DLNR. Vol. 21, Tr. 01/04/17 at 60:2-14. Specific factors that are required to be considered during the development of the SRP include cultural sensitivity. WDT Dr. Sanders at 12. TMT employees took approximately 960 photographs of the site, over 600 photographs of the Batch Plant area, and aerial

photographs to a resolution of 2- 3 inches to document the original conditions so that the site may be restored as close to its original condition as possible upon decommissioning. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 39:1-14; Vol. 21, Tr. 01/04/17 at 58:16-19, 60:2-24.

356. Site restoration activities may involve using cinder or materials similar to the surroundings either to fill holes or to reconstruct topography. Consideration will be given to where fill material will come from, how excavation and removal of materials will impact the collection area and any wēkiu bug habitat surrounding the restoration area, and the cultural considerations related to bringing materials from a different area on Hawai‘i Island to Mauna Kea. Upon the completion of site restoration, monitoring of the restoration activities will begin and continue for at least three years. Results of the monitoring activities will be submitted to OMKM. Ex. C-2 (WDT Dr. Sanders) at 12.
357. Some underground facilities may be left in place because removing them could cause more of a disturbance than leaving them. This decision will be during the planning and review of the decommissioning process, however, the starting point for determining the level to restore the site begins with full restoration. Vol. 21, Tr. 01/04/17 at 61:3-21; Ex. A-13 at 26.
358. During decommissioning of the TMT Observatory, there may be temporary adverse impacts due to noise, traffic, dust, visual intrusion, and the increase in human presence on the mountain. Possible adverse impacts during construction and decommissioning also include potential disturbance beyond project limits. Ex. A-1/R-1 at 2-7; Vol. 8, Tr. 11/15/16 at 147:18-24.

M. FUNDING

359. Petitioners and Opposing Intervenors argue that the CDUA should be denied because TIO does not yet have all the funds necessary to build the TMT Project. *See, e.g.*, B.19a at 5, 6-7.
360. Dr. Sanders, the Project Manager for the TMT Project, provided testimony that TIO has already received substantial funds and will undertake additional fundraising efforts once a decision has been made as to the project approval. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 35:15-20. The members of TIO have committed to providing their respective shares of the operating budget. Vol. 20, (Dr. Sanders) Tr. 1/3/17 at 55:1-6. If the TMT Project is permitted, sufficient funds would be committed to decommission it by the current termination of the General Lease in 2033. Vol. 7, (Dr. McLaren) Tr. 11/02/16 at 233:8-17.
361. Petitioner Ching posited that the TMT Project has not taken proper steps to ensure funding of the project. Ching cites Section II(C) of the Mauna Kea Plan (1977), which provides that "[n]o application or any proposed facility shall have final approval without the applicant having first filed with the Board, adequate security equal to the amount of the contract to construct the telescope facilities, support facilities and to cover any other direct or indirect costs attributed to the project[.]" Ching argues that, to comply with the foregoing, a bond in the amount of the contract to construct the project (and ancillary

facilities) must be posted before the CDUA can be approved. Ex. B.19a at 6-7; Ex. B.17g; Vol. 29, Tr. 1/24/17 at 215:9-21.

362. The Mauna Kea Plan (1977) is a "policy guide" and "a policy framework for the management of Mauna Kea." Ex. B.17g at 6, 16. The plan indicates that it is "conceptual" and must be reviewed and updated as time goes on, and circumstances change. *Id.* at 16. It was the first "master plan" for Mauna Kea and consists of 17 pages. It has obviously been superseded by the much more detailed and extensive planning efforts that are described elsewhere in these findings of fact.

N. THE OCCL REPORT RECOMMENDS APPROVAL OF CDUA

363. On February 25, 2011, OCCL submitted its staff report recommending that DLNR approve the University's CDUA. Ex. A-7/R-7; Ex. A-8/R-8; Ex. A-24; Ex. A-25. Lemmo, the administrator of OCCL and signatory to the OCCL report, testified that in drafting its recommendation, OCCL consulted the CDUA, the FEIS, the CMP and subplans, and comments from members of the community and various state agencies. Vol. 42, Tr. 2/28/17 at 34:8-34:17, 40:3-41:1; 83:5-83:14, 84:23-85:1; Vol. 41, Tr. 2/27/17 at 218:14-17, 219- 220, 222-223; Ex. A-7/R-7.
364. OCCL's conclusion that astronomy is an economically and environmentally sustainable use was the result of very difficult, deep analysis, reflection, and concern. It looked at all actions in the context of the setting in which the action might take place, the framework that is currently in place, and the outcomes that it believes will occur if it should recommend approval. Vol. 42, Tr. 2/28/17 at 65:10-66:6.
365. OCCL's recommendation was based upon its finding that:
- a. The TMT Project had done everything possible to absolutely mitigate or ameliorate cultural, ecological, recreational effects of placing the largest telescope in the world on the summit of Mauna Kea. Vol. 42, Tr. 2/28/17 at 65:10-66:6; Ex. A-7/R-7 at 19-21, 59-61.
 - b. The TMT Observatory will not be built in critical habitat for the wēkiu bug or any species of concern. Vol. 42, Tr. 2/28/17 at 66:22-67:3; Ex. A-7/R-7 at 6, 45, 50-51.
 - c. The TMT Project is proposed to be located on the north slope, away from traditional cultural properties ("TCPs"). A portion of the Access Way will traverse the lower portion of Kūkahau'ula. There are no known burial sites, ahu, or other historic features near the project area. Historic maps do not show any paths crossing the Northern Plateau where the TMT is being proposed. The proposed location is removed from the Kūkahau'ula Summit and other identified culturally significant features. Vol. 42, Tr. 2/28/17 at 66:22-67:3; 67:25-68:9; Ex. A-7/R7 at 49-50, 59; Ex. A-59 at 39.
 - d. The TMT Project will bring significant funds to Hawai'i that will be used to reinvest in Mauna Kea. It also will provide needed blue-collar and professional

jobs. The financial and other resources that TMT will bring will improve the University's ability to implement many of the management plan actions. Ex. A-7/R-7 at 45, 60; Vol. 42, Tr. 2/28/17 at 68:10- 68:18.

e. A strong management regime, approved by the BLNR, is now in place for caring for the mountain's resources. The management framework consists of a comprehensive management plan with the subplans, resource plans, cultural plans, public access plans, and decommissioning plans. Vol. 42, Tr. 2/28/17 at 68:19-69:1; Ex. A-7/R-7 at 46- 47, 60.

366. Lemmo further testified that the TMT Project met all eight of the criteria applicable to conservation district use applications, as set forth in HAR § 13-5-30, and thus, he recommended approval of the CDUA to the BLNR. OCCL considered the cultural and religious issues and concluded that the site location below the summit ridge in Area E mitigated the impacts of the new telescope in the area. While the TMT Project represents an incremental impact, the TMT Project in and of itself is not a significant impact in the context of the proposed mitigation measures and the already existing significant impacts within the Astronomy Precinct. Vol. 42, Tr. 2/28/17 at 66:7-70:22.

III. MAUNA KEA CONSIDERED SACRED

367. Ku'ulei Kanahale, a witness called by KAHEA, is a researcher with the Edith Kanaka'ole Foundation. Here is her story:

"My name is Ku'ulei Kanahale and I am the lead Papahūhūhonua (earth science) researcher with the Edith Kanaka'ole Foundation, a Hawaiian cultural-based organization whose mission is to heighten indigenous Hawaiian cultural awareness, knowledge, and participation through educational programs. My primary duty is to interpret traditional Hawaiian chants to understand how our ancestors lived and thrived in our island environment. Understanding traditional chants is important because chants document centuries of environmental observations and is the method our ancestors used to record that information. I have presented my findings locally, nationally and internationally, most recently to Google X and the Hōkūle'a Mālama Honua Worldwide Voyage as well as at the 2016 IUCN World Conservation Congress.

Aside from my work at the Edith Kanaka'ole Foundation, I am an instructor at the Hawai'i Community College, where I have taught Hawaiian language since 1998. I have my Masters in Education from Central Michigan University and I am currently a graduate student at the University of Hawai'i at Hilo, where I am earning my Ph.D. in Hawaiian and Indigenous Language and Culture Revitalization.

I am writing to provide my testimony on the hydrology of Maunakea from a Hawaiian worldview." WDT of Kuulei Kanahale; Ex. B.11a.

368. Mauna Kea is born of the gods Wakea and Papa, these same gods are also the progenitors of the Hawaiian race. Kanahale, Vol. 29, Tr. 1/24/17, at 143:1-9; Ex. B.11a at 2.