

**1. WBS ID** 1.2.1 \$2,381,686 total cost for this WBS

2. WBS Name Implementation Management & Systems Engineering

**3. Estimated by** Terry Benson, Delia Tosi, & Ian McEwen (University of Wisconsin)

#### 4. WBS Dictionary Description

This WBS includes functional areas that directly support the seven string installation efforts at the South Pole. Primary components are Management/ Engineering/Logistics, Drill, and Installation. Northern hemisphere Enhanced Hot Water Drill (EHWD) refit activities included design, procurement, and construction of new drill systems, integration, verification, and testing of the drill system and subsystems as well as planning and implementation of drill field operations for refit activities and to accomplish required string borehole deliverables. Installation is responsible for sensor/device handling process development, South Pole Acceptance Testing activities, string hardware design and procurements, and surface cable/s optical sensor, calibration and special device string installation activities at the South Pole.

## 5. Assumptions and Related Documents

The estimates described in this document rely on the following assumptions, which are consistent with the Project's "Key Assumptions" document" (1) and the "Cost Estimating Plan" (2).

- The cost estimate technique classifications (A-L) follow the US Government Accountability Office (GAO) best practices. These are summarized in the Project's Key Assumptions document (1). The techniques are: A=Analogy; C=Engineering build-up; D=Expert opinion; E=Extrapolation from actuals; F=Parametric; L=Learning Curves.
- Contingency codes are assigned to each item: C1—C8. These reflect the estimated uncertainty in the estimate. The meanings of the contingency codes and the percentage of contingency in each case are described in the Key Assumptions document (1).

#### 6. Scope

The scope of this BOE covers the following L4 areas:

| 1.2.1.1 | Implementation Management & Controls     | Includes project management for drill and installation systems.  |
|---------|--|--|
| 1.2.1.2 | Drill Management &<br>System Engineering | EHWD Upgrade management; Plan, schedule, and budget development; Develops EHWD logistics and support requirements, works closely with 1.1's Polar Operations and the USAP Contractor. Facilitates design, production, and field season readiness reviews; Recruitment; Training; post- |





|         |   | drill season close-out. Systems engineering, thermal modeling, fuel analyses, CAD support, procedures, post-drill season wrap up.  |  |
|---------|---|--|--|
| 1.2.1.3 | Installation Management & Systems Engineering | Installation management and coordination. Develop site plans. Plan & Coordinate String Installation Area. Work closely with 1.3 (DOM's) and 1.4 (CPT, especially Cables) to determine requirements, schedules, logistics, and constraints. Develop procurement lists of Installation related hardware and equipment. Develop detailed plans and procedures hazard analysis and safety plans for deep string installation. Assemble and lead a team of "Installers" during 2025/26 season to deploy 7 instrumented strings safely and successfully. |  |
| 1.2.1.4 | Implementation Quality and Safety             | d Drill & installation safety, quality assurance, documentation, post-drill sea wrap up.   |  |
| 1.2.1.5 | Implementation Travel                         | Travel for meetings and reviews, recruitment, and vendor visits.   |  |
| 1.2.1.6 | Transportation & Logistics                    | Cargo crating and shipping from UW sites.  |  |

## 7. Materials, Supplies, Equipment, Travel

## 7.1. Equipment

No equipment is included.

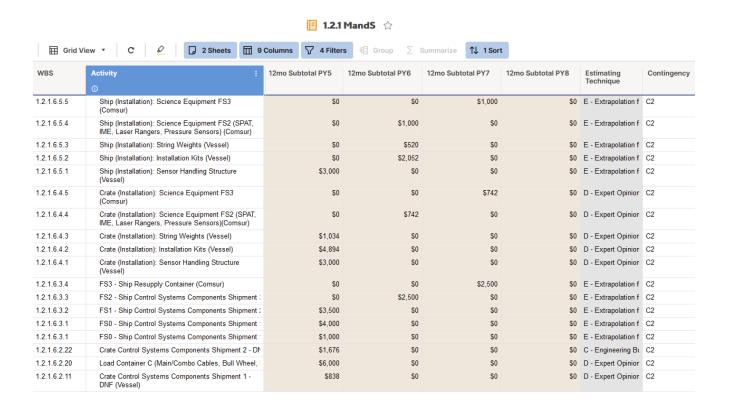
## 7.2. Materials & Supplies

Procurements in 1.2.1 are limited to the Transportation & Logistics area, 1.2.1.6. Materials and Supplies (M&S) for 1.2.1.6 include:

- Shipment crating materials to support both Drill & Installation needs have been estimated using 2021 actuals, from current pricing posted on W.W. Grainger's website, and Subject Matter Expert (SME) input. PY5-PY8 drill and installation packaging materials total \$18,926 in base cost.
- Shipping estimates are based on 2021 actuals and cover the shipping leg from PSL to Port Hueneme. PY5-PY8 drill and installation estimated shipping costs total \$21,072 in base cost.

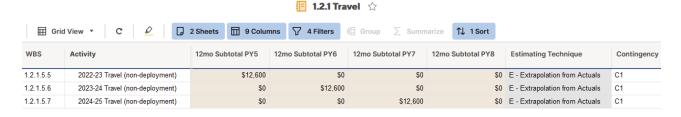
The drilling and installation M&S base costs are given in the table below.





#### 7.3. Travel

- FY23 non-deployment travel, estimated at \$12,600 using, standard University Rates for the Annual Collaboration Meeting (international) 1x \$3600; and a meeting with the USAP contractor in Denver (domestic): 5x \$1800 = \$9k Total
- FY24 non-deployment travel, estimated at \$12,600 using, standard University Rates for the Annual Collaboration Meeting (international) 1x \$3600; and a meeting with the USAP contractor in Denver (domestic): 5x \$1800 = \$9k Total
- FY25 non-deployment travel, estimated at \$12,600 using, standard University Rates for the Annual Collaboration Meeting (international) 1x \$3600; and a meeting with the USAP contractor in Denver (domestic): 5x \$1800 = \$9k Total





#### 8. Labor

#### 8.1. Labor Estimate

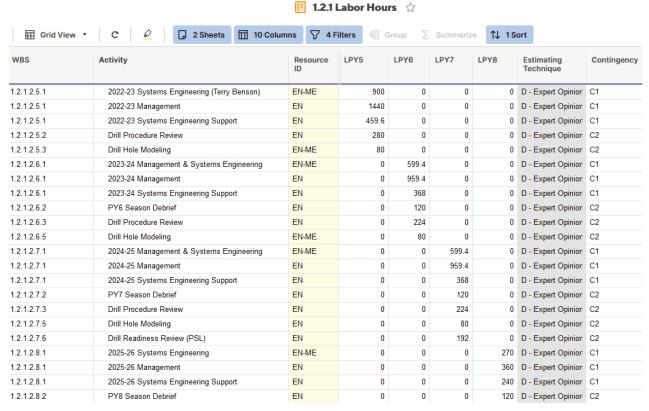
1.2.1 labor largely Level of Effort (LOE) to support management and engineering tasks. Task related labor, primarily in the Crating and Shipping area 1.2.1.6 has been estimated by subject matter experts with deep knowledge of the planned tasking and experience with previous efforts.

### 8.2. Summary of Labor Resources

1.2.1.1 covers the 1.2 L2 manager full time. Note that PY8 is prorated to 7 months (7/12)(1800) = 1050 hr.



1.2.1.2 is Drill Systems Engineering. 1.2.1.2.5 captures PY5, 1.2.1.2.6 captures PY6, and so forth.



The basis for the 1.2.1.2 estimates are as follows:



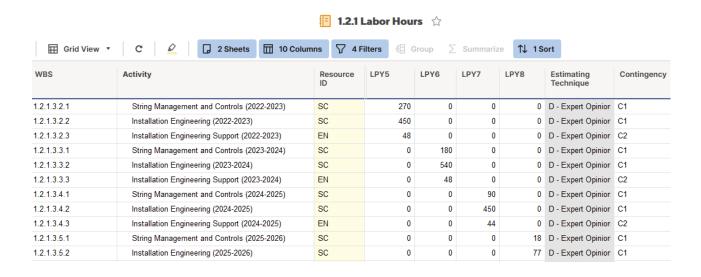


|             |  |                                    | PY5   | PY6   | PY7   | PY8   |
|-------------|--|------------------------------------|---|---|---|---|
|             |  |                                    | P15   | P10   | P17   | P10   |
|             |  |                                    |   |   |   |   |
| 1.2.1.2.5   | 2022-23 Drill Management & Systems Engineering |                                    | Note: Full year, no field season  |   |   |   |
|             | 2022-23 Management & Systems Engineering       | System Engineering                 | 0.5 FTE x 1800hr/yr = 900 hr  |   |   |   |
|             | 2022-23 Management & Systems Engineering       | Drill Management                   | 0.8 FTE x 1800hr/yr = 1440 hr   |   |   |   |
| 1.2.1.2.5.1 | 2022-23 Management & Systems Engineering       | Sys Engr Support: Team<br>Meetings | weekly: (34wks)(1hr)(12people) =<br>408hr<br>ASC coord, biweekly:<br>(17wks)(3people) = 51hr<br>Total = 408+51 = "460hr |   |   |   |
| 1.2.1.2.5.2 | Drill Procedure Review                         | Team Procedure<br>Review           | 1hr session/wk x 35 wks/yr x<br>8people = 280hr/yr  |   |   |   |
| 1.2.1.2.5.3 | Drill Hole Modeling                            | Hole Modeling                      | 80hr, engr estimate   |   |   |   |
|             |  |                                    |   |   |   |   |
| 1.2.1.2.6   | 2023-24 Drill Management & Systems Engineering |                                    |   | Note: Offseason only, assumed 8<br>months   |   |   |
|             | 2023-24 Management & Systems Engineering       | System Engineering                 |   | 0.5 FTE x (8/12)(1800hr/yr) = 600hr   |   |   |
| 1.2.1.2.6.1 | 2023-24 Management & Systems Engineering       | Drill Management                   |   | 0.8 FTE x (8/12)(1800hr/yr) = 960hr   |   |   |
| 1.2.1.2.6.1 | 2023-24 Management & Systems Engineering       | Sys Engr Support: Team<br>Meetings |   | weekly:<br>(8mo)(4wk/mo)(10people) = 320hr<br>ASC coord, biweekly:<br>(16wks)(3people) = 48hr<br>Total = 320+48 = 368hr |   |   |
| 1.2.1.2.6.2 | PY6 Season Debrief                             | Season Debrief                     |   | hybrid, (30people)(4hr) = 120hr   |   |   |
| 1.2.1.2.6.3 | Drill Procedure Review                         | Team Procedure<br>Review           |   | 1hr session/wk x 28 wks/yr x<br>8people = 224hr/yr  |   |   |
| 1.2.1.2.6.5 | Drill Hole Modeling                            | Hole Modeling                      |   | 80hr, engr estimate   |   |   |
| 1.2.1.2.7   | 2024-25 Drill Management & Systems Engineering |                                    |   |   | Note: Offseason only, assumed 8   |   |
|             |  |                                    |   |   | months  |   |
| 1.2.1.2.7.1 | 2024-25 Management & Systems Engineering       | System Engineering                 |   |   | 0.5 FTE x (8/12)(1800hr/yr) = 600hr   |   |
| 1.2.1.2.7.1 | 2024-25 Management & Systems Engineering       | Drill Management                   |   |   | 0.8 FTE x (8/12)(1800hr/yr) = 960hr   |   |
| 1.2.1.2.7.1 | 2024-25 Management & Systems Engineering       | Sys Engr Support: Team<br>Meetings |   |   | weekly:<br>(8mo)(4wk/mo)(10people) = 320hr<br>ASC coord, biweekly:<br>(16wks)(3people) = 48hr<br>Total = 320+48 = 368hr |   |
| 1.2.1.2.7.2 | PY7 Season Debrief                             | Season Debrief                     |   |   | hybrid, (30people)(4hr) = 120hr   |   |
| 1.2.1.2.7.3 | Drill Procedure Review                         | Team Procedure<br>Review           |   |   | 1hr session/wk x 28 wks/yr x<br>8people = 224hr/yr  |   |
| 1.2.1.2.7.5 | Drill Hole Modeling                            | Hole Modeling                      |   |   | 80hr, engr estimate   |   |
| 1.2.1.2.7.6 | Drill Readiness Review (PSL)                   | FS3 Readiness Review               |   |   | (2days)(8hr/day)(12people) =  |   |
| 1.2.1.2.8   | 2025-26 Drill Management & Systems Engineering |                                    |   |   |   | Note: Offseason only, assumed 3<br>months (Oct25, Feb26, Apr26)   |
| 1.2.1.2.8.1 | 2025-26 Management & Systems Engineering       | System Engineering                 |   |   |   | 0.6 FTE x (3/12)(1800hr/yr) = 270hr   |
|             | 2025-26 Management & Systems Engineering       | Drill Management                   |   |   |   | 0.8 FTE x (3/12)(1800hr/yr) = 360hr   |
|             | 2025-26 Management & Systems Engineering       | Sys Engr Support: Team<br>Meetings |   |   |   | weekly:<br>(2mo)(4wk/mo)(10people) = 80hr<br>final documentation: 4 areas (sys,<br>mech, elec, ops) x 40hr/ea = 160hr<br>Total = 80+160 = 240hr |
|             | PY8 Season Debrief                             | Season Debrief                     |   |   |   | hybrid, (30people)(4hr) = 120hr   |

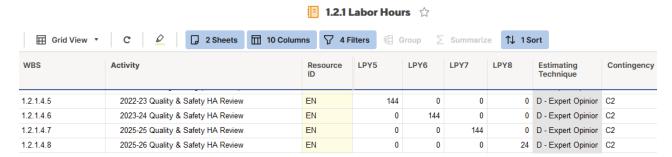
1.2.1.3 is Installation Management and Engineering. The Installation Manager position is broken into management/controls and installation engineering LOE tasks for each project year. This is 0.4 FTE for PY5 and 6, then tapers off. Engineering support is also included each year at a low level.

Last revision: 10 May 2022 5





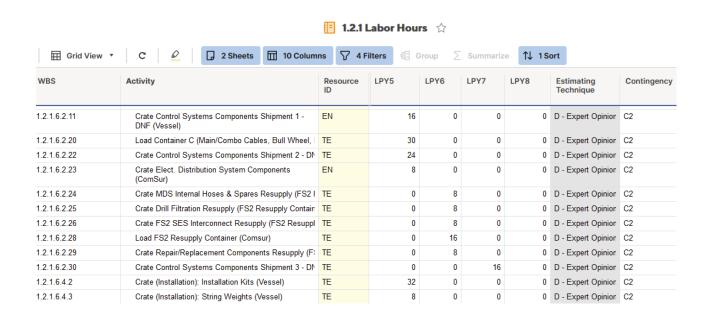
Project and drill/installation quality/safety is captured in 1.1.3 Project Office Quality and Safety, and embedded within Implementation management and engineering (1.2.1.1, 1.2.1.2, 1.2.1.3). 1.2.1.4, however, specifically captures annual hazard analysis (HA) review. This is assumed to be (2 HAs/month)(1.5 hr/HA)(4 engr/HA) = 12 hr/mo = 144 hr/yr.



1.2.1.6 is crating and shipping tasks, estimated by expert opinion.







#### 9. References

[Ref-1] 1. IceCube Upgrade Project. Key Assumptions for the IceCube Upgrade Project.

[Ref-2] 2. —. Cost Estimating Plan.

## **Revision History**

| Date                    | Revised by | Summary of changes |
|-------------------------|------------|--------------------|
| 2022-02-25              | Delia Tosi |                    |
| 2022-04-11 Terry Benson |            | Updated tables     |
|                         |            |                    |
|                         |            |                    |