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MAUNA KEA ANAINA HOU, KEALOHA PISCIOTTA;  
CLARENCE KUKAUAKAHI CHING; DEBORAH J.  
WARD; PAUL K. NEVES; and KAHEA: THE  
HAWAIIAN-ENVIRONMENTAL ALLIANCE

BOARD OF LAND AND NATURAL RESOURCES

STATE OF HAWAII

In the Matter of:	) Case No. BLNR-CC-16-002
	)
A Contested Case Hearing Re Conservation	) MAUNA KEA HUI'S REPLY TO TMT
District Use Permit (CDUP) HA-3568 for the	) INTERNATIONAL OBSERVATORY LLC'S
Thirty Meter Telescope at the Mauna Kea	) MEMORANDUM IN OPPOSITION, UNIVERSITY
Science Reserve, Kaohe Mauka, Hamakua	) OF HAWAII' I AT HILO'S SUBSTANTIVE JOINTER
District, Island of Hawai'i, TMK (3) 4-4-	) TO TMT INTERNATIONAL OBSERVATORY LLC'S
015:009	) MEMORANDUM IN OPPOSITION, AND
	) PERPETUATING UNIQUE EDUCATIONAL
	) OPPORUNITIES' SUBSTANTIVE JOINDER TO
	) TMT INTERNATIONAL OBSERVATORY LLC'S
	) MEMORANDUM IN OPPOSITION;
	) DECLARATION OF SHELLEY MUNEOKA;
	) EXHIBITS "08"- "10"; CERTIFICATE OF SERVICE
	)

MAUNA KEA HUI'S REPLY TO TMT INTERNATIONAL OBSERVATORY LLC'S MEMORANDUM IN  
OPPOSITION, UNIVERSITY OF HAWAII' I AT HILO'S SUBSTANTIVE JOINTER TO TMT  
INTERNATIONAL OBSERVATORY LLC'S MEMORANDUM IN OPPOSITION, AND  
PERPETUATING UNIQUE EDUCATIONAL OPPORUNITIES' SUBSTANTIVE JOINDER TO TMT  
INTERNATIONAL OBSERVATORY LLC'S MEMORANDUM IN OPPOSITION

Office of Conservation and Coastal Lands  
Department of Land and Natural Resources  
State of Hawaii  
Nov 12 2021 09:20

MAUNA KEA ANAINA HOU, an unincorporated association, KEALOHA PISCIOTTA; CLARENCE KUKAUAKAHI CHING; DEBORAH J. WARD; PAUL K. NEVES; and KAHEA: THE HAWAIIAN ENVIRONMENTAL ALLIANCE, a domestic non-profit corporation ("Petitioners") respectfully submit this reply to TMT INTERNATIONAL OBSERVATORY LLC's (TIO) memorandum in opposition to the Mauna Kea Hui's motion to reopen contested case proceedings, or in the alternative, for declaratory orders, filed November 4, 2021 (TIO opp.), Applicant UNIVERSITY OF HAWAII AT HILO's (UH Hilo) substantive joinder to TIO's memorandum in opposition, filed November 4, 2021, and Party PERPETUATING UNIQUE EDUCATIONAL OPPORTUNITIES' (PUEO) substantive joinder to TIO's memorandum in opposition, filed November 4, 2021.

This reply is filed pursuant to Minute Order no. 1, filed October 24, 2021, Hawai'i Revised Statutes (HRS) §91-8, Hawai'i Administrative Rule (HAR) §§13-1-13, -27, and -34 and is based on the declaration, exhibits, record, and evidence herein.

#### **I. REQUESTED DECLARATORY ORDERS**

In compliance with Minute Order No. 1, Petitioners conform their positions and motion to their requested alternative relief of declaratory orders providing:

- (1) the Department of Land and Natural Resources' (DLNR) Office of Conservation and Coastal Lands' (OCCL) or the DLNR chairperson's approval of UH Hilo's April 28, 2021 request for confirmation of its notice of initiation of work or construction was incorrect;
- (2) OCCL or the DLNR chairperson's summary approval of UHH's request prejudiced the due process rights of Petitioners and UH Hilo's non-compliance Condition No. 4<sup>1</sup> require full examination by the Board, at which time the Board should reconsider its initial grant of the permit in 2017;
- (3) UH Hilo's letter to OCCL constituted an improper request for a determination of conditions exercised under an unlawful rule; and,
- (4) UH Hilo failed to provide supportive documentation for its claim to have initiated work on the land or construction of the TMT.

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<sup>1</sup> The specific activities consist in the following as represented by UH Hilo: Unpermitted ahu removed; Goodfellow Bros, Inc. ("GBI"), the civil contractor for the TMT Project, and M3 Construction Management ("M3"), the construction manager for the TMT Project, met at the project site to test the GPS equipment, and verify the benchmark locations and coordinates with the existing site survey; Kick-Off Meeting between TMT International Observatory, LLC ("TIO"), GBI, M3, subcontractors, and others; GBI, M3, and SMA representatives located and surveyed the underground fiber optic and electrical lines; Big Island Invasive Species Committee ("BIISC") inspected TIO construction equipment and vehicles; and TIO attempted to access the TMT Project site. Petitioners' Exh. 03 at 2 (2021 UH Hilo request).

## II. ARGUMENT

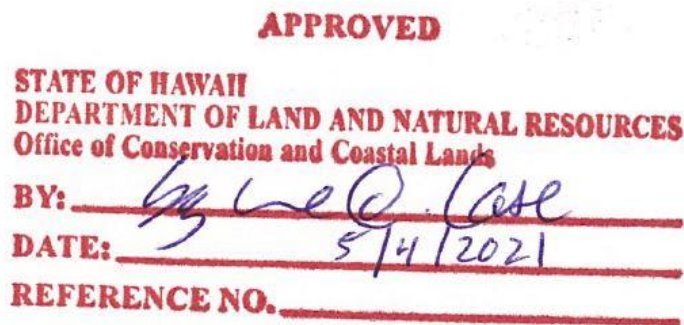
### A. CARD is inapplicable and does not foreclose the Board's issuance of declaratory orders.

#### 1. *CARD does not foreclose declaratory orders arising from post-decision enforcement questions.*

TIO contends Petitioners' petition for declaratory orders concerning compliance with Condition No. 4<sup>2</sup> of the Conservation District Use Permit (CDUP) is foreclosed by the "already-made" decision by the Board to approve Applicant University of Hawai'i at Hilo's (UH Hilo) request dated April 28, 2021. TIO opp. at 1-2 citing *Citizens Against Reckless Development v. Zoning Bd. of Honolulu*, 114 Hawai'i 184, 196, 159 P.3d 143, 155 (2007) ("CARD"). Declaratory orders are specifically available to Petitioners to ascertain the applicability of an "order" of the Board, which presumes that the Board has already made an order. HRS §91-8 ("Any interested person may petition an agency for a declaratory order as to the applicability of any statutory provision or of any rule or order of the agency.") (emphasis added); HAR §13-1-27(a) (same). Here, Petitioners seek declaratory orders as to the applicability of Condition No. 4 of the Board's Decision and Order in the underlying case, dated September 27, 2017, to alleged initiation of work or construction of the Thirty-Meter Telescope on the northern plateau of Mauna Kea and in light of facts raised in their May 24, 2021 motion to reopen hearing.

#### 2. *The Board did not "already" make a determination on Condition No. 4 compliance.*

TIO's contention that the Board already rendered a decision lacks merit because OCCL, and not the Board, approved the UH Hilo's request as depicted below:



[Left]: Exhibit 03 at 3, attached to Petitioners' Motion to Reopen Hearing to Hear Motion to Confirm Non-Compliance with Condition No. 4, or Alternative, Petition for Declaratory Orders Concerning the Same, filed May 24, 2021 (Mauna Kea Hui motion).

<sup>2</sup> Condition No. 4 of CDUP HA-3568 provides:

Any work done or construction to be done on the land shall be initiated within two (2) years of the approval of such use, in accordance with construction plans that have been signed by the Chairperson, and, unless otherwise authorized, shall be completed within twelve (12) years of the approval. The UH Hilo shall notify the Department in writing when construction activity is initiated and when it is completed[.]

That OCCL, and not the Board, approved UH Hilo's request is material, because the Board did not already make a decision. *CARD* petitioners could not avail themselves of procedures under HRS §91-8 to request the City and County of Honolulu Director of Planning and Permitting's (DPP Director) to issue declaratory orders concerning whether the DPP Director should have issued a conditional use permit. See *CARD*, 114 Hawai'i at 201, 159 P.3d at 160 (affirming decision to uphold DPP's refusal to issue a declaratory ruling).

*CARD* examined the Uniform Law Commissioners' Model State Administrative Procedure Act of 1961 and adopted the position taken by the Supreme Court of Wisconsin, which interpreted a similar provision also derived from the model act. *CARD*, 114 Hawai'i at 199, 159 P.3d at 1158 citing *Wisconsin Fertilizer Ass'n v. Karns*, 158 N.W.2d 294, 300 (Wis.2d 1968) and *Aiello v. Litscher*, 104 F.Supp.2d 1068, 1073-74 (W.D. Wis. 2000). Both Wisconsin cases concerned the futility of utilizing declaratory order proceedings to require agencies to "sit in judgment on a decision made by itself[.]" *CARD*, 114 Hawai'i at 199, 159 P.3d at 1158 quoting *Aiello*, 104 F.Supp.2d at 1073-74 (plaintiff inmates were not required to seek declaratory orders from the Department of Corrections, which had already dismissed their complaint). *Karns* held complainants were not required to seek redress through "a declaratory ruling from the commissioner as to an application of a statute when he had already made that determination and indicated he intended to prosecute for violation of the statute." *Id.*, 158 N.W.2d at 306 quoted by *CARD*, 114 Hawai'i at 199, 159 P.3d at 1158 ("declaratory ruling procedure does not provide a method of review of a determination already made but a method of requesting an agency to make a determination."). Instead, *Karns* complainants could avail themselves of proceedings for declaratory orders from the *agency* and not the commissioner.

*CARD* thus adopted the view that declaratory orders should not be sought from specific persons or entities who have "already made" a decision. It does not hold declaratory orders are inappropriate whenever a decision already exists. Here, OCCL's approval of UH Hilo's interpretation of Condition No. 4 is not a decision already made by the Board. Petitioners' petition for declaratory orders does not seek for the Board to sit in judgment of itself, but rather of its subordinate department. Further, the Board's 2017 order approving UH Hilo's CDUP explicitly anticipate Board review of non-compliance.

The Board's Decision and Order approving the CDUP provides for their role in reviewing noncompliance with CDUP conditions: "In case of noncompliance with these conditions, the chairperson shall first attempt to secure compliance from the responsible party, and if unsuccessful, shall bring the matter to the board, with notice to the permittee, to request an order revoking the permit." 2017 Board Order at 286. This provision underscores the Board's role in securing compliance with permit conditions

and the propriety of Petitioners' request for declaratory orders concerning the same. The Board did not "already" make a determination about permit compliance and explicitly provided for review of non-compliance with permit conditions, thereby rendering *CARD*'s limitation on petitions for declaratory orders inapplicable. *Compare CARD*, 114 Hawai'i at 199, 159 P.3d at 1158.

3. *OCCL's approval was defective and renders CARD inapplicable.*

*CARD* is further inapplicable because OCCL's approval was defective for failure to provide notice to parties with property rights in the CDUP proceeding or an opportunity to be heard on the impacts of OCCL's actions on those rights. *CARD* concluded declaratory order procedures under HRS §91-8 were not meant to be a "back door" around deadlines for appeals from the City and County of Honolulu Director of Planning and Permitting's (DPP) permitting approvals, for which notice could be provided under DPP Rule §6.2, and were subject to appeal under HRS chapter 91 procedures for contested cases. *See CARD*, 114 Hawai'i at 201, 159 P.3d at 160 (affirming decision to uphold DPP's refusal to issue a declaratory ruling). Here, unlike in *CARD*, Petitioners had no notice of UH Hilo's request nor OCCL's approval, and no recourse to request reconsideration or otherwise review the approval.

Concerns that declaratory procedures would allow a back-door to contested case appeals in *CARD* are not present in the instant case and do not foreclose the Board's ability to enter declaratory orders as to the applicability of Condition No. 4 to UH Hilo's alleged actions and, implicitly, whether the Board chair should have found non-compliance with Condition No. 4.

B. Due process requires the Board's review of OCCL's interpretation of Condition No. 4.

Neither OCCL nor the Board can determine project construction has begun to be in compliance with the permit (and extend it) and then not allow the parties notice and opportunity to contest that determination, particularly where the determination strains the ordinary meaning of the terms of Condition No. 4. Here, the erroneous determination is tantamount to an amendment of the approval.

In approving UH Hilo's request, OCCL interpreted Condition No. 4 to mean specific "Project Activity" initiated within the time extension period constituted "work done or construction to be done on the land shall be initiated within two (2) years of the approval of such use, in accordance with construction plans that have been signed by the Chairperson[.]" 2017 Board Order at 281 (Condition No. 4). OCCL's interpretation of this condition extended the meaning of work or construction to be done "in accordance with construction plans" because none of the specified activities constituted construction of the TMT. As discussed further *supra*, TMT construction is delayed by at least another two years. OCCL's interpretation of Condition No. 4 constituted an amendment to the CDUP and required Board review with notice to all

parties and an opportunity to contest the proposed interpretation.

Petitioners have an undisputed due process right to participate as parties to the CDUP permitting process. Preventing Petitioners from a meaningful opportunity to be heard as to OCCL's substantive amendment to that permit violates their due process rights to protect and preserve their constitutional Hawaiian traditional and customary rights and rights to a clean and healthful environment, amongst other property rights. See *In re Conservation District Use Application HA-3568*, 143 Hawai'i 379, 431 P.3d 752 (2018); *Mauna Kea Anaina Hou v. Board of Land & Natural Resources*, 136 Hawai'i 376, 363 P.3d 224 (2015). The Hawai'i Supreme Court critically examined the means to seek relief from agency orders based on facts that develop after periods for re-hearing, reconsideration, or appeal have passed. See *In re Hawaiian Elec. Co.*, SCOT-20-0000309, at \*44 (Haw. Jun. 29, 2021) (slip op.) (*In re HECO*). In such circumstances, *In re HECO* held an appellant "reasonably argues" post-decision relief may be available, in that case with reference to Hawai'i Rules of Civil Procedure (HRCP) Rule 60(b). *Id.* *In re HECO* is instructive because it underscores the continuing nature of litigants' due process rights to enforce decisions already-made. Further, the interpretation set a dangerous precedent under which agencies could impose conditions on approvals that are then eroded away through substantive post-decision amendments. Here, Petitioners are not seeking relief from the Board order from September 27, 2017, but rather for the Board to interpret the conditions imposed as part of that order as applied to the facts presented by UH Hilo's April 2021 request.

C. UH Hilo has not initiated construction of the TMT on Mauna Kea

1. *UH Hilo had no ability to initiate TMT construction in 2019 or in the near future.*

TIO provides extensive contortions of the definitions of "work" and "construction" in support of its contention that UH Hilo has initiated work or construction of the TMT. TIO opp. at 4-9. What is plain to the rest of the world, however, is that the TMT is not being constructed, nor will it be initiated any time soon. See Petitioners' Exh. 08 (T. Hurley, "Construction of Thirty Meter Telescope delayed at least 2 years," *Honolulu Star-Advertiser* (Oct. 11, 2021); Declaration of Shelley Muneoka (Muneoka Decl.) ¶2. Project proponents lack funds to construct the TMT and will be required to initiate procedures to procure public monies, which will take four to five years. See Exh. 09 (M. Brestovansky, "Could take 'four or five years' for TMT to receive funding," *Hawai'i Tribune Herald* (Nov. 5, 2021); Muneoka Decl. ¶3. In its report assessing requests for TMT funding, the National Academies of Sciences wrote: "TMT has the added risk that the site has not yet been selected, adding cost and schedule uncertainty" and noted the "biggest risk . . . is the large gap between commitments in-hand from the partners, and what is required to complete the projects, even with a significant federal investment by NSF of \$0.8 billion per project." Petitioners' Exh.

10 (Nat'l Academies of Sciences, Engineering, Medicine, "Pathways to Discovery in Astronomy and Astrophysics for the 2020s," at 7-24 (2021) ("Astro2020 Report"); Muneoka Decl. ¶4. The TMT's rising price tag of \$2.65 to \$3.1 billion is the "most serious risk" to its construction. *Id.*, at K-10. The Astro2020 Report refers to further external review to determine the TMT project's financial viability with "target completion in 2023" and the need to complete "final site selection". *Id.* at 1-19, 7-25, K-9 ("TMT will either be sited at the Mauna Kea Observatory in Hawaii (MKO), or at Roque de los Muchachos Observatory in the Canary Islands (ORM).") The "uncertainty in its choice of site" is a "significant programmatic risk" for TMT construction in any location. *Id.* at K-10, K-11. The National Academies of Sciences reports: "Based on the documents presented by TMT, . . . a timely decision to build TMT on ORM would not lead to an increase in cost or a delayed schedule compared to MKO. Moreover, the panel has reviewed the relevant metrics on site quality and finds that—while MKO is the superior site—the ORM site is acceptable." *Id.*

Despite representations to the Board that UH Hilo has initiated TMT construction on Mauna Kea, new, current information demonstrates the TMT may not be constructed on Mauna Kea or at all. OCCL was not presented with this information, rather relying exclusively on UH Hilo's representations. Petitioners' appropriately petition the Board to enter requested declaratory orders.

2. *The ahu was not in the construction area and its destruction did not initiate construction.*

TIO contends "the removal of the unpermitted ahu plainly constituted ground-disturbing 'construction . . . on the land[.]'" TIO opp. at 7 n.4. First, as pointed out by Party Cindy Freitas, the Board found the ahu was not on the TMT construction site. "Cindy Freitas Brief in Response to Petitioners' Motion" at 2, filed Nov. 3, 2021 citing 2017 Board Order, FOF ¶ 692. The Board found "W. Freitas oversaw the construction of two new ahu structures in the TMT Project site area[.]" and stressed their proximity to the site "area" did not mean "the two uprights are in fact on the TMT Project site" as opposed to being "near the boundary of the TMT Project site." *Id.* ¶¶690,692 citing (Rechtman) Tr. 12/20/16 at 88:6-14). Rechtman, an archaeologist hired by project proponents, testified the "upright" ahu stones were "just off to the side of the construction work area." Case No. BLNR-CC-16-002, Tr. 12/20/16 at 88:13-14. UH Hilo's removal of the "unpermitted ahu" did not constitute initiation of work or construction because the ahu was not in the construction work area.

D. No rule or declaratory order permitted approval of UH Hilo's "notice" of initiation of work or construction on the land.

TIO contends UH Hilo's April 28, 2021 letter "did exactly what should have been done with respect to notifying BLNR of compliance with the condition pursuant to the CDUP" and did not require

declaratory order proceedings or rulemaking. TIO opp. at 13-14. In stamping UH Hilo's April 28, 2021 letter with its approval, OCCL and/or the DLNR chairperson operated outside of the plain, ordinary meaning of the requirement of written documentation of "[a]ny work done or construction to be done on the land" that is required to be initiated within two years. UH Hilo's alleged meetings and surveys on the project site, inspection of equipment, and access attempts were not work or construction on the land. OCCL's approval rather operated under an unpromulgated "agency statement of general or particular applicability and future effect that implements, interprets, or prescribes law or policy, or describes the organization, procedure, or practice requirements of any agency." HRS §91-1. Petitioners seek declaratory orders providing that OCCL and/or its chairperson could not so deform the meaning of work or construction *on the land* without undergoing promulgation or declaratory petition procedures to provide notice of its new rule or interpretation.

E. "Unclean hands" doctrine inapplicable and outside of the Board's authority

1. *TIO, PUEO, and UH Hilo concede construction was not initiated in 2019.*

TIO contends the Board should consider the doctrine of "unclean hands" as to Petitioners' alleged acts in regard to UH Hilo's July 30, 2019 request for extension of time to comply with Condition No. 4. TIO opp. at 16-17. Whether OCCL could grant UH Hilo's July 30, 2019 request is not at issue in the present proceedings and TIO's contention is irrelevant. However, TIO's contention that Petitioners' have caused UH Hilo to be unable to initiate construction in compliance with Condition No. 4 concedes non-compliance with Condition No. 4. That is, TIO and UH Hilo cannot assert both that Petitioners' obstructed TMT construction and that TMT construction has been initiated. In both its July 2019 and April 2021 letters, UH Hilo represented to OCCL that TMT construction has been initiated and therefore cannot now also represent that Petitioners' have obstructed initiation of construction. *See* TIO opp. at 20 ("Petitioners have brought this proceeding with unclean hands, because they, with others, actively worked to advocate, manufacture and/or coordinate the very situation that they now seek to obtain relief from.").

2. *Alleged "unclean hands" does not excuse the Board from its obligations under HRS chapter 183C*

TIO contends the Board should deny Petitioners' petition for declaratory orders "[a]s a matter of equity and fairness (as well as in the interests of good and sound public policy)[.]" TIO opp. at 20. First, "unclean hands" is an equitable doctrine applied by courts. *See Richardson v. Sport Shinko (Waikiki Corp.)*, 76 Hawai'i 494, 507, 880 P.2d 169, 182 (1994) (Hawai'i "courts have inherent equity . . . powers," which "are derived from the state Constitution and are not confined by or dependent on statute."). By contrast, the Board lacks equitable powers or jurisdiction to adjudicate equitable claims as their powers are granted



by statute. Compare *Executive Risk Indemnity v. Pacific Education Services*, 451 F.Supp.2d 1147, 1159 (D. Haw. 2006) (Hawai‘i courts need not wait for legislative guidance as to exercises of equitable power). The Board is not a court and its authority is confined to what it is granted and therefore cannot refuse to examine UH Hilo’s permit compliance on the basis of Petitioners’ alleged “unclean hands.” It is a basic concept of administrative law that “an agency cannot act outside its delegated authority.” Charles H. Koch, 4 *Administrative Law and Practice* § 11.13, at 21 (3rd ed. 2010).

Second, to the extent the Board could consider it, “unclean hands” does not apply to statutory claims. See *Robert’s Hawai‘i School Bus, Inc. v. Laupahoehoe Transportation Co.*, 91 Hawai‘i 224, 246 n.19, 982 P.2d 853, 875 n.19 (1999) (“[i]t is well settled that the unclean hands defense is precluded in HRS § 480-13”) citing *Davis v. Wholesale Motors, Inc.*, 86 Hawai‘i 405, 417-18, 949 P.2d 1026, 1038-39 (App.1997) (citing *International Tel. and Tel. Corp. v. General Tel. & Elecs. Corp.*, 296 F. Supp. 920, 926 (D. Haw. 1969)); see *Perma Life Mufflers, Inc. v. International Parts Corp.*, 392 U.S. 134, 139 (1968) (“plaintiff who reaps the reward of treble damages may be no less morally reprehensible than the defendant, but the law encourages his suit to further the overriding public policy in favor of competition”), *overruled on other grounds by Copperweld Corp. v. Independence Tube Corp.*, 467 U.S. 752, 765-66 (1984).

The overriding public policy of the conservation district statute is “to conserve, protect, and preserve the important natural resources of the State through appropriate management and use to promote their long-term sustainability and the public health, safety and welfare.” HRS §183C-1. The Board’s implementation of this statute also implicates the state’s obligations as a public trustee under article XI, § of the Hawai‘i Constitution. The alleged misconduct of private parties is irrelevant to the Board’s duty to ensure conservation district use permits are enforced. Deadlines for initiating construction under a permit are reasonable and necessary measures to ensure permittees do not obtain permits for purposes other than those stated and, most relevant here, provide opportunities for the Board to review whether interceding circumstances require re-examination of permit approval. Allegations that Petitioners’ obstructed project construction in 2019 do not address whether and how OCCL’s approval in May 2021 complies with conservation district rules and the Board’s 2017 order. See *Gaudiosi v. Mellon*, 269 F.2d 873, 882 (3d Cir.), *cert. denied*, 361 U.S. 902 (1959) (equitable doctrine of unclean hands is not “a matter of ‘defense’ to the defendant.”).

3. *No evidence supports Petitioners’ bad faith or misconduct to support allegations of “unclean hands.”*

TIO’s contends Petitioners are “among others, who caused or advocated for the delay in the transport of heavy equipment to the TMT Project site[.]” TIO opp. at 19. That newsmedia identify

Petitioners as opponents to the TMT who exercised their First Amendment rights of speech and protest does not establish their “unclean hands,” which refers to a failure to “be frank and fair with the court, nothing about the case under consideration should be guarded, but everything that tends to a full and fair determination of the matters in controversy should be placed before the court[.]” *Keystone Driller Co v. General Excavator Co* *Keystone Driller Co v. Osgood Co*, 290 U.S. 240, 244 (1933) citing Story's Equity Jurisprudence (14th Ed.) § 98. The requirement of clean hands stresses “he who asks relief must have acted in good faith. The equitable powers of this court can never be exerted in behalf of one who has acted fraudulently, or who by deceit or any unfair means has gained an advantage.” *Id.*, 290 U.S. at 245 (cited case omitted).

TIO points to no evidence that Petitioners have conducted wrongdoing or acted in bad faith in asserting UH Hilo is noncompliant with its CDUP and the Board needs to review its permit. Holding opinions and advocating against the building of TMT is not illegal and protected speech under the First Amendment. See e.g. *In re Investigation of KAHEA*, SCAP-20-0000110, at \*21 (Haw. Sep. 21, 2021) (slip op.) (“KAHEA's opposition to development on Mauna Kea falls squarely within the heartland of the First Amendment's protections.”). Petitioners have consistently advocated for review of the Board’s 2017 permit and themselves raised the interceding demonstrations in 2019 one of many reasons for review. There is nothing “unclean” about exercising First amendment rights and there were many more than the five Petitioners who expressed their opinion that the TMT should not be built.

TIO concedes “others” who are not Petitioners oppose TMT construction. TIO opp. at 19. It is too much to attribute to the five Petitioners the actions of hundreds of thousands of persons who protest TMT construction on Mauna Kea through their petitions, advocacy, litigation, donations, social media posts, and demonstrations. The breadth and depth of opposition to the TMT does not originate with the Petitioners’ alleged private agendas. No one, including TIO, even alleges this is so. UH Hilo’s inability to initiate TMT construction is but one symptom of a more than a century-deep foundation of the opposition to settler state construction on Mauna Kea. TIO is missing the forest for the trees. Allegations that Petitioners' protested the TMT sweep the tips of the larger groundswell of community concern with the project that requires the Board to revisit the reasons UH Hilo cannot comply with its permit.

### **III. CONCLUSION**

For the foregoing reasons, Petitioners request this Board enter requested declaratory orders concerning Applicant UH Hilo’s non-compliance with Condition No. 4 of the subject CDUP and OCCL or the DLNR chairperson’s non-compliance with procedures necessary to protect due process.

DATED: Honolulu, Hawai'i

November 12, 2021

/s/ Richard Naiwieha Wurdeman  
RICHARD NAIWIEHA WURDEMAN  
ATTORNEY AT LAW, A LAW CORPORATION



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LAW OFFICE OF BIANCA ISAKI  
BIANCA ISAKI  
Attorneys for the Mauna Kea Hui

BOARD OF LAND AND NATURAL RESOURCES

STATE OF HAWAII

In the Matter of: ) Case No. BLNR-CC-16-002  
)  
A Contested Case Hearing Re Conservation District ) DECLARATION OF SHELLEY MUNEOKA  
Use Permit (CDUP) HA-3568 for the Thirty Meter )  
Telescope at the Mauna Kea Science Reserve, Kaohe )  
Mauka, Hamakua District, Island of Hawai‘i, TMK )  
(3) 4-4-015:009 )  
\_\_\_\_\_ )

DECLARATION OF SHELLEY MUNEOKA

I, SHELLEY MUNEOKA, declare under penalty of law that the following is true and correct.

1. I am the treasurer of the Board of KAHEA: THE HAWAIIAN-ENVIRONMENTAL ALLIANCE, which is a petitioner in the above entitled proceedings.

2. Attached as Exhibit “08” is a true and correct copy of T. Hurley, “Construction of Thirty Meter Telescope delayed at least 2 years,” *Honolulu Star-Advertiser* (Oct. 11, 2021) available at: <https://www.staradvertiser.com/2021/10/11/hawaii-news/construction-of-tmt-delayed-at-least-2-years/>).

3. Attached as Exhibit “09” is a true and correct copy of M. Brestovansky, “Could take ‘four or five years’ for TMT to receive funding,” *Hawai‘i Tribune Herald* (Nov. 5, 2021) available at: <https://www.hawaiitribune-herald.com/2021/11/05/hawaii-news/could-take-four-or-five-years-for-tmt-to-receive-funding/>.

4. Attached as Exhibit “10” is a true and correct copy of excerpts from the National Academies of Sciences, Engineering, Medicine, “Pathways to Discovery in Astronomy and Astrophysics for the 2020s,” (2021) available at: <https://www.nap.edu/read/26141/chapter/1>.

DECLARANT FURTHER SAYETH NAUGHT

DATED: Honolulu, Hawai‘i

November 11, 2021



\_\_\_\_\_  
SHELLEY MUNEOKA  
DECLARANT

HAWAII NEWS

# Construction of Thirty Meter Telescope delayed at least 2 years

By [Timothy Hurley](#) • Oct. 11, 2021

The developers of the planned Thirty Meter Telescope are now saying that construction of the \$2.4 billion cutting-edge observatory isn’t likely to start for at least a couple of years.

“TMT needs time to heal our relationship with the community and to recover from the delays caused by the pandemic,” Kerry Slater, TMT chief of staff and vice president of communications, said in a statement provided Friday to the Honolulu Star-Advertiser.

The project also faces the real likelihood it will have additional regulatory hurdles placed before it when and if it scores additional funding from the U.S. government.

Slater said the project is now awaiting the results of the federal Decadal Survey on Astronomy and Astrophysics, which is expected to provide guidelines and recommendations to federal agencies regarding U.S. scientific funding for the next decade.

Slater said the outcome of the survey “will shape the future of astronomy for the years to come.”

The survey’s report is expected to be released in the next few months and might well recommend funding for the TMT as many of the white papers submitted as part of the once-a-decade evaluation describe the importance of next-generation telescopes, such as the TMT, to carry astronomy to the next level.

In the meantime, the Native Hawaiian opponents of the stalled project held their first major protest in the past year and a half Friday as the University of Hawaii is preparing a master plan for Mauna Kea that welcomes construction of the controversial observatory.

An anti-TMT crowd of about 100 gathered late Friday afternoon on the UH campus, where speakers criticized the university for its role in continuing to push for the large telescope in spite of years of protest.

“The UH has shown itself to be a bad manager of these important lands for over 50 years and their master plan for the future of Mauna Kea validates the fact that UH has not been listening nor do they care about the harm further development on the summits will do to the Kanaka Maoli people and to those who love and protect this mountain,” organizers said in a news release publicizing the event.

Speakers pledged Friday to continue resisting the TMT whenever it is built, saying it will desecrate sacred land that was stolen from the Indigenous people of Hawaii.

“The moment we stay silent is the moment we lose everything,” Healani Sonoda- Pale of Ka Lahui Hawai’i told the crowd. “And if you have a choice at any time to stand up or to speak out for our aina, for our people, for our lahui, you have to do it, because that’s our kuleana.”


## EXHIBIT "08"

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During a virtual forum Wednesday, UH officials said that while the 20-year master plan certainly does accommodate the TMT — since it is an authorized and permitted project — it also works even if the telescope isn't built in Hawaii.

"The master plan has been crafted in a way that basically reflects reality," said Doug Simons, director of the UH Institute for Astronomy. "We don't know if TMT is going to get built or not. Nobody knows, right? There are funding challenges ahead for the TMT, and the master plan is resilient to either outcome for the TMT."

Greg Chun, executive director of the Center for Maunakea Stewardship, said that if the TMT is not built, the site will be available for another telescope, although the master plan will continue to restrict the number of telescopes on the mountain to nine by the end of 2033.

"Anybody proposing to build there would have to weigh the risks pretty heavily," Chun said.

If TMT does get the additional funding it needs, there likely are several regulatory hoops the project would have to go through.

Environmental planner Jim Hayes, president of Planning Solutions and primary author of the Mauna Kea master plan, said the additional environmental review would be determined by the U.S. agency giving the money.

But it is possible, he said, that the project would be required to complete a new environmental impact statement that complies with the National Environmental Policy Act, as well as conduct a formal consultation with Native Hawaiians as called for in Section 106 of the National Historic Preservation Act.

There may also be endangered species requirements, coastal zone management issues "and a host of other environmental rules and regulations," Hayes said, but it would be up to the federal agency giving the funds.

The TMT, which would be 10 times more powerful than anything now on Earth, attempted to start construction in 2015 and in 2018 but was thwarted by protesters each time.

At the time, officials had estimated the cost of the project at \$1.4 billion, but inflation and other factors prompted a recalculation that added an additional billion dollars to the price tag.

Last year the TMT teamed up with another proposed mega-observatory, the U.S.-led Giant Magellan Telescope, planned for Chile, and created the U.S. Extremely Large Telescope Program.

Under their combined funding plan, the National Science Foundation would contribute \$850 million to each project, and that would guarantee American astronomers about one-fourth of the observing time on each of the powerful telescopes.

According to the plan, the two telescopes would offer astronomers full coverage of the heavens from both hemispheres. Instruments on both telescopes could be used for joint or even simultaneous investigation of any number of objects in the sky.

Last week the TMT described some of the details of its proposed operations plan on its website.

The telescope, according to the plan, would have its main headquarters in Hilo and base as many staff members as possible there while minimizing the number of staff required to travel up the mountain daily for on-site maintenance and engineering support. In this model, only about 35 staff members will need to travel daily to the site.

It was estimated that 115 staff members will be needed to fully operate the TMT 24 hours a day, seven days a week all year long.

Mauna Kea continues to be the preferred location for the telescope, but the island of La Palma in the Canary Islands remains the backup site, officials said.



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## Could take 'four or five years' for TMT to receive funding

By [MICHAEL BRESTOVANSKY](https://www.hawaiitribune-herald.com/author/michael-brestovansky/) Hawaii Tribune-Herald (<https://www.hawaiitribune-herald.com/author/michael-brestovansky/>) | Friday, November 5, 2021, 12:05 a.m.

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# EXHIBIT "09"





Despite a strong recommendation that the federal government provide funding to the Thirty Meter Telescope, it likely will take at least “four or five years” before that project receives the money.

The Astronomy and Astrophysics Decadal Survey, also called Astro2020, was released Thursday and included a strong argument that the National Science Foundation award \$800 million to both the TMT and a similar Chile-based observatory called the Giant Magellan Telescope in order to maintain U.S. competitiveness in the field of astronomy.

ADVERTISING

But despite historical precedent — the NSF typically has followed the recommendations of previous decadal surveys — there is no guarantee that TMT will get the funding, and certainly will not receive it anytime soon.

Keivan Stassun, professor of physics and astronomy at

Vanderbilt University and a member of the Astro2020



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steering committee, said that both the TMT and the GMT are no doubt scrambling to get their affairs in order for a critical review by the NSF of both projects to take place in approximately two years.

ADVERTISING



In TMT's case, this includes finalizing a site — both the Maunakea summit and a site in the Canary Islands, Spain, are possibilities — and filling a multi-million-dollar hole in its budget.

According to Astro2020, even if the NSF commits the full \$800 million to TMT, it will still fall short of its estimated \$2.65 billion construction budget by about \$310 million.

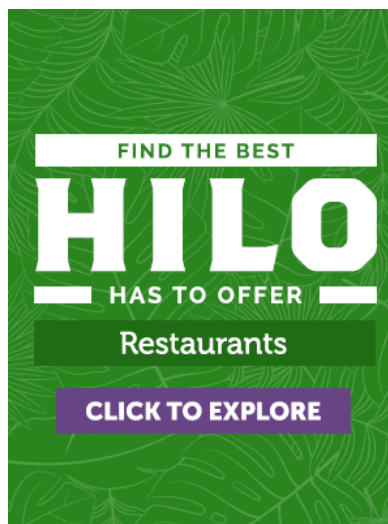
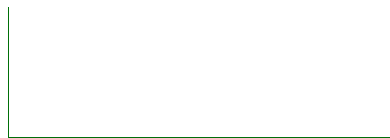
If the TMT does not have a clear plan for how to secure those funds by the time of the NSF review, Stassun said, the NSF funding would be in jeopardy.

"The two things feed off each other, though," Stassun said. "TMT could go back to its major partners and say that, if they contribute another \$310 million, that will trigger the \$800 million."

But even if the TMT has all its ducks in a row by the time of the review in two years, NSF still will have to go through the long and arduous federal appropriations process, Stassun said.

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# **Pathways to Discovery in Astronomy and Astrophysics for the 2020s**

Committee for a Decadal Survey on Astronomy and Astrophysics 2020 (Astro2020)

Space Studies Board

Board on Physics and Astronomy

Division on Engineering and Physical Sciences

A Consensus Study Report of

*The National Academies of*  
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## Preface

The summary charge for the Committee for a Decadal Survey of Astronomy and Astrophysics (Astro2020; hereafter the “steering committee”) reads as follows:

The National Academies of Sciences, Engineering, and Medicine shall convene an ad hoc survey committee and supporting study panels to carry out a decadal survey in astronomy and astrophysics. The study will generate consensus recommendations to implement a comprehensive strategy and vision for a decade of transformative science at the frontiers of astronomy and astrophysics.

The complete statement of task and its scope is provided in Appendix A of this report. The steering committee, with inputs from 13 expert panels encompassing the breadth of astronomy and astrophysics, was specifically asked to (1) provide an overview of the current state of astronomy and astrophysics science, and technology research in support of that science, with connections to other scientific areas where appropriate; (2) identify the most compelling science challenges and frontiers in astronomy and astrophysics, which shall motivate the committee’s strategy for the future; (3) develop a comprehensive research strategy to advance the frontiers of astronomy and astrophysics for the period 2022-2032 that will include identifying, recommending, and ranking the highest-priority research activities; (4) utilize and recommend decision rules, where appropriate, that can accommodate significant but reasonable deviations in the projected budget or changes in urgency precipitated by new discoveries or unanticipated competitive activities; (5) assess the state of the profession, including workforce and demographic issues in the field, identify areas of concern and importance to the community, and where possible, provide specific, actionable, and practical recommendations to the agencies and community to address these areas.

Astro2020 was sponsored by the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Department of Energy (DOE) Office of High Energy Physics, and the Air Force Office of Space Research (AFOSR). These federal agencies all participate in different aspects of the U.S. space- and ground-based astronomy and astrophysics program. Internally, the decadal survey effort at the National Academies was a joint project of the Board on Physics and Astronomy and the Space Studies Board. This is the seventh decadal plan for astronomy and astrophysics conducted over the history of the National Academies.

The scope of the science assessed by the decadal survey is broad, encompassing all aspects of observational, theoretical, and computational astronomy including ground-based solar observations, but specific activity recommendations were limited to those administered by NSF Division of Astronomical Sciences and the NASA Astrophysics Division. Scientific areas in astronomy and astrophysics pursued by the DOE Office of High Energy Physics were also included in the study, but activity recommendations were limited to NSF and NASA as described above.

The committee was also tasked with assessing three space projects, WFIRST (since renamed the Nancy Grace Roman Space Telescope), Athena (Advanced Telescope for High-Energy Astrophysics), and LISA (Laser Interferometer Space Antenna)—the latter two being European-led missions with significant NASA participation. These three projects were highly ranked priorities for the 2010 *New Worlds New Horizons* (NWNH) decadal survey, also called Astro2010, and are under development but not yet launched.<sup>1</sup> The committee was invited to comment on the status and future direction of NASA

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<sup>1</sup> National Research Council, 2010, *New Worlds, New Horizons in Astronomy and Astrophysics*, The National Academies Press, Washington, D.C., <https://doi.org/10.17226/12951>.



support for these projects, but they were not considered together with nor ranked against new projects proposed for the coming decade. Likewise the survey was invited to consider the status and evolution of ongoing programs within NASA's program of record.

## STUDY PROCESS AND PARTICIPANTS

Organization of the Astro2020 decadal survey, including the steering committee and 13 expert panels, began with the appointment of the co-chairs in late 2018. The steering committee consisted of 20 members, including the co-chairs. Members were selected to cover as fully as possible the scientific scope of the survey, the range of observational (ground, space, and particle/gravitational astrophysics) and theoretical disciplines, as well as technical and managerial background in space and/or ground-based facilities, and to comprise as representative a group of experts as possible in terms of individual, institutional, and geographical demographics. National Academies policies governing potential conflicts of interest by steering committee and panel members were strictly enforced. In particular, broad and open-minded thinkers were sought out as opposed to advocates for individual missions or subfields. The role of the Executive Officer was also redefined for this survey, to that of a full voting member of the steering committee, with additional administrative and coordination responsibilities as part of the leadership team.

All meetings and deliberations for the survey operated under a code of conduct to guide discussions. This code of conduct was developed in addition to the National Academies policy on sexual harassment and bullying for committee members, panelists, and meeting attendees, and in addition to a code of conduct for National Academy of Sciences members. The statement includes a recognition of strongly held, possibly differing opinions; a dedication to open dialogue and open exchange of ideas; and professional, civil, and collegial treatment of colleagues so that an open exchange of ideas can occur.

During the course of the panel and steering committee meetings, a number of public information-gathering sessions were held. These included briefings by the agencies (NASA, NSF, DOE), invited presentations by selected projects to the program panels, and other informational sessions sponsored by the other panels or the steering committee. Throughout the survey, the representatives of all three agencies urged the committee to be “ambitious”<sup>2</sup> and “aspirational,”<sup>3</sup> and the committee hopes that it has risen to this challenge.

The charges of the expert panels were similar to that of the Astro2010 survey, but with a few important changes. The number of science panels was increased from five to six panels, to accommodate the very rapid growth over the previous decade of exoplanetary astronomy and multi-messenger astrophysics, while preserving balance across all subject areas. The basic programmatic panel structure from Astro2010 was also retained, except that the Panel on Electromagnetic Observations from Space was divided into two panels, in order to accommodate the very large number of project proposals and community white papers in that area. Finally, two new panels for Astro2020 were appointed—the Panel on an Enabling Foundation for Research (program panel) was charged with evaluating cross-cutting supporting programs (e.g., grants programs, laboratory astrophysics, data archiving and data science, computation, theory), and the Panel on State of the Profession and Societal Impacts (SoPSI) was charged to advise the steering committee on this specific area in its statement of task. These 13 appointed panels (six science, six program, and one state of the profession) comprised 127 members. In addition, a steering committee “liaison” member was appointed to each panel to facilitate the flow of information and communication between panels and the main survey committee. The liaisons participated in the panel discussions but did not hold formal voting rights. In all, 141 individuals participated in the panel deliberations with a purpose of providing input to the steering committee. Each panel drafted its own report, with suggestions for the steering committee to consider, as it held its own deliberations to reach its

<sup>2</sup> Presentation to Astro2020 committee by Paul Hertz, NASA Astrophysics Division, July 2019.

<sup>3</sup> Presentation to Astro2020 committee by Ralph Gaume, NSF Division of Astronomical Sciences, July 2019.

recommendations for the main report. To underscore the importance of the panel reports, they have been published together with this main report as appendixes.

The science panels were asked to provide a brief review of the current state of the science in their topic areas and determine four important science questions to be addressed in the next decade and one area that shows great promise for discovery. The program panels were charged to assess the ability of current and proposed projects under consideration to address the science panels' questions and discovery areas, to comment on the Technical, Risk, and Cost Evaluations (TRACE) of the proposed projects, to identify key areas of technical development or precursor research activities, and to discuss the balance of small, competitively selected activities versus larger strategic investments needed to address the science questions. The program panels were not asked to prioritize or rank projects, but rather to suggest to the steering committee the projects with the best potential to realize the capabilities needed to address the science panels' questions and discovery areas. The Panel on the State of the Profession and Societal Impacts was asked to gather information on the health and demographics of the astronomy and astrophysics community and make actionable suggestions to the steering committee on the topics of demographics, diversity and inclusion, workplace climate, workforce development, education, public outreach, and relevant areas of astronomy and public policy. Further information about the charges to the panels is found in Appendix A.

The information-gathering and deliberative phases of Astro2020 were carefully coordinated. Members of the astronomical community were invited to submit white papers to the survey, and these papers formed the foundation and starting point for all of the panel deliberations. In the first phase, 572 science white papers were received in early 2019. A second call for "activity, project, and state of profession consideration" (APC) white papers in July 2019 elicited 294 responses. Every white paper was assigned to and read by one or more of the panels.

The panel meetings themselves were phased. The science panels each held two formal meetings, the program panels each held three formal meetings, and all held several additional teleconferences. Meetings of the science panels took place during the second half of 2019, so that the priorities emerging from the reports of those panels could be incorporated into the program panel deliberations. The science panel chairs presented their findings to the steering committee and the program panels at a face-to-face meeting in December 2019 and delivered their written reports in early 2020. The program panels' meetings began in November 2019, and they presented their results to the steering committee in May 2020 and delivered initial written reports in June 2020. The SoPSI panel met and deliberated on an independent schedule, including holding a public listening session at the American Astronomical Society meeting on January 6, 2020. The SoPSI report was fully incorporated into the overall deliberations and prioritization phases of the steering committee activities.

During the course of the panel deliberations, a number of other inputs were received, and these were especially important for the program panels. After an initial review of all projects proposed for a given panel area, the panels issued requests for information (RFIs) from selected projects to obtain more detailed information that was initially provided in the respective APCs. These included all of the large space and ground "flagship" proposals and selected examples of smaller projects. Selected projects were also invited to present summaries to their respective program panels in public sessions. Many of these projects then underwent a detailed TRACE study, conducted by an independent contractor (The Aerospace Corporation). This independent analysis was mandated by the 2008 NASA Authorization Act, which "directs the Administrator to enter into agreements periodically with the National Academies for decadal surveys to take stock of the status and opportunities for Earth and space science discipline fields and aeronautics research and to recommend priorities for research and programmatic areas over the next decade."<sup>4</sup> Additionally, the act "requires that such agreements include independent estimates of life cycle costs and technical readiness of missions assessed in the surveys whenever possible." In-house analyses of technology readiness, risk, and cost estimates provided by the project teams themselves supplemented

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<sup>4</sup> National Aeronautics and Space Administration Authorization Act of 2008, P.L. 110-422, Section 1104 (October 15, 2008).

this analysis. Details of the TRACE process are provided in Appendix O of this report. This process was formerly labeled “Cost and Technical Evaluation” (CATE) and was conducted for recent National Academies surveys in planetary science and solar and space physics, as well as Astro2010.

The schedule for this review was impacted by two outside events—a 35-day government shutdown from December 2018 to January 2019, and the COVID-19 pandemic of 2020 to 2021. The shutdown happened just as science white papers were being solicited, so the deadline for submissions was delayed by a month. The impacts of the COVID-19 pandemic were much more severe. The initial disruptions in March and April 2020 occurred when the program panels were completing their final meetings. Final panel deliberations were held virtually, and delivery of the panel reports to the steering committee were delayed by up to 2 months as everyone adjusted to the new reality of working, caring for children, teaching, and performing service to the community, all while under a stay-at-home order. The greatest impact was on the deliberations of the steering committee, which needed to replace its remaining schedule of four 3- to 4-day face-to-face meetings (out of six total) with more than 20 all-day Zoom meetings. Early into the pandemic, the survey co-chairs and National Academies’ staff decided not to allow the disruptions to compromise the quality or integrity of the survey, and the inevitable result was a several month delay from the original schedule. Included in these virtual meetings were presentations of preliminary results by the program and SoPSI panels during the summer of 2020.

After the panel reports were received and assembled, the steering committee proceeded with the main prioritization discussions, fully informed by the panel reports. The steering committee addressed a few additional topics that were not taken up in full by a program panel (e.g., satellite constellations and radio frequency interference). In such cases, working groups were appointed within the steering committee or by committee and cross-panel working groups. The steering committee’s deliberations were aided by the introduction of innovative strategies to assist in reaching consensus in the virtual environment necessitated by COVID-19, such as online voting tools, collaborative online document editing, the utilization of various videoconferencing features, and asynchronous deliberations (Figure P.1).



**FIGURE P.1** Steering committee members and staff met virtually on May 27, 2021.

sufficient investment this could be completed before the end of the decade, and the mission could commence formulation prior to 2030. (Section 7.5.2)

*Decision Rules:* Prior to commencing mission formulation, a successful Great Observatories Mission and Technology Maturation program must be completed, and a review held to assess plans in light of mission budgetary needs and fiscal realities.

### **The U.S. Extremely Large Telescope Program (Highest Priority in the Ground-Based Frontier Category)**

Because of the transformative potential that large (20–40 m) telescopes with diffraction-limited adaptive optics have for astronomy, and because of the readiness of the projects, the survey committee's top recommendation for frontier ground-based observatories is investment in the U.S. ELT program. The U.S. ELT program is made up of three elements: the Giant Magellan Telescope (GMT), the Thirty Meter Telescope (TMT), and NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab). The primary mirror of the GMT has a total diameter of 24.5 m and the telescope has a 25 arcmin field-of-view (FOV). The GMT will be located at the Las Campanas Observatory in Chile. The TMT primary mirror has a diameter of 30 m, and the telescope has a 20 arcmin FOV. The TMT will either be sited on Maunakea in Hawaii, or at Roque de los Muchachos Observatory on La Palma in the Canary Islands. These observatories will create enormous opportunities for scientific progress over the coming decades and well beyond, and they will address nearly every important science question across all three priority science themes. Both projects are essential for keeping the U.S. community's global scientific leadership, providing important synergistic capabilities that complement those planned for the European ELT. However, both projects have significant remaining risks primarily associated with the need to raise additional private or international contributions. The success of at least one of these projects is absolutely essential if the United States is to maintain a position as a leader in ground-based astronomy. The objective is to achieve a time share that is equivalent to 25 percent in each telescope. If only one project is viable, then a larger fraction on that telescope is required to meet the survey's scientific goals, with the aim of achieving an NSF share up to 50 percent time in that project. (Section 7.6.1.1)

*Decision Rules:* Successful completion of an external review that will determine the financial viability of both projects, final site selection (in the case of TMT), development of an appropriate management plan and governance structure, and appropriate plans for public access and data archiving.

### **The Cosmic Microwave Background Stage 4 Observatory (CMB-S4)**

Given technical and scientific progress over the last decades, ground-based studies of the CMB are poised to take a major step forward in the coming decade. The Cosmic Microwave Background Stage 4 (CMB-S4) observatory will leverage this progress and will have broad impact on both cosmology and astrophysics. Realizing the ultimate scientific potential of ground based CMB observations will take an effort far beyond what can be achieved by independently scaling up existing experiments. CMB-S4 observatory, a joint effort of NSF and DOE, is the compelling and timely next leap for ground-based observations. It will conduct a 7-year ultra-deep survey of a few percent of the sky from the South Pole with a combination of large and multiple small aperture telescopes observing from 30-270 GHz. This will be done in parallel with a 7-year deep/wide survey of roughly half the sky with additional telescopes sited in the Atacama desert in Chile. The Survey is also excited by the breadth of science, including time-domain and transient studies, and the potential engagement of a community well beyond traditional CMB cosmologists. To maximize the science, transient alerts and well calibrated maps from all surveys will need to be made available to the entire community in a timely fashion, even if it requires some extra resources to do so. (Section 7.6.1.3)

full-sky coverage, important for leveraging the current U.S. multi-billion dollar bi-hemispheric system of ground-based OIR and radio astronomical facilities (JVLA and the future ngVLA in the north, ALMA and the Vera Rubin Observatory in the south) and assure observations of rare objects (e.g., nearby habitable exoplanets, rare classes of transient events) regardless of where they lie in the sky. Complementary instrumentation on the two telescopes developed in a coherent manner in partnership with NOIRLab would significantly increase the scientific reach of the overall U.S. ELT program. Investing in two telescopes would also maximize the total number of nights of public-access observing time—potentially as much as 200 nights per year—and far more than remain available for NSF partnership on either of the observatories alone.

The enormous scientific potential of the ELTs has also been recognized overseas. Several international organizations are partners in the GMT and TMT project, and in 2008 a European Astronomer decadal study identified an ELT as one of its top priorities (along with a Square Kilometer Array radio telescope project). ESO now is constructing a 39 m ELT in Chile, with planned commissioning later in this decade. NSF participation in a U.S. ELT program will position the U.S. community to take full advantage of the promise of these facilities. Although smaller in aperture the TMT and GMT offer a number of unique capabilities, including fields of view 4-6 times larger than the ESO ELT (facilitating multi-object spectroscopy), and high-resolution first-generation spectrometers capable of carrying out groundbreaking observations of exoplanets, ancient stars, and the circumgalactic and intergalactic media, key elements of the Habitable Worlds and Galaxy Growth priority areas. These capabilities are regarded less as competitive advantages than as powerful synergies between complementary facilities which will hasten the advancement of the science frontier objectives highlighted in this survey.

As proposed to this survey, the U.S. ELT program would be comprised as a collaboration between the GMT and TMT projects with the NSF NOIRLab. NOIRLab would provide proposer and user support, public data products and archiving, broaden participation in U.S. ELT science, foster research inclusivity, and engage and represent the whole U.S. community in the U.S. ELT governance and scientific planning. NSF partnership would leverage major investments by universities and foundations (\$1.5 billion), and international partners (\$1.2 billion), and assure that the fruits of these revolutionary facilities are shared by the largest possible community of researchers and students in the United States.

The Panel on Optical and Infrared Observations from the Ground (OIR) assessed the programmatic and technical risks and cost of both the GMT and TMT separately, and both underwent an independent TRACE analysis. The TRACE construction cost estimates of \$2.4 billion and \$3.1 billion for GMT and TMT respectively are within 20 percent of the project cost estimates (\$2 billion and \$2.65 billion), which is within the uncertainties. While there are technical challenges for both projects, solutions appear to be in-hand. TMT has the added risk that the site has not yet been selected, adding cost and schedule uncertainty. However, the biggest risk for both projects is the large gap between commitments in-hand from the partners, and what is required to complete the projects, even with a significant federal investment by NSF of \$0.8 billion per project. This programmatic risk is significant, and the TRACE analysis gave both projects a medium-high programmatic risk rating.

The scientific potential of the ELTs is so compelling, and the science so broad, that ideally community access would be at least 25 percent on each of the ELTs (as proposed to the survey). If, however, programmatic or financial challenges preclude the viability of one of the projects, the survey recommends that NSF invest in at least one ELT, with a share of the time proportional to the fractional federal investment in constructions and operations.

**Recommendation: The National Science Foundation (NSF) should achieve a federal investment in at least one and ideally both of the two extremely large telescope projects—the Giant Magellan Telescope and the Thirty Meter Telescope, with a target level of at least 25 percent of the time on each telescope. If only one project proves to be viable, NSF should aim to achieve a larger fraction of the time, in proportion to its share of the costs and up to a maximum of 50 percent.**

### 7.6.1.2 Criteria and Decision Rules for Investment in the U.S. ELTs

It will be necessary for NSF to commence with an external review with a target completion in 2023 in order to evaluate the financial and programmatic viability of both proposed U.S. ELT projects, with the level of federal investment in at least one of the projects determined at the end of the review. Federal investment in either project should be predicated on:

1. Demonstration of financial viability with agreed-upon commitments from partners for all of the necessary capital and operations money, pending only NSF investment.
2. Final site selection in the case of the TMT.
3. A public share of telescope time (run through NSF's NOIRLab) roughly equivalent to the total federal investment of construction and operations expenses.
4. Full public archiving of all data taken by the ELTs, after a reasonable proprietary period. This applies to both federal and consortium telescope time.
5. Development of a management plan and governance structure for the joint project, agreed by all parties including the relevant observatory corporations and NSF.

Approval of the project is also subject to the recommendation in Section 5.1.1 that makes the initiation of any new astronomy MREFC project contingent on NSF developing a plan for managing the operations costs of the new facilities within its projected budget envelope.

**Recommendation: The National Science Foundation (NSF) should conduct an external review of the U.S. extremely large telescopes, with a target completion date of 2023. If only one of the Giant Magellan Telescope or the Thirty Meter Telescope can meet the conditions enumerated above by the time of NSF's review, NSF should proceed with investment in that project alone.**

Depending on the outcome, the decision rules for NSF are the following: In the case that only one project can proceed, NSF's investment of up to a 50 percent share in the project should be undertaken if doing so will ensure that the project has the financial resources to come to fruition. If NSF investment can only fund partnership in one telescope, but both are viable, NSF's investment should factor in complementarity to the ESO ELT, the ability to address the science questions of the Astro2020 survey, and the relative advantages of a larger diameter ( $D$ ), which increases the sensitivity  $\sim D^2$  to  $D^4$  (depending on the science application), versus a larger field of view, which increases survey speed and the number of targets per observation.

### 7.6.1.3 CMB-S4

Observations of the CMB have not only been central to establishing the standard model of cosmology, but the telescopes designed to undertake them are becoming increasingly important for understanding phenomena ranging from transients to galactic ecosystems to the formation of cosmic structure. The advances possible with a new generation of receivers include searching for polarization signals from gravitational waves from the Big Bang and, when combined with Euclid, Roman, and Rubin Observatory, revealing a detailed picture of our cosmic web, its composition, and its evolution. At the same time, by tracing the electron pressure in halos of galaxies and galaxy clusters, CMB observations can trace feedback between the intergalactic medium, the circumgalactic medium, and the cores of galaxies.

Building on the scientific and technical progress brought about by decades of individual private and public investments by the U.S. community, we are poised in the next decade to make a major step forward in ground-based CMB studies. Over the last two decades, second- and third-generation ground-

strain the financial capacity of even a full partnership between the projects and the National Science Foundation.

The GMT project now estimates a total construction cost of \$2 billion in real year (RY) dollars. Of this amount, 20 percent has been spent to-date. An additional 10 percent has been committed by current partners. The project plans for the remaining 70 percent to come from NSF (40 percent), additional (uncommitted) funds from existing partners (15 percent), and funds from unidentified new partners (15 percent). To state it differently, even with all the funds expended and committed, and with an \$800 million commitment from NSF, there is still a shortfall of roughly \$600 million.

The TMT project now estimates a total construction cost of \$2.65 billion in RY dollars. Of this amount, 18 percent has been spent-to-date. An additional 41 percent has been committed by the current partners. The project plans for the remaining 41 percent to come from NSF (30 percent) and additional (uncommitted) funds from current partners (11 percent). In this case, with all the committed funds and full funding from NSF, there is still a shortfall of \$310 million.

The construction costs estimated in the TRACE reports are both about 20 percent higher than the project estimates (\$2.4 billion for GMT and \$3.1 billion for TMT). They are largely the result of conservative assumptions made by the TRACE analysis as to risk. All these numbers are summarized in Table K.2.

**TABLE K.2** Summary of Construction Costs and Funds, in Million Dollars and Real Years

	<b>GMT</b>	<b>TMT</b>
Funds spent	\$400 (20%)	\$475 (18%)
Additional funds committed	\$197 (10%)	\$1063 (41%)
NSF ask	\$800 (40%)	\$800 (30%)
Missing funds	\$603 (30%)	\$310 (11%)
<b>TOTAL</b>	<b>\$2000</b>	<b>\$2650</b>
_____	_____	_____
TRACE delta	\$400 (20%)	\$450 (17%)
TRACE TOTAL	\$2400	\$3100
TRACE missing funds	\$1003	\$760

### K.3.6 Programmatic Risks

The largest single programmatic risk to each project derives directly from the funding issues summarized above. *Both projects need significant additional new funding beyond the planned request from NSF. Both projects believe that the combination of the imprimatur of a top ranking in the decadal survey, followed by the full financial involvement of the U.S. federal government would make it possible to secure additional resources from existing partners and possibly from new partners.*

Before discussing the two projects, it is important to emphasize that they are based on very different funding models, each with different potential risk factors. The majority of the GMT partners are U.S. universities (plus the Carnegie Institution for Science). The model for the contribution and allocation of financial resources is strongly cash-based. In contrast, the majority of the TMT partners are international entities funded by their respective national governments. The TMT funding model is largely based on significant in-kind contributions from these partners in terms of completion of assigned technical work packages.

The GMT project's estimate of the additional funds needed in addition to the funds currently committed and the funds requested from NSF is \$600 million. If the construction cost for the TRACE is adopted, this increases to \$1000 million. A further risk factor for GMT is the relative immaturity of estimates for cost-to-go. Only 16 percent of these are based on signed contracts or detailed bids, with the

other 84 percent being based on “Rough-Order-of-Magnitude” or project estimates. This leads to additional uncertainty in cost and schedule.

The TMT project’s corresponding estimate of these additional new funds is \$310 million. If the TRACE cost estimate is adopted this becomes \$760 million. A further potential risk factor is TMT’s reliance on international partners. This is based on a model of low-cost in-kind critical components and sub-systems. While TMT has agreements in place that a given international partner would shoulder any additional costs associated with the delivery of their work packages, this model has not been tested under extreme circumstances. If this funding model is successful, the TRACE delta could be significantly decreased.

An additional potential programmatic risk for TMT is posed by the uncertainty in its choice of site. Based on the documents presented by TMT, which were analyzed by the panel and in the TRACE report, a timely decision to build TMT on ORM would not lead to an increase in cost or a delayed schedule compared to MKO. Moreover, the panel has reviewed the relevant metrics on site quality and finds that—while MKO is the superior site—the ORM site is acceptable. The largest impact would be in the thermal infrared and in the ultraviolet near the atmospheric cut-off. Despite this assessment, the choice of a site still poses a significant programmatic risk since it could adversely affect the partnership.

The TRACE analysis—based primarily on the considerations above—gave both projects a medium-high programmatic risk. The TRACE evaluation flagged the schedules as being too aggressive. GMT plans for 12 years, including LTAO commissioning, while the TRACE estimate was 13 years. TMT plans for 10 years, while the TRACE estimate was 13 years. The panel notes that there is better agreement with risk-adjusted schedules from the projects: 13.7 years for GMT and 11.2 years for TMT. Both stated their costing included the risk-adjusted schedules.

### **K.3.7 Life Cycle Costs**

As is discussed further in Sections K.3.8 and K.3.9, the panel regards it as essential that a plan is developed to ensure that adequate funding is in place through a combination of federal and project funds to operate the U.S.-ELTs with high efficiency, and to continue to provide them with state-of-the art instruments throughout their scientifically productive lifetimes.

The two projects have developed bottom-up estimates for operations of these facilities and have budgeted for partial funding of future instruments. The panel is concerned that the estimated operations and instrumentation budgets are too lean, for both GMT and TMT. GMT has budgeted \$30.6 million per year for operations and \$10 million per year for new instruments. The total annual amount of \$40.6 million represents about 2.1 percent of construction costs (all numbers being in \$2020). TMT has an annual budget of \$33.3 million for operations and \$13.7 million for new instruments. The total annual budget of \$47 million represents 2 percent of construction costs. In comparison, the corresponding fractions are 4 percent for the E-ELT and 5 percent for the VRO and ALMA.

It is the panel’s assessment that the currently proposed operations budgets are too low to support the type of highly efficient, flexible mode that will be needed to capitalize fully on the financial investment. Likewise, the budget for future instrumentation will not be adequate to ensure a continuing line of state-of-the-art new instruments.

### **K.3.8 Consideration of the U.S.-ELT Program**

In this section, the panel considers the case for the proposal to Astro2020 by the U.S.-ELTP for federal investment that would unite the GMT, TMT, and NOIRLab. The panel first discusses the question of whether this should be done, and then asks whether it can be done, from a financial point-of-view.

The panel emphasizes here that a single proposal was received from the U.S.-ELTP (not separate GMT and TMT proposals). The panel has therefore considered this proposal for investment in a two-ELT



**CERTIFICATE OF SERVICE**

The undersigned hereby certifies that a copy of the foregoing documents was duly served upon the following parties, by email, on this date:

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