ARBOR CONSULTANTS, PC
2902 East Eisenhower, Ann Arbor, MI 48108 • (734) 971-5862

August 17, 2022
Revision 1

Mr. Mark Dorogi
Homeland Solar
4975 Miller Road
Ann Arbor, MI 48103

Subject: **Craft Cannabis (Winewood Organics) - Rooftop Solar PV Array, Structural Review**
2394 Winewood Avenue, Ann Arbor, MI 48103

Dear Mark,

Per your request, I reviewed the placement of a single solar PV array on the south-facing wood rafter-supported roof over the single-story Craft Cannabis building addition at the subject address. *Later in August, 2022, I also reviewed the viability of adding more solar PV on the original building roof as part of Revision 1.* The following report summarizes the structural analysis that was completed on the roof decks and supporting structures for the various arrays. The building addition dimensions were found as nominally 19'-6" wide (north-south) by 62' long (east-west), with the building roof being a sheet-metal deck and plywood deck supported by 2x10 wood rafters running north-south at 3:12 slope. The rafters span nominally 19 feet and are end-supported by a concrete block wall (via ledge) on the north side and load bearing wall on south side, with walls assumed supported by code-compliant concrete footings. The total gross roof area of the addition is roughly 1,240 square feet – the gross area of the generally flat interconnected building to the north is 1,740 square feet although such area is interrupted with significant rooftop HVAC equipment with limited space exists for new ballasted or attached racking/modules.

A. REFERENCE DOCUMENTS:

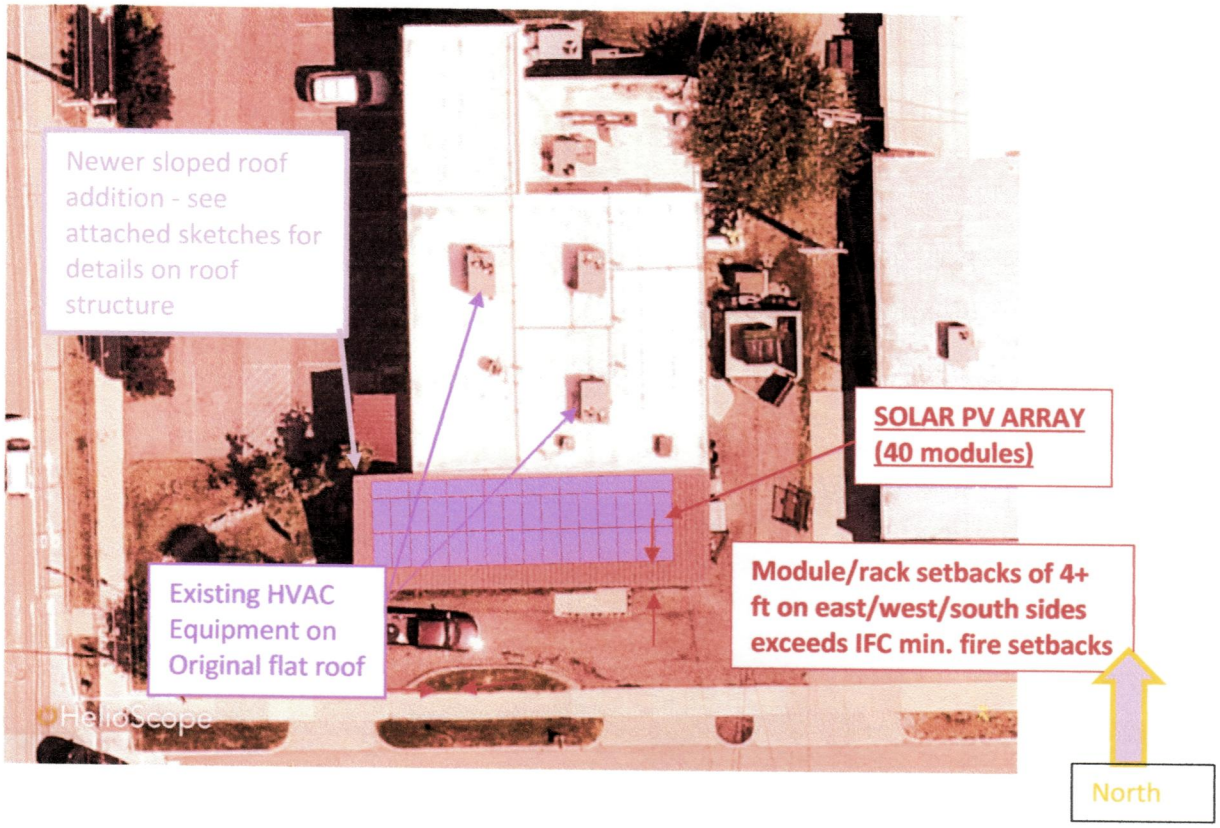
- 2015 Michigan Building Code (MBC), and 2015 Rehabilitation Code for Existing Buildings (RCEB) and 2015 International Fire Code – applicable codes per City of Ann Arbor Code of Ordinances.
- Homeland Solar, Craft Cannabis, IronRidge Racking Construction Set, Project 990547, July 18, 2022 and tentative layout for original building
- Meier Architects, Architectural Plans (Interior Renovations) for Parkhurst Services, May 2022 Issued for Permits

B. PROPOSED SOLAR PV ARRAYS:

Building Addition

The solar array on the building addition consists of a single row of (8) landscape and (32) portrait modules totaling (40) Hanwha QCells 400W mono solar modules and representing a 16 kW DC total nameplate rating, feeding DC power to a new inverter and the DTE service interconnection. The modules will be installed in rows of deck-connected IronRidge XR100 racks with nominal air gaps between the modules and existing metal roof deck with no roof penetrations. The referenced IronRidge package reveals that the solar array creates nominally 2.6 pounds per square foot of dead load and is distributed equally along each row. The MBC treats the solar PV array load as dead load as the array prevents the roof deck from further live loading (Section 1607.12.5.3), so key loads to be resisted and transferred to ground are the array/roof dead load, snow load, and wind acting on the roof deck. It was found that wind loads control over seismic for this project, particularly given the low composite dead load at the roof deck level.

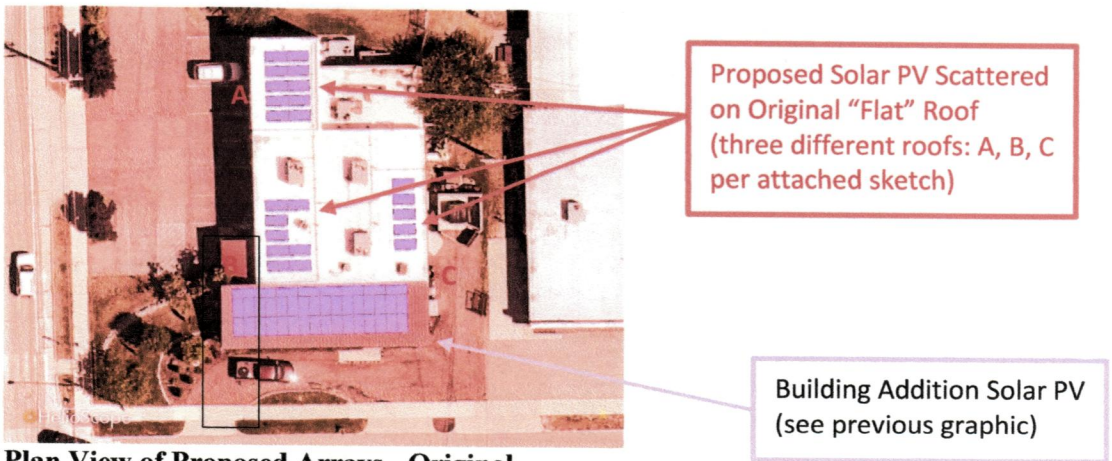
A superimposed plan view of solar array on the existing roof deck is provided below. The array will be principally visible from grade although such will not be aesthetically significant as such will blend with the deck. Electrical interconnection to the existing building power supply system is addressed in a separate Homeland permit application.



Plan View of Craft Cannabis Building Addition Roof
(Solar array with setbacks – see attached sketch for structural detail)

Original Building

The original building is uniquely comprised of a number of different interconnected spaces with different roof supporting structures including wood framing and steel trusses as described herein.



Plan View of Proposed Arrays - Original

C. NARRATIVE/ANALYSIS:

Only architectural drawings from recent business improvements were located; no structural drawings for original construction or building addition were located so a brief visual inspection were completed on July 15, 2022 (addition) and August 12, 2022 (original building) to define as-built structural configuration of the roof framing.

Building Addition

The attic space above reflected ceiling consists of 2x8 wood ceiling joists at 16-inch centers from northerly block wall to southern framed wall, indicating this building was an addition at some point in time; the 2x10 roof rafters also span from the block wall to framed southerly wall at nominally 4:12 slope connecting as shown in the attached framing sketches. The structure and deck were found in suitable condition although there appears to be some mold present in the attic space (non-structural issue). Arbor Consultants re-analyzed the building roof frame using as-recovered field dimensions, section properties/dimensions, and condition-related detail as well as IronRidge Construction Set and the MBC. Key structural/construction findings included:

- Roof rafters carry loads from the slightly sloped roof deck and deliver such to existing block and framed walls and their underlying concrete foundations via direct bearing on both ends (block wall and foundations not accessible to inspect). IronRidge solar array loads were superimposed over the field-verified structural system to enable re-analysis with MBC-mandated loads. There is no cross-bracing between the rafters but the plywood sheathing as nailed to the joists provides lateral bracing and continuity. Please see the attached sketch for details.
- The 2x10 rafters (and other lumber) do not possess mill marks; visual grading found such to be free of significant knots and other defects and were thus considered to be spruce-fir-pine #2.
- All roof framing members accessible were found in good condition. Arbor did find a few places where minor water intrusion into the building may have occurred at one time but roof deck material (architectural metal decking over plywood sheathing) appears to be in good condition.
- Load-bearing walls are assumed to be in good condition, permitting roof loads to be delivered to underlying foundations. The framed wall is plumb and no signs of structural degradation were observed; the block wall and structural connections could not be visually inspected due to access constraints.
- Solar rack loads were extracted from the referenced IronRidge Construction Set; applied loads are consistent with other deck-attached systems reviewed by Arbor Consultants, and were used with code-prescribed loads to analyze roof structures under the solar array (see attached; dead loads from existing structure and future solar loads per MBC requirements).
- Roof live, wind, and snow loads were derived from the MBC. Ground snow loads were increased to account for local drifting around and under the deck-attached solar racking.
- Because of the configuration of the overhang and rafter support along the southern framed wall, Homeland should avoid stacking large loads during solar array construction at any one point. Loads should be distributed rather than stacked (maximum stack of 200 lbs over four square feet).

The solar PV array will be installed in a single installation phase, and with roof edge distances provided in accordance but with Section 605.11.1.3.1 of the 2015 International Fire Code (IFC), that requires a minimum 4-foot setback from array to perimeter eaves of the roof. Section 605.11.1.3.2 specifying centerline aisles (4-foot width) in each direction between sub-arrays is not applicable. There are no ridges, roof hatches or dedicated smoke ventilators in the roof, so supplemental setbacks are not necessary. Arbor Consultants did not complete any smoke abatement analyses to determine if adequate ventilation exists. Based on assessment of the 2015 IFC and noted setbacks (see attached), requirements for safe perimeter setback and fireman access are accounted for. Lastly, the solar array design/construction utilizes equipment all meeting MBC Sections 1505.9 and 1510.7, including UL 1703, with installation to comply with Hanwha/IronRidge instructions.

Original Building (see attachment, page 3)
A similar approach was taken by Arbor in considering expanded solar PV sub-arrays on the original building: (1) definition of existing roof structure; (2) application of "best fit" ballasted solar PV arrays in rows to existing roof structure, to assess structural capability. There are three different roof locations considered (Roofs A, B, and C). Arbor found that each roof was comprised of different support systems:

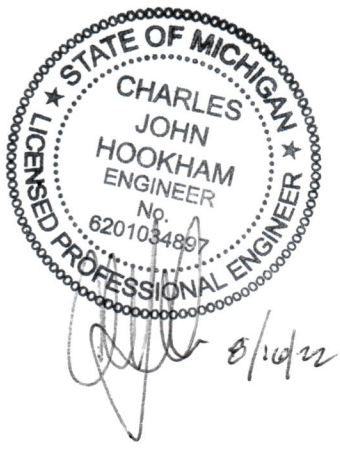
- Roof "A": Shop-fabricated steel round bar joists at 6-foot centers, spanning approximately 19 feet east-west and supported by block walls;
- Roof "B": Shop-fabricated steel angle bar joists at 6-foot to 6'-6" centers, spanning approximately 19 feet east-west and supported by block walls;
- Roof "C": 2x10 dimensional wood rafters (relatively flat) at 36-inch centers, spanning approximately 11 feet east-west and supported by block walls.

For each of these three roof sections, one common concern identified was the spacing between primary joists or rafters along with their respective spans. Typical roof live/snow loads are distributed at deck level and spread via tributary area to these joists/rafters; solar PV loads would also be principally distributed with supplemental concentrated loads at the points of ballast attachment. The distance between joists/rafters in all three Roofs A, B, and C all require the addition of new structural members underneath the planned PV system. Either an attached or heavier ballasted PV system would require significant structural reinforcing and there are many internal building constraints that would complicate said addition. In addition to requiring structure to overcome current limitations, any heavier ballasted PV array requires more ballast to resist much higher applied wind loads locally adding to reinforcing need. The existing metal deck is also uncertain in terms of its ability to safely resist and distribute any additional load to the support system. In my perspective, the elevated cost to reinforce the roofs in Roofs A and B does not support the limited additional solar PV benefits to be gained under DTE's current "distributed energy" program and payback would be a long time. Roof C is more accessible to reinforce but narrow east-west width limits how many modules can be added and all existing 2x10 rafters affected must be reinforced in addition to new 2x10s added between existing with bridging repaired.

D. CONCLUSIONS:

1. It is concluded that the southern building addition roof of the Craft Cannabis Building roof structure can support the added solar PV array and accompanying wind/snow loads without structural modification (maximum MBC-defined rafter spans exceed actual). The final arrangement meets the referenced MBC and IFC fire access requirements.
2. Given the need for significant reinforcement of each of the three roof areas of the original building for handling elevated solar PV ballast loads and disruption to the building spaces therein, the feasibility for additional solar PV modules in these areas is low and such are not recommended.

Please advise if you have any questions or concerns regarding this letter.
Regards,



Charles J. Hookham, PE

Chuck Hookham, P.E.
Michigan Professional Engineer #6201034897
Arbor Consultants, PC
Cell: (517) 416-4721

Attachments
1. Annotated Craft Cannabis Building Solar PV Array sketches (3-pages)

ARBOR CONSULTANTS PC

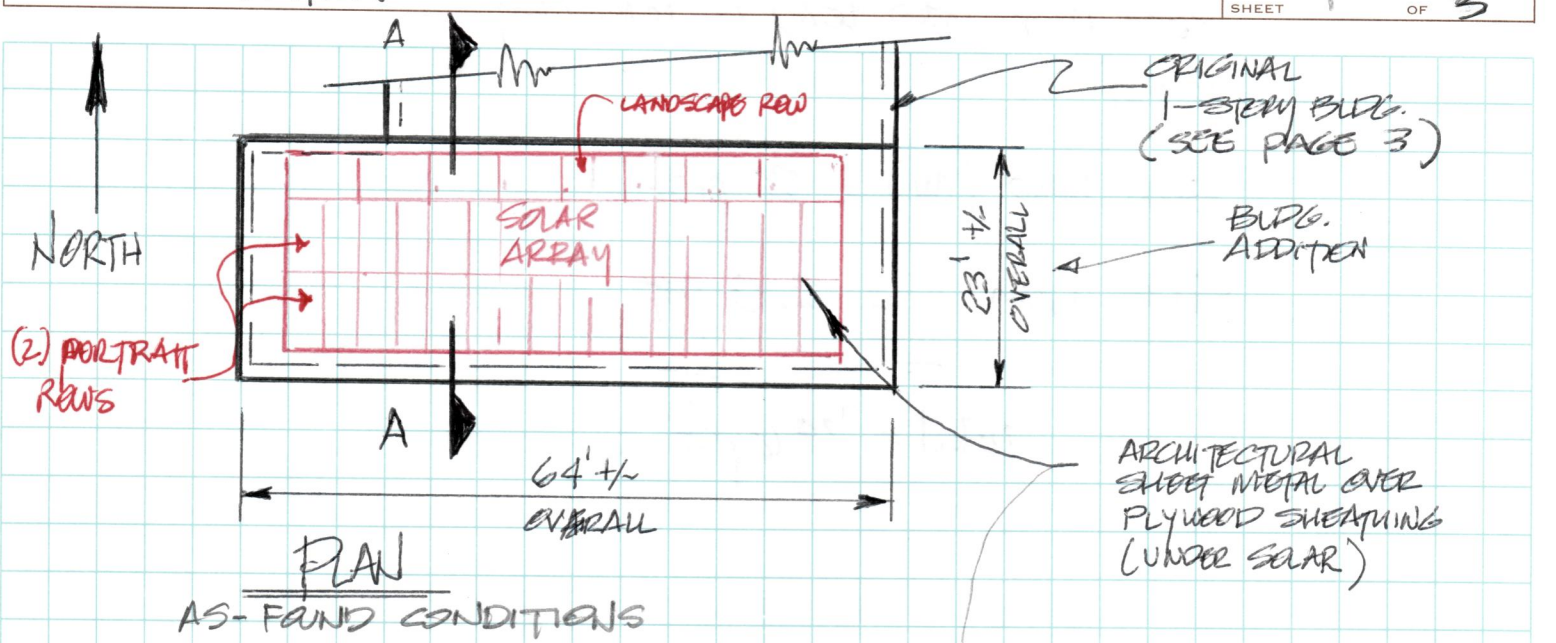
CALCULATIONS AND DESIGN DATA

PREPARED BY CM

SUBJECT CRAFT CANNABIS ROOFTOP SOLAR ANALYSIS ADDITION

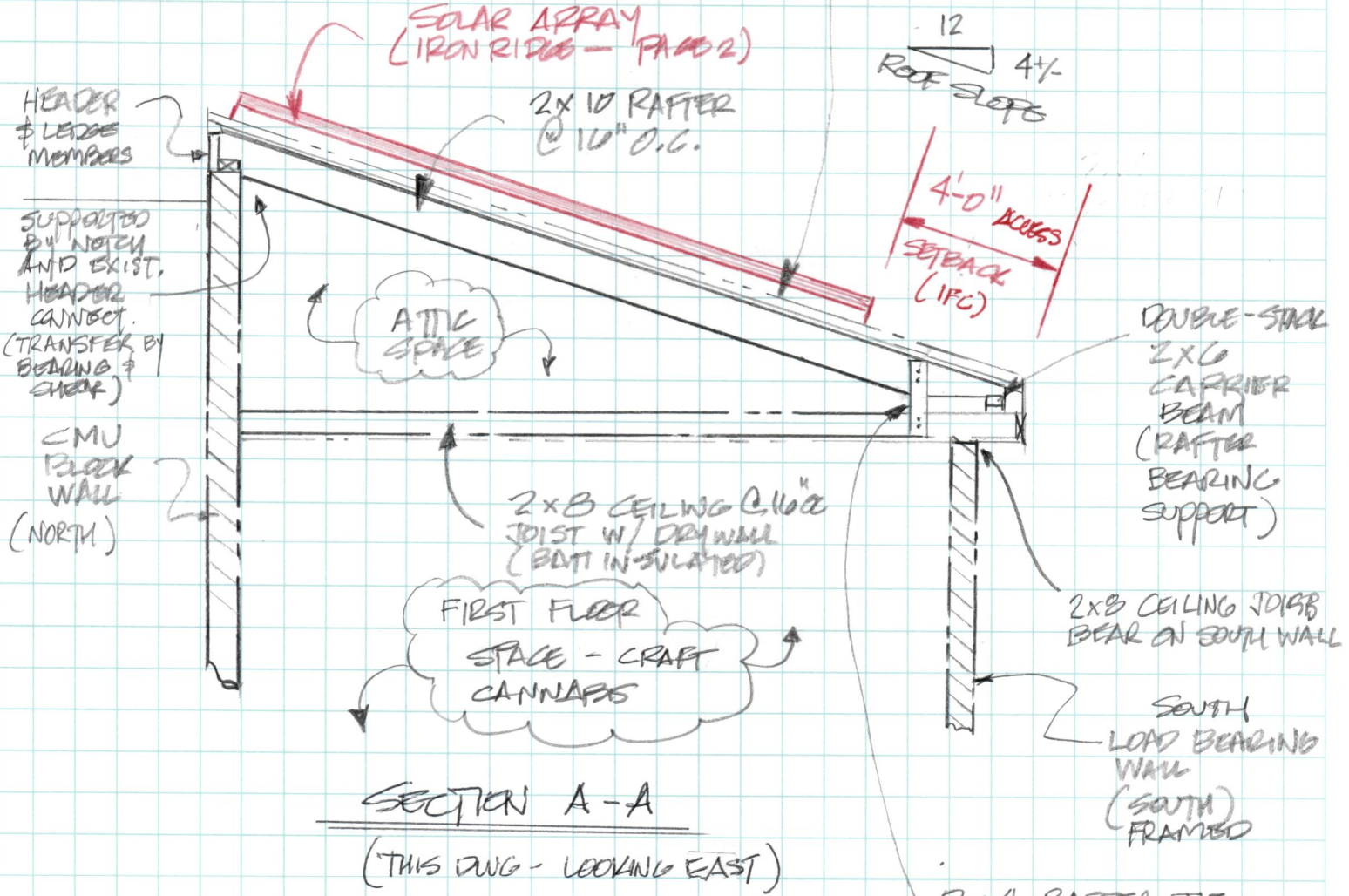
DATE 8/17/22

SHEET 1 OF 3



PLAN

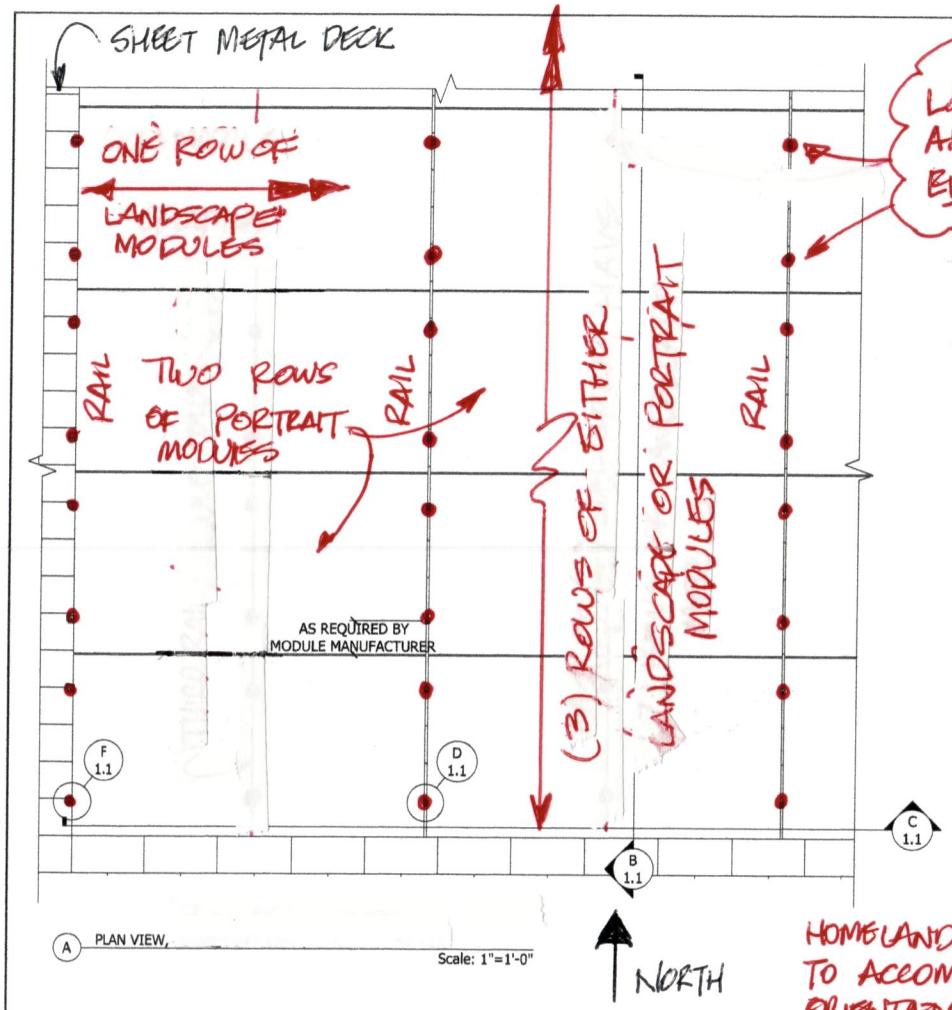
AS-FOUND CONDITIONS



SECTION A-A

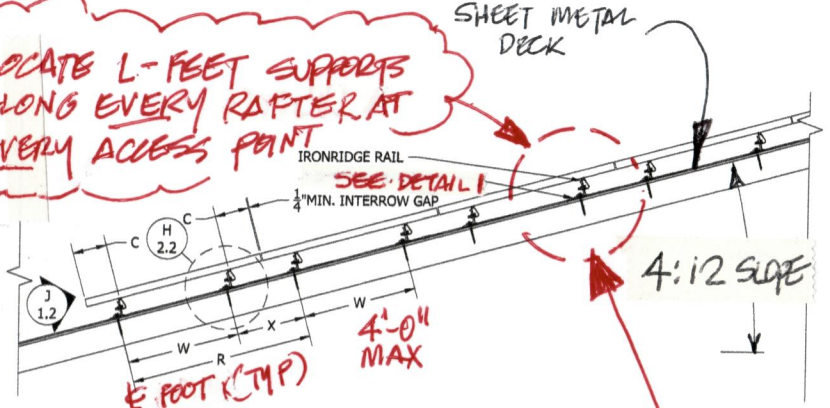
(THIS DWG - LOOKING EAST)

ARBOR CONSULTANTS
CRAFT CANNABIS - SOLAR
IRON RIDGE XR 100 DECK ATTACHMENT
PAGE 2/3



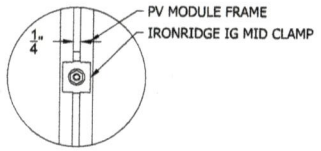
A PLAN VIEW,
Scale: 1"=1'-0"

LOCATE L-FEET SUPPORTS ALONG EVERY RAFTER AT EVERY ACCESS POINT

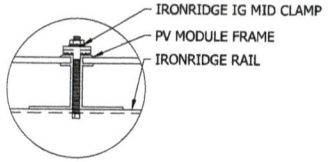


B SIDE VIEW, ~~FLASHFOOT MOUNT~~, LANDSCAPE MODULE
Scale: 1"=1'-0"

L-FOOT AND S-5 DECK ATTACH. (TYPICAL)

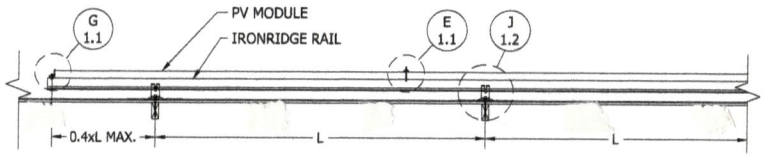


D DETAIL, MID CLAMP PLAN
Scale: 6"=1'-0"

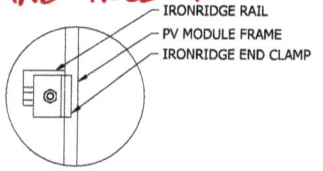


E DETAIL, MID CLAMP FRONT
Scale: 6"=1'-0"

HOMELAND TO ALIGN RACKING TO ACCOMMODATE MODULE ORIENTATION AND HOLD-DOWN



C FRONT VIEW, ~~FLASHFOOT MOUNT~~, LANDSCAPE MODULE
Scale: 1"=1'-0"



F DETAIL, END CLAMP PLAN
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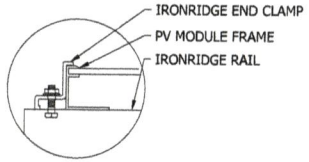


G DETAIL, END CLAMP FRONT
Scale: 6"=1'-0"

IRON RIDGE XR 100 RAIL SYSTEM

IRONRIDGE
1495 ZEPHYR AVE. HAYWARD, CA 94544
800.227.8523 IRONRIDGE.COM

CLIENT NAME
IRONRIDGE
PROJECT NAME
SLOPED ROOF MOUNT SYSTEM
PROJECT ADDRESS
SYSTEM KW DC

WIND SPEED, MPH
SNOW LOAD, PSF
EXPOSURE CAT
RISK CAT
MODULE TYPE
MODULE W DC
MODULE QTY
- - - - 72-CELL, GENERIC - -

APPROVAL STATUS
NOT FOR CONSTRUCTION

REVISION HISTORY

REV	DESCRIPTION	DATE

SHEET NAME
SLOPED ROOF PV SYSTEM DETAILS:
~~FLASHFOOT~~

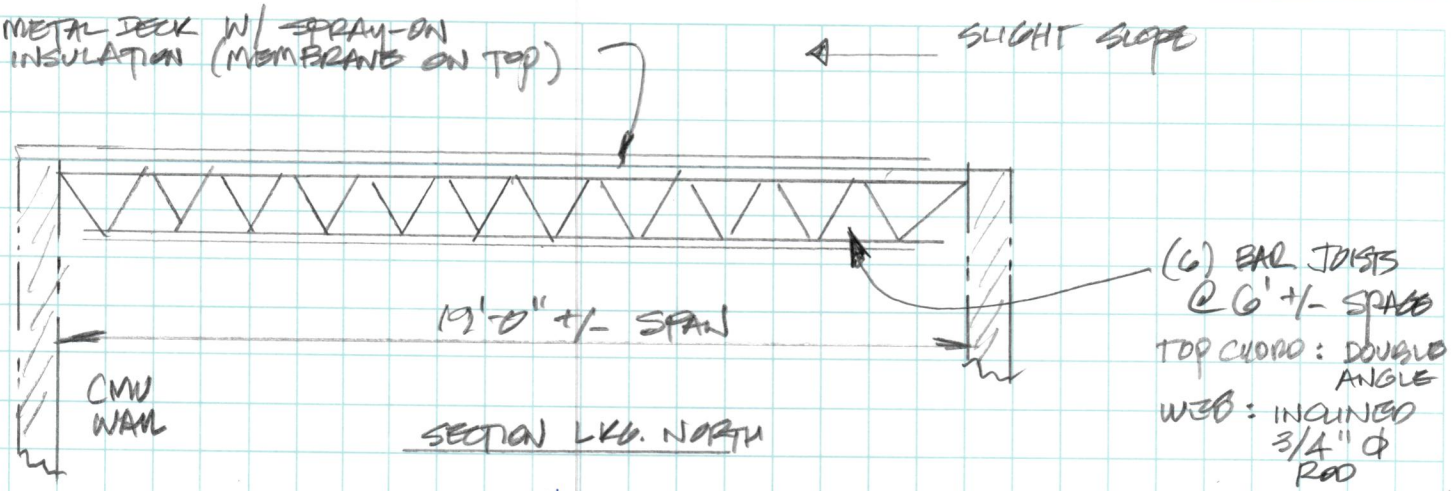
JOB NO.	3.1 SR
ISSUE DATE	XX FEB 2016
SHEET NO.	IR 1.1
SHEET SIZE	24X36

ARBOR CONSULTANTS PC — CALCULATIONS AND DESIGN DATA — PREPARED BY CWT

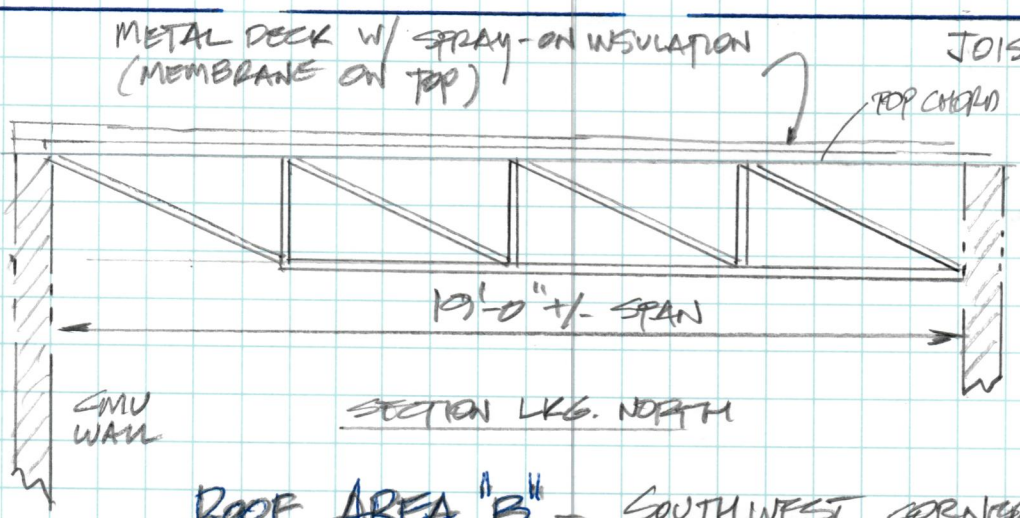
SUBJECT: CRAFT CANNABIS ROOFTOP SOLAR ANALYSIS
ORIGINAL BUILDING

DATE: 8/17/22

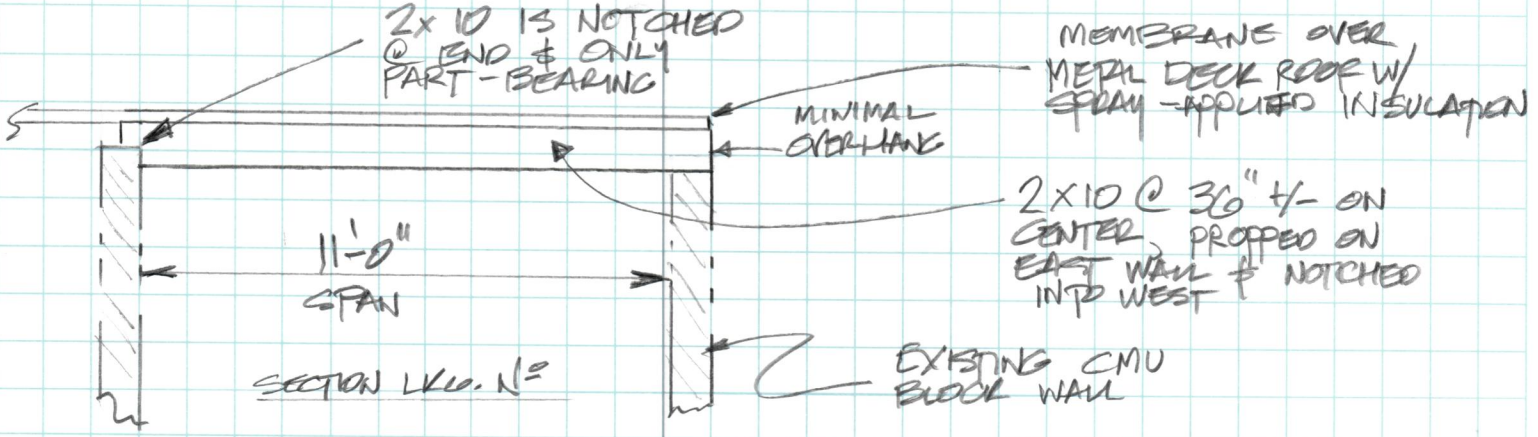
SHEET 3 OF 3



ROOF AREA "A" — NORTHWEST CORNER OF EXISTING BLDG.



ROOF AREA "B" — SOUTHWEST CORNER OF EXISTING BUILDING



ROOF AREA "C" — SOUTHEAST CORNER OF EXISTING BUILDING