ADDENDUM NO. 2
REQUEST FOR SEALED PROPOSALS
27DJ-00415

PURPOSE: The purpose of this Addendum is to clarify, modify, or supplement the originally published terms, conditions, specifications, or documents, in order to ensure that all Proposers receive the same accurate and up-to-date information.

This document is incorporated into and becomes an integral part of the Request for Sealed Proposals for the Design-Build of Puerto Rico's New Trauma Hospital. All terms, conditions, provisions, and specifications contained in the original RFP shall remain in full force and effect, without alteration, and shall apply in their entirety to this supplement and any related process, its content shall prevail over any prior provision in the event of a conflict.

MODIFY

1. Proposals Opening. The Procurement Manager will open the proposals in Puerto Rico's Medical Center, ASEM's Central Laundry Conference Room, located in the Bo. Monacillos, San Juan, Puerto Rico and will be streamed live via Microsoft Teams, as posted on the website **https://www.asem.pr.gov/administrativo#Avisos**

2. The C-Arm information provided as part of Attachment F of the Request for Sealed Proposals is replaced by the following text:

EQUIPMENT	USAGE DESCRIPTION	EQUIPMENT SPECIFICATIONS
C-Arm	It is a mobile fluoroscopy unit used to obtain real-time radiographic images during surgical or interventional procedures.	Mobile digital C-arm with flat panel detector for surgical and interventional procedures. High frequency X-ray generator, minimum 15 kW, with rotation anode X Ray tube. Flat panel detector: minimum 26X26 cm, pixel pitch ≤184 µm. C-arm depth ≥70 cm with orbital

		angulation of approximately 140° or greater. Integrated laser positioning and motorized collimation. Digital fluoroscopy and radiography with pulsed fluoroscopy, dose optimization, and advance imaging processing. Mobile viewing station with two 19" or large high brightness color LCD monitors, each with a resolution ≥1280 x 1024, luminance ≥ 650 cd/ m^2, contrast ratio of ≥700:1, and viewing angle of ≥170°. Touchscreen or tablet style user interface for image processing, patient data manage, and real time image viewing; monitors compliant with DICOM GSDF. DICOM Connectivity for PACS/RIS, including modality Performed Procedure Step (MPPS) with USB image export. Complete system, including workstation, acquisition software, cables, power cord, and all accessories required for operation. Electrical requirements: 120 VAC, 60HZ. Includes installation, calibration, acceptance testing, training, and technical support. 1-year warranty on parts and labor.

3. The title of section 10.1.2.1 in the Table of Contents, on page iv of viii of the Request for Sealed Proposals, should read "*General Contractor Experience and Past Performance* ".

4. The title of section 10.1.2.4.2 in the Table of Contents, on page iv of viii of the Request for Sealed Proposals, should read "Campus Logistics." ".

5. The title of Attachment 7 of the Request for Sealed Proposals should read " *HUD General Provisions and other Federal Statutes, Regulations, and PRDOH Requirements of Healthcare Strengthening Set-Aside*".

ADDITIONAL

1. The contract resulting from this Request for Sealed Proposals process will have a term of 60 months. The project execution period will be 54 months (Phase 1: 21 months and Phase 2: 33 months).

2. Proposers may access the recording of the Pre-Proposal Meeting through the following link: https://www.asem.pr.gov/administrativo#Avisos

3. Explosive and Flammable Hazards (24 CFR Part 51 Subpart C)

   The project is located near facilities that store, handle, or process flammable or explosive hazardous substances, which can expose the inhabitants of the Project to the risk of injury in the event of a fire or an explosion.

   To identify stationary hazards, the following were conducted:

   - Identification of a 1-mile (5,280 feet) radius of the project of any current or planned stationary aboveground storage tank (AST) with more than 100-gallon capacity, containing common liquid industrial fuels or any capacity, containing hazardous liquids or gases that are not common liquid industrial fuel.

   - Georeferenced photos were taken of the Hazard stationary or the place where it is located.

   - The type of material, capacity of the tanks, and information on the dams were identified.

   - The tanks were in an aerial photo to determine the distance from the project.

- The acceptable distance was determined using the Acceptable Separation Distance (ASD) Electronic Assessment Tool. https://www.hudexchange.info/environmental-review/asd calculator/.

- The ASD is measured from the center of the assessed container to the perimeter of the Project.

A stationary hazards assessment for the project site was conducted based on field investigations performed on January 9, 2026, and September 23, 2026, in accordance with HUD requirements under 24 CFR Part 51, Subpart C. The field investigations were conducted to identify, document, and verify stationary aboveground storage hazards within the study area, including fuel and gas storage systems located throughout the Centro Médico campus and at surrounding institutional and commercial properties. The identified stationary hazards include diesel and propane storage tanks, liquid oxygen (LOX) tanks, and diesel tanks integrated into emergency generators.

The assessment identified and evaluated a total of 98 individual stationary hazard entries. **Exhibit A - Stationary Hazards Location (Requiring Mitigation)** of this document identifies and depicts the location of each aboveground storage tank (AST) and stationary hazard evaluated in relation to the proposed project site, while **Exhibit B – Stationary Hazards Table** of this document provides the corresponding hazard identification, location, description, storage capacity, distance from the project, applicable Acceptable Separation Distances (ASDs) for people and buildings, existing dike information, where applicable, and mitigation determination.

Acceptable Separation Distances (ASDs) for people and buildings were evaluated for the stationary hazards identified in **Exhibit A** of this document. Based on the evaluation, most of the stationary hazards are identified as "Not Required" for mitigation. **Exhibit B** of this document identifies 16 individual hazards as "Required" for mitigation or further evaluation: Hazards 16, 16b, 18, 19, 20, 23, 24,24b, 27, 29a, 29b, 31, 32, 33, 34, and 36.

Hazard 16 consists of a 15,000-gallon diesel tank at the San Juan City Hospital, located approximately 330 feet from the project. The ASD is 854.59 feet for people and 175.84 feet for buildings. An existing approximately 15-foot-by-25-foot spill-prevention dike is identified. The project distance meets the ASD for buildings but is about 524.59 feet less than the ASD for people; therefore, mitigation is required.

Hazard 16b consists of a proposed 4,000-gallon diesel tank at the San Juan City Hospital, located approximately 320 feet from the project. The ASD is 540.74 feet for people and 105.81 feet for buildings. The project distance satisfies the ASD for

buildings but is approximately 220.74 feet less than the ASD for people. Mitigation is identified as required.

Hazard 18 consists of an 8,000-gallon diesel tank at the San Juan City Hospital, located approximately 334 feet from the project. The ASD is 657.70 feet for people and 131.49 feet for buildings. An existing approximately 12-foot-by-12-foot spill-prevention dike is identified. The tank satisfies the ASD for buildings but is approximately 323.70 feet less than the ASD for people; mitigation is identified as required.

Hazard 19 consists of a 1,500-gallon diesel tank at the San Juan City Hospital, located approximately 277 feet from the project. The ASD is 327.46 feet for people and 60.65 feet for buildings. The tank satisfies the ASD for buildings but is approximately 50.46 feet less than the ASD for people; mitigation is identified as required.

Hazard 20 consists of a 5,000-gallon diesel tank at ASEM, located approximately 506 feet from the project. The ASD is 540.74 feet for people and 105.81 feet for buildings. An existing approximately 12-foot-by-12-foot spill-prevention dike is identified. The tank satisfies the ASD for buildings but is approximately 34.74 feet less than the ASD for people; mitigation is identified as required.

Hazard 23 consists of a 3,000-gallon diesel tank at the Industrial Hospital, located approximately 250 feet from the project. The ASD is 437.09 feet for people and 83.56 feet for buildings. The tank satisfies the ASD for buildings but is approximately 187.09 feet less than the ASD for people; mitigation is identified as required.

Hazard 24 consists of a 5,000-gallon diesel tank at the Oncology Hospital, located approximately 376 feet from the project. The ASD is 540.74 feet for people and 105.81 feet for buildings. The tank satisfies the ASD for buildings but is approximately 164.74 feet less than the ASD for people; mitigation is identified as required.

Hazard 24b consists of a 3,000-gallon liquid oxygen (LOX) tank at the Oncology Hospital, located approximately 364 feet from the project. The applicable ASD is 437.09 feet for people and 83.56 feet for buildings. The project distance satisfies the ASD for buildings but is approximately 73.09 feet less than the ASD for people. Therefore, mitigation or further evaluation is identified as required.

Hazard 27 consists of a 4,000-gallon diesel tank at the Oncology Hospital, located approximately 273 feet from the project. The ASD is 492.74 feet for people and 95.44 feet for buildings. The tank satisfies the ASD for buildings but is approximately 219.74 feet less than the ASD for people. Mitigation is identified as required.

Hazards 29a and 29b consist of two generator-integrated diesel tanks at the Industrial Hospital, each with a capacity of 4,096 gallons and located approximately 142 feet

from the project. The ASD is 497.63 feet for people and 96.49 feet for buildings. Both tanks satisfy the ASD for buildings but are approximately 355.63 feet less than the ASD for people. Mitigation is identified as required for both tanks.

Hazard 31 consists of a generator-integrated 1,500-gallon diesel tank at the Industrial Hospital, located approximately 62 feet from the project. The ASD is 327.46 feet for people and 60.65 feet for buildings. The project distance satisfies the ASD for buildings by approximately 1.35 feet but is approximately 265.46 feet less than the ASD for people. An existing approximately 12-foot-by-10-foot spill-prevention dike is identified. Mitigation is identified as required.

Hazard 32 consists of a generator-integrated 1,200-gallon diesel tank at Abigail Robles/ASEM, located approximately 55 feet from the project. The ASD is 298.39 feet for people and 54.70 feet for buildings. The project distance satisfies the ASD for buildings by approximately 0.30 feet but is approximately 243.39 feet less than the ASD for people. Mitigation is identified as required. Hazard 32 represents the shortest reported separation distance among the stationary hazards identified as requiring mitigation.

Hazard 33 consists of a generator-integrated 450-gallon diesel tank at the Oncology Hospital, located approximately 190 feet from the project. The ASD is 198.30 feet for people and 37.76 feet for buildings. The project distance satisfies the ASD for buildings but is approximately 8.30 feet less than the ASD for people. Mitigation is identified as required.

Hazard 34 consists of a generator-integrated 3,000-gallon diesel tank at ASEM, located approximately 236 feet from the project. The ASD is 437.09 feet for people and 83.56 feet for buildings. An existing approximately 15-foot-by-10-foot spill-prevention dike is identified. The tank satisfies the ASD for buildings but is approximately 201.09 feet less than the ASD for people; mitigation is identified as required.

Hazard 36 consists of a generator-integrated 8,000-gallon diesel tank at the Pediatric Hospital, located approximately 503 feet from the project. The ASD is 657.70 feet for people and 131.49 feet for buildings. The tank meets the ASD for buildings but is about 154.70 feet below the ASD for people; mitigation is required.

Mitigation Measures – Stationary Hazards

Buildings and other physical features between certain identified stationary hazards and the Design-Build of Puerto Rico's New Trauma Hospital may reduce direct exposure to thermal radiation and blast overpressure. However, the presence of an intervening structure does not, by itself, demonstrate compliance with 24 CFR Part 51,

Subpart C or establish that the structure provides an acceptable level of protection. Where an existing natural or man-made barrier is proposed to provide mitigation, its adequacy shall be evaluated to determine whether it provides the required level of protection.

For the stationary hazards identified in **Exhibit B** of this document as requiring mitigation or further evaluation, a detailed, site-specific engineering evaluation shall be completed before commencement of construction of the Design-Build of Puerto Rico's New Trauma Hospital. The Design-Builder shall be responsible for retaining a qualified licensed professional engineer experienced in civil or structural engineering to perform and certify the required evaluation. The engineering evaluation shall determine the mitigation measures, if any, required for each applicable stationary hazard to provide the level of protection required under 24 CFR Part 51, Subpart C.

ASEM has incorporated this requirement into the procurement process through an *Addendum to the Request for Sealed Proposals* (RFP). The RFP Addendum establishes the Design-Builder's responsibility for retaining the qualified licensed professional engineer and for completing the required engineering evaluation and the design and implementation of any mitigation measures determined to be necessary for compliance with the applicable HUD requirements.

The engineering evaluation shall consider, as applicable, the type and quantity of material stored; tank capacity; existing separation distance; orientation relative to the Design-Build of Puerto Rico's New Trauma Hospital; relative elevations of the hazard and exposed receptors; and the location, height, width, continuity, configuration, and structural characteristics of any buildings, walls, walkways, roofs, dikes, or other physical elements located between the hazard and the project. Where an existing natural or man-made barrier is proposed to provide mitigation, the licensed professional engineer shall evaluate its adequacy for the applicable thermal heat flux, blast overpressure, or both, as appropriate.

No existing building, wall, dike, or other physical feature shall be relied upon as mitigation solely because it interrupts the line of sight between a stationary hazard and the project. Any such feature proposed to provide mitigation shall be evaluated and certified by the licensed professional engineer as providing an acceptable level of protection consistent with applicable HUD requirements.

Where the engineering evaluation determines that existing site conditions do not provide the required level of protection, the Design-Builder shall be responsible for incorporating the mitigation measures identified by the licensed professional engineer into the final project design, plans, specifications, and construction documents and for implementing the required mitigation measures. Depending on the applicable hazard and site conditions, such measures may include relocation,

removal, or burial of storage containers; reduction or modification of storage capacity; reconfiguration of the site plan to increase separation; modification of the building design; use or modification of existing natural or man-made barriers; construction or modification of dikes or containment features; construction of purpose-designed protective barriers; or other measures determined by the licensed professional engineer to provide an acceptable level of protection under applicable HUD requirements.

If a purpose-designed protective barrier is required, the barrier should be designed to address applicable thermal radiation, blast overpressure, or both, based on the site-specific engineering analysis. HUD's *Barrier Design Guidance for HUD Assisted Projects Near Hazardous Facilities* **Exhibit D** of this document shall be provided to and used by the licensed civil or structural professional engineer responsible for the mitigation analysis and design. The Design-Builder shall be responsible for coordinating the design and construction of any required protective barrier or other physical mitigation measure in accordance with the licensed professional engineer's evaluation and applicable HUD requirements.

Prior to commencement of construction of the Design-Build of Puerto Rico's New Trauma Hospital, the Design-Builder shall complete the required site-specific engineering evaluation through the retained licensed professional engineer and shall incorporate all mitigation measures determined to be necessary into the final project design, plans, specifications, and construction documents. No construction of the Design-Build of Puerto Rico's New Trauma Hospital shall commence until the responsible entity has received documentation from the licensed professional engineer identifying the required mitigation measures and confirming that the project design incorporates those measures.

Any mitigation measure that must be physically constructed or installed to provide the required protection shall be implemented in accordance with the site-specific engineering evaluation and shall be completed before construction activities would result in exposure of the HUD-assisted project to the applicable stationary hazard. Upon completion, the licensed professional engineer shall verify and provide written certification that the required mitigation measures have been implemented in accordance with the approved engineering evaluation and design and provide the level of protection required under 24 CFR Part 51, Subpart C.

The engineering evaluation, final plans and specifications, professional certifications, and documentation demonstrating implementation of the required mitigation measures shall be maintained as part of the Environmental Review Record.

Stationary hazards identified in **Exhibit B** of this document as being located beyond the applicable ASD or otherwise meeting the applicable HUD separation requirements do not require additional mitigation under 24 CFR Part 51, Subpart C.

4. The utility plans generated by the project named "Nueva Plazoleta" are provided. Refer to **Exhibit E**

In San Juan, Puerto Rico, today October 16, 2026.

Celeste Robles Batolomei
Procurement Manager
Puerto Rico Medical Services Administration

Exhibits:

A: Stationary Hazard Location (Requiring Mitigation)
B: Stationary Hazard Table
C: Photos of the AST
D: HUD's Barrier Design Guidance for HUD Assisted Projects Near Hazardous Facilities
E: Utility Plans by "Nueva Plazoleta" project

Exhibit A: Stationary Hazard Location (Requiring Mitigation)

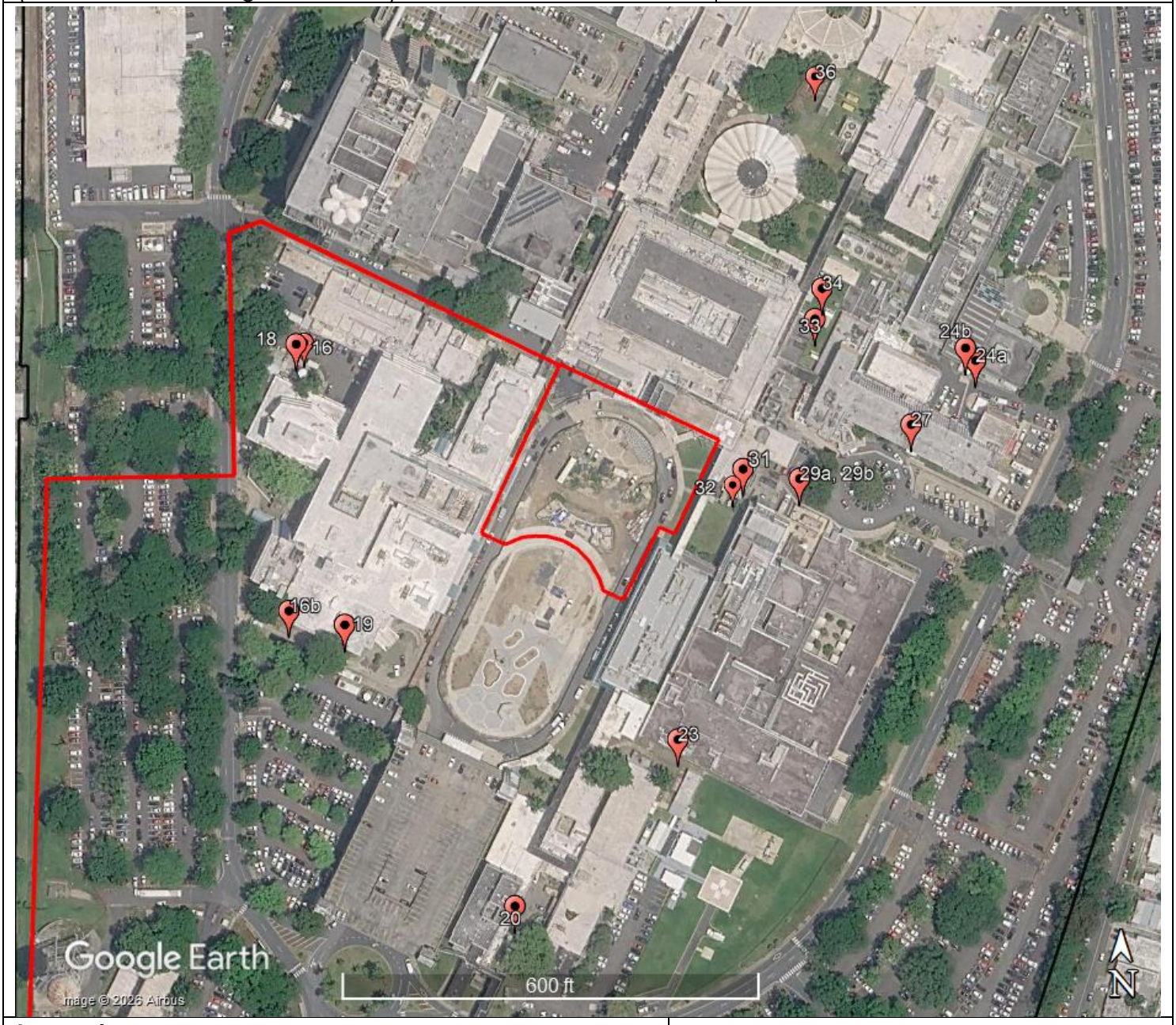
Stationary Hazards Location
(Requiring Mitigation)
(INFRA-HSAS-00005)

Centro Médico de Puerto Rico, St.22,
Bo. Monacillos, San Juan, PR 00935
(Lat: 18.395740, Long: -66.073640)

Green PRojects

Prepared on
10/12/2026





Legend:

- Project Limit
- Property Limit

Source: Google Earth
Spatial Reference, Accessed on: 10/12/26,
Effective Date: June, 2026
https://earth.google.com/web/@18.3958646,-66.0736306

Exhibit B: Stationary Hazard Table

Stationary Hazards Table:

AST ID	Location	Description Stationary Hazards	Project Distance (fT)	Acceptable Separation Distance (ft)		Dike	Mitigation
				People	Buildings		
16	18.39561, -66.07508 San Juan City Hospital	Diesel Tank 15,000 gal	330	854.59	175.84	15x25 (Spill Prevention)	Required
16b	18.39455, -66.07514 San Juan City Hospital	Proposed Diesel Tank 4,000 gal	320	540.74	105.81		Required
18	18.39561, -66.07509 San Juan City Hospital	Diesel Tank 8,000 gal	334	657.70	131.49	12x12 (Spill Prevention)	Required
19	18.39448, -66.07492 San Juan City Hospital	Diesel Tank 1,500 gal	277	327.46	60.65		Required
20	18.39339, -66.07420 ASEM	Diesel Tank 5,000 gal	506	540.74	105.81	12x12 (Spill Prevention)	Required
23	18.39404, -66.07352 Industrial	Diesel Tank 3,000 gal	250	437.09	83.56		Required
24a	18.39553, -66.07229 Oncologico	Diesel Tank 5,000 gal	376	540.74	105.81		Required
24b	18.39558, -66.07233 Oncologico	LOX (Liquid Oxygen) Tank 3,000 gal	364	437.09	83.56		Required

27	18.39528, -66.07256 Oncologico	Diesel Tank 4,000 gal	273	492.74	95.44		Required
29a	18.39507, -66.07302 Industrial	Generator Integrated Diesel Tank 4,096 gal	142	497.63	96.49		Required
29b	18.39507, -66.07302 Industrial	Generator Integrated Diesel Tank 4,096 gal	142	497.63	96.49		Required
31	18.39511, -66.07325 Hospital Industrial	Generator Integrated Diesel Tank 1,500 gal	62	327.46	60.65	12x10 (Spill Prevention)	Required
32	18.39507, -66.07330 Abigail Robles ASEM	Generator Integrated Diesel Tank 1,200 gal	55	298.39	54.70		Required
33	18.39570, -66.07296 Oncologico	Generator Integrated Diesel Tank 450 gal	190	198.30	37.76		Required
34	18.39582, -66.07293 ASEM	Generator Integrated Diesel Tank 3,000 gal	236	437.09	83.56	15x10 (Spill Prevention)	Required
36	18.39667, -66.07296 Pediatrico	Generator Integrated Diesel Tank 8,000 gal	503	657.70	131.49		Required

Exhibit C: Photos of the AST

Photos of the AST:

16. San Juan City Hospital Diesel Tank
15,000 gal
Coordinates: 18.39561, -66.07508



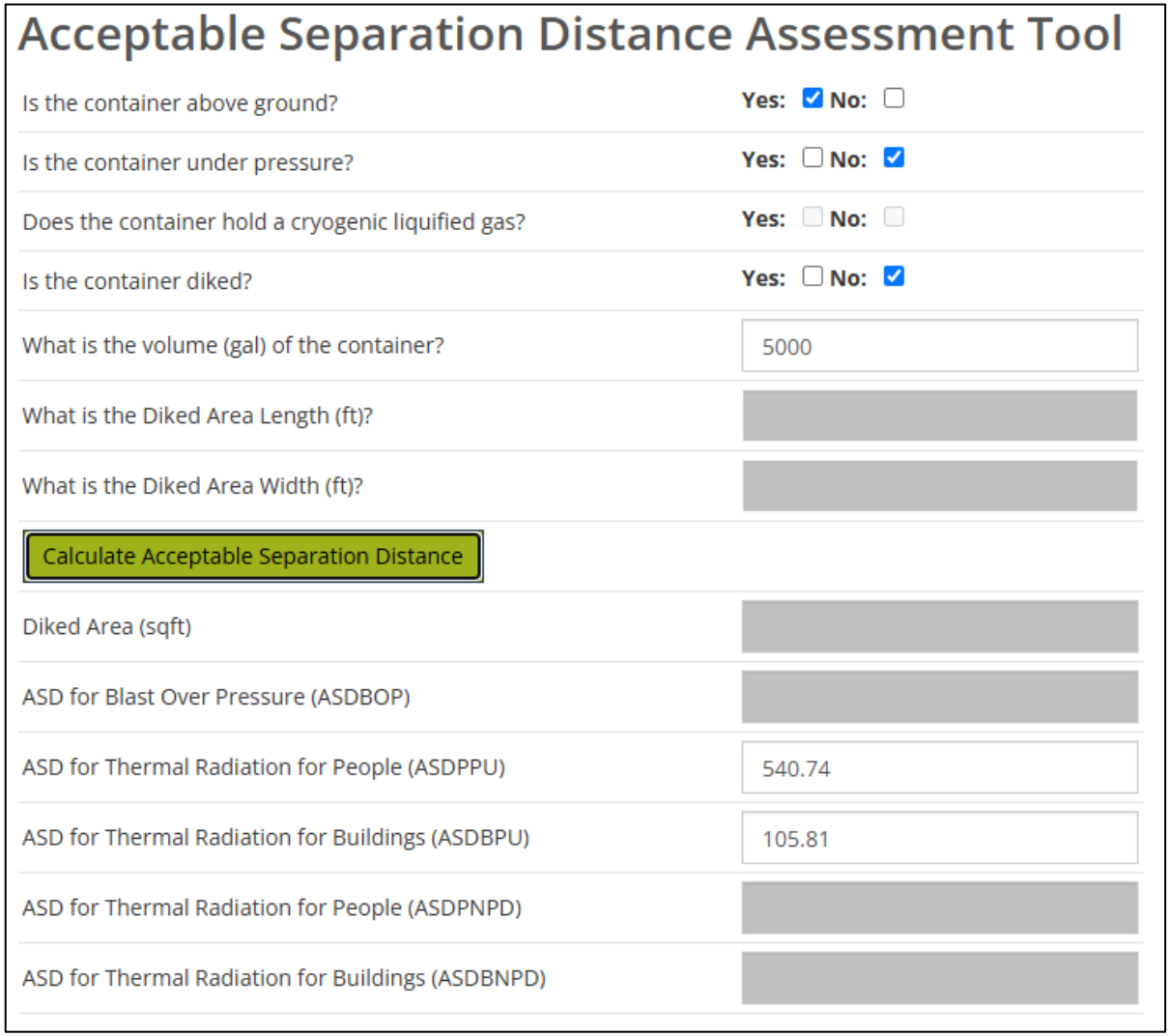
Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	15000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	854.59
ASD for Thermal Radiation for Buildings (ASDBPU)	175.84
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

16b. San Juan City Hospital **Proposed Diesel Tank**

5,000 gal

Coordinates: 18.39455, -66.07514



Acceptable Separation Distance Assessment Tool

Is the container above ground?	**Yes:** ☑ **No:** ☐
Is the container under pressure?	**Yes:** ☐ **No:** ☑
Does the container hold a cryogenic liquified gas?	**Yes:** ☐ **No:** ☐
Is the container diked?	**Yes:** ☐ **No:** ☑
What is the volume (gal) of the container?	5000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	540.74
ASD for Thermal Radiation for Buildings (ASDBPU)	105.81
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

18. San Juan City Hospital Diesel Tank
8,000 gal
Coordinates: 18.39561, -66.07509



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	8000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	657.70
ASD for Thermal Radiation for Buildings (ASDBPU)	131.49
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

19. San Juan City Hospital Diesel Tank
1,500 gal
Coordinates: 18.39448, -66.07492



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	1500
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	327.46
ASD for Thermal Radiation for Buildings (ASDBPU)	60.65
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

20. ASEM Diesel Tank
5,000 gal
Coordinates: 18.39339, -66.07420



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	5000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	540.74
ASD for Thermal Radiation for Buildings (ASDBPU)	105.81
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

23. Industrial, Diesel Tank
3,000 gal
Coordinates: 18.39402, -66.07351



Acceptable Separation Distance Assessment Tool

Is the container above ground?	**Yes:** ☑ **No:** ☐
Is the container under pressure?	**Yes:** ☐ **No:** ☑
Does the container hold a cryogenic liquified gas?	**Yes:** ☐ **No:** ☐
Is the container diked?	**Yes:** ☐ **No:** ☑
What is the volume (gal) of the container?	3000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	437.09
ASD for Thermal Radiation for Buildings (ASDBPU)	83.56
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

24a. Oncológico Diesel Tank

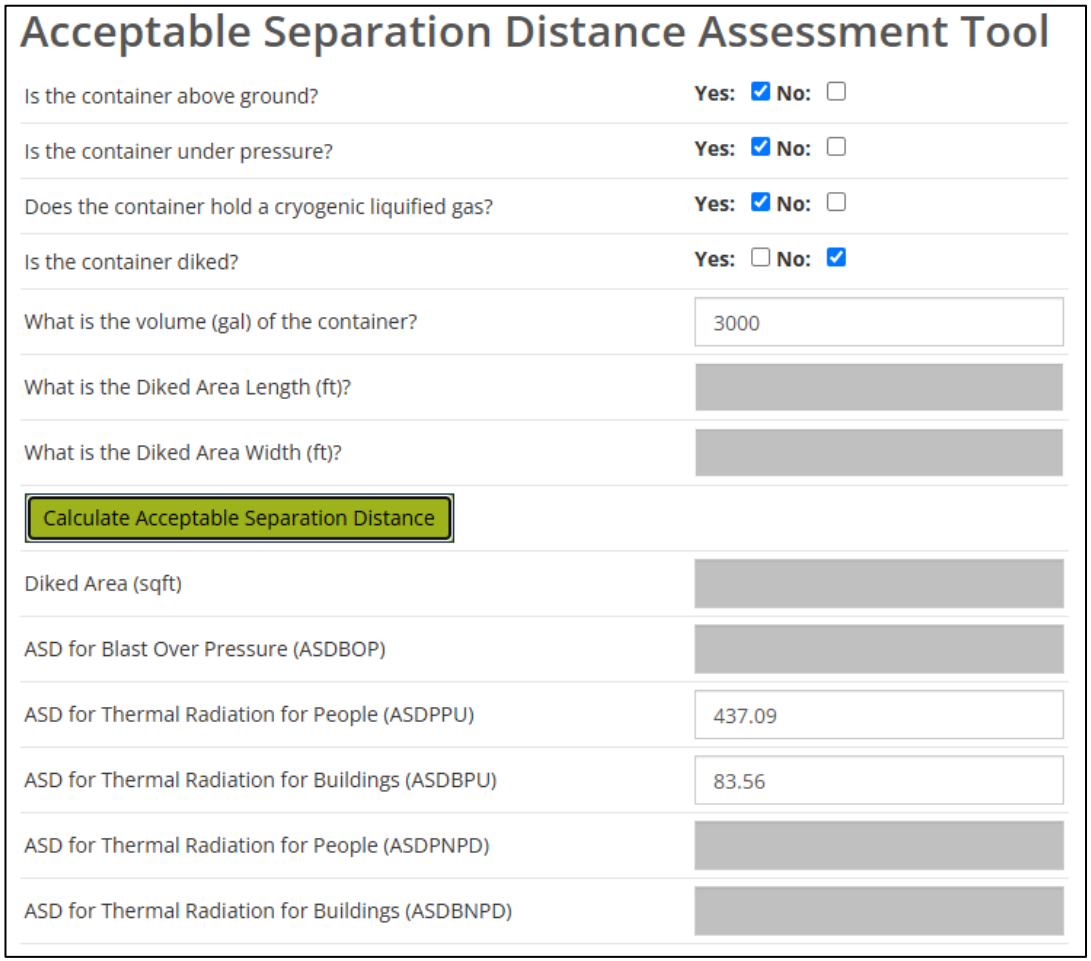
5,000 gal
Coordinates: 18.39553, -66.07229

Acceptable Separation Distance Assessment Tool

Is the container above ground?	**Yes:** ☑ **No:** ☐
Is the container under pressure?	**Yes:** ☐ **No:** ☑
Does the container hold a cryogenic liquified gas?	**Yes:** ☐ **No:** ☐
Is the container diked?	**Yes:** ☐ **No:** ☑
What is the volume (gal) of the container?	5000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	540.74
ASD for Thermal Radiation for Buildings (ASDBPU)	105.81
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

24b. Oncológico LOX (Liquid Oxygen) Tank

3,000 gal
Coordinates: 18.39558, -66.07233



Acceptable Separation Distance Assessment Tool

Is the container above ground?	**Yes:** ☑ **No:** ☐
Is the container under pressure?	**Yes:** ☑ **No:** ☐
Does the container hold a cryogenic liquified gas?	**Yes:** ☑ **No:** ☐
Is the container diked?	**Yes:** ☐ **No:** ☑
What is the volume (gal) of the container?	3000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	437.09
ASD for Thermal Radiation for Buildings (ASDBPU)	83.56
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

27. Oncológico Diesel Tank
4,000 gal
Coordinates: 18.39528, -66.07256



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	4000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	492.74
ASD for Thermal Radiation for Buildings (ASDBPU)	95.44
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

29a, 29b. Industrial, 2 Generator Integrated Diesel Tank

4,096 gal each / 8,192 gal total
Coordinates: 18.39507, -66.07302



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	4096
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	497.63
ASD for Thermal Radiation for Buildings (ASDBPU)	96.49
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

31. Hospital Industrial Generator Integrated Diesel Tank
1,500 gal
Coordinates: 18.39511, -66.07325



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	1500
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	327.46
ASD for Thermal Radiation for Buildings (ASDBPU)	60.65
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

32. Abigail Robles ASEM Generator Integrated Diesel Tank
1,200 gal
Coordinates: 18.39507, -66.07330



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	1200
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	298.39
ASD for Thermal Radiation for Buildings (ASDBPU)	54.70
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

33. Oncologico Generator Integrated Diesel Tank
450 gal
Coordinates: 18.39570, -66.07296



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	450
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	198.30
ASD for Thermal Radiation for Buildings (ASDBPU)	34.76
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

34. ASEM Generator Integrated Diesel Tank
3,000 gal
Coordinates: 18.39582, -66.07293



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	3000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	437.09
ASD for Thermal Radiation for Buildings (ASDBPU)	83.56
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

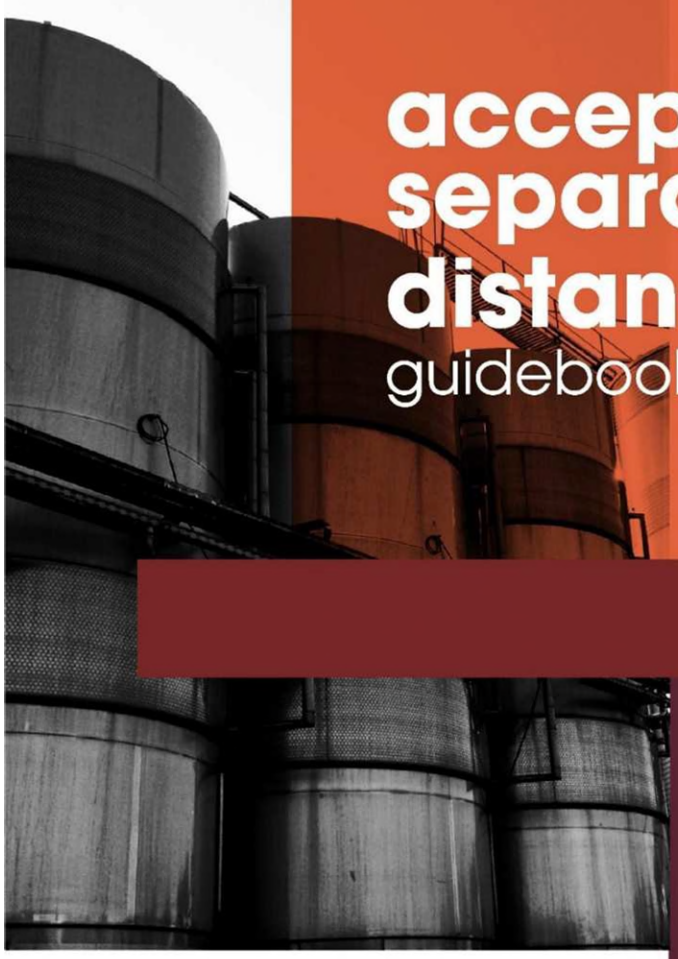
36. Pediatrico Generator Integrated Diesel Tank
8,000 gal
Coordinates: 18.39667, -66.07296



Acceptable Separation Distance Assessment Tool

Is the container above ground?	Yes: ☑ No: ☐
Is the container under pressure?	Yes: ☐ No: ☑
Does the container hold a cryogenic liquified gas?	Yes: ☐ No: ☐
Is the container diked?	Yes: ☐ No: ☑
What is the volume (gal) of the container?	8000
What is the Diked Area Length (ft)?	
What is the Diked Area Width (ft)?	
Calculate Acceptable Separation Distance	
Diked Area (sqft)	
ASD for Blast Over Pressure (ASDBOP)	
ASD for Thermal Radiation for People (ASDPPU)	657.70
ASD for Thermal Radiation for Buildings (ASDBPU)	131.49
ASD for Thermal Radiation for People (ASDPNPD)	
ASD for Thermal Radiation for Buildings (ASDBNPD)	

Exhibit D: HUD's Barrier Design Guidance for HUD Assisted Projects Near Hazardous Facilities



acceptable separation distance guidebook

Implementing 24 CFR Part 51
Subpart C: Siting of HUD-Assisted
Projects Near Hazardous Operations
Handling Conventional Fuels
or Chemicals of an Explosive
or Flammable Nature

August 2025

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Introduction

The *Acceptable Separation Distance Guidebook* (*Guidebook*) focuses on the hazardous operations that can potentially harm properties assisted by the U.S. Department of Housing and Urban Development (HUD), and the people who live or work there. It reflects the parameters established by 24 CFR Part 51 Subpart C (Part 51C) which regulates the technical requirements of determining Acceptable Separation Distances (ASD) from HUD-assisted projects in proximity to hazardous operations. The ASD is the distance beyond which the explosion or combustion of a hazard is not likely to cause structures or individuals to be subjected to blast overpressure or thermal radiation flux levels in excess of the safety standards in 24 CFR 51.203. The ASD is measured between a structure or outdoor amenity and an aboveground storage tank (AST) at which a fire or explosion hazard is present.

Purpose

This *Guidebook* provides HUD staff, Responsible Entities (RE), planners, developers, engineers, and grantees with specific steps to determine the ASD required between a HUD-assisted project and a hazardous operation. It provides environmental review professionals with information about the implementation of regulation 24 CFR Part 51C. The *Guidebook* also provides both the analytical foundation and recommended strategy for determining the distance between a proposed HUD-assisted project and a hazardous operations site.

Background

The technical material referenced in previous editions of this *Guidebook* was obtained from a December 1975 study[1] by Arthur D. Little, Inc., and a December 19, 1981, study[2] by Rolf Jensen and Associates (RJ&A), Deerfield, Illinois. The previous iterations of these guidelines are:

- *Urban Development Siting with Respect to Hazardous Commercial/Industrial Facilities* – HUD – 777-CPD),
- Regulation 24 CFR Part51C; HUD Handbook 1390.2, "*Environmental Assessment Guide for Housing Projects*,"
- HUD Handbook 1390.4, '*A Guide to HUD Environmental Criteria and Standards contained in 24 CFR* Part *51*," and
- *Siting of HUD-Assisted Projects Near Hazardous Facilities*.

This edition was updated by HUD to reflect technical and regulatory developments since previous editions. The substance and findings of the work are dedicated to the public. Neither the United States Government, nor any of its employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any

[1] U.S. Department of Housing and Urban Development, "*Safety Considerations in Siting Housing Projects*," December 1975.
[2] Rolf, Jensen and Associates, "*Urban Development in Siting with Respect to Hazardous Commercial/Industrial Facilities*," U.S. Department of Housing and Urban Development, April 1982.

information, apparatus, product, or process disclosed, or represents that its use would not infringe privately-owned rights. Reference herein to any individuals, agencies, companies, products, process, services, service by trade name, trademark, manufacturer, or otherwise does not constitute or imply an endorsement, recommendation, or favoring by the author(s), contributor(s), the U.S. Government or any agency thereof. Opinions contained herein are those of the author(s) and do not necessarily reflect the official position of, or a position that is endorsed by, HUD or any Federal agency.

Authority

HUD's authority to implement the information in this *Guidebook* is found in 24 CFR Part 51C, "*Siting of HUD–Assisted Projects Near Hazardous Operations Handling Conventional Fuels or Chemicals of an Explosive or Flammable Nature*." HUD-assisted projects are required to meet criteria, standards and guidelines for site acceptability and a suitable living environment as provided under the following statutes and regulations:

- The National Housing Act, which was enacted "to encourage improvements in housing standards and conditions, to provide a system of mutual mortgage insurance, and for other purposes," thus providing the basis for HUD's Minimum Property Standards (MPS) which have evolved as required by legislation over the past 50 years.

- The Housing and Community Development Act of 1974, as amended, which sets forth the national goal of "a decent home and a suitable living environment for every American family."

- The National Environmental Policy Act of 1969, as amended, which directs Federal agencies to develop procedures to carry out the purposes of the Act.

- 24 CFR 905.602(d)(7) Site and Neighborhood Standards, which directs the site shall be free from adverse environmental conditions, natural or manmade, and shall not be detrimental to family life.

Applications

The information in this *Guidebook* can be applied to HUD-assisted projects as defined in 24 CFR 51.201. These are projects that are intended for residential, institutional (this category includes public and government buildings), recreational, commercial, or industrial use that are planned for development, construction, rehabilitation, modernization or conversion with HUD subsidy, grant assistance, loan, loan guarantee, or mortgage insurance.

For purposes of 24 CFR Part 51C, the terms "rehabilitation" and "modernization" refer only to such repairs and renovation of buildings that will result in an increased number of people being exposed to hazardous operations by increasing residential densities, converting the use of a building to human habitation, or making a vacant building habitable. The information also applies to other projects that may increase risk. These include installation of above-ground tanks near residential properties and economic or community development projects that increase the number of people exposed to hazards from tanks storing explosive or flammable substances.

Regulation 24 CFR Part 51C, the ASD assessment tool, and the information in this *Guidebook* apply only to above-ground stationary containers (tanks) of more than 100 gallon capacity that hold common liquid industrial fuels (for more information, please see Appendix I of the Regulation and Appendix C of this *Guidebook*) and above-ground stationary containers of any capacity that hold hazardous liquids or gases (see glossary) that are not common liquid industrial fuels (see also the list of hazardous substances in Appendix C of this *Guidebook*).

Exclusions

The information contained in this *Guidebook* and in the ASD assessment tool **do not apply** in the following situations, which are excluded from the definition of "hazard" noted in 24 CFR 51.201:

- **Underground Storage Containers**: If the container is buried (see glossary), there is no need for an ASD.

- **Stationary above-ground containers of 100 gallons or less capacity that hold *common liquid industrial fuels***: According to the preamble to HUD's 1984 ASD Regulations[3] stationary containers of 100 gallons or less capacity that store common liquid industrial fuels (such as gasoline, fuel oil, kerosene and crude oil) have an ASD of only 15 feet which was assumed not to emit thermal radiation heat flux effects at levels that would pose a danger to HUD-assisted projects. **Note:** This exception ***does not apply*** to above-ground stationary containers that store hazardous gases, such as those listed in Appendix I of the Regulation or in Appendix C of this guidebook.

- **Natural gas containers with floating tops**: These are stationary above-ground storage containers used to store natural gas. These containers are less susceptible to corrosion and tank perforations that can cause explosions.

- **Mobile conveyances *(tank trucks, barges, railroad tank cars)***: These are containers that are mobile and have the capacity to store common liquid industrial fuels or hazardous gases as listed in Appendix I of the regulation 24 CFR Part 51C and in Appendix C of this *Guidebook*.

- **Certain high-pressure natural gas transmission pipelines or liquid petroleum pipelines**: Pipelines that transmit hazardous substances are not considered a hazard under 24 CFR Part 51C.
- **Liquefied petroleum gas or propane (LPG/propane) containers 1,000 gallons or less that comply with industry standard, National Fire Protection Association 58 (NFPA 58) (Liquefied Petroleum Gas Code) (2017)**.

    - Aboveground LPG/propane tanks with a water capacity of 1,000 gallons or less that comply with NFPA 58 (2017, are excluded from the definition of "hazard," and thereby from coverage under the rule.

[3] 49 FR 5102 (February 10, 1984)

1. Overview: Organization of the Guidebook

Petrochemical gases and liquids are used worldwide. Their demand varies depending on the consumer. Domestic household consumers use petrochemicals to cook, heat their homes and water tanks, and run appliances. Commercial consumers such as restaurants, office buildings, hotels and gas stations use petrochemicals to run their businesses. Industrial consumers such as power stations, material manufacturers, pharmaceutical and medical researchers, automotive and tool manufacturers use petrochemicals to support the production of their products.

Regulation 24 CFR Part 51C applies specifically to petrochemical liquids and gases that could ignite and explode and that are stored in above-ground stationary containers. A list of such chemicals is in Appendix I of the Regulation and in Appendix C of this *Guidebook*.

This *Guidebook*, as well as 24 CFR Part 51C and the ASD assessment process, are tools designed to determine whether a proposed HUD-assisted project site is too close to a container with hazardous substances. They are tools that also help environmental review professionals understand and implement the regulation.

This latest edition of the *Guidebook* is a revision of the September 1996 "*Siting of HUD-Assisted Projects Near Hazardous Facilities*." This latest edition corrects inconsistencies, adds information on the use of HUD's online ASD calculator, at the Acceptable Separation Distance (ASD) Electronic Assessment Tool website (https://www.hudexchange.info/programs/environmental-review/asd-calculator/), allows use of updated fire science, and removes either questionable or unresolved policy statements and principles.

Additional features in this revision include:

- Flowcharts that illustrate:
    - Site analysis steps for ASD calculation (procedures and findings for a HUD-assisted project),
    - Procedural calculation of the ASD for thermal radiation (fire) or blast overpressure (explosion),
    - Procedural calculation of the ASD for blast overpressure (explosion) and thermal radiation provided the substance being assessed has flammable or combustible properties and is pressurized, and
    - Mitigation analysis for a proposed HUD-assisted project.
- Examples of multiple mitigation options involving natural and man-made barriers.
- A section appendix on "Frequently Asked Questions" about 24 CFR Part 51C.
- Use of the volume of a dike rather than the area of the dike in determining the ASD and requiring the use of the electronic ASD assessment tool for ASD determinations with a dike.

- Consideration of dike volume in determining the ASD for cryogenic pressurized containers.

This *Guidebook* contains an Introduction, six Chapters and six Appendices.

Introduction: Outlines purpose, background, authority, exclusions, applications and limitations and frequently asked questions.

Chapter 1: *Overview* reviews the purpose and background of the *Guidebook,* providing important basic information.

Chapter 2: *Regulatory Framework* discusses the foundation and structure of 24 CFR Part 51C and the need to develop the standards of blast overpressure and thermal radiation from which the ASD is calculated for the proposed HUD-assisted project.

Chapter 3: *Compliance Process* outlines the process to follow to comply with the Regulation.

Chapter 4: *Evaluations and Findings* explains and outlines the procedures required to evaluate proposed HUD-assisted projects that are close to a potentially hazardous site.

Chapter 5: *Mitigation Options* provides information about mitigation analysis and how to determine if mitigation is required on a proposed HUD-assisted project.

Chapter 6: *Complex Circumstances* identifies complex circumstances under which proposed HUD-assisted projects are subject to consultation by HUD Regional and Field Environmental Officers. Under these circumstances, additional detailed information and procedures that are not provided in 24 CFR Part 51C would be required.



1. A house sits near large storage tanks in the South Hill neighborhood of Chesapeake, Virginia. Procedures in this guidebook are used to determine if housing is too close to storage tanks.

2. Regulatory Framework

Before the development of 24 CFR Part 51C in the 1970s, HUD received inquiries from developers, planners, engineers, HUD field staff and grantees about what risks had to be considered when siting HUD projects. This included how to determine ASD for HUD-assisted projects near facilities with stationary containers that store, handle, or process explosive or fire prone substances. In response, HUD commissioned Arthur D. Little, Inc., to develop standards for blast overpressure and thermal radiation, and a method for calculating ASD for HUD-assisted projects. The study, "Safety Considerations in Siting Housing Projects", was completed in December of 1975. Answering those inquiries involved determining the potential blast overpressure and thermal radiation effects of the hazard.

The analysis involved in determining the hazard might delay HUD-assisted project approval because there were no previous standards from which an ASD could be determined for explosives or fire-prone substances. As a result, HUD decided there was a need for the development of two standards, including defining methods for determining compliance with the standards:

- Thermal Radiation – Applicable to people and buildings
- Blast Overpressure – Applicable to buildings, building occupants, outdoor areas, and unprotected facilities

HUD researched the most relevant sources of information regarding how stored flammable substances affect people and structures. The research, which included a review of federal agencies, professional organizations, regulatory agencies, and councils and boards, revealed that the existing standards, specific to each entity's function and purpose, were limited in both scope and application.

The following are some of the entities that were involved in the research study:

- Federal Fire Safety Standards: The Federal Fire Safety standards for Liquified Natural Gas (LNG) Facilities establish thermal radiation standards that are applicable only to LNG facilities.
- National Fire Protection Association (NFPA): The NFPA fire standards are limited to fire hazards and are for the specific use of industry in the determination of the internal configuration of petrochemical facilities.

Due to additional comments gathered from the NPR, as well as comments from other industry experts, HUD decided to do a second research study,[4] with the purpose of addressing two concerns:

1. Simplifying the method of calculating the ASD required between HUD-assisted projects and stationary hazards, and
2. Modifying standards already developed by the first study to include additional substances that were mostly used as fuels in the industry.

[4] Urban Development Siting with Respect to Hazardous Commercial/Industrial Facilities

This study, done by Rolf Jensen and Associates, Inc., of Deerfield, Illinois, under contract to HUD, provided the required technical support and was used to address HUD concerns and to complete the current 24 CFR Part 51C and the previous editions of this *Guidebook*. Regulation 24 CFR Part 51C became effective on February 10, 1984, and was amended on March 26, 1996. Results of the Rolf Jensen and Associates study were encapsulated in a report titled *Urban Development Siting with Respect to Hazardous Commercial/Industrial Facilities*.

Average fire data at stationary bulk liquid fuel storage facilities from 1994 to 1998. Data[5] provided from the NFPA.

Total:	Damage off premises:
Annual average fire incidents: 387	Annual average fire incidents: 288
Casualties: 1	Casualties: 0
Injuries: 8	Injuries: 3
Direct Property Damage: $5,540,000	Direct Property Damage: $948,000

Average fire data at stationary LP-gas fuel storage facilities from 1994 to 1998. Data[6] provided from the NFPA.

Total:	Damage off premises:
Annual average fire incidents: 49	Annual average fire incidents: 26
Casualties: 1	Casualties: 0
Injuries: 5	Injuries: 1
Direct Property Damage: $722.00	Direct Property Damage: $117,000

A 2014 study by the NFPA found an average of 301 tank fires between 2007 and 2011.[7]
The data presented supports the reason behind the development of the ASD under the regulation 24 CFR Part 51C, which is to avoid injuring people or destroying property by properly assessing the distance between project sites and facilities that store, handle or process flammable or combustible chemicals.

This edition of the *Guidebook* incorporates the results of the 1981 Rolf Jensen and Associates study. Later experiments at the National Institutes of Health confirm the Regulation standards of thermal radiation for people (450 BTU/ft^2-hr). A BTU is a British Thermal Unit and BTU/ft^2-hr is a unit of heat flux.[8]

A Review of the Thermal Radiation Standard - Buildings

The standard for the determination of an ASD for thermal radiation is based on heat flux. Referenced studies[9] show that the maximum thermal radiation exposure that combustible materials can tolerate for a long period of time, without being susceptible to pilot ignition, is 4,000

[5] Fires at Flammable or Combustible Liquid Tank Storage Facilities: Statistical Analysis
[6] Fires at LP-Gas Bulk Storage Plants: Statistical Analysis
[7] Campbell, Richard, *Fires at Outside Storage Tanks*, National Fire Protection Association, August 2014.
[8] *Temperature Threshold for Burn Injury, an Oximeter Safety Study*, National Library of Medicine and the National Institutes of Health report, 2004., Greenhalgh, G.H., Lawless, B.B. Chew, W.A. Crone, M.E. Fein, T.L. Palmieri.
[9] Lees, F.P*., Loss Prevention in the Process Industries, Second Edition*, Butterworth-Heinemann, Oxford, 1996.

BTU/ft^2-hr. From 5,000 BTU/ft^2-hr to 9,000 BTU/ft^2-hr, the limit of exposure time before combustible materials experience pilot ignition reduces gradually as thermal heat flux increases.

According to the Department of Homeland Security, United States Fire Administration/National Fire Data Center, response times for structure fires are generally less than 5 minutes 50 percent of the time, regardless of region, season, or time of day. The nationwide 90th percent response time to structural fires is generally less than 11 minutes.[10]

The maximum thermal radiation heat flux exposure to buildings is 10,000 BTU/ft^2-hr for a maximum duration of 15 minutes.

This is based upon the assumption that there will be fire department responses to protect exposed combustible buildings within 15 minutes and that the exposed combustible materials will not spontaneously ignite before the fire department responds.

A Review of the Thermal Radiation Standard - People

Human skin reacts to heat by perspiring and increasing blood flow to the affected area. Pain is felt when skin temperature rises to just above 44° C or 111° F over a depth of 0.1 mm (Normal is 37° C or 98.4° F). 44° C is an approximate value due to various skin depths, body fat, etc.

The National Library of Medicine and the National Institutes of Health, in collaboration with the Food and Drug Administration, performed an oximeter study[11] to determine the temperature threshold for burn injury. Pulse oximeters, essential devices for evaluating and monitoring patient oxygenation, emit a small amount of heat into the skin then detect a signal.

The standard for thermal radiation flux level for open spaces such as parks and playgrounds where people of all ages congregate is based on the time it would take to react and find protection from a fire hazard.

At 41° C or 106° F, the thermal heat flux is 175.3 BTU/ft^2-hr. At this heat flux level, people in open spaces will experience some degree of "redness" on their skin depending on their distance from the hazard, exposure time and atmospheric conditions such as wind temperature and speed, etc. This set parameter of thermal heat flux (175.3 BTU/ft^2-hr) is the normal standard for protection of people in outside environments.

At 55° C or 131° F, the thermal heat flux is 450 BTU/ft^2-hr. At 55° C or 131° F, people will experience severe pain in about 1.5 minutes and 2nd degree burns in about 7.75 minutes.[12]

Therefore, the standard for maximum thermal heat flux, as applied to protection of people in open spaces where people congregate, such as parks, playgrounds, etc., is 450 BTU/ft^2-hr.

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[10] U.S. Fire Administration/National Fire Data Center, *Structure Fire Response Times,* Topical Fire Research Series, Volume 5: Issue 7, January 2006, Revised August 2006.

[11] Greenhalgh, G.H., Lawless, B.B. Chew, W.A. Crone, M.E. Fein, T.L. Palmieri, *Temperature Threshold for burn Injury, an Oximeter Safety Study*, National Library of Medicine and the National Institutes of Health report, 2004.

[12] National Oceanic and Atmospheric Administration (NOAA), "Thermal Radiation Levels of Concern," https://response.restoration.noaa.gov/oil-and-chemical-spills/chemical-spills/resources/thermal-radiation-levels-concern.html

A Review of the Blast Overpressure Standard - Buildings

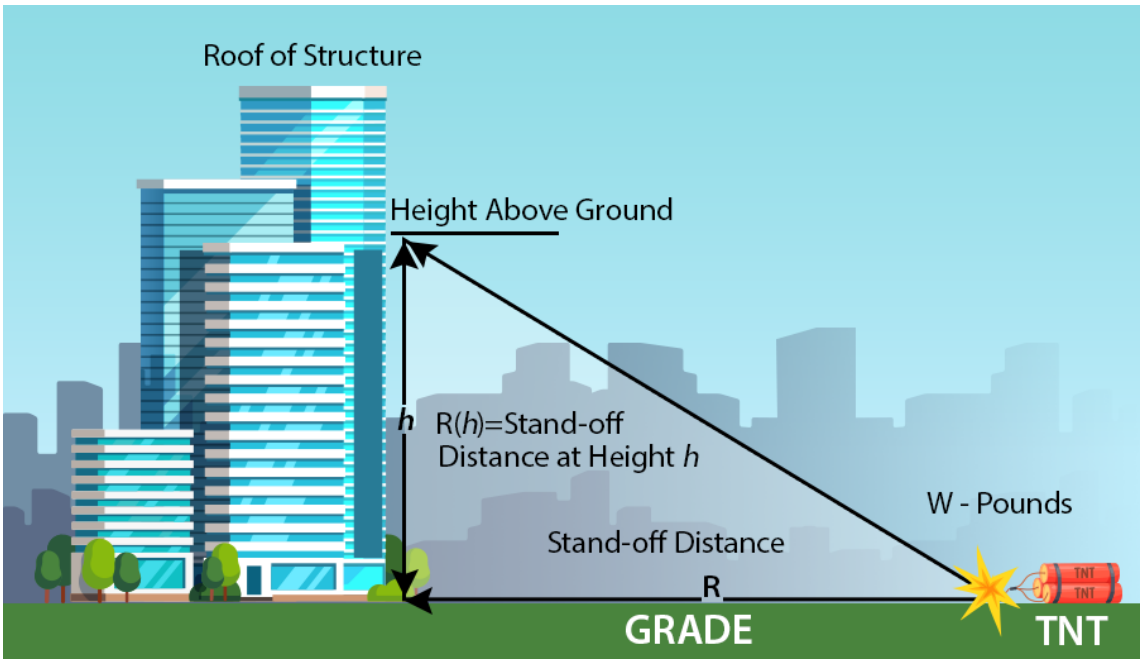
The criteria for determining ASD for blast overpressure is based on the pressure wave exerted by detonation of a set mass quantity of TNT. Blast overpressure is the increase in air pressure caused by an explosion and that causes damage.

The method of comparison, also known as the "TNT Equivalent," is used because the blast overpressure produced by 1 pound of TNT is known. This is the TNT equivalent weight of the actual explosive.

The TNT equivalent weight is defined by W (in pounds) = mass of the explosive in question times its relative strength.

For reference purposes, virtually all explosives have TNT equivalent weights within a factor of 1.4 of their physical weight, so, for the purposes of this Guidebook, the physical weight is used.

The mathematical formula to calculate the scaled distance (Z) is $Z = R/W^{1/3}$, where W = pounds of TNT equivalent weight at a distance R (the stand-off distance) from the vertical exterior wall of a building (example). The scaled distance is used to calculate the blast overpressure at a given distance from the tank. It indicates that the blast overpressure declines proportional to the actual distance and inversely proportional to the cube root of the TNT equivalent weight.
Below is a visual representation of a hazard (TNT equivalent weight – W) and the standoff distance (R) between the explosive hazard and a structure, as well as the greater standoff distance R(*h*) at a height *h* above the level of the hazard. The distance above the level of the hazard is calculated from the Pythagorean Theorem, $R(h) = (R^2 + h^2)^{1/2}$. The peak blast overpressure will be smaller at greater distances from the hazard.



The following table illustrates several test results developed by a Department of Defense and Sandia National Laboratories study[13] of explosives detonation and the blast overpressure effects on different materials. The amount and type of explosive used and the distance between the explosives and the structural element were not released as part of the results of the subject study.

Structural element	**Overpressure effects on structural element**	**Approximate peak positive incident pressure recorded on structural element (psi)**
Glass windows, large and small	Shattering usually, occasional frame failure	0.5 - 1.0
Corrugated asbestos siding	Shattering	1.0 - 2.0
Corrugated steel or aluminum paneling	Connection failure following by buckling	2.0
Brick wall panel, 8in, or 12 in thick (not reinforced)	Shearing and flexure failures	3.0 - 10.00
Wood siding panels, standard house construction	Usually, failure occurs at the main connections allowing a whole panel to be blown in	1.0 - 2.0
Concrete or cinder-block wall panels, 8 in, or 12 in thick (not reinforced)	Shattering of the wall	1.5 - 5.5

According to the preamble to the 1980 proposed rule for 24 CFR Part 51C, the Department of Defense set a standard of 0.5 psi for blast overpressure because no serious damage would occur to the structure, and it is unlikely that someone inside would be injured at that pressure.[14]
Therefore, the maximum blast overpressure standard for protecting buildings, occupants, and individuals in unprotected outdoor areas and facilities is set at 0.5 psi.

[13] Glasstone, S. and Dolan, P. J. *Effects of Nuclear Weapons, Conditions of failure of overpressure-sensitive elements*, Table 5.145, page 221, 1997.,
[14] 45 FR 55227 (August 19, 1980).



2. The aftermath of the propane blast at the Little General Store (January 30, 2007) in Ghent, West Virginia. Enhancements note the approximate location of the store, the propane tanks, and the ambulance overturned in the explosion.

3. Compliance Process

HUD-assisted projects (as defined in 24 CFR 51.201) shall comply with 24 CFR Part 51C. The implementation of the Regulation is the responsibility of the HUD approving official or the certifying officer of a responsible entity (RE). An RE is a unit of general local government that is responsible under certain HUD funding programs (those covered by 24 CFR Part 58) for the scope and content of the environmental review and making the environmental review finding.

The Regulation addresses the protection of buildings and people when siting HUD-assisted projects near hazardous operations that handle conventional fuels or chemicals of an explosive, combustible, or flammable nature.

For a HUD-assisted project to comply with the regulation 24 CFR Part 51C, the locations of buildings and outdoor unprotected areas and facilities must be at a distance equal to or greater than ASD established by HUD from facilities with stationary containers that store, handle or process explosive or fire prone substances.

The key steps to complying with the regulation 24 CFR Part 51C are as follows:

Step 1: Identify all hazardous operations/facilities with stationary, aboveground storage tanks within a 1-mile radius of the proposed HUD-assisted project.

Step 2: Identify which tanks are exempt from the regulation. The following tanks are exempt:

- Stationary containers of 100 gallons or less capacity containing common liquid industrial fuels
- Above-ground storage tanks with a water gallon capacity of 1,000 gallons or less that are used to store LPG/propane if the storage tank complies with the 2017 edition of NFPA 58 (Liquefied Petroleum Gas Code), A sample conformance memo is available on the HUD Exchange.
- Natural gas holders with floating tops

Step 3: Calculate the ASD required between the proposed HUD-assisted project site and the non-exempt hazardous stationary containers using thermal radiation and blast overpressure (if applicable) standards. Instructions on calculating the ASD are in Chapter 4.

Step 4: Determine whether the project site meets the standard.

Step 5: If the project meets the standard, after entering the documentation of it doing so, no further action is required. However, if the project does not meet the standard, mitigation (covered in detail in Chapter 5) is required.

The ASD is prescribed from the standards set out in regulation 24 CFR Part 51C, as follows:

- Thermal Radiation, 10,000 BTU/ft^2 – hr
    - Applicable to buildings

- Thermal Radiation, 450 BTU/ft^2 – hr
    - Applicable to people in outdoor areas of congregation
- Blast Overpressure, 0.5 psi
    - Applicable to buildings, building occupants, and outdoor unprotected areas and facilities where people may congregate or be present.

To protect buildings and housing units from thermal radiation, HUD established the thermal radiation standard of 10,000 BTU/ft^2 – hr.

To protect people in outside areas where people may congregate, such as patios, common areas, parking lots, recreation areas, parks, walkways with benches or gazebos, or extended walkways, HUD established the thermal radiation standard of 450 BTU/ft^2-hr. If people are likely to congregate for more than 5 minutes in an area, it will generally be considered an area of congregation. Open space not intended for public use will not be considered an area of congregation. Short walkways taking less than five minutes to traverse will not be considered an area of congregation.

If no mitigation exists or is planned, HUD-assisted projects must be located at a distance from the hazardous container, equal to or greater than the ASD at which the thermal radiation flux will not exceed 450 BTU/ft^2-hr.

Blast overpressure can harm people or destroy buildings if this pressure is higher than 0.5 psi. For proposed HUD-assisted project sites where there are stored hazards that can cause blast overpressure and no mitigation exists or is planned as part of the project, buildings and outdoor unprotected areas and facilities where people may congregate or be present must be located at a distance from the hazard equal to or greater than the ASD at which blast overpressure is no higher than 0.5 psi.

HUD/the RE will not approve applications for assistance unless:

- the proposed project meets the required ASD from the stationary container assessed as hazardous, or
- appropriate mitigation measures are in place, or
- plans for appropriate mitigation are incorporated into the HUD-assisted project.

Appropriate mitigation measures are classified as either natural or artificial structures that shield or serve as an abatement to the HUD-assisted project site from the blast overpressure and/or thermal radiation effects from the hazard. Whether natural or man-made, mitigation measures shall be stationary, of adequate size and strength, and located between the hazard and the proposed HUD-assisted project site and shall shield all points of the project from the line-of-sight exposure of the hazard. (Chapter 5 of this *Guidebook* covers mitigation measures in detail.)

If the HUD-assisted project is a facility that will process, manufacture, or store hazardous substances, HUD will not approve applications for assistance unless the proposed project is located at the required ASD from existing or planned housing developments or uses where

members of the public would be exposed to increased risk, and from unprotected outdoor areas and facilities where people congregate or engage in outdoor activities.

HUD/the RE shall evaluate all development plans proposed in applications for HUD-assistance, when found to be located within one mile of existing or proposed hazardous operations. In cases where the tank does not meet the ASD, the project must comply with the regulatory standards through adequate mitigation measures. If such measures are not already in place, HUD/the RE must obtain satisfactory assurances that adequate mitigation measures will be installed before the facility begins operation.



3. Fire and smoke caused by the explosion of a propane tank at a maintenance facility for Como Oil, located at Duluth, Minnesota.

4. Evaluations and Findings

To determine if the proposed HUD-assisted project meets the established standards for blast overpressure or thermal radiation, HUD or RE is required to calculate the ASD required between the proposed project and the hazardous stationary container.

The following steps are intended to help the user of this *Guidebook* understand the required process necessary for evaluating a HUD-assisted project that is located near a potentially hazardous site.

Step 1: Obtain a map, site plan or photos of the proposed HUD-assisted project site and surrounding areas.

- Maps
    - Scaled maps with site contours (topographic maps) are highly recommended for the analysis of proposed HUD-assisted project sites. These maps make it easier to determine the existence of natural or man-made barriers and to perform an analysis of these barriers with reference to the location of the stationary container storing hazardous or explosive substances.
    - Topographic maps or site maps can be obtained from the United States Geological Survey (USGS), City, County or Tribal engineer's or planning office related to the proposed HUD-assisted project.
    - Digitized topographic maps (free of cost) can be obtained from the following sources. (HUD does not endorse any of the referenced electronic sources of information.)
        - Google Earth https://earth.google.com
        - US Geological Survey https://ngmdb.usgs.gov/topoview/
- Site maps provide geographic site information for reconnaissance and analysis of the various facilities near proposed HUD-assisted project sites
- Site plans
    - Site plans provide detailed existing land-use information for proper identification and analysis of the areas comprising the proposed HUD-assisted project site. Site plans may be obtained from the engineer's, planning or developer's office working on the HUD-assisted project.
- Photos
    - Aerial photographs may be available from the developer of the HUD-assisted project, local commercial survey firms, planning departments or https://earth.google.com.

- Site photographs provide actual images of the facilities and stationary containers near proposed HUD-assisted project sites and nearby land uses when current. Site photographs provide valuable information for site evaluation. This information can be gathered (camera required by the person gathering the information) by scheduling a visit to the hazardous facility (making sure that photographs are allowed) to be assessed and contacting the facility site manager.

Step 2: Use the maps, photos and plans of the proposed HUD-assisted project site, identify the following:

- HUD-assisted project site boundaries – to determine the area where facilities that store, manufacture, or process hazardous substances are located, plot a mile-radius perimeter from the center of the proposed HUD-assisted project site.

  - Consider all the stationary, above-ground containers containing hazardous substances that can pose a hazard to the buildings or open areas where people congregate, play, etc., associated with the HUD-assisted project.

  - Collect the following information for each container to be considered:

    - Container's capacity (in gallons). A calculator to convert tank size to capacity is available at: https://www.calculatorsoup.com/calculators/construction/tank.php.

    - Container's product's chemical name (not the trade name). This information should be available from the product's material safety data sheet.

    - Container's product phase of state (gases or liquids).

    - If the container is unpressurized (containing liquids) or is a cryogenic pressurized container (containing gases in liquid state), find out if the container is diked or undiked. If it is diked, determine the dike volume (**Length** X **Width** X **Depth** - in units of cubic feet). Diked area can be used if diked volume is not known. Note: When containers are diked, use the diked volume instead of container size.

  - Measure the actual distance between the proposed HUD-assisted project site and the container(s) being assessed.

    Actual distances from the hazards to the buildings or open areas where people congregate should be measured in units of "feet." This distance must be measured from the center of the above-ground storage container(s) to the closest point of the building or outdoor unprotected area or facility. If final locations of these features are unknown, measure to the perimeter of the proposed HUD-assisted project site.

  - Determine which container(s) to use in making ASD calculations.

When plotting the actual distances from the hazards in stationary, above ground storage containers, always measure the distance from the center of the containers to the perimeter of the proposed HUD-assisted project site.

Guidelines on container evaluation (applies to pressurized and non-pressurized containers) for ASD calculations:

- When there is a facility with stationary above-ground storage containers of the same size, the ASD needs to be calculated for the container closest to the proposed HUD-assisted project site.

- When there is a facility with stationary above-ground containers of different sizes, the ASD needs to be calculated for the container or diked volume of largest capacity closest to the proposed HUD-assisted project site.

- If a facility has multiple above-ground containers the ASD for the closest container must always be calculated. If there are one or more larger containers further away, the ASD for the largest container must also be calculated. When there is a facility with the same type of stationary above-ground containers of different capacity and the smaller capacity container is the one closest to the proposed HUD-assisted project site, the ASD must be calculated for the container that is closest to the proposed HUD-assisted project site, as well as the largest capacity container.

- Calculate the ASD for the stationary container of largest capacity (whether pressurized or unpressurized) closest to the proposed HUD-assisted project. Always calculate the ASD for the pressurized container, regardless of its location. Consider only aboveground storage tanks.

- Smaller tanks that are far away from the site will not be within the ASD. The table below may be used to determine that a tank is too small and far away to affect the site. If the tank is smaller than the indicated size and more than the indicated distance away, the ASD doesn't need to be calculated.

Tank Size (gal) less than:	Distance (feet) greater than:
1,100 gallons	287 feet
4,000 gallons	492 feet
12,000 gallons	779 feet
30,000 gallons	1141 feet
100,000 gallons	1884 feet

Information on containers:

<u>The regulation 24 CFR Part 51C applies to three types of above-ground stationary containers:</u>

1. Pressurized containers (gases such as propane, butane, etc.) stored as a gas and condensed liquid mixture under pressure at ambient temperatures. If the substance contained is a hazardous substance, ASDs for this container must be calculated for blast overpressure (explosion) and thermal radiation (fire). If the substance contained is not of a flammable or combustible nature, the container does not need to be considered for the ASD analysis.

2. Pressurized containers (gases) holding cryogenic hazardous substances kept in a liquid state by pressure and temperature control, consider ASD calculations for fire

only. Hazardous cryogenic gases are kept in their liquid state at very low temperatures by refrigeration, insulation, etc. Hazardous cryogenic gases (e.g., LNG and Hydrogen) are listed under the "Hazardous Gases" list located in Appendix I of 24 CFR Part 51C and at Appendix C of this *Guidebook*.

3. Unpressurized containers designed to store a substance in a liquid phase of state (for liquids), calculate the ASD for thermal radiation (fire) only if the substance is of a hazardous nature. Since the substance contained is not under pressure, there is no need to calculate the ASD for blast overpressure (explosion). If the liquid substance contained is not of a hazardous nature, the container does not need to be considered for the ASD analysis.

Recommended guidelines on calculating the ASD for non-cryogenic pressurized containers:

This is an ASD calculation guideline for non-cryogenic pressurized containers. The diked volume is never used for calculation of the ASD in non-cryogenic pressurized containers.

1. The ASD calculation will not be affected by the diked volume on non-cryogenic pressurized containers (hazardous substances) because gases occupy the volume of a container. If a leak occurs, the gas escapes to the atmosphere while the liquid boils and turns into vapor. Therefore, the diked volume is not considered in the analysis.

ASD calculation facts on unpressurized containers and cryogenic pressurized containers:

1. If the container is diked: the ASD will be of a smaller numerical value for diked containers vs undiked containers storing hazardous liquids (including cryogenic gases in liquid state) because the diked volume defines the fire width, limiting the flames, heat dispersion and extension.

2. If the container is undiked: the ASD will be of a larger numerical value for undiked containers storing hazardous liquids. Without the dike volume, the fire has no boundary or controlled perimeter.

Step 3: Calculate the required ASDs for the proposed HUD-assisted project:

The ASD can be calculated between a proposed HUD-assisted project and a stationary container that stores, handles, or processes hazardous substances for:

- Thermal radiation (fire)
- Blast Overpressure (explosion)
- Or both

Steps 1 and 2 of this Chapter provide the user of this *Guidebook* with the steps required to gather the data necessary for calculating the ASD required between a proposed HUD-assisted project and a stationary container that stores, handles, or processes hazardous substances. Flowcharts illustrating procedural calculation of the ASD for thermal radiation, blast overpressure or both can be found in Appendix A.

The ASD can be calculated using one of the following methods:

Electronic based calculation (The ASD Assessment Tool)

The web-based tool for calculation of the ASD offers an electronic application of the manual approach to calculation requirements contained in regulation 24 CFR Part 51C and this *Guidebook*. Mathematical equations were derived from the nomographs located in the Regulation and applied to the component parts of the assessment to determine the ASD required between a proposed HUD-assisted project site and facilities that store, handle, or process hazardous substances. This tool is accessible at: https://www.hudexchange.info/environmental-review/asd-calculator/

For diked containers, the ASD Assessment Tool involves the calculation of either the diked volume or diked area. Therefore, for ASD calculation procedures, the use of the electronic calculator provides the equation of the line with the fire width and the other variables to allow the determination of the ASD for thermal radiation for buildings and people for stationary, aboveground containers with and without a dike, i.e., for gases and liquids.

The electronic calculator is available for the determination of the ASD for blast overpressure for buildings, building occupants and outdoor unprotected areas and facilities where people may congregate.

Manual Calculation (Nomographs)

Using the nomographs located in Appendix B, calculate the ASD by plotting the required information (represented by the x-axis) to the respective graph (graphs are represented by a logarithmic line, as in worksheets #1 through #3, Appendix B) and then plotting the intersection point (between the x-axis and the graph) to the y- axis. The y-axis represents (depending on the worksheet) an interim calculation result required in the procedure to obtain the ASD or the ASD.

For diked containers, the new method of determination of the ASD involves the calculation of the volume and not the area of the dike. Therefore, for manual calculation procedures, the use of nomographs **is limited to** stationary, aboveground containers without a dike, i.e., **for gases, and not for liquids.** For scenarios involving stationary, aboveground containers with a dike, the electronic calculator **must** be used.

The equation of the line for calculation of the fire width is not available in the nomographs to match with the other variables for determination of the ASD for thermal radiation for buildings and people. The equation of the line is available for the determination of the ASD for blast overpressure for buildings, building occupants and outdoor unprotected areas and facilities where people may congregate or be present.

Acceptable Separation Distance Principles

Most of these principles have been cited through the previous chapters of this *Guidebook*. However, because of their significance in the Regulation, they are all reiterated here:

1. There are two standards from which ASD calculations are produced:

- Thermal Radiation (fire)
    - Buildings – 10,000 BTU/ft^2 – hr
    - People – 450 BTU/ft^2 – hr
- Blast Overpressure (explosion)
    - Buildings, building occupants and outdoor unprotected areas and facilities– 0.5 psi

2. When measuring the actual distance between a proposed HUD-assisted project and a stationary container that stores, handles, or processes hazardous substances, always measure from the center of the container to the closest point of the building or outdoor unprotected area or facility. If the final locations of these features are unknown, measure to the perimeter of the proposed project site.

3. ASD must be calculated for each above-ground storage tank or diked volume of a tank that stores, handles, or processes hazardous substances. When calculating the ASD for thermal radiation for people, outdoor areas where people congregate must be assessed, such as:

    - Outdoor recreation areas (parks, playgrounds, yards, planned open space where people are likely to congregate) - Ancillary facilities would also include "common areas," which are the non-private ancillary spaces on the housing site that residents are allowed or expected to access.
        - Common areas are areas where people would likely congregate, and include playgrounds, and outdoor recreation areas.
        - Walking trails, pathways and sidewalks that include items such as sitting benches, tables, pergolas, or gazebos are always considered common areas of congregation. Walking trails, pathways and sidewalks without these amenities may be excluded on a case-by-case basis (for example a trail in a natural area that is not actively managed or monitored by the property, or a trail segment and connects to a larger biking or walking trail network.)
    - Parking lots included within the site boundaries of, and designed to serve the residents of, a HUD-insured residential, community, commercial, or mixed-use development are covered under this definition.
        - Balconies – are considered in the ASD evaluation but analysts may also consider the vertical separation distance. (The actual separation distance between the nearest point of a balcony and a container should be calculated as the hypotenuse of the vertical and horizontal distances. Distance = (vertical distance^2 + horizonal distance^2)$^{0.5}$).

4. For stationary, above-ground **non-cryogenic pressurized** containers that hold hazardous substances, the ASD calculations are generally required for blast-over pressure and thermal radiation.

5. For stationary, above-ground **unpressurized** containers and **cryogenic pressurized** containers that hold hazardous substances, the ASD calculations are generally required only for thermal radiation.

6. The diked volume (in cubic feet) has an effect only on ASD calculations involving stationary above-ground **unpressurized** containers and **cryogenic pressurized** containers that store hazardous substances. The diked volume does not affect ASD calculations involving stationary, above-ground **non-cryogenic pressurized** containers that hold hazardous substances.

7. If a proposed HUD-assisted project has more than one ASD, the ASD which assures the greatest separation distance will be applied to the proposed project.

8. If the actual distance between the hazardous facility-tank and the proposed HUD-assisted project is equal to or greater than the ASD, then the actual separation distance is acceptable for the proposal.

9. If the actual distance between the hazardous facility-tank and the proposed HUD-assisted project is less than the ASD, then the site is unacceptable unless natural or man-made mitigation measures already exist or are implemented between the above-ground stationary hazard and the proposed project site.

10. Consider only the ASD for thermal radiation (fire) for gases kept in a liquid phase of state by a low temperature setting (known as cryogenic gases). Hazardous cryogenic gases (e.g., LNG and Hydrogen) are listed under the "Hazardous Gases" list located in the Appendix I of 24CFR Part 51C and in Appendix C.

11. Regulation 24 CFR Part 51C, this *Guidebook*, and the ASD assessment tool apply to HUD-assisted projects located near hazardous operations which store, handle or process hazardous substances.

12. Barriers for blast overpressure should be constructed as close to the hazard source as possible. The barrier design, location and construction must be site specific.

13. Gasoline service stations usually do not fall within the purview of 24 CFR Part 51C. In most gasoline service stations, the containers where the fuel is stored are underground, and underground storage containers are not subject to the Regulation. However, if a gasoline service station does have one or more above-ground stationary containers of capacities of greater than 100 gallons that store common liquid industrial fuels (such as gasoline, fuel oil, kerosene, and crude oil), or greater than 1000 gallons of LPG/propane, then those containers would be considered under the Regulation.

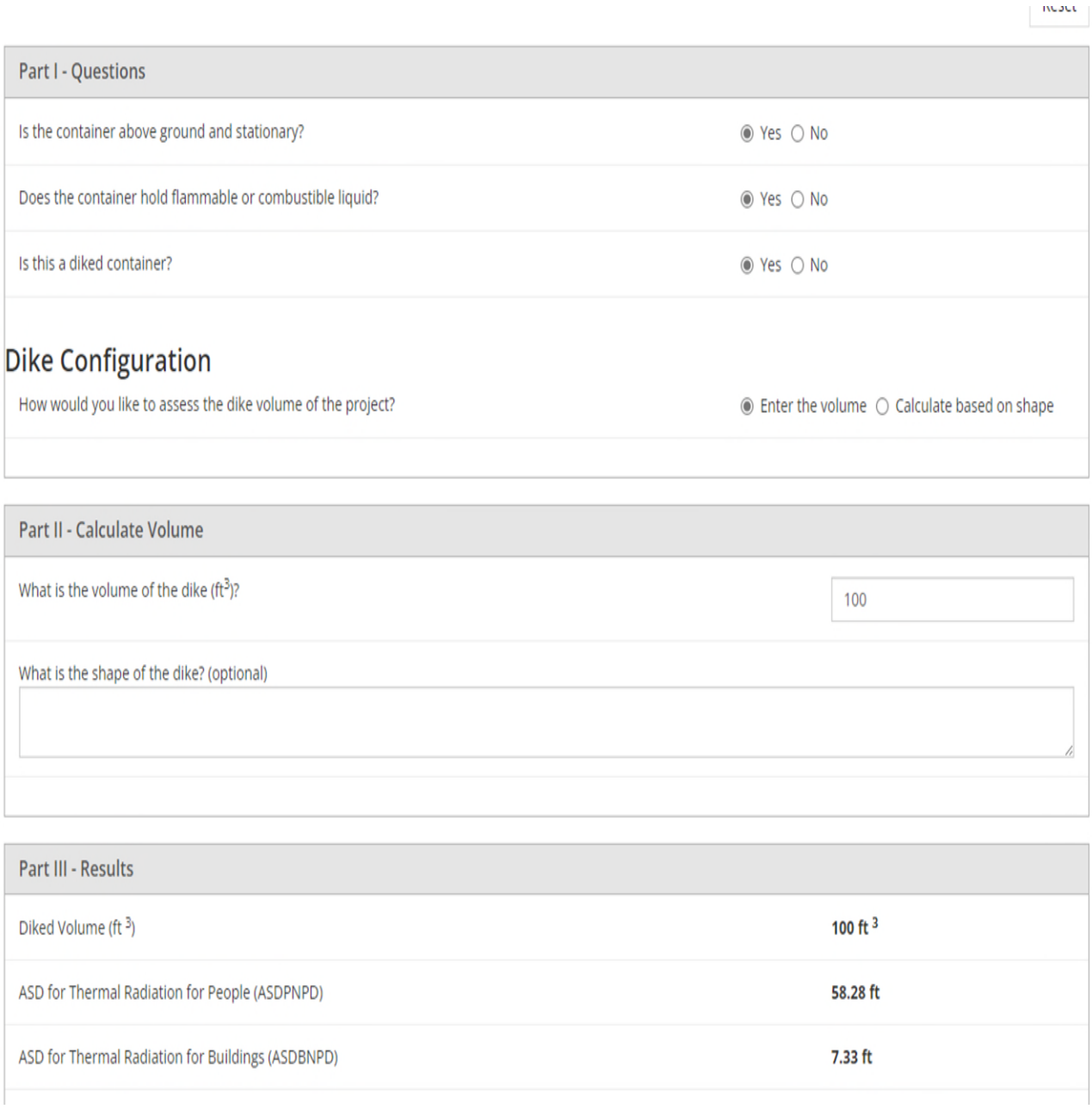
14. If a portion of the property is less than the ASD obtained from using the ASD Calculator or the nomographs, an engineering report prepared by a licensed professional engineer using alternative ASD calculation methods may be submitted. It is recommended that the engineer use the free NOAA-EPA Areal Locations of Hazardous Atmospheres (ALOHA) software for this purpose. ALOHA allows the user to input site-specific and chemical-specific parameters for more accurate modelling. The engineer may consider tank construction and fire suppression systems in calculating the ASD. For guidance on choosing acceptable modelling parameters, contact HUD's environmental engineer.

15. If the ASD cannot be achieved between a hazard involving thermal radiation effects and a proposed HUD-assisted project, please refer to Chapter 5 – Mitigation Options of this *Guidebook*. If difficulties are found calculating the ASD or performing a mitigation analysis for the proposed HUD-assisted project site, contact the respective HUD Field or Regional Environmental Officer. The thermal heat flux effects on the proposal need to be calculated by a licensed professional engineer on a case-by-case basis. Depending on the results of the analysis, if a fire mitigation wall is required, it may not be feasible for the developer due to the size requirements to mitigate the fire ball produced by the hazard, in which case a barrier cannot be used for mitigation.

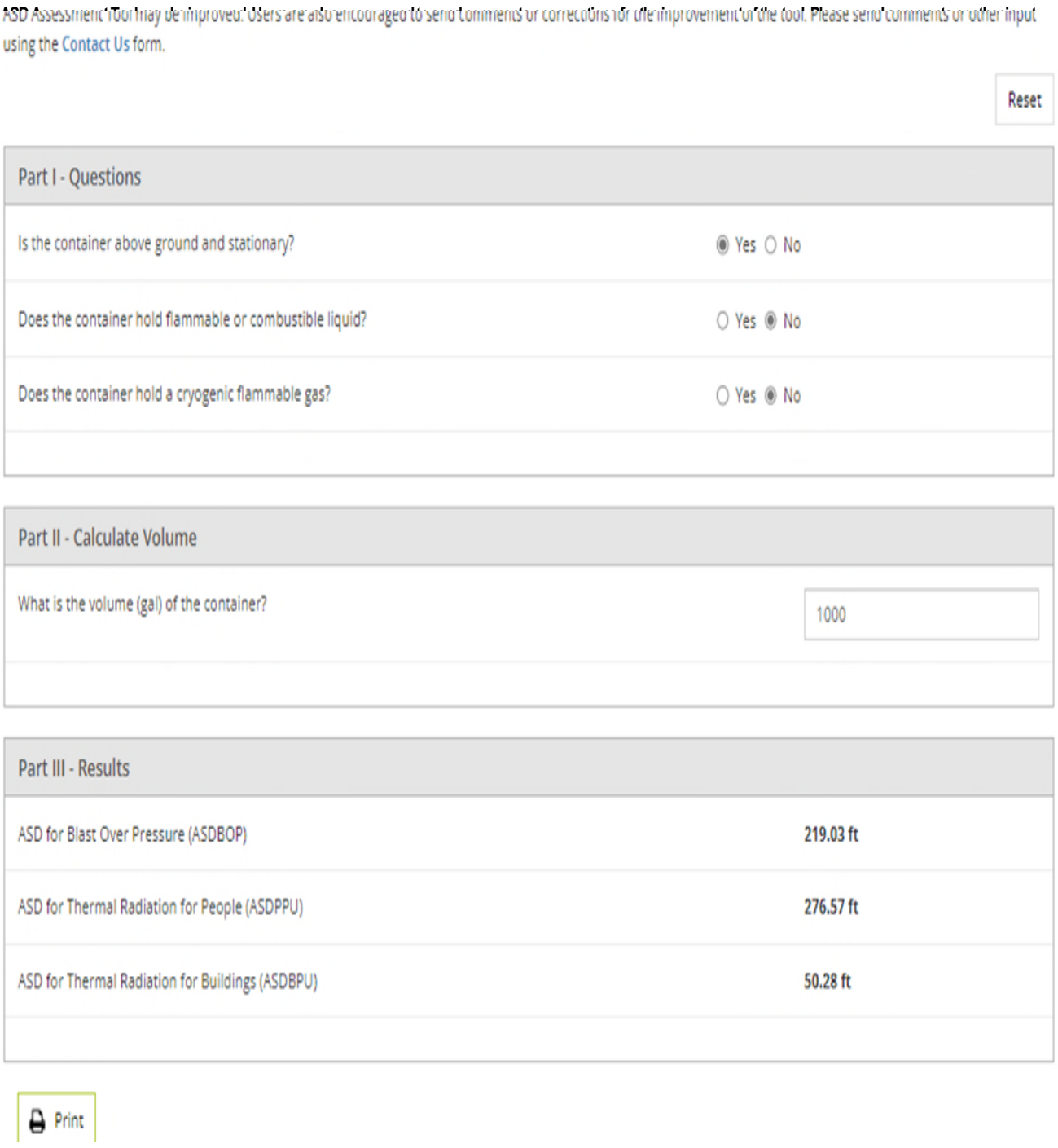
16. If the ASD cannot be achieved on a hazard involving blast overpressure effects on a proposed HUD-assisted project, please refer to Chapter 5 – Mitigation Options of this *Guidebook.* If difficulties are found calculating the ASD or performing a mitigation analysis for the proposed HUD-assisted project site, contact the HUD Field or Regional Environmental Officer. Blast barriers should be designed and implemented based on the calculation of the peak positive incident pressure (blast overpressure) produced by the hazard. The blast barrier should be implemented as close as possible to the hazard producing the blast overpressure. Only licensed professional engineers (civil or structural) should design and implement blast barriers. Design and implementation of blast barriers is site specific.

17. The Regulation does not address safety or health requirements of employees at facilities that store, handle, or process flammable or explosive substances. Such standards and guidance or safety requirements would fall within the purview of the NFPA, local fire codes, permitting requirements, the Occupational Safety and Health Administration (OSHA), and, where applicable, state occupational safety and health plans.

Example 1: On the determination of the ASD from a **stationary, aboveground container, containing an unpressurized product in a diked container (volume of the dike)**, using the electronic calculator.



Example 2: On the determination of the ASD for blast overpressure (explosion) and thermal radiation (fire):



Example 3: On the determination of the ASD from a **stationary, aboveground container, containing an unpressurized product or a pressurized cryogenic product in a diked container (shape of the dike to determine volume)**, using the electronic calculator

Part I - Questions

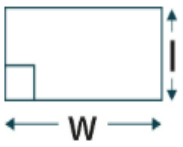
Is the container above ground and stationary?	(●) Yes ( ) No
Does the container hold flammable or combustible liquid?	(●) Yes ( ) No
Is this a diked container?	(●) Yes ( ) No

Dike Configuration

How would you like to assess the dike volume of the project?	( ) Enter the volume (●) Calculate based on shape

Part II - Calculate Volume

Select the shape of the dike and enter the dimensions to calculate the area.
If the dike is an irregular-shape, select a combination of smaller, regular shapes to determine the total capacity.

Shape		Dimensions	Area
Rectangle		width 10 length 10	100.00 ft ^{2}

Add a shape

Total Area: 100.00 ft ^{2}

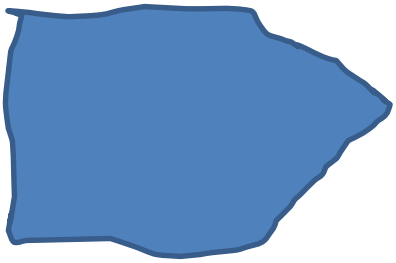
What is the height of the dike? 10

Part III - Results

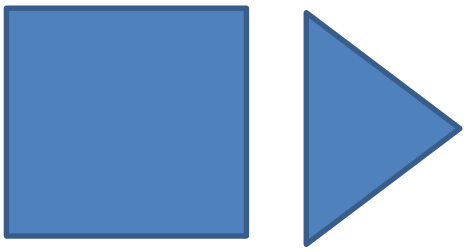
Diked Volume (ft ^{3})	1000 ft ^{3}
ASD for Thermal Radiation for People (ASDPNPD)	151.53 ft
ASD for Thermal Radiation for Buildings (ASDBNPD)	18.97 ft

Example 4: On the determination of the ASD from a **stationary, aboveground container, containing an unpressurized product or a pressurized cryogenic product in a diked container (with a complex dike shape to determine volume)**, using the electronic calculator.

This example is different from the last in that the shape of the dike is not one of the simple geometric forms in the pull-down menu. Several simple shapes will need to be combined to approximate the complex shape constructed at the subject site. For this example, the existing dike has this shape.



This figure can be approximated by areas of a similar sized square and triangle.

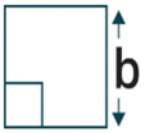
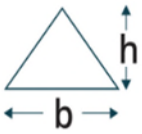


Use the Square shape option as in the previous example. Then use the “Add Another Shape” button to combine the square with a triangle to approximate the total diked area.

Inputting the height of the dike in the next line allows the ASD Assessment Tool to calculate the volume for the area contained within the complex shape.

Part II - Calculate Volume

Select the shape of the dike and enter the dimensions to calculate the area.
If the dike is an irregular-shape, select a combination of smaller, regular shapes to determine the total capacity.

Shape		Dimensions	Area
Square		base 10	100.00 ft ^{2}
Triangle		base 10 height 5	25.00 ft ^{2}

Add a shape

Total Area: 125.00 ft ^{2}

What is the height of the dike? 5

Part III - Results

Diked Volume (ft ^{3})	**625 ft ^{3}**
ASD for Thermal Radiation for People (ASDPNPD)	**124.68 ft**
ASD for Thermal Radiation for Buildings (ASDBNPD)	**15.62 ft**



4. View of the aftermath of an explosion (caused by a chemical contained under pressure) at the Georgia Pacific Plant located in Ohio (September 10, 1997).

5. Mitigation Options

This chapter provides information about mitigation analysis and how to determine if mitigation is required on a proposed HUD-assisted project. This chapter identifies the data points and explains the analytic guidelines for a proposed HUD-assisted project, focusing on HUD standards for blast overpressure and thermal radiation produced by stationary hazards covered under 24 CFR Part 51C.

Mitigation is required to protect buildings and people when the ASD cannot be met between the specific stationary hazardous operation and the proposed project site. Mitigation applies only for HUD-assisted projects in proximity to stationary hazardous operations that have above-ground stationary storage containers of:

1. more than 100- gallon capacity that contain common liquid industrial fuels (see Appendix I of the Regulation and Appendix C of this *Guidebook)*; and

2. of any capacity that contains hazardous liquids or gases that are not common liquid industrial fuels (see also the list of hazardous substances in Appendix C of this *Guidebook*); and

3. of over 1000 gallons of LPG/propane (or less if the storage tank does not comply with the 2017 NFPA 58 (Liquefied Petroleum Gas Code).

Mitigation analysis:

The best mitigation is based on site analysis using the following 11 questions:

1. **Has the ASD been calculated?**

   If the ASD has not been calculated, then calculate the ASD. The ASD is the first step of the mitigation analysis for HUD-assisted projects near hazardous operations that store, handle, or process flammable or explosive substances.

   If the ASD has been calculated, two results are possible: 1.) The ASD is achievable using the proposed site and no further action required, or 2.) The ASD is not achievable using the proposed site and so mitigation may be required

2. **Where is the technical information for the ASD determination available?**

   Technical assistance is available from the following sources:

   - This *Guidebook*,
   - Regulation 24 CFR Part 51C , and
   - HUD field environmental staff (Regional Environmental Officers and Field Environmental Officers)

3. **What properties or characteristics apply to the substances stored at the site make them hazardous?**

   The physical state, or form, of substances in general, is classified as liquid, solid, or gas. Gases are stored under pressure. Liquids cannot be compressed and thus take the form of the storage container in question. Solids are incompressible and have a solid structure.

   If the substances being assessed are hazardous and/or have blast overpressure properties and are in stationary above-ground containers, a hazard analysis is required for the proposed HUD-assisted project site. For ASD determination and mitigation hazard analysis of a proposed HUD-assisted project site, only hazardous liquids or gases and/or blast overpressure properties are considered. Non-cryogenic, pressurized containers with hazardous substances, if ruptured, can cause steam gas explosions or gas explosions. For products (substances) stored under pressure, two results are possible:

   - Blast overpressure or pressure wave
   - A fireball accompanied by a pressure wave (blast overpressure)

4. **What differences are there between a diked and an undiked container?**

   If containers are diked:

   - The ASD calculation will not be changed by the diked volume on non-cryogenic pressurized containers storing hazardous substances; and
   - The ASD will be of a smaller numerical value for diked containers vs undiked containers storing hazardous liquids (including cryogenic containers storing hazardous gases in liquid state).

   If containers are undiked:

   - The ASD will be of a larger numerical value for undiked containers vs diked containers storing hazardous liquids (including cryogenic gases in liquid state).

   (Chapter 4 includes calculation guidelines and facts for pressurized and non-pressurized containers.)

5. **What role does topography have in influencing ASD calculations? Do natural or man-made barriers between the proposed HUD-assisted project and the hazard make a difference?**

   Natural barriers are hills, mountains, earthen elevations, etc. Man-made barriers are buildings, housing developments and other structures. Natural and man-made barriers may serve as abatement from thermal radiation or blast overpressure effects that can have an impact on HUD-assisted projects and the people who live and work there.

   If there are natural or man-made barriers between the proposed HUD-assisted project site and the hazard, the available barrier must serve to abate the effects of thermal radiation, blast overpressure or both, from the hazard.

The following points provide valuable information to evaluate the available barrier between the proposed HUD-assisted project and the hazard:

- Man-made or natural barriers may serve to abate the effects of thermal radiation or blast overpressure on HUD-assisted projects and the people who live and work there.
    - If an ASD cannot be established between the proposed HUD-assisted project site and the hazardous stationary container, but there is no clear line of sight between the proposed HUD-assisted project and the hazard, mitigation may not be required. Under the regulation 24 CFR Part 51C, if there is a natural or man-made abatement between the proposed HUD-assisted project and the hazard that impedes a clear view, the abatement might serve as mitigation for the proposed HUD-assisted project.
        - To determine whether additional mitigation may be required using the above-mentioned analysis, the natural or man-made abatement must be further analyzed to determine whether it will provide an acceptable level of mitigation for the proposed HUD-assisted project site. Only a licensed professional engineer should analyze the preexisting barriers for their acceptability as mitigation based on the hazard being analyzed and provide documentation of the basis for the determination.
    - If the required ASD is not achievable between the site to be developed and the hazard and there is a clear line of sight between the proposed HUD-assisted project and the hazard, mitigation is required.

  If there are no natural or man-made barriers between the proposed HUD-assisted project site and the hazard, and the ASD is not achievable, there are mitigation options described in this *Guidebook* to achieve abatement and compliance with HUD standards.

6. **Where can I get maps or other geographic information?**

- Sources of information:
    i. Maps and related site (topographic) information are available from the United States Geological Survey (USGS), and/or the City or County engineer's or planning office related to the proposed HUD-assisted project.

    ii. Although HUD does not endorse these sources, it is aware that free digitized topographic maps and other relevant information can be found at:

        a. Google Earth, https://earth.google.com/

        b. U.S. Geological Survey https://ngmdb.usgs.gov/topoview/

- Types of information:
    i. Scaled maps with site contours (topographic maps) are highly recommended for the analysis of proposed HUD-assisted project sites.

ii. Site maps similar in content to the scaled maps, but without site contours, are recommended as an initial type of geographic based information for analysis of proposed HUD-assisted project sites.

iii. Site photos provide actual images of the facilities and stationary containers near proposed HUD-assisted project sites and are recommended for use with scaled and site maps for the analysis of proposed HUD-assisted project sites.

7. **What sources can I use if the facility storing these hazards will not release subject information?**

- Fire Department: the local fire department can provide information about facilities, storage tanks, and operations

- Local Emergency Planning Committee Database: the governor of each state has designed a State Emergency Response Commission Contact (SERC) whose responsibility is to implement the Emergency Planning Community Right to Know Act (EPCRA) provisions within that State. The SERC supervises and coordinates the activities of the Local Emergency Planning Committee (LEPC) for each district, establishes procedures for receiving and processing public requests for information collected under EPCRA, and reviews local emergency response plans. The local LEPC database for public use can be found at https://www.epa.gov/epcra/local-emergency-planning-committees.

- Some states and local jurisdictions provide online databases that can be searched in a variety of ways or downloaded.

8. **What are the options for fire suppression systems?**

- Can fire suppression systems modify or change the analysis to obtain ASD?

    - An engineer can consider fire suppression systems in their determination of an alternative ASD.

9. **What are the options if you cannot achieve the ASD?**

In addition to a barrier, other options include:

- Removing or burying the hazard, an alternative that may be less expensive than building a mitigation barrier.

- Adding a dike if there isn't one already.

- Modifying the building design to compensate for the ASD. The building design can be modified by using heat retardant and high tensile strength materials in the direction where the hazardous stationary container is located, to compensate for the ASD. Buildings can also be rearranged and their exterior shapes modified. A combination of these approaches may be used to provide an acceptable level of mitigation (e.g., a horseshoe-shaped building can be oriented with the convex curve facing the hazard and the structure augmented with heat retardant and tensile strength materials). A

licensed structural engineer must evaluate structural modifications to determine their effectiveness.

- Choosing a different site.

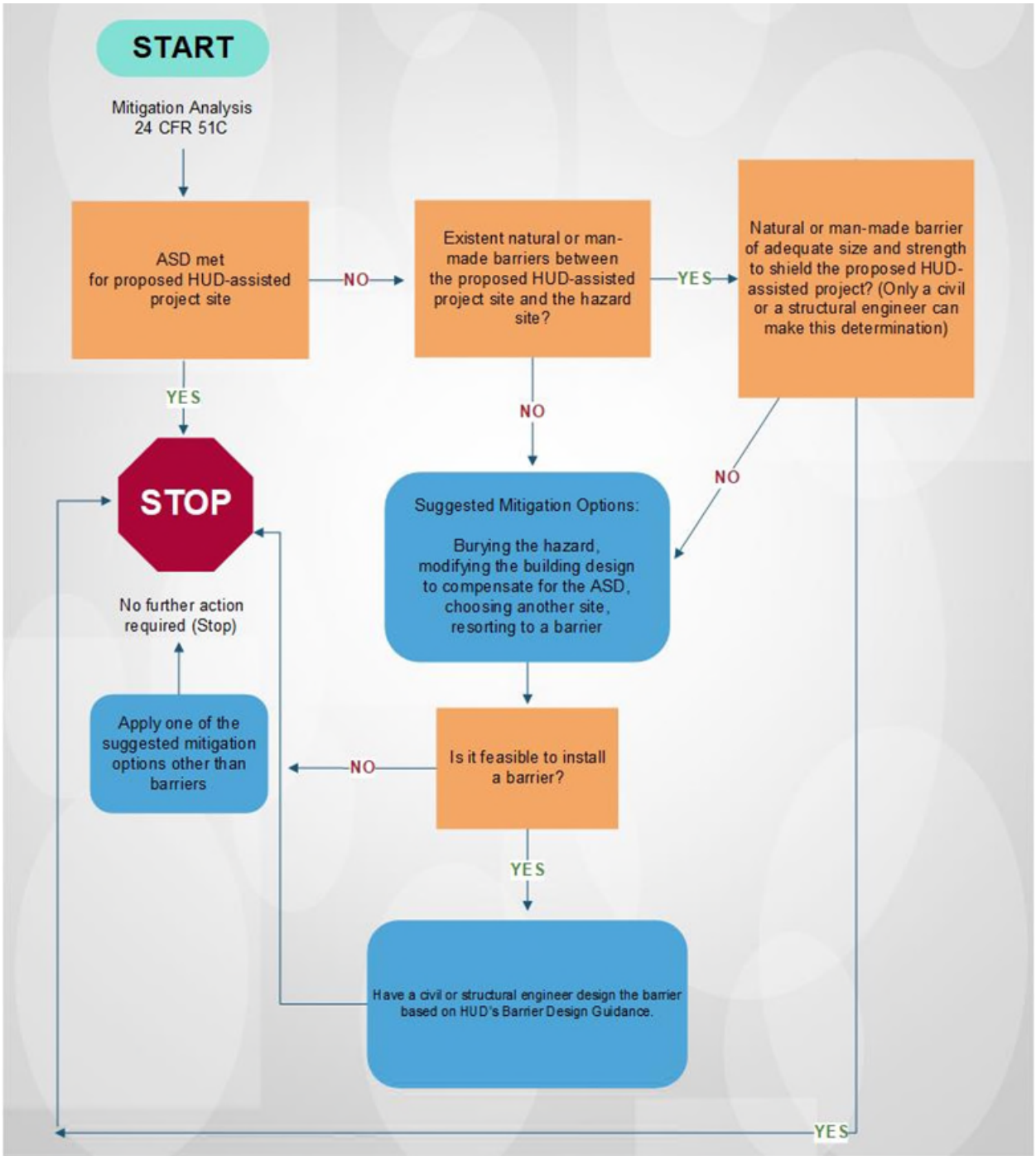
10. **How does a barrier work?**

- A barrier works as an abatement for thermal radiation and blast overpressure and provides mitigation to HUD-assisted projects when the ASD is not achievable.

11. **Who should design a barrier?**

- Only a licensed professional engineer (civil or structural) should design and oversee the construction of mitigation barriers.

Flowchart illustrating a mitigation analysis for a proposed HUD-assisted project site



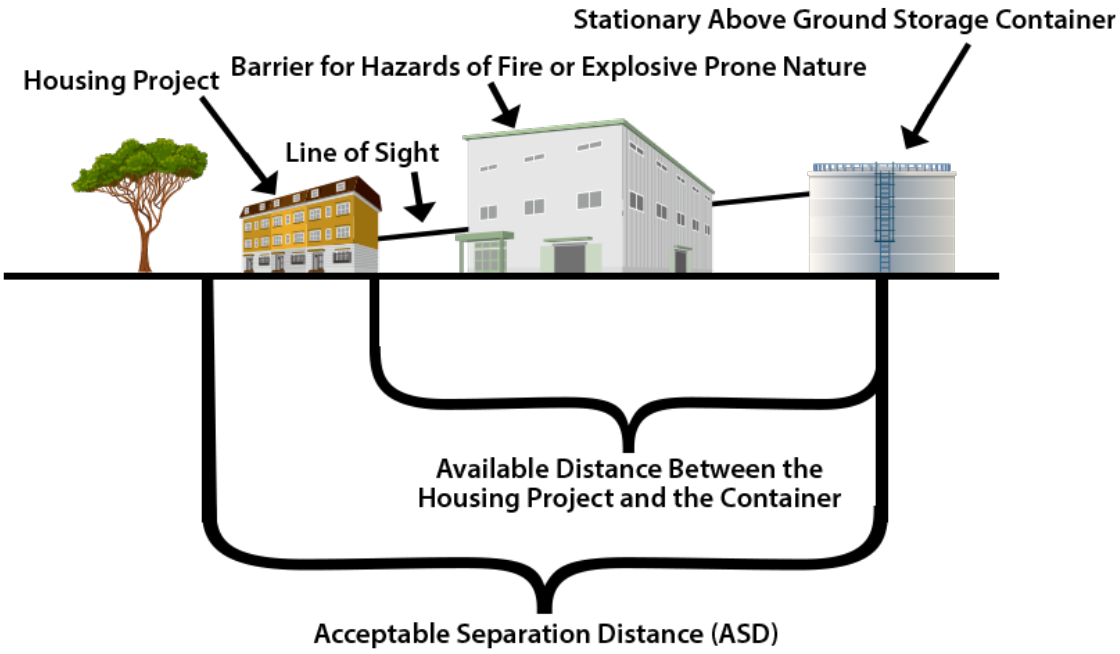
Text Explanation of Flowchart:

Start mitigation under 24 CFR Part 51C by determining if ASD is met. If yes, stop. If no determine if there is an existing natural or manmade barrier. If yes and a civil or structural engineer determines that the barrier is adequate to shield the project, stop. If there is no natural manmade barrier, the hazard can be seen from the site, or if the existing barrier is not adequate, mitigation options are burying the hazard, modifying the building design, choosing another site,

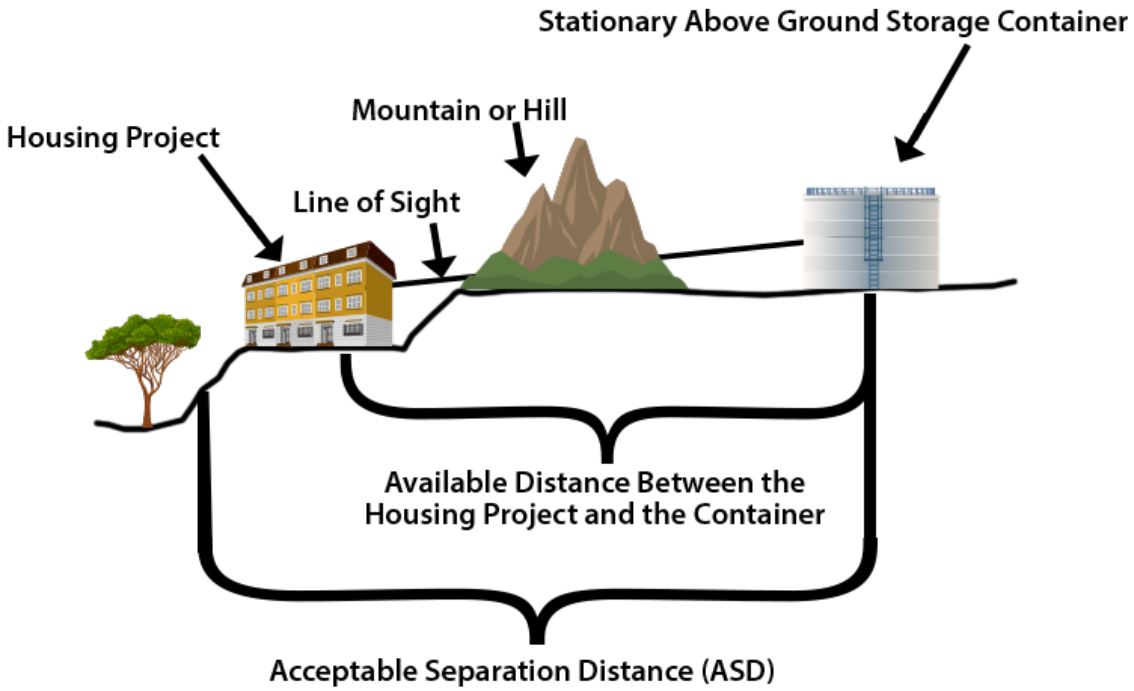
or constructing a barrier. If a barrier is not adequate, choose another option. If a barrier is adequate, have a barrier installed by civil or structural engineer, , using HUD guidelines.

The following scenarios illustrate mitigation options involving natural and man-made barriers if the ASD cannot be achieved between the proposed HUD-assisted project and the hazard being assessed.

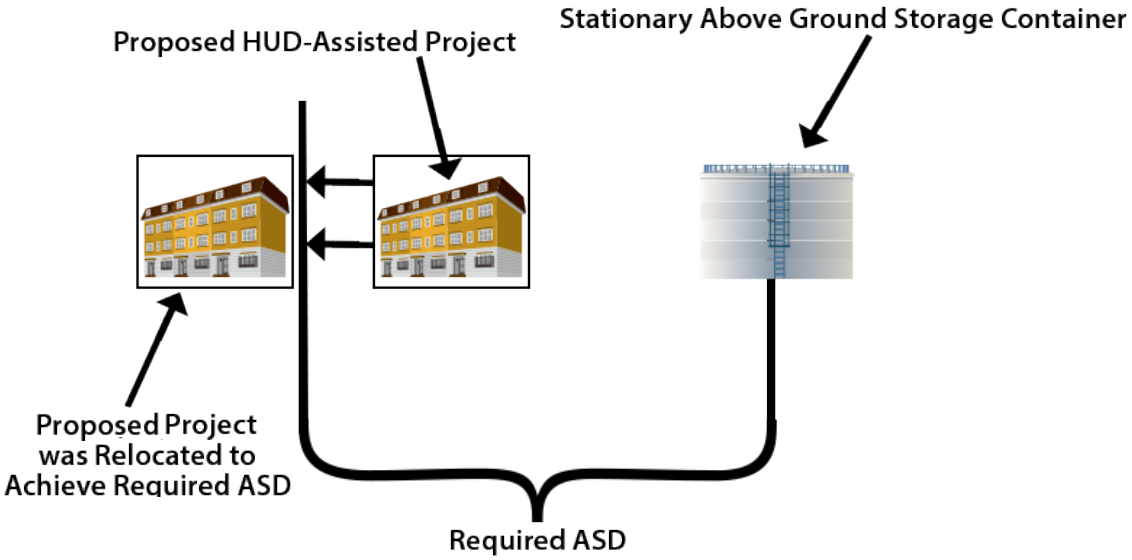
Scenario 1: A man-made barrier (warehouse) is located between a proposed housing project and a stationary above-ground storage tank as a mitigation measure, following the regulation 24 CFR Part 51C. (Only a civil or structural engineer can evaluate the barrier's effectiveness)



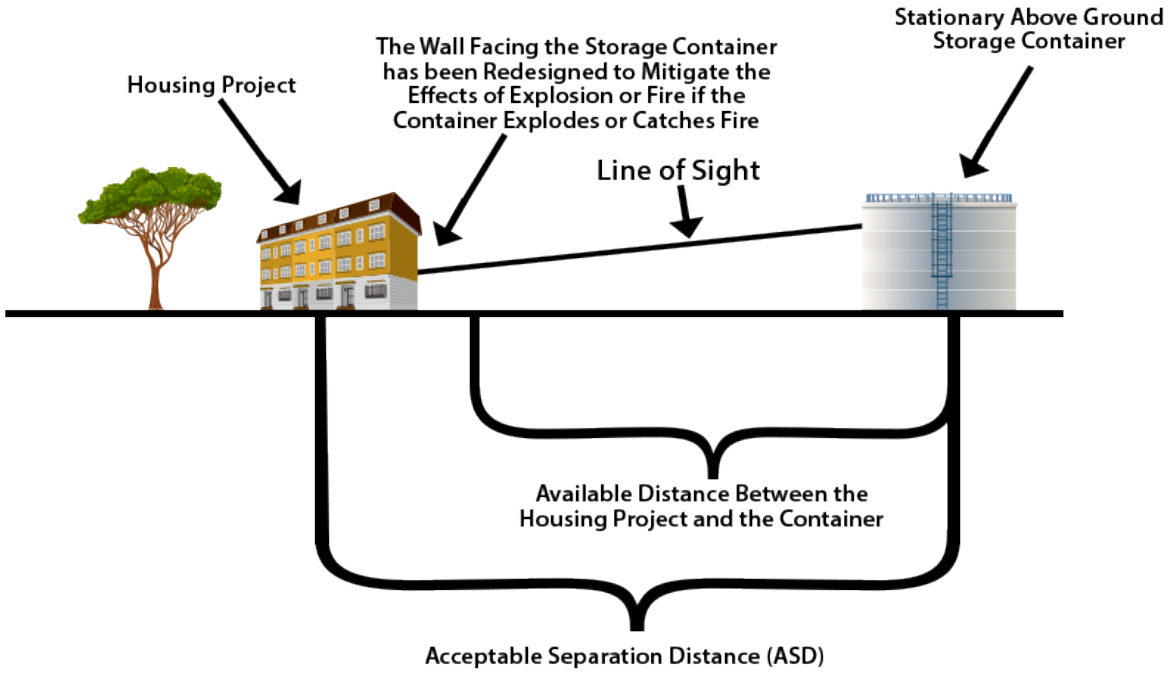
Scenario 2: A natural barrier (mountain, hill, or substantial berm) is located between a proposed housing project and a stationary above-ground storage tank, providing mitigation to the housing project if the tank explodes or catches on fire. (Only a licensed civil or structural engineer can evaluate the barrier's effectiveness)



Scenario 3: Reconfigure/relocate proposed HUD-assisted project to increase the available distance between the project and the hazard and achieve the required ASD in accordance with the regulation 24 CFR Part 51C.



Scenario 4: Modification of the building design with blast resistant wall to compensate for the ASD. *



*Only a civil or structural engineer can evaluate the modifications made, to determine the effectiveness of such modifications.



5. The aftermath of the propane blast near a unit townhouse complex in Brampton, California (January 10, 2008). More than a dozen propane containers had been stored near the townhouse complex.

6. Complex Circumstances

This chapter identifies complex circumstances that require consultation with HUD Regional and Field Environmental Officers and additional information and procedures that are not provided in the regulation 24 CFR Part 51C. Applicants for HUD funding assistance must comply with the standards and the ASD required under the Regulation between specific stationary hazardous containers that store, handle, or process hazardous substances and the HUD-assisted project. Complex circumstances include:

- Analysis of containers that hold hazardous substances (liquids or gases) not listed in Appendix I of the Regulation or in Appendix C of this Guidebook that are near proposed HUD-assisted projects.

- Analysis of existing natural or man-made barriers that may serve as mitigation for HUD-assisted projects from flammable or explosive hazards.

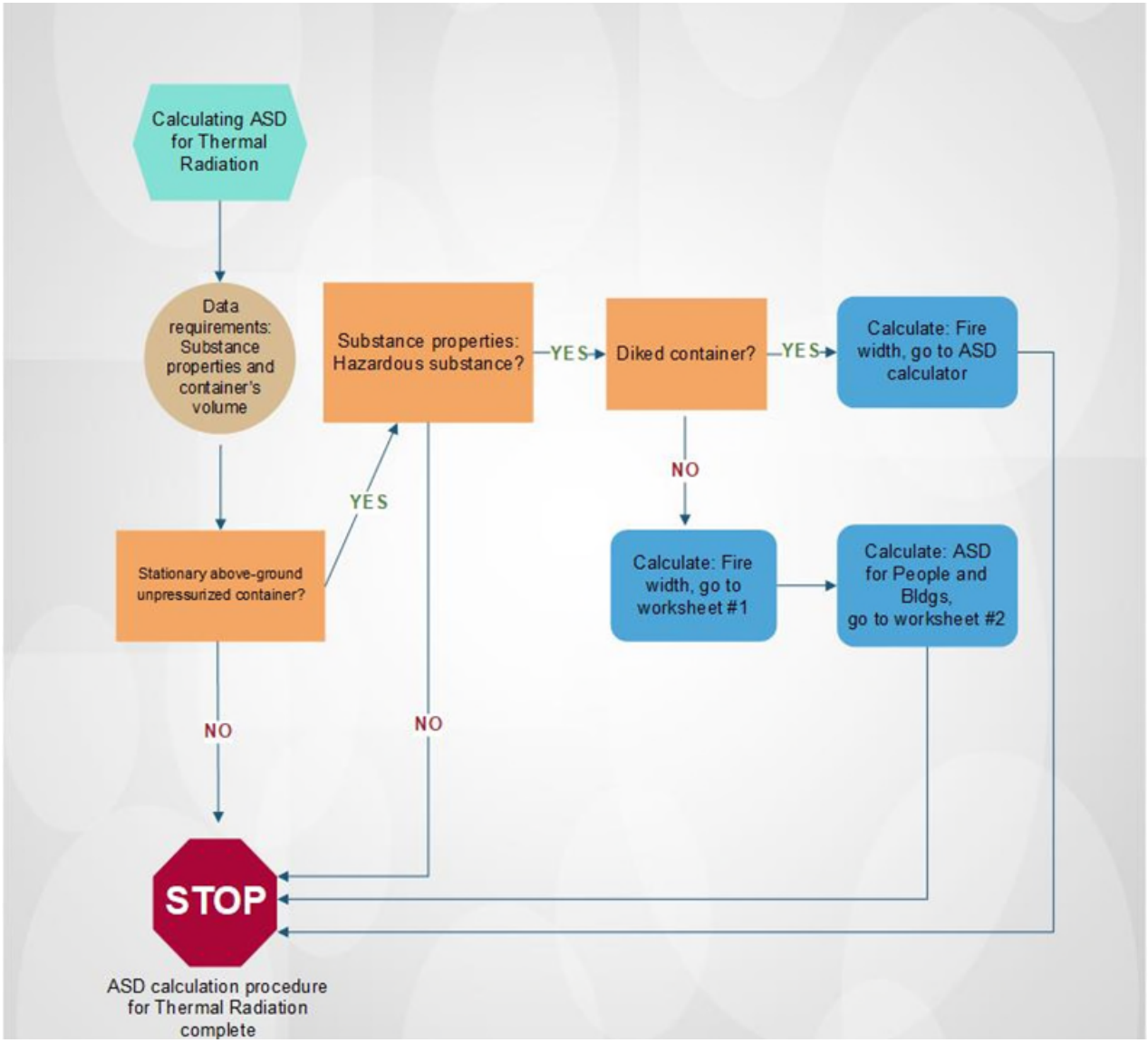
- Calculation of design specifications for barriers used to mitigate flammable and explosive hazards that are located near proposed HUD-assisted projects.

Every proposed HUD-assisted project is different. Therefore, each one should be analyzed according to site conditions such as container size, location, and proximity to residential structures, etc. Mitigation and/or safety measures may be required at some sites but only suggested at others.

Appendices

Appendix A –Flowcharts

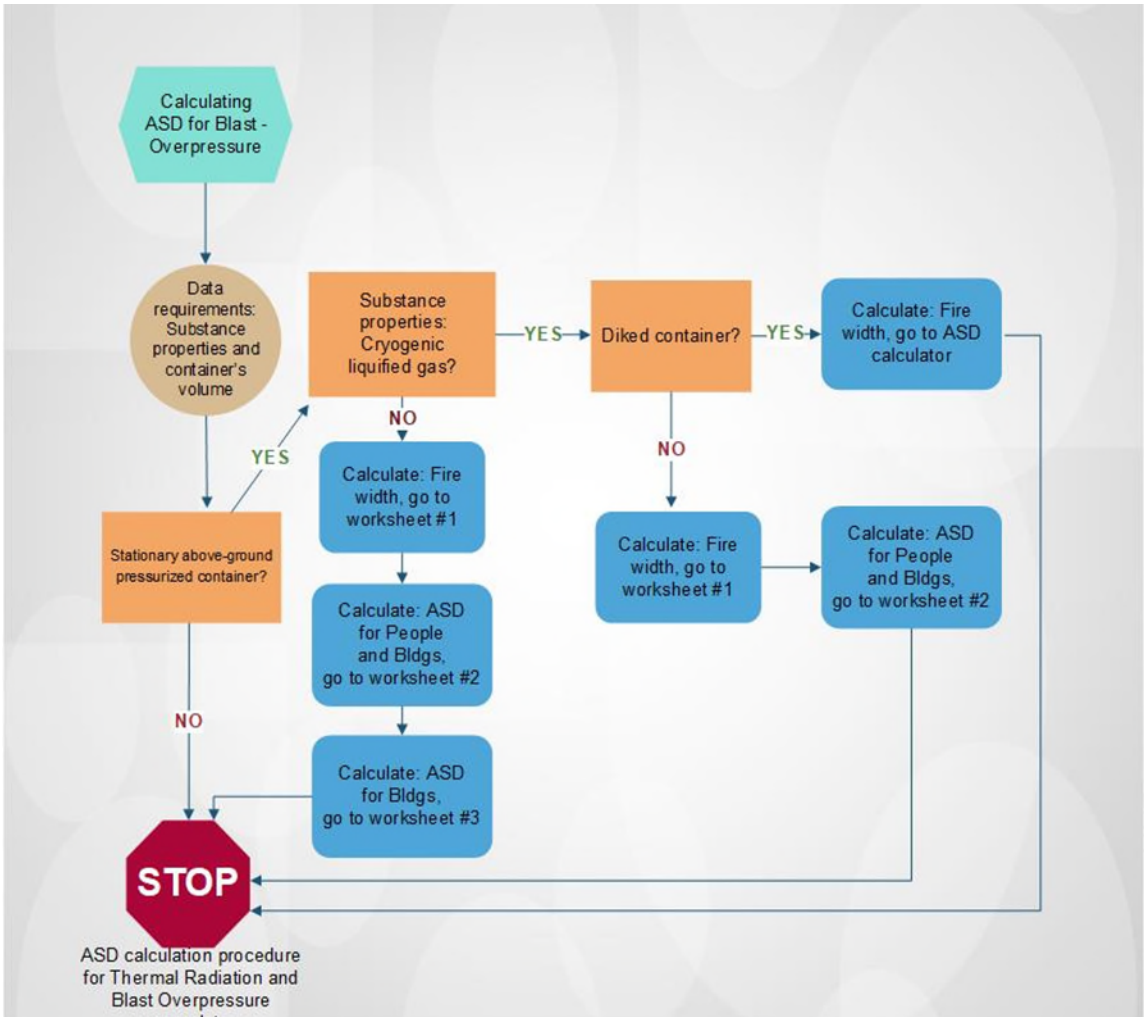
ASD for Unpressurized Containers: The flowchart below illustrates procedural calculation of the ASD for Thermal radiation (fire) for unpressurized containers. For pressurized containers, refer to the ASD for Pressurized Containers flowchart below.



Text Explanation of Flowchart:

To calculate the ASD for thermal radiation, gather data on substance properties and container volume. If the tank is not stationary, aboveground, and unpressurized, stop. If it is any of these but does not contain a hazardous substance, stop. If the substance is a hazardous substance, and the container is diked, calculate fire width and go to ASD calculator, then stop. If the container is not diked, calculate fire width and ASD for people and buildings using worksheets 1 and 2, then stop.

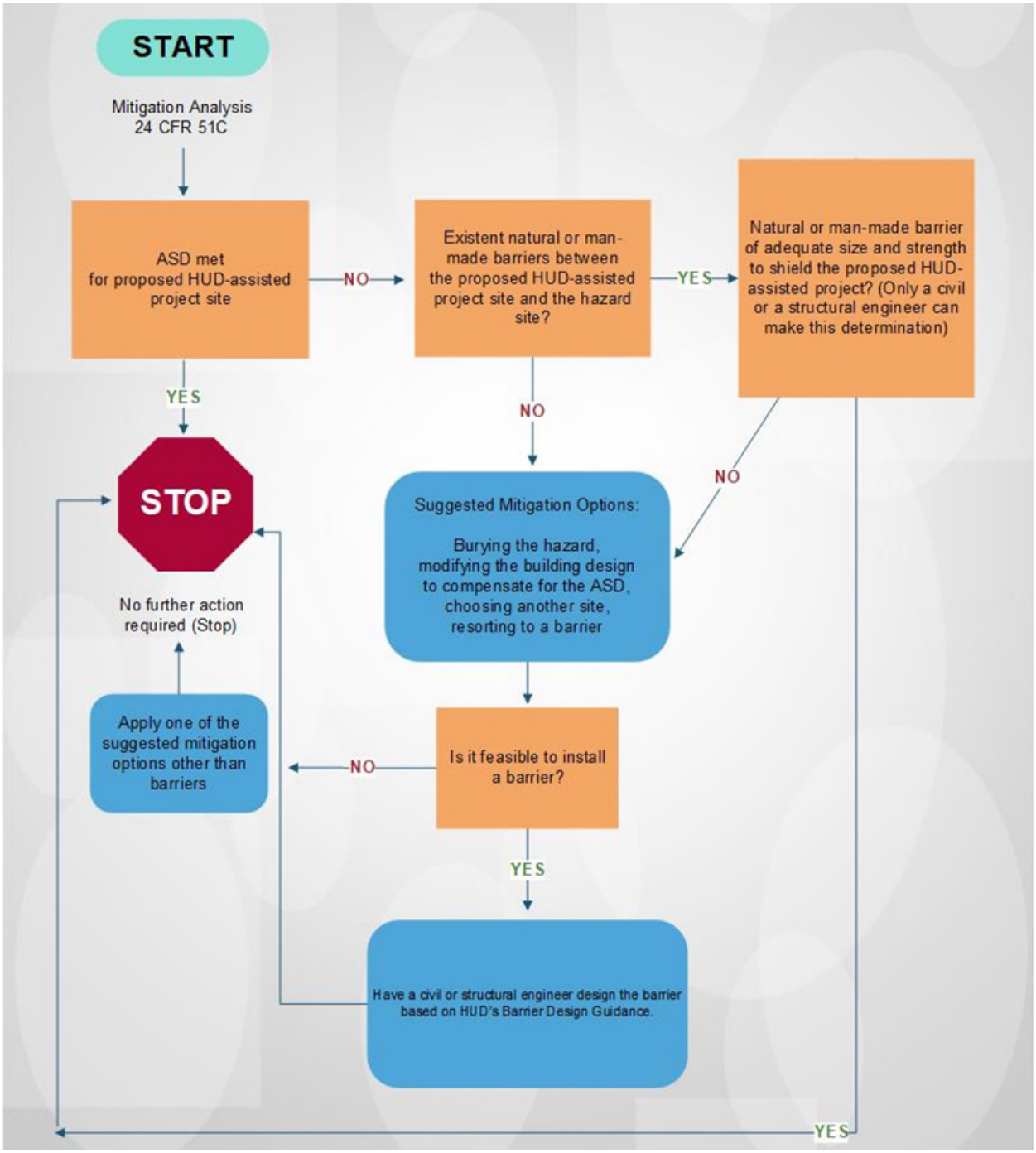
ASD for Pressurized Containers: The flowchart below illustrates procedural calculation of the ASD for Blast Overpressure (explosion) only or Thermal Radiation (fire) and Blast Overpressure if the substance being assessed has flammable properties and is in an above-ground pressurized container.



Text Explanation of Flowchart:

To calculate the ASD for blast overpressure, collect data requirements, then determine if the container is a stationary aboveground pressurized tank. If not, stop. If yes, determine if it is a cryogenic liquified gas. If no, calculate the fire width, and ASD for people and buildings, using worksheets 1, 2 and 3, then stop. If yes, determine if the container is diked. If not, calculate the fire width and ASD for people, use worksheets 1 and 2, then stop. If yes, calculate the fire width and ASD.

Flowchart illustrating a mitigation analysis for a proposed HUD-assisted project site.

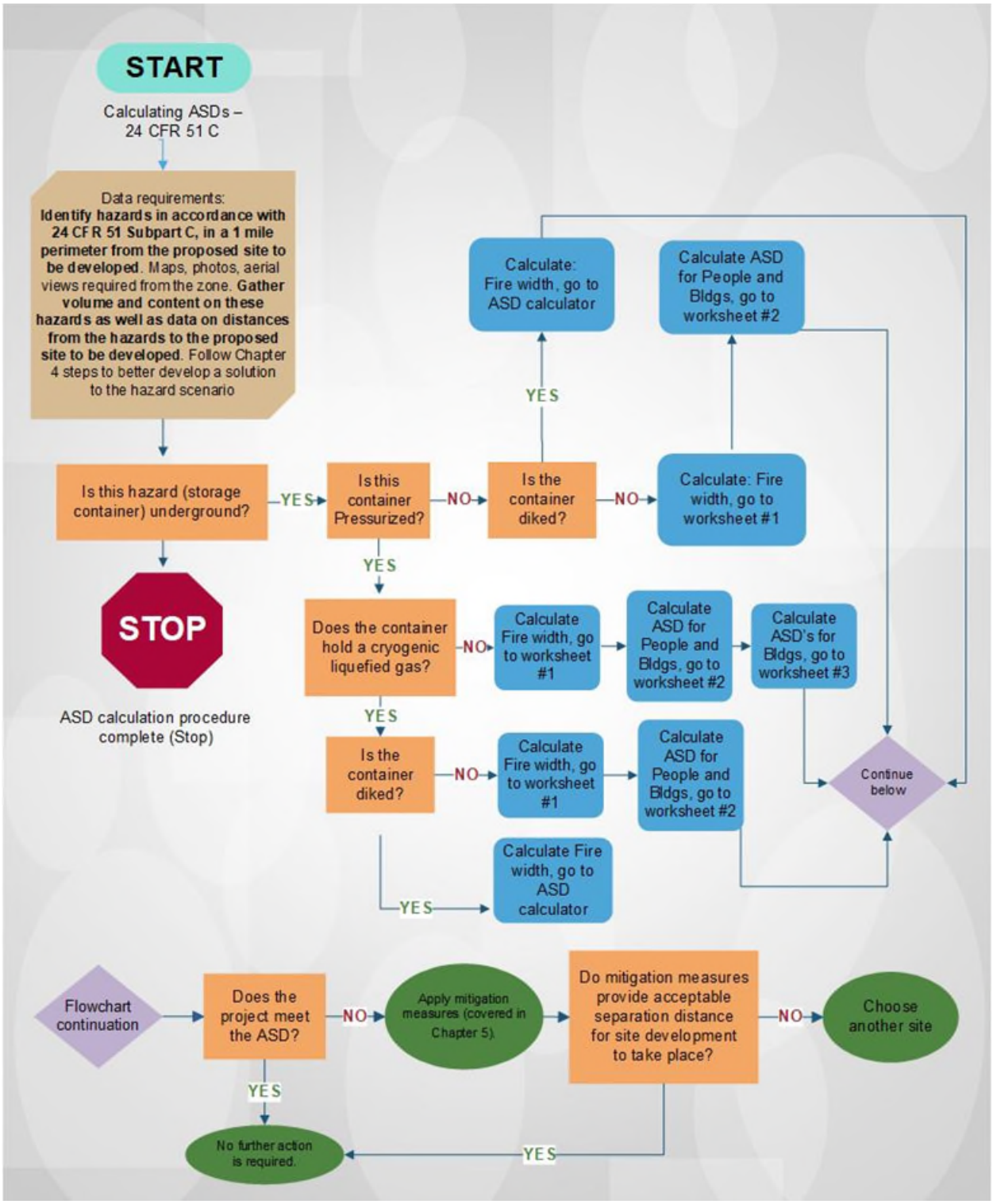


Text Explanation of Flowchart:

Start mitigation under 24 CFR Part 51C by determining if ASD is met. If yes, stop. If no determine if there is an existing natural or manmade barrier. If yes \ and a civil or structural engineer determines that the barrier is adequate to shield the project, stop. If there is no natural manmade barrier, the hazard can be seen from the site, or if the existing barrier is not adequate, mitigation options are burying the hazard, modifying the building design, choosing another site,

or constructing a barrier. If a barrier is not feasible, choose another option. If a barrier is feasible, have a barrier installed by licensed engineer using HUD guidelines.

Summary Flowchart of Site Analysis Steps on ASD calculation procedures and findings for a HUD-assisted project from hazards of fire or explosion prone nature.

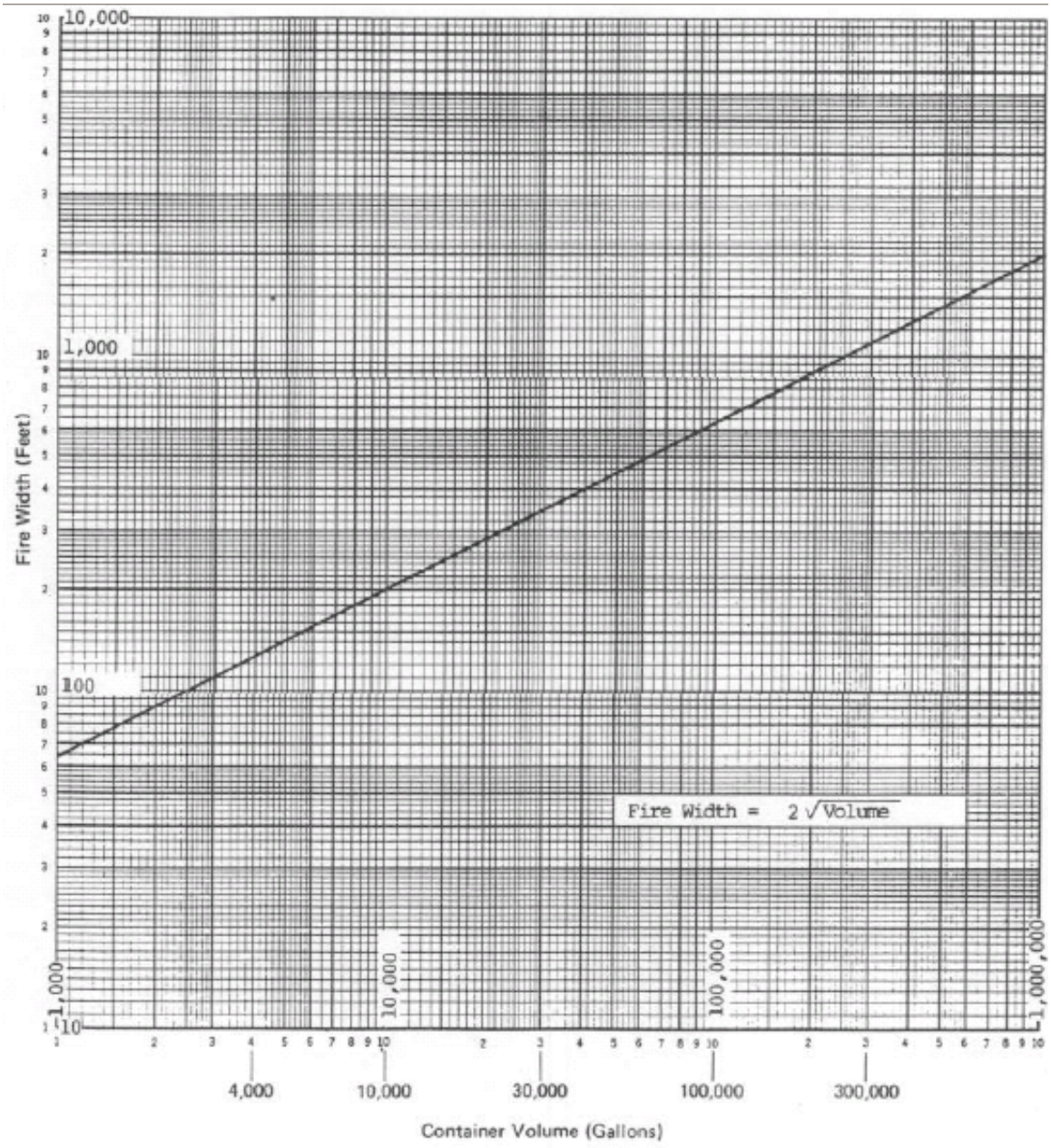


Text Explanation of Flowchart:

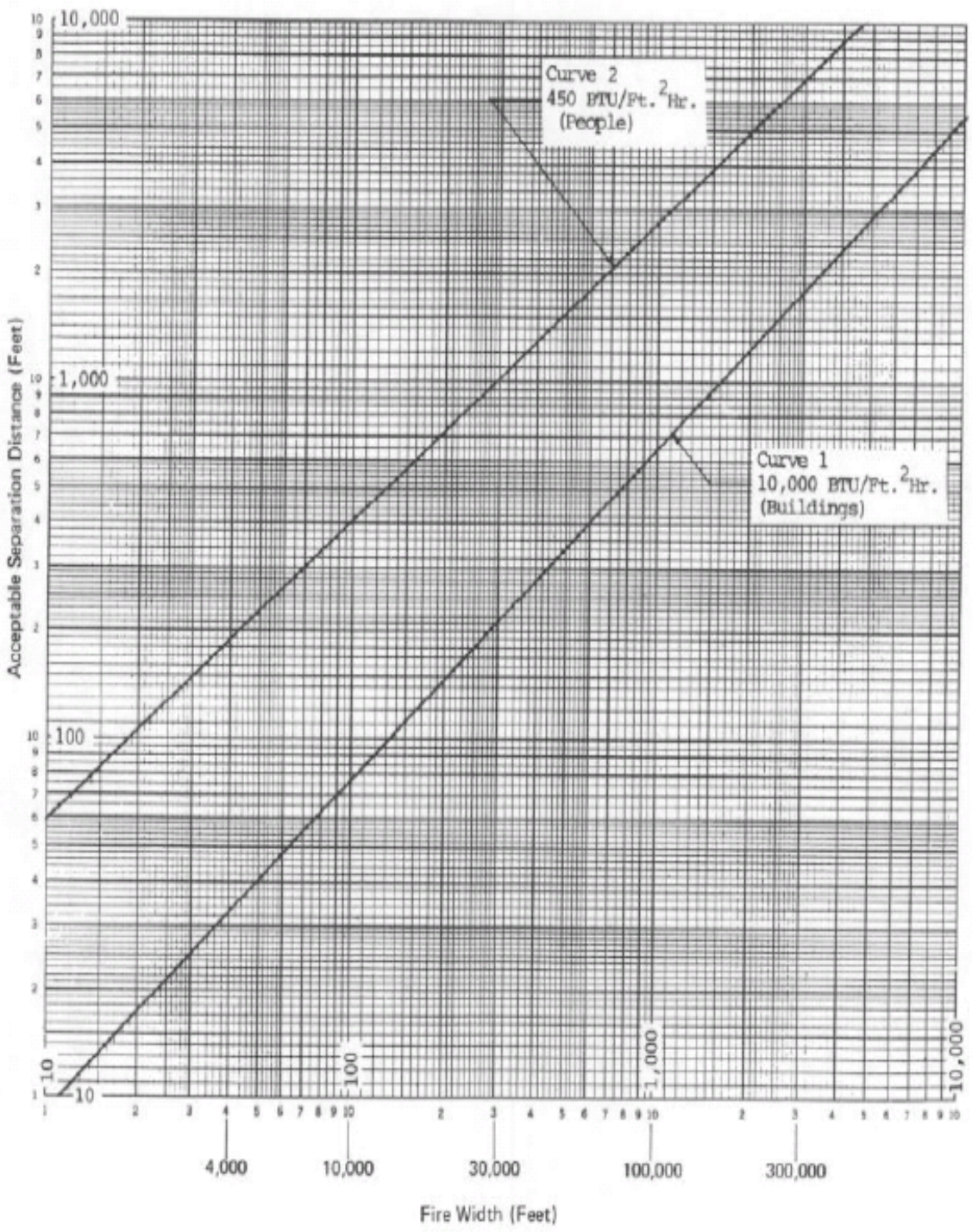
Identify hazards within one mile of the site using maps, photos, and aerial views. Gather volume, distance and content information and follow information in chapter 4. If the hazard is underground, stop. If above ground and not pressurized, and diked, calculate fire width and ASD. If container is not diked, go to worksheet 1, then calculate ASD for buildings and people and go to worksheet 2. If the ASD is acceptable, no further action is required. If not acceptable, see chapter 5 for mitigation measures. If mitigation measures are acceptable, use mitigation measures. If not, choose another site. If the container is pressurized and doesn't hold a liquified cryogenic gas and isn't diked, calculate the fire width and go to worksheets 1, 2 and 3. If the ASD is acceptable, no further action is required. If not acceptable, see chapter 5 for mitigation measures. If mitigation measures are acceptable, use mitigation measures. If not, choose another site. If the container holds a pressurized gas and not diked, calculate fire width and ASD using worksheets 1 and 2. If the ASD is acceptable, no further action is required. If not acceptable, see chapter 5 for mitigation measures. If mitigation measures are acceptable, use mitigation measures. If not, choose another site. If the container holds a pressurized gas and is diked, calculate fire width and go to ASD calculator.

Appendix B – Worksheets

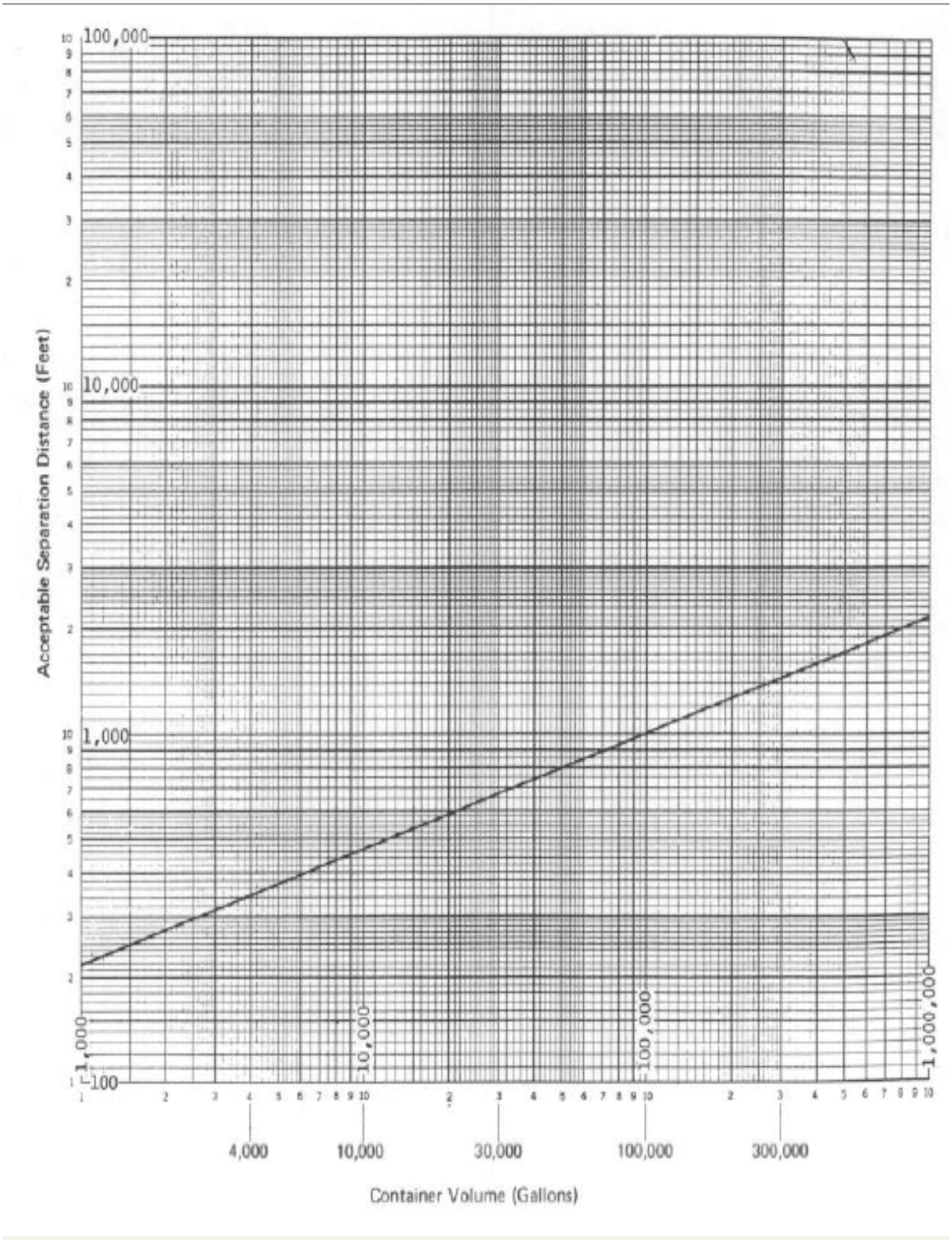
Worksheet #1 – Fire Width calculation – Undiked container



Worksheet #2 – ASD calculation for Buildings and People (Thermal Radiation)



Worksheet #3 - ASD calculation for Buildings (Blast Overpressure), Building occupants and outdoor unprotected facilities



Appendix C – Data Resources

Table I: Volume Conversion

The following table provides unit conversion factors for volume calculation:

The actual number of a unit of measurement listed in the lefthand column should be multiplied by the appropriate factor listed to the right to convert to the unit of measurement listed along the top of the table.

	Cubic meters	**Cubic centimeters**	**Liters**	**Cubic feet**	**Cubic inches**
Cubic meters	1	10^{6}	1000	35.31	6.102×10^{4}
Cubic centimeters	10^{-6}	1	10^{-3}	3.531×10^{-5}	6.102×10^{-2}
Liters	10^{-3}	1000	1	3.531×10^{-2}	61.02
Cubic feet	2.832×10^{-2}	2.832×10^{4}	28.32	1	1728
Cubic inches	1.639×10^{-5}	16.39	1.639×10^{-2}	5.787×10^{-4}	1

1 U.S fluid gallon = 4 U.S fluid quarts = 8 U.S pints = 128 U.S. fluid ounces = 231 in^3
1 British imperial gallon = 277.4 in^3
1 liter = 10^{-3} m^3

HINT: To change from gallons to m^3 (cubic meters), multiply the number of gallons (volume) by 231 to get the number of cubic inches, and then multiply that number by the quantity 1.639×10^{-5}, to get the number of cubic meters.

Note: "x" means multiply

Table II: Length Conversion

The following table provides unit conversion factors for length calculation

The actual number of a unit of measurement in the lefthand column should be multiplied by the appropriate factor listed to the right to convert to the unit of measurement listed along the top of the table.

	Centimeters	**Meters**	**Kilometers**	**Inches**	**Feet**	**Miles**
Centimeters	1	10^{-2}	10^{-5}	0.3937	3.281×10^{-2}	6.214×10^{-6}
Meters	100	1	10^{-3}	39.37	3.281	6.214×10^{-4}
Kilometers	10^{5}	1000	1	3.937×10^{4}	3281	0.6214
Inches	2.540	2.540×10^{-2}	2.540×10^{-5}	1	8.333×10^{-2}	1.57×10^{-5}
Feet	30.48	0.3048	3.04×10^{-4}	12	1	1.89×10^{-4}
Miles	1.609×10^{5}	1609	1.609	6.336×10^{4}	5280	1

Specific Hazardous Substances

The Regulation applies to the chemicals listed in Table III when stored in stationary above ground containers of more than 100 gallons capacity. The Regulation applies to the chemicals listed in Table IV when stored in stationary above ground containers of any capacity, except that the Regulation does not apply to liquefied petroleum gas in containers not to exceed 1000 gallons capacity that comply with National Fire Protection Association (NFPA) 58, Liquefied Petroleum Gas Code, 2017 Edition.

It should be noted that the listed chemicals do not represent the "universe" of hazardous liquids and gases that can produce blast overpressure or thermal radiation levels in excess of the standards. The listed hazardous substances to which the regulations apply are common hazardous liquids and gases used mostly for domestic and industrial purposes. Tables III and IV include the specific liquids and gases listed in Appendix I of 24 CFR Part 51C.

Table III - Hazardous Liquids

Acetic Acid	Crude Oil (Petroleum)	Isobutyl Alcohol
Acetic Anhydride	Cumene	Isopropyl Acetate
Acetone	Cyclohexane	Isopropyl Alcohol
Acrylonitrile	No. 2 Diesel Fuel	Jet Fuel and Kerosene
Amyl Acetate	Ethyl Acetate	Methyl Alcohol
Amyl Alcohol	Ethyl Acrylate	Methyl Amyl Alcohol
Benzene	Ethyl Alcohol	Methyl Cellosolve
Butyl Acetate	Ethyl Benzene	Methyl Ethyl Ketone
Butyl Acrylate	Ethyl Dichloride	Naphtha
Butyl Alcohol	Ethyl Ether	Pentane
Carbon Bisulfide	Gasoline	Propylene Oxide
Carbon Disulfide	Heptane	Toluene
Cellosolve	Hexane	Vinyl Acetate
Cresols	Isobutyl Acetate	Xylene

Table IV - Hazardous Gases

Acetaldehyde	Ethylene	Liquefied Petroleum Gas (LPG)
Butadiene	Ethylene Oxide	Propane
Butane	Hydrogen	Propylene
Ethene	Liquified Natural Gas (LNG)	Vinyl Chloride

Tables V and VI list hazardous liquids or gases that are not common industrial fuels and are not listed in Appendix I of 24 CFR Part 51C. The listed chemicals on tables V and VI are not inclusive of the specific petroleum products listed in the Appendix I of 24 CFR Part 51C. As stated in 24 CFR 51.207, the HUD Secretary or designee may require application of 24 CFR Part 51C to these substances on a case-by-case basis if circumstances warrant. If tanks with these substances are present, consult with HUD for guidance.

Table V – Uncommon Hazardous Liquids

Acryloyl Chloride	Ethanol	Nickel Carbonyl
Allylamine	2-Ethoxyethanol	Propyl Acetate
Aviation Gas (motor propulsion, not Jet propulsion, i.e. Jet Fuel)	Ethyl Mercaptan	Pyridine
Methyl Butyl Ketone	Ethylamine	1-3 Pentadiene
2-Chloropropene	Ethyleneimine	1-Pentene
Crotonaldehyde	Furan	2-Pentene (Z)
Crotonaldehyde (E)	Hydrazine	Piperidine
Cyclohexanone	Iron Pentacarbonyl	Styrene
1,1 Dichloroethane	Isopentane	Tetrahydrofuran
1,2 Dichloroethane	Isoprene	Tetramethylsilane
Diethylamine	Isopropyl Chloride	Tetranitromethane
Diethyl Ether	Isopropylamine	Trichlorosilane
Di-isobutyl Ketone	Methanol	1-1-1 Trichloroethane
Di-isopropyl Ether	Methyl Acetate	Trimethylchlorosilane
1,4 Dioxane	2-Methyl-1 butene	Vinyl Ethyl Ether
Diethylene Glycol Dinitrate	Methyl Chloroformate	Vinylidene Chloride
1,1 Dimethylhydrazine	Methyl Formate	M-Xylene
Dimethyldichlorosilane	Methylamine	O-Xylene
Epichlorohydrin	Methyltrichlorosilane	P-Xylene

Table VI – **Uncommon Hazardous Gases**

Acetylene	Dimethylamine	Silane
Butene	Dimethyl Ether	Propadiene
2-Butene	2,2 Dimethylpropane	Propyne
Dichlorosilane	2-Pentene, (E)	
Difluoroethane	Phosphine	

Basic Data Requirement Checklist

I. Assemble the following geographic information:

1. A map covering the proposed project site and surrounding area up to at least one mile around the area.
2. An aerial photograph of the same area.
3. Sketch the proposed project site boundaries and approximate building locations on the map or photograph.
4. Similarly locate on the map or aerial photograph the positions of:
    a. Industries handling chemical products
    b. Storage tanks and their surrounding dikes
    c. Major highways and roads
    d. Barge docking areas
    e. Tanker truck and railroad car terminals

II. Assemble the following information about the hazardous facility:

1. Are the storage containers buried underground?
2. List the chemical name of all substances stored at the facility that pose a potential hazard to the proposed project site (e.g., gasoline, fuel oil, liquefied propane gas, vinyl chloride, etc.). Identify whether the tank contains a cryogenic flammable or combustible substance.
3. Determine the number of containers involved
4. Determine the distance of the containers to the proposed project site (always measuring from the center of the container to the nearest part of the proposed project site)
5. Identify the physical dimensions of all storage containers (height and diameter)

6. Determine the volume (gallons) of each container

7. Note the shape of each container (e.g., spherical, cylindrical)

8. If the storage tanks are horizontal to the ground, in which direction do the ends face (parallel or perpendicular to the project site)?

9. Identify each storage container surrounded by a dike. Calculate the dike volume (length times the width times the depth (in cubic feet) for those containers surrounded by a dike. Remember that the secondary containment provided by double walled containers is not considered “diked”.

10. What are the general characteristics of the terrain surrounding the storage containers? Does the terrain slope away from the storage tanks toward the proposed HUD-assisted project site?

11. Standing at the proposed HUD-assisted project site, is there a clear line of sight to the site deemed hazardous?

12. Are there permanent structures between the project site and the hazard?

13. For each industry located near the proposed HUD-assisted project site, list those facilities serviced by truck, rail, or barge.

14. Identify how the storage tanks are filled and emptied:
    a. Tanker truck. If so, how many gallons does the truck hold? Is the truck tank compartmentalized?

    b. Railroad car. If so, how many gallons does the railroad car hold? Is the railroad car compartmentalized?1

    c. Barge. If so, how many gallons does the barge hold? What is the largest compartment?

III. List the sources used to locate information for the previous questions. Include the organizational (agency, company, etc.) names and the people contacted and their telephone numbers and, if available, their email addresses.

Use additional sheets of paper as needed.

Request for Headquarters Analysis of Potential Hazardous Site (If requesting by email, include this information in the email or attachments)

Name: _____ Date:_____

Title: _____

Field Office: _____

Phone #: _____ Email: _____

Site Profile: _____

_____

Project Name: _____

Project Location (City, County, State): _____

Type of Project

Residential: Yes_____ No _____

Single _____ Multi _____ High rise _____ No. of stories _____ Low rise _____

Housing for the elderly: Yes _____ No _____

Housing for persons with disabilities: Yes _____ No _____

Rehab (no change in use) _____ Rehab (conversion to new use) _____

Non-residential (describe) _____
_____

Potential Problems (for Headquarters to address):

Project Status (include any deadlines):

Additional Information: _____
_____
_____
_____

Container Data

Contents*	Type**	Number	Size (gallons)	Distance (feet)***

* Are the contents stored under Pressure? Yes _____ No _____

** Indicate “D” for diked or “UD” for undiked.

*** Measured from center of the tank to nearest point of the project site

Does any tank contain toxic or other hazardous materials (e.g. asphyxiants) not covered by 24 CFR Part 51C?

Yes _____ No _____ If “yes,” briefly describe using categories described above in Tables III, IV, V, and VI.

Describe conditions between tanks and project site (include natural, man-made, and structural barriers):

Diagrams (describe storage container in relation to project site. Include and identify location of industrial storage facilities, proposed site, and relevant roadways, railroad tracks, other buildings, etc.)

Describe any safety measures at the industrial site designed or positioned in a manner to minimize the hazard.

Other pertinent information (attachments as necessary).

Acceptable Separation Distance (ASD) Chart (Thermal Radiation)

Undiked Container Volume (gallons)	Fire Width (Feet)	ASD Bldgs. (Feet)	ASD People (Feet)	Diked volume (Cubic feet)		ASD Bldgs. (Feet)	
100	20	17	106	100	8		59
200	28	24	141	200	10		78
300	35	29	167	300	12		92
400	40	33	189	400	13		104
500	45	36	207	500	15		114
600	49	40	224	600	16		123
700	53	43	238	700	17		131
800	57	45	252	800	18		139
900	60	48	265	900	19		146
1000	63	50	277	1000	19		152
2000	89	69	369	2000	26		203
3000	110	84	437	3000	29		240
4000	126	95	493	4000	34		270
5000	141	106	541	5000	37		296
6000	155	115	583	6000	40		319
7000	167	124	622	7000	43		340
8000	179	131	658	8000	45		360
9000	190	139	691	9000	48		378
10000	200	146	722	10000	50		394
20000	283	201	963	20000	66		526
30000	346	242	1141	30000	78		622
40000	400	277	1286	40000	88		701
50000	447	307	1411	50000	96		769
60000	490	334	1523	60000	103		829
70000	529	358	1624	70000	110		884
80000	566	381	1716	80000	116		934
90000	600	403	1803	90000	122		981
100000	632	423	1884	100000		127	
200000	894	582	2514	200000		169	

Undiked Container Volume (gallons)	Fire Width (Feet)	ASD Bldgs. (Feet)	ASD People (Feet)	Diked volume (Cubic feet)	ASD Bldgs. (Feet)
300000	1095	702	2977	300000	200
400000	1265	802	3356	400000	225
500000	1414	889	3683	500000	247
600000	1549	968	3974	600000	266
700000	1673	1039	4237	700000	284
800000	1789	1105	4479	800000	300
900000	1897	1167	4705	900000	315
1000000	2000	1225	4916	1000000	329

Acceptable Separation Distance (ASD) Chart (Blast Overpressure)

Tank Volume (Gallons)	ASD (Feet)
100	102
200	129
300	147
400	162
500	174
600	185
700	195
800	203
900	212
1000	219
2000	275
3000	315
4000	346
5000	373
6000	396
7000	417
8000	436
9000	453
10000	469
20000	590
30000	674
40000	742
50000	798
60000	848
70000	892
80000	933
90000	970
100000	1004
200000	1262
300000	1444
400000	1588
500000	1709
600000	1815
700000	1910
800000	1996
900000	2076
1000000	2149

Units of Measure

The following are the units of measure used throughout this *Guidebook*:

Area

Unit of measure	Abbreviation
Square foot	ft^2

Volume

Unit of measure	Abbreviation
Cubic foot	ft^3

Density

Unit of measure	Abbreviation
Kilogram per cubic meter	kg/m^3

Heat of Combustion

Unit of measure	Abbreviation
Kilocalories/Kilogram	kcal/kg
Megajoules/Kilogram	MJ/kg

Heat Emissivity

Unit of measure	Abbreviation
British Thermal Unit per square foot per hour	BTU/ft^2-hr
Kilowatt per square meter	kw/m^2

Length

Unit of measure	Abbreviation
Meter	m
Centimeter	cm
Kilometer	km
Inch	in
Foot	ft
Mile	mi

Mass

Unit of measure	Abbreviation
Kilogram	kg

Pressure

Unit of measure	Abbreviation
Pounds per square inch	psi

Volume

Unit of measure	Abbreviation
Cubic Meter	m^3
Cubic Centimeter	cm^3
Cubic Inch	in^3
Cubic Foot	ft^3
Ounce	oz
Pint	pt
Quart	qt
U.S. Gallon	gal
British Imperial Gallon	Imp gal

Appendix D – Bibliography and Photographic Credits

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Photographic Credits

1. View of a house near Chesapeake, Virginia, located near stationary above ground storage tanks. Photo courtesy of Mr. Steve Early, The Virginian Pilot.

2. View of the aftermath of the January 30, 2007, propane blast at the Little General Store in Ghent, West Virginia. Enhancements note the approximate location of the store, the propane tanks, and an ambulance overturned in the explosion. Photo courtesy of W. Dayton Whittle, The Register-Herald.

3. View of a plume of black smoke following explosion and fire at a maintenance facility for Como Oil in Duluth, Minnesota. Photo courtesy of the Duluth News Tribune.

4. View of the aftermath of an explosion at Georgia Pacific Resins plant in Columbus, Ohio. Photo courtesy of the U.S. Environmental Protection Agency.

5. View of the aftermath caused by the explosion of propane tanks near a house in Brampton, California. Photo courtesy of City News.

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Appendix F – Glossary

Acceptable Separation Distance (ASD) – 24 CFR 51.201 *Acceptable separation distance (ASD)* —means the distance beyond which the explosion or combustion of a hazard is not likely to cause structures or individuals to be subjected to blast overpressure or thermal radiation flux levels in excess of the safety standards in § 51.203. The ASD is determined by applying the safety standards established by subpart C to the guidance set forth in HUD Guidebook, "Siting of HUD-Assisted Projects Near Hazardous Facilities." Facilities must be placed either outside the ASD or mitigated. In addition, it is the minimum distance that HUD-assisted projects involving the installation of hazardous facilities can be located from existent or planned residences or from any other facility or area where people may congregate.

Barrier – A barrier designed to sustain blast overpressure (generated pressure from an explosion of a substance contained under pressure) from a substance stored under pressure undergoing a liquid-gas unbalanced reaction or thermal radiation (generated heat from the effects of combustion from a flammable substance) or both (blast overpressure and thermal radiation). The design, location and implementation of the barrier is not the same for all cases; the nature of the barrier varies depending on the results of the analysis of the proposed HUD-assisted project site.

Blast Overpressure (also known as Peak Positive Incident Pressure; measured in units of psi) – The pressure, in pounds per square inch, in excess of normal atmospheric pressure on the surrounding medium caused by an explosion.
.

British Thermal Unit (BTU) – A measure of the heat content of fuels or energy sources. One BTU is the quantity of heat required to raise the temperature of one pound of liquid water by 1° Fahrenheit (F) at the temperature that water has its greatest density (approximately 39° F).

Buried Container (or underground storage container) – Any container or combination of containers that is used to hold a regulated substance or an accumulation of regulated substances and is located beneath the surface of the ground with no part of the container exposed to the air. Underground storage containers are not considered to be a hazard under 24 CFR Part 51C, this *Guidebook*, or the ASD assessment tool for the calculation of the ASD from a hazard for a HUD-assisted project.

Combustion – A complex sequence of chemical reactions among oxygen, a fuel source and an ignition source resulting in the production of heat and light in the form of glow or flames.

Container – A structure (also known as a vessel, tank, or enclosure) built to contain material in liquid, gas or solid state that can be designed for stationary or transport purposes. If this structure contains a product under pressure (this includes gases and liquefied gases that are kept in their liquid state maintained at very low temperatures) it is called a vessel. For liquid or solid products, it is called a tank or an enclosure. **Note:** Commercial containers used to hold liquids, solids or gases are all referred to as tanks. Technically speaking, however, containers that hold solids or liquids are properly referred to as tanks or enclosures and those for gases as vessels.

Cryogenics – The branches of physics and engineering that involve the study of very low temperatures, how to produce them, and how materials behave at those temperatures.

Cryogenic container – Containers designed to hold cryogenic gases at very low temperatures, that behave as liquids inside the container at designed pressures. Examples of these gases are, but not limited to liquid nitrogen, liquid oxygen, liquid helium, liquid hydrogen, and LNG.

Dike – A continuous wall (built out of soil, asphalt, steel, or concrete) surrounding a container, constructed as a defense or as a boundary to provide containment or impoundment during a spill. The dike completes the containment within the diked area and serves as the diked area perimeter. The combination of the diked area and the dike provides spill protection.

Diked area – The area between the container's outside wall and the dike. The dike area provides containment if there is a rupture and a spill.

Diked volume – The calculated volume between the container's outside wall and the dike. The dike volume provides volumetric containment if there is a rupture and a spill for liquids.

Fire Suppression Systems – Systems designed to extinguish fires by automatically discharging fire suppressing media (e.g., water, high expansion foam, Halon gas) at the site of the fire. Fire suppressing systems work along with fire alert systems (fire alarms and sirens) to protect people and buildings from fire effects. Fire suppression systems detect fire by using special sensors called Ultraviolet Infrared (UVIR) sensors. UVIR sensors are localized in areas that require fire protection. Once the sensor(s) captures a change in temperature and wavelength on the ambient light from the area being protected, a signal is sent to discharge fire suppressing media at the area being protected from the fire.

Fire ball – The flame front produced by an explosion, typically resembling a ball*.*

Fire Width – Diameter of a fire ball.

Flash Point – The lowest temperature of a flammable liquid at which it can form an ignitable mixture with oxygen. At this temperature the vapor may cease to burn when the source of ignition is removed.

Ground Flash – Occurs as the mass of burning, expanding vapor is partially confined and channeled along the ground. It can cover an area hundreds of feet in diameter and cause massive burns to people in the ground flash area.

Hazard – 24 CFR 51.201 *Hazard* —means any stationary container which stores, handles, or processes hazardous substances of an explosive or fire prone nature. The term "hazard" does not include:

(1) Pipelines for the transmission of hazardous substances, if such pipelines are located underground, or comply with applicable Federal, State, and local safety standards;

(2) Containers with a capacity of 100 gallons or less when they contain common liquid industrial fuels, such as gasoline, fuel oil, kerosene, and crude oil, since they generally would pose no danger in terms of thermal radiation or blast overpressure to a project;

(3) Facilities that are shielded from a proposed HUD-assisted project by the topography, because these topographic features effectively provide a mitigating measure already in place;

(4) All underground containers; and

(5) Containers used to hold liquefied petroleum gas with a volumetric capacity not to exceed 1,000 gallons water capacity, if they comply with National Fire Protection Association (NFPA) 58. NFPA 58, Liquefied Petroleum Gas Code, 2017 Edition, copyright 2016 is incorporated by reference into this section with the approval of the Director of the Federal Register, under 5 U.S.C. 552(a) and 1 CFR part 51.

Hazardous Gas – A flammable or combustible chemical or petroleum product which exists as a gas at normal atmospheric pressure and room temperature. Hazardous gases may be stored, processed, or transported in a gaseous state in an unpressurized container or in a liquefied state in a pressurized or temperature-controlled container. It is distinguished from the solid and the liquid states by relatively low density and viscosity, relatively great expansion, and contraction with changes in pressure and temperature, the ability to diffuse readily, and the spontaneous tendency to become distributed uniformly throughout any container.

Hazardous Liquid – A flammable or combustible chemical or petroleum product which exists as a liquid at normal atmospheric pressure and room temperature. It is distinguished from the gaseous and solid states by its characteristic readiness to flow, little or no tendency to disperse, and relatively high incompressibility.

Hazardous substances – Petroleum products (petrochemicals) and chemicals that can produce blast overpressure or thermal radiation levels in excess of the standards set forth in § 51.203. A specific list of hazardous substances is found in appendix I to this subpart.

HUD-assisted project – The development, construction, rehabilitation, modernization, or conversion, with HUD subsidy, grant assistance, loan, loan guarantee, or mortgage insurance, of any project intended for residential, institutional, recreational, commercial, or industrial use. For purposes of this subpart, the terms “rehabilitation” and “modernization” refer only to repairs and renovations of a building or buildings that increase the number of people exposed to hazardous operations by increasing residential densities, converting the building’s use to habitation, or making a vacant building habitable.

Heat of Combustion – The energy released as heat when a compound undergoes complete combustion with oxygen. The chemical reaction of an organic compound is typically a hydrocarbon reacting with oxygen to form carbon dioxide, water, and heat.

Liquefied Natural Gas (LNG) – A natural gas that has been processed to remove either valuable components (e.g., helium), or those impurities that could cause difficulty downstream (e.g., water or heavy hydrocarbons) and is then condensed into a liquid at almost atmospheric pressure (transport pressure around 25 kPa) by cooling it to approximately -163° Celsius. LNG is transported by specially designed cryogenic sea vessels and cryogenic road tankers and stored in specially designed tanks.

Liquefied Petroleum Gas (LPG) – A mixture of hydrocarbon gases (also called liquefied petroleum gas, liquid petroleum gas, LPG, LP Gas, or autogas) used as a fuel in heating appliances and vehicles and increasingly replacing chlorofluorocarbons as an aerosol propellant and a refrigerant to reduce damage to the ozone layer. Varieties of LPG in commerce include mixes that are primarily propane, mixes that are primarily butane, and mixes including both propane and butane, depending on the season (in winter, more propane; in summer, more butane).

Loading facility – A facility where hazardous products are loaded and unloaded from tanker trucks, railcars, and sea vessels.

Mitigation – The process for implementing the required level of protection to a HUD-assisted project site from stationary hazardous operations which store, handle, or process materials of explosive or flammable nature. This level of protection can be either a designed barrier or it can be a preexisting barrier, either natural (e.g., mountains, hills) or man-made (e.g., elevated buildings or housing developments).

Open Spaces – Regarding the regulation 24 CFR Part 51C, these are areas where people perform outside activities (congregation, playing sports) outside of a building, such as a park, residential yard, canopy, residential parking space, etc.

Peak Positive Incident Pressure (measure in units of psi) – Blast overpressure

Pulse Oximeter – A medical device used to monitor and evaluate a patient's temperature and blood oxygen saturation levels. The oximeter measures the temperature of the tissue to which the sensor is attached, as well as the oxygen saturation of a person's blood and changes in blood volumes in the skin, producing a graph representing such volume levels (photoplethysmograph).

Responsible Entity (RE) – A unit of general local government that, by assuming HUD environmental responsibilities, is responsible under certain HUD funding programs (those covered by 24 CFR Part 58) for the scope and content of the environmental review and making the environmental review finding. The regulatory definition is at 24 CFR 58.2(a)(7).

Self-Contained Above Ground Containers (SCAC's) – Containers with interstitial spill countermeasure systems for spill prevention control. SCAC's have two external walls. The first wall holds the product in the container; the second prevents the spill if the first wall ruptures. The interstitial space between the first and the second wall serves to prevent spillage.

Standoff Distance – For the calculation of the thermal heat flux and the peak positive incident pressure, the standoff distance means:

- For the thermal heat flux calculation – Standoff Distance is the calculated distance from the center of the fireball to the target. The target can be the perimeter of the proposed HUD-assisted project site or where the fire barrier can be implemented.
- For the peak positive incident pressure calculation – Standoff Distance is the measured distance from the center of the container (hazard) being assessed to the target. The target can be the perimeter of the proposed HUD-assisted project site or where the blast barrier can be implemented.

Thermal Radiation – Process by which energy is emitted by a warm or hot surface. The energy is electromagnetic radiation and so travels at the speed of light and does not require a medium to carry it. Thermal radiation ranges in frequency from infrared rays through visible light to ultraviolet rays. The intensity and frequency distribution of the emitted rays are determined by the nature and temperature of the emitting surface; in general, the hotter the object, the shorter the wavelength.

TNT (Trinitrotoluene) – Useful explosive material with convenient handling properties.

Thermal Radiation Flux – Measured in BTU per square foot per hour, it is the amount of heat emitted by standard area of a warm or hot surface over time.

TNT Equivalent Weight – The weight of TNT which would produce an explosion of equal magnitude as a unit mass of the hazardous substance under pressure.

Appendix G – Frequently Asked Questions

Frequently Asked Questions

Is there a list of steps to assess whether a proposed HUD-assisted project is too close to a hazardous container?

Yes, that information is located in Chapter 4. There you will find the steps necessary for assessing the proposed HUD-assisted project and examples using the nomographs (Worksheets #1 through #3).

Is there a procedure for calculating the ASD?

Yes. Chapter 4 has manual calculation procedures. Chapter 4 and Appendix A provide detailed flowcharts on how to calculate the ASD for blast overpressure, thermal radiation, or both. You can also calculate the ASD by using the ASD assessment tool available on HUD's environmental webpage at https://www.hudexchange.info/environmental-review/asd-calculator/

Which guidelines apply when the proposed HUD-assisted project site does not meet the standard and mitigation is required? Is there detailed information available on mitigation analysis?

Chapter 5 (Mitigation Options) provides information and steps required for a mitigation analysis. The results of this analysis provide key information that will help you determine if mitigation is required. Chapter 5 also provides flowcharts on the mitigation analysis for a site that has natural or man-made barriers if the ASD cannot be achieved between the site and the hazard being assessed.

Are there guidelines for chemicals that are held in above-ground stationary containers?

Yes. These guidelines can be found in Appendix C (Data Resources).

Aside from the manual calculation procedure (Nomographs) or the ASD assessment tool, is there another way to access already calculated ASD results based on the volume of the container?

Yes, there are 2 charts with ASD results (one for blast overpressure, the other for thermal radiation) based on the volume of the container. These charts are located in Appendix C.

How are Self-Contained Above Ground Containers (SCAC's), also known as double-walled tanks, evaluated for calculation of the ASD?

SCAC's are considered containers without a dike, **and calculations must be done for containers without a dike.** If both walls of SCAC are penetrated, the container will leak on to the ground and could burn. A dike would contain both the product and the fire, but these could spread further without a dike.

Are above-ground, stationary tanks that contain flammable or explosive petrochemical fuels and are ancillary to the operation of a building (e.g., comfort heating, cooking, water heating) subject to the Regulation?

Yes, with some exceptions. The ASD must be calculated for above-ground, stationary tanks containing flammable or explosive petrochemical fuels ancillary to the operation of a building. If the tanks have a capacity of 100 gallons or less and contain common liquid industrial fuels, or 1000 gallons or less and contain LPG/propane (if the storage tank complies with the 2017 or later edition of NFPA 58 (Liquefied Petroleum Gas Code), the ASD does not have to be calculated. In addition, if the categorical exclusion at 24 CFR 50.19(b)(17) applies, the ASD does not have to be calculated, UNLESS the building is a new construction, 1-3 family FHA-insured property, in accordance with 24 CFR 200.926d(b)(3)(i) if applicable. A sample conformance memo is available on HUD Exchange.

Does the Regulation consider tank designs (e.g., double wall, fire resistant, protected) in the ASD calculation procedures for a proposed HUD-assisted project site?

No, the Regulation does not consider tank designs in the ASD calculation procedures for a proposed HUD-assisted project (except that the exclusion for propane/LPG tanks of 1000 gallons or less requires compliance with NFPA 58 (2017).

Does the Regulation consider fire suppression systems (e.g., water, high expansion foam, Halon gas, Aqueous Film Forming Foam) as a substitute for the ASD or mitigation?

No, the Regulation does not consider fire suppression systems as a substitute for mitigation or the ASD.

When should above-ground, stationary tanks containing hazardous substances be moved from a proposed HUD-assisted project in order for the project to be in compliance with the Regulation?

The tanks must be moved before the HUD-assisted building or site is occupied or used.

Does the Regulation provide standards for the location of above-ground stationary storage tanks for the protection of construction workers?

No, the Regulation does not regulate or provide standards for the location of storage tanks for the safety requirements of construction workers. Such standards and guidance or safety requirements would fall within the purview of the NFPA, local fire codes and permitting requirements, and OSHA, respectively.

Does the Regulation apply to protecting HUD-assisted hazardous facilities from the facility's own tanks?

No, the Regulation does not apply to the protection of the proposed HUD-assisted industrial facility from the facility's own tanks. For a proposed HUD-assisted project involving the installation of a hazardous facility, the Department shall ensure that such hazardous facility is located at an acceptable distance from residences and from any other facility or area where people may congregate. The ASD determination methods described in this Guidebook should be used for determining such an acceptable distance.

Does the Regulation apply to public facilities, such as sewer and water treatment plants that may have water tanks, underground sewer lines, and pumping facilities?

Public facilities like the ones described above are not subject to consideration under the Regulation as it applies to above-ground stationary storage containers that hold hazardous substances. The Regulation does not generally apply to public facilities unless there are above-ground stationary containers on site that would meet the criteria contained in the Regulation.

HUD has revised the regulation to exempt from coverage above-ground storage tanks with a water gallon capacity of 1,000 gallons or less that are used to store LPG/propane if the storage tank complies with the 2017 edition of NFPA Code 58 (Liquefied Petroleum Gas Code. How do I determine whether this exception applies to my environmental review?

ASD requirements under 24 CFR 51C apply when there is an aboveground storage tank with a volume greater than 100 gallons containing flammable or explosive liquids or gases within the recommended search distance (1-mile) from the proposed HUD-assisted project site. The exception applies specifically to LPG/propane tanks of 1,000 gallons or less water volume that would otherwise require compliance under 24 CFR 51C, where the tank is operated within a state or local jurisdiction that has adopted NFPA 58 (2017 edition).

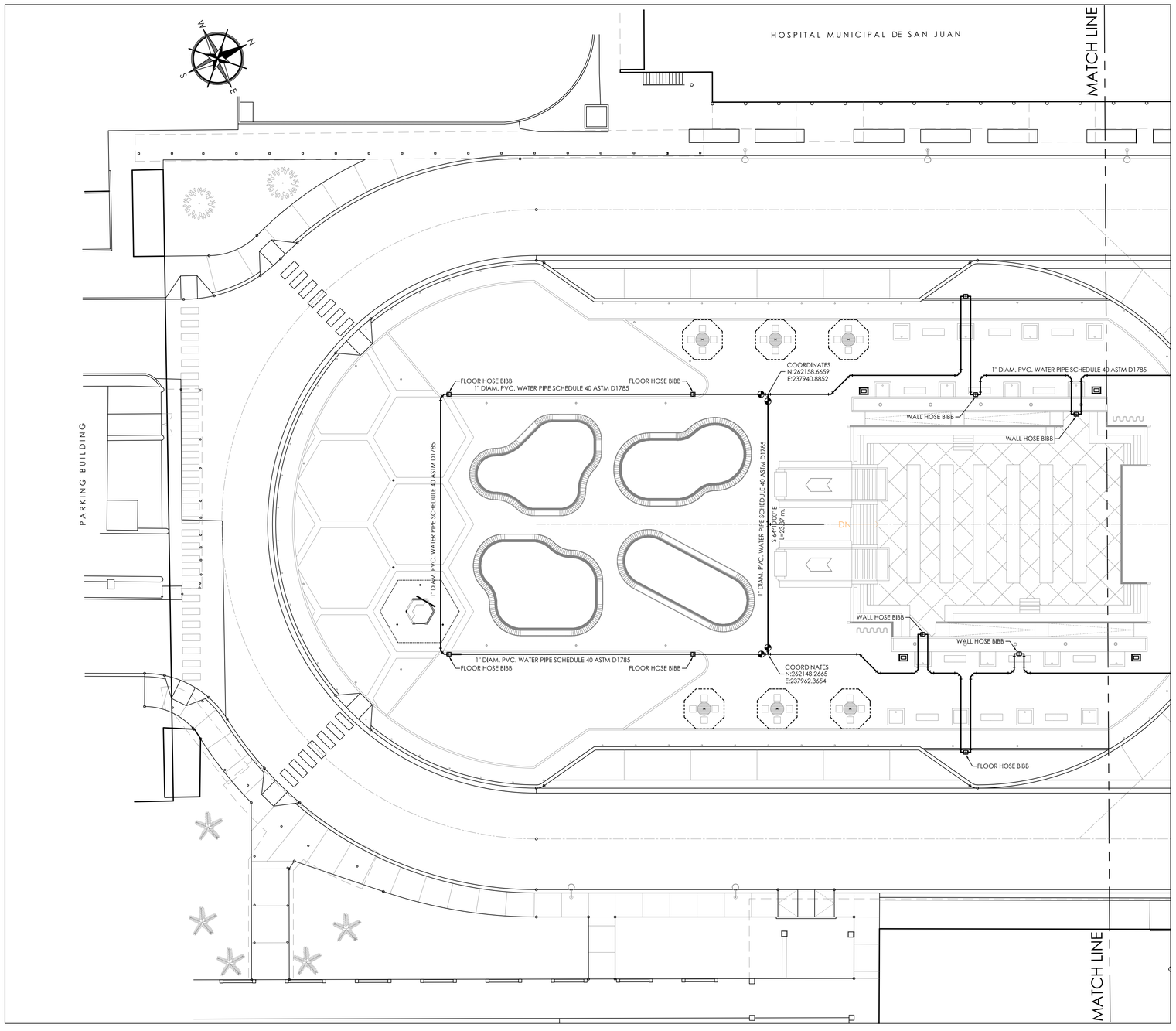
What are the steps to follow after the ASD of a proposed HUD-assisted project has been calculated?

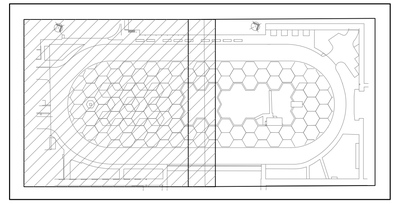
- If the ASD meets the standard requirement, no further action is required.
- If the ASD does not meet the standard requirement, mitigation (explained in Chapter 5) may be required.
- If the ASD does not meet the standard requirement and mitigation is not possible, consult Chapter 5 (mitigation analysis #9).



Office of Community Planning and Development
Office of Environment and Energy

Exhibit E: Utility Plans by “Nueva Plazoleta” project





KEY MAP
NOT TO SCALE

NOTES:

1. ALL MANHOLES, VALVES AND OTHERS UTILITIES BELONGING TO P.R.A.S.A. SHALL BE RESETED TO FIT THE NEW ELEVATIONS, BE IT IN NEW PAVEMENT AREA, SIDEWALKS, AND/OR PLANTING AREAS.
2. WHENEVER THE CONTRACTOR IS GOING TO WORK ON ANY WAY AFFECTING ANY UTILITY, HE SHALL COORDINATE WITH THE CONCERNED AUTHORITY, PRIOR TO STARTING THE WORK.
3. WHEREVER THE CONTRACTOR FINDS ANY UTILITY, NOT SHOWN ON THE PLANS, AND IN A POSITION AFFECTING THE CONSTRUCTION, HE SHALL INFORM THE RESIDENT ENGINEER AS WELL AS THE CONCERNED UTILITY COMPANY, PRIOR TO WORKING ON IT.
4. CONTRACTOR WILL REFER TO MECHANICAL DRAWINGS FOR EXACT POSITION OF ALL HOUSE CONNECTIONS.
5. PIPE SHALL BE INSTALLED AT DEPTH OF NO LESS THAN 0.75 METER MEASURED FROM GROUND SURFACE TO THE UPPER PART OF THE PIPE AND A DETECTABLE PLASTIC TAPE SHALL BE PLACE ABOVE ALL THE LENGTH OF THE PIPE AT NO LESS THAN 0.30 METER MEASURED FROM GROUND SURFACE PERMIT LOCATION OF THE PIPE.
6. EXISTING WATER MAIN PIPES SHOWN ON PLANS ARE APPROXIMATELY LOCATED. CONTRACTOR SHALL BE RESPONSIBLE TO FIELD VERIFY EXACT LOCATION BEFORE TRENCH EXCAVATIONS.

PRASA REQUIREMENTS FOR WATER SAVING:

1 – ALL EQUIPMENTS INSTALLED SHALL BE WATER SAVING EQUIPMENTS SIMILAR OR EQUAL TO "AFC" (WATER SAVING) "UFO" OR "ECO".
2 – THE DEVICE SHALL CLOSE AUTOMATICALLY THE FLOW AFTER THE USER REMOVES HIS HAND FROM THE WATER FLOW.
3 – THE DEVICE SHALL STOP LEAKINGS CAUSED BY DEFECTIVE FAUCETS AND WASHERS.
4 – THE EFFECTIVE LOSS SHALL BE 00 GPM AND THE DEVICE FLOW SHALL NOT BE GREATER THAN 15 GPM.
5 – WATER CLOSETS SHALL NOT BE GREATER THAN 1.6 GALLONS PER DISCHARGE.
6 – ALL FIRE HYDRANTS SHALL BE PROVIDED WITH AN ANTI–THEFT SYSTEM. EQUAL OR SIMILAR TO MCGARD HYDRANT LOCK.

LEGEND:

- NEW 1" DIAM. BRONZE GATE VALVE
- NEW 1" DIAM. PVC. WATER PIPE SCHEDULE 40 ASTM D1785
- NEW 4"x4"x4" DIAM. TAPPING SLEEVE AND 4" DIAM. GATE VALVE
- EXISTING 4" DIAM. FIRE HYDRANT AND 4" DIAM. GATE VALVE
- NEW 1" DIAM. HOSE BIBB BOX
- NEW 1" DIAM. PVC. HOUSE CONNECTION SCHEDULE 40 ASTM D1785

PIPE TO BE INSTALLED

PIPE DIAMETER	METERS
2" DIAM. PVC. CLASS 200 (DR 14) AWWA C–900	58.00
1" DIAM. PVC. WATER PIPE SCHEDULE 40 ASTM D1785	561.00

GRAPHIC SCALE
0m 5m 10m 15m
SCALE 1:200

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PROFESSIONAL CERTIFICATION LAW

I, JORGE RIGAU PÉREZ, LICENSE 7650, CERTIFY THAT I AM THE PROFESSIONAL WHO DESIGNED THESE PLANS AND THE COMPLEMENTARY SPECIFICATIONS. I ALSO CERTIFY THAT I UNDERSTAND THAT SUCH PLANS AND SPECIFICATIONS COMPLY WITH THE APPLICABLE PROVISIONS OF THE JOINT REGULATIONS AND APPLICABLE PROVISIONS OF THE REGULATIONS AND CODES OF AGENCIES, REGULATORY BOARDS AND/OR PUBLIC CORPORATIONS WITH JURISDICTION.

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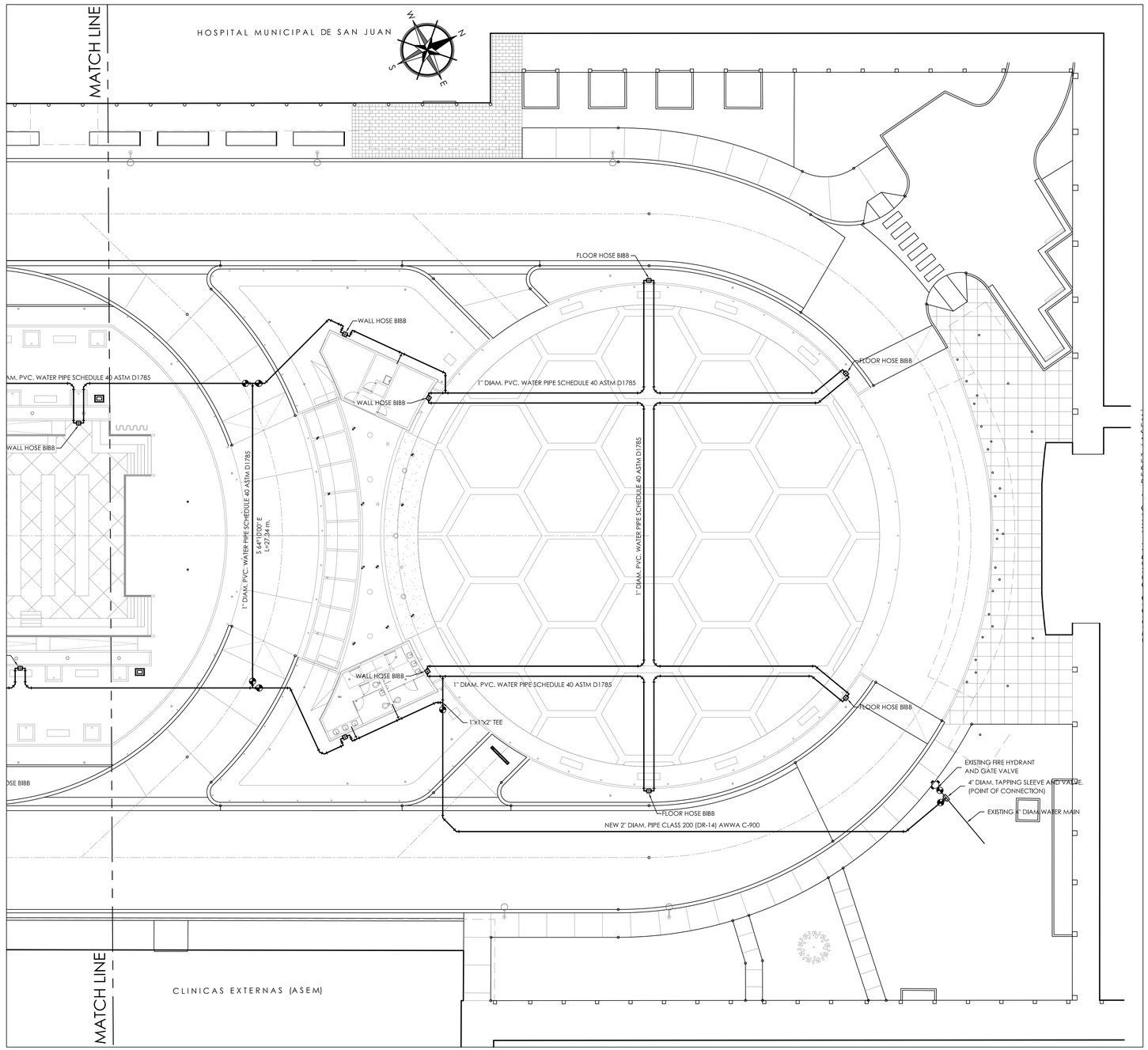
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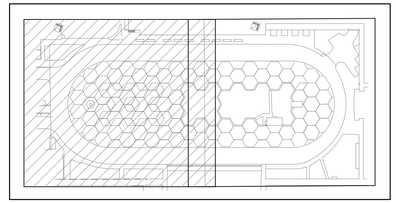
JORGE RIGAU ARQUITECTOS PSC
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TEL: (787) 982-0002 | EMAIL: RIGAU@JORGERIGAU.COM

TITLE
WATER DISTRIBUTION PLAN

SCALE	PRINTED ON	SHEET NO.
1:200		CU-101
DRAWN BY: G. MEDINA		
PHASE: ISSUED FOR CONSTRUCTION		DATE: OCTOBER 12, 2023

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KEY MAP
NOT TO SCALE

NOTES:

1. ALL MANHOLES, VALVES AND OTHERS UTILITIES BELONGING TO P.R.A.S.A. SHALL BE RESETED TO FIT THE NEW ELEVATIONS, BE IT IN NEW PAVEMENT AREA, SIDEWALKS, AND/OR PLANTING AREAS.
2. WHENEVER THE CONTRACTOR IS GOING TO WORK ON ANY WAY AFFECTING ANY UTILITY, HE SHALL COORDINATE WITH THE CONCERNED AUTHORITY, PRIOR TO STARTING THE WORK.
3. WHEREVER THE CONTRACTOR FINDS ANY UTILITY, NOT SHOWN ON THE PLANS, AND IN A POSITION AFFECTING THE CONSTRUCTION, HE SHALL INFORM THE RESIDENT ENGINEER AS WELL AS THE CONCERNED UTILITY COMPANY, PRIOR TO WORKING ON IT.
4. CONTRACTOR WILL REFER TO MECHANICAL DRAWINGS FOR EXACT POSITION OF ALL HOUSE CONNECTIONS.
5. PIPE SHALL BE INSTALLED AT DEPTH OF NO LESS THAN 0.75 METER MEASURED FROM GROUND SURFACE TO THE UPPER PART OF THE PIPE AND A DETECTABLE PLASTIC TAPE SHALL BE PLACE ABOVE ALL THE LENGTH OF THE PIPE AT NO LESS THAN 0.30 METER MEASURED FROM GROUND SURFACE PERMIT LOCATION OF THE PIPE.
6. EXISTING WATER MAIN PIPES SHOWN ON PLANS ARE APPROXIMATELY LOCATED. CONTRACTOR SHALL BE RESPONSIBLE TO FIELD VERIFY EXACT LOCATION BEFORE TRENCH EXCAVATIONS.

PRASA REQUIREMENTS FOR WATER SAVING:

1 – ALL EQUIPMENTS INSTALLED SHALL BE WATER SAVING EQUIPMENTS SIMILAR OR EQUAL TO "AFC" (WATER SAVING) "UFO" OR "ECO".
2 – THE DEVICE SHALL CLOSE AUTOMATICALLY THE FLOW AFTER THE USER REMOVES HIS HAND FROM THE WATER FLOW.
3 – THE DEVICE SHALL STOP LEAKINGS CAUSED BY DEFECTIVE FAUCETS AND WASHERS.
4 – THE EFFECTIVE LOSS SHALL BE 00 GPM AND THE DEVICE FLOW SHALL NOT BE GREATER THAN 15 GPM.
5 – WATER CLOSETS SHALL NOT BE GREATER THAN 1.6 GALLONS PER DISCHARGE.
6 – ALL FIRE HYDRANTS SHALL BE PROVIDED WITH AN ANTI–THEFT SYSTEM. EQUAL OR SIMILAR TO MCGARD HYDRANT LOCK.

LEGEND:

- NEW 1" DIAM. BRONZE GATE VALVE
- NEW 1" DIAM. PVC. WATER PIPE SCHEDULE 40 ASTM D1785
- NEW 4"x4"x4" DIAM. TAPPING SLEEVE AND 4" DIAM. GATE VALVE
- EXISTING 4" DIAM. FIRE HYDRANT AND 4" DIAM. GATE VALVE
- NEW 1" DIAM. HOSE BIBB BOX
- NEW 1" DIAM. PVC. HOUSE CONNECTION SCHEDULE 40 ASTM D1785

PIPE TO BE INSTALLED

PIPE DIAMETER	METERS
2" DIAM. PVC. CLASS 200 (DR 14) AWWA C–900	58.00
1" DIAM. PVC. WATER PIPE SCHEDULE 40 ASTM D1785	561.00

GRAPHIC SCALE
0m 5m 10m 15m
SCALE 1:200

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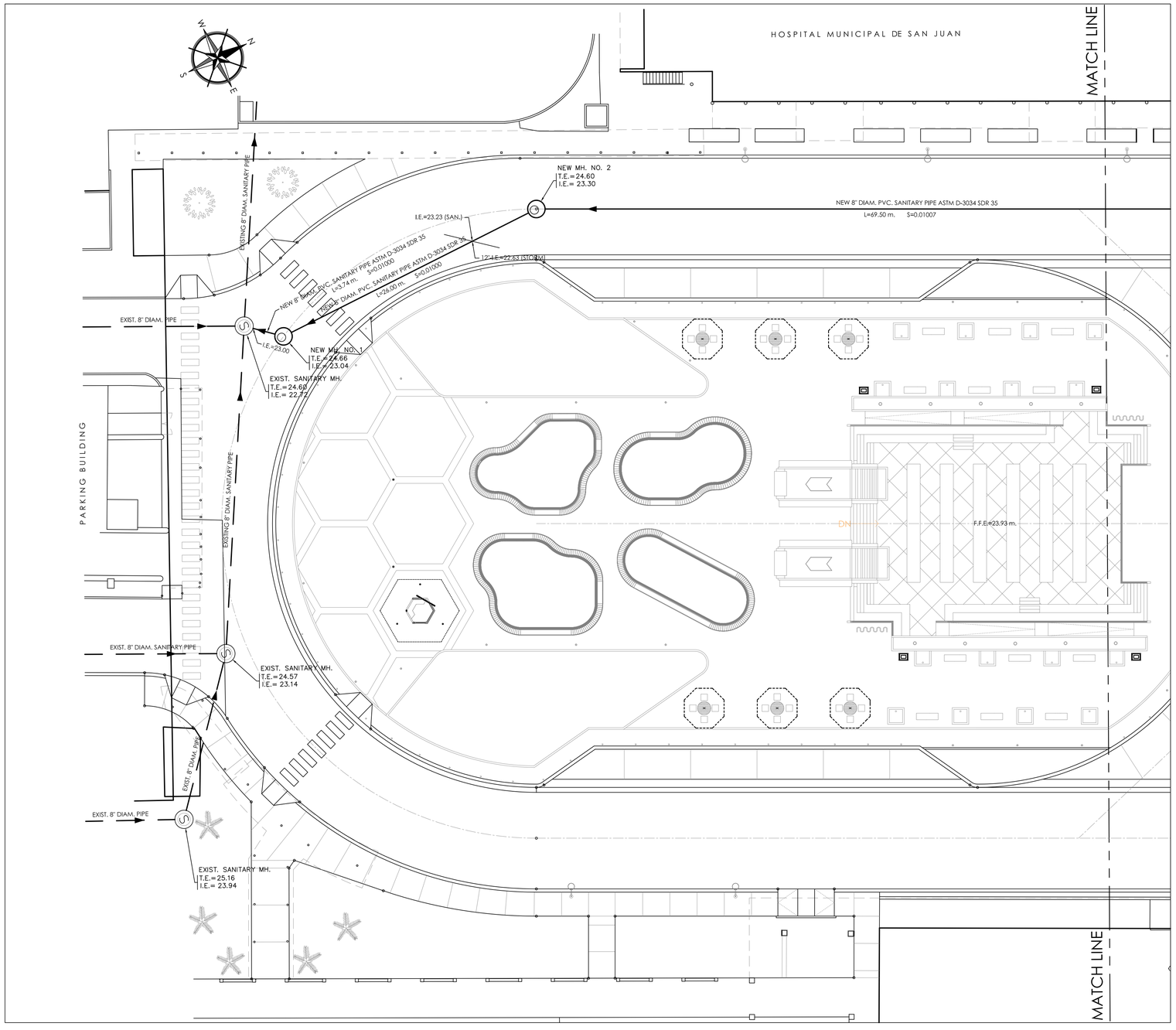
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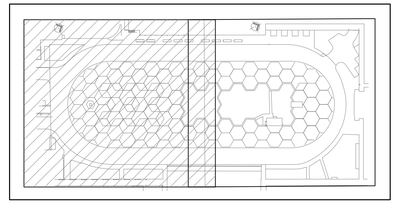
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TITLE
WATER DISTRIBUTION PLAN

SCALE 1:200	PRINTED ON	SHEET NO. CU-102
DRAWN BY G. MEDINA		
PHASE ISSUED FOR CONSTRUCTION		DATE OCTOBER 12, 2023

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KEY MAP
NOT TO SCALE

LEGEND:

- NEW SANITARY SEWER MANHOLE
- NEW SANITARY SEWER LINE 8"-6" OR 4" DIAM. PVC. PIPE ASTM D-3034 SRD 35
- FLOW DIRECTION
- L= LENGTH
- S= SLOPE
- T.E. TOP ELEVATION
- I.E. INVERT ELEVATION
- NEW 6" OR 4" DIAM. CONNECTION
- CO. NEW 6" OR 4" DIAM. CLEANOUT
- (S) EXISTING SANITARY SEWER MANHOLE

NOTES:

1 - THE INFILTRATION AND EXFILTRATION OF WATER IN PIPES SHALL NOT BE MORE THAN 100 GALLONS PER INCH OF DIAMETER PER MILE OF LENGTH OF PIPE PER 24 HOURS. THE CONTRACTOR SHALL PROVIDE THE NEEDED MEANS, AS REQUIRED BY P.R.A.S.A. ENGINEER, FOR THE PERFORMANCE OF INFILTRATION AND/OR EXFILTRATION TESTS IN SECTIONS OF PIPES SELECTED BY THE ABOVE MENTIONED ENGINEER.

2 - ALL PIPES THAT FAIL THE ABOVE MENTIONED TESTS SHALL BE REPAIRED OR REPLACED BY THE CONTRACTOR AND WILL BE SUBMITTED TO NEW TESTS UNTIL IT IS DEFINITELY APPROVED BY P.R.A.S.A. ENGINEER.

3 - SEE MECHANICAL DRAWINGS FOR PLUMBING DISTRIBUTION.

GRAPHIC SCALE
0m 5m 10m 15m
SCALE 1:200

frank collazo
Professional Engineer
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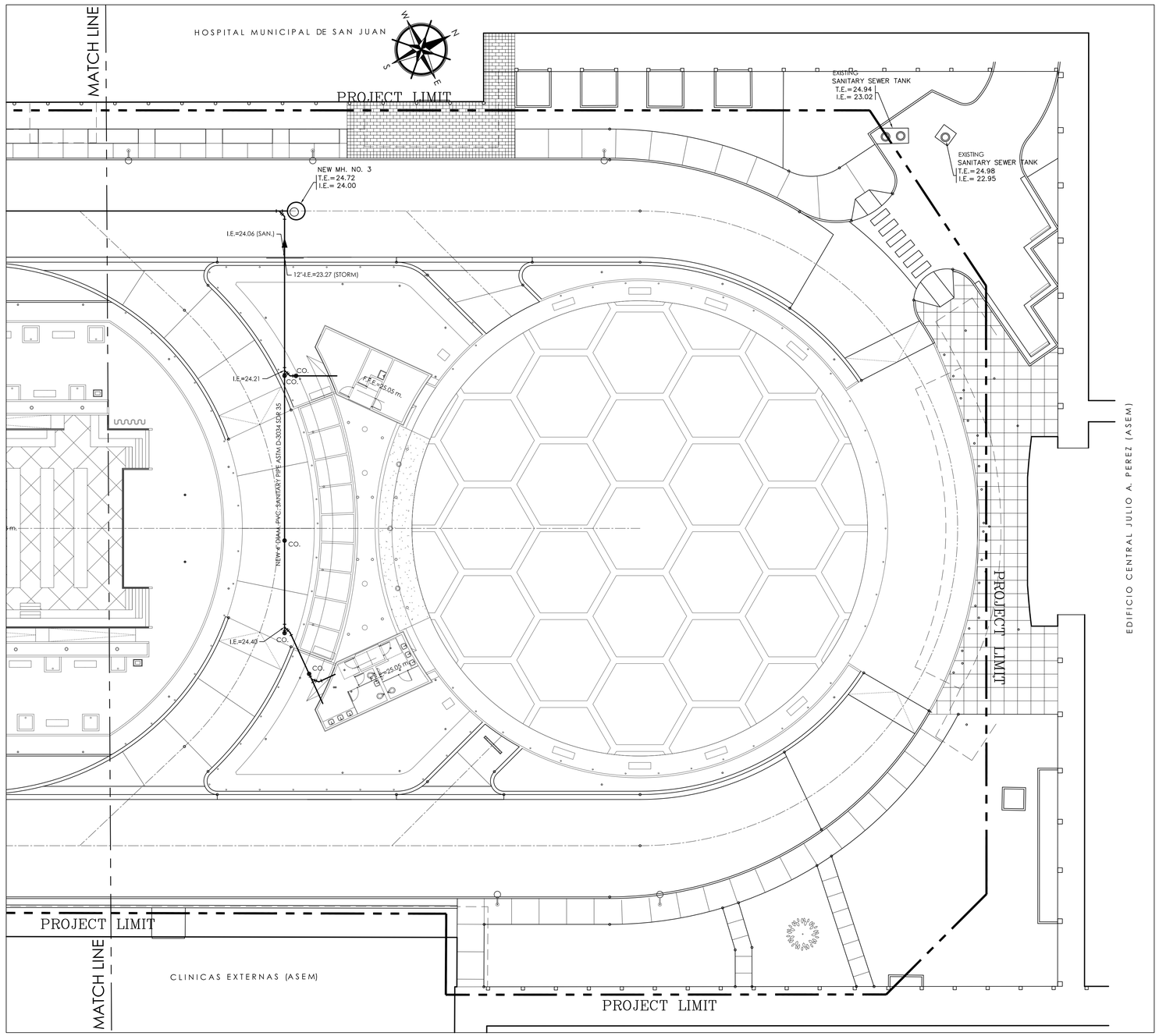
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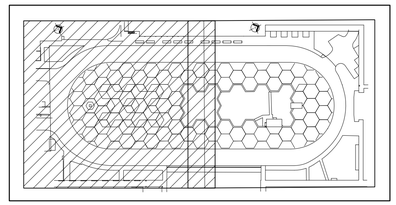
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TITLE
SANITARY SEWER PLAN

SCALE	PRINTED ON	SHEET NO.
1:200		CU-103
DRAWN BY: G. MEDINA		
PHASE: ISSUED FOR CONSTRUCTION		DATE: OCTOBER 12, 2023

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KEY MAP
NOT TO SCALE

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- NEW SANITARY SEWER LINE 8"-6" OR 4" DIAM. PVC. PIPE ASTM D-3034 SRD 35
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3 - SEE MECHANICAL DRAWINGS FOR PLUMBING DISTRIBUTION.

GRAPHIC SCALE
0m 5m 10m 15m
SCALE 1:200

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ISSUE CHART

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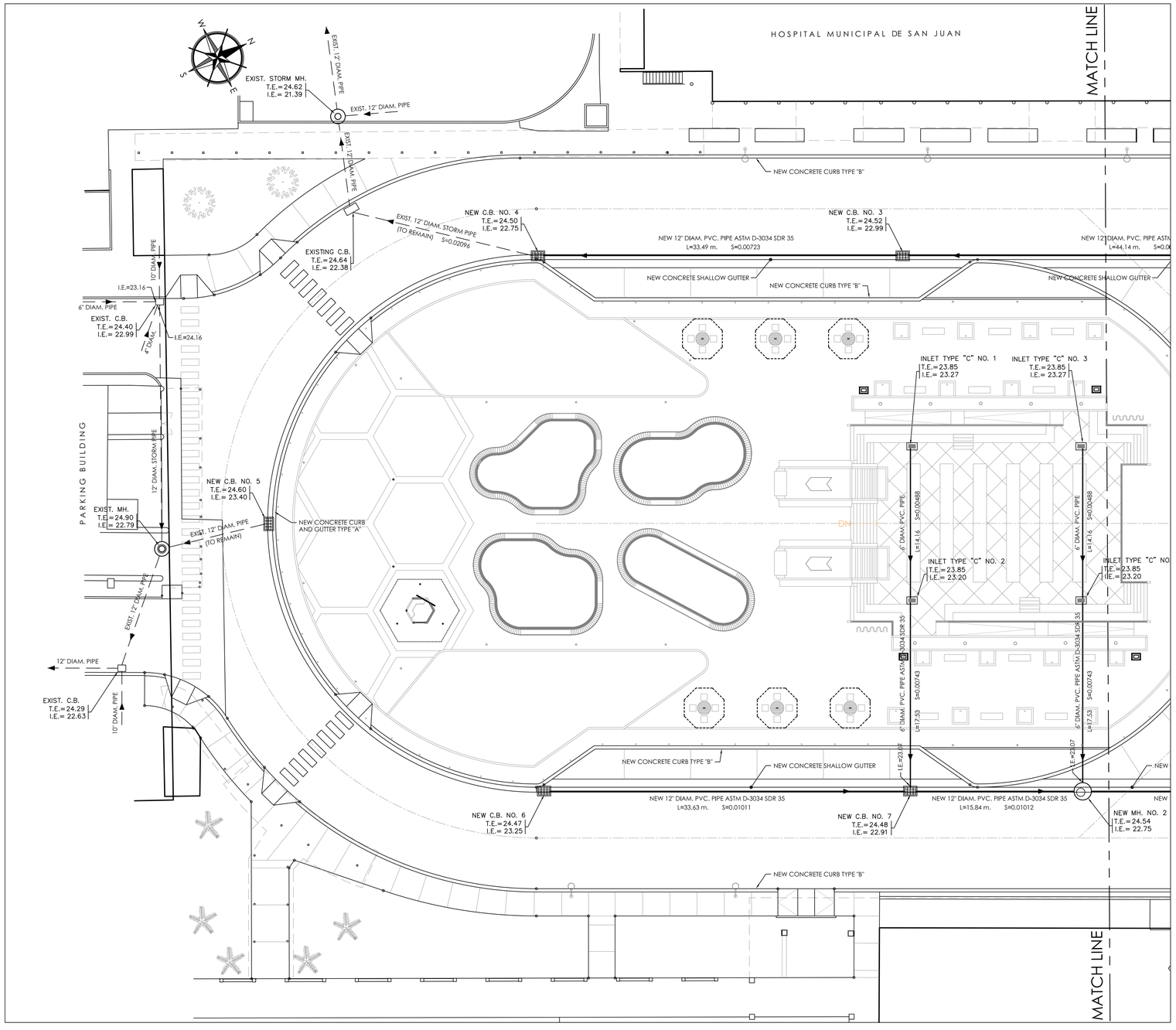
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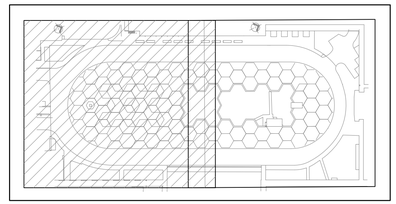
TITLE

SANITARY SEWER PLAN

SCALE	PRINTED ON	SHEET NO.
1:200		CU-104
DRAWN BY: G. MEDINA		
PHASE: ISSUED FOR CONSTRUCTION		DATE: OCTOBER 12, 2023

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KEY MAP
NOT TO SCALE

NOTES:

1- DIMENSIONS AND/OR ELEVATIONS ARE SHOWN IN METRIC SYSTEM, UNLESS OTHERWISE NOTED.

2- THIS PLAN AND OTHER RELATED ONES, HAVE BEEN PREPARED CONSIDERING THE INFORMATION INCLUDED IN THE PLANIMETRIC SURVEY PLAN PREPARED BY ALEXIS OCASIO AGOSTO, (PROFESSIONAL LAND SURVEYOR) LIC. NO. 14879, DATED MARCH 31, 2016

3- CONTRACTOR SHALL COMPLY WITH THE RECOMMENDATIONS INCLUDED IN THE SUB-SOIL STUDY PREPARED FOR THIS PROJECT. IF CONFLICT BETWEEN PLANS AND THE SUB-SOIL STUDY ARISES, THE SUBSOIL STUDY RECOMMENDATIONS SHALL PREVAIL.

4- THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTROLLING SOIL EROSION AND SEDIMENT RUNOFF FROM THE CONSTRUCTION AREA. THE CONTRACTOR SHALL OBTAIN ALL PERMITS AND ABIDE TO APPLICABLE STORM WATER RUNOFF AND/OR DISCHARGE REQUIREMENTS SET BY ENVIRONMENTAL QUALITY BOARD (EPA), OR ANY OTHER REGULATORY AGENCY.

5- CONTRACTOR SHALL REPAIR AND MAINTAIN IN ACCEPTABLE CONDITIONS ANY EXISTING PAVEMENT AND UTILITIES THAT WILL REMAIN IN USE AFTER THE COMPLETION OF THE PROJECT. ALSO, CONTRACTOR SHALL REPAVE ANY AFFECTED AREA OF PAVEMENT WITH 1" ASPHALT TYPE IV-B.

KEY:

	NEW CATCH BASIN
	NEW CATCH BASIN (TYPE "B")
	NEW STORM SEWER LINE (DIAMETER AS INDICATED)
C	NEW CONCRETE MANHOLE
T.E.	TOP ELEVATION
I.E.	INVERT ELEVATION
	NEW CONCRETE SHALLOW GUTTER
	NEW EARTH SWALE
	NEW 1.22 m. CONCRETE GUTTER
L	LENGTH
S	SLOPE
EXIST.	EXISTING
MH.	MANHOLE
C.B.	CATCH BASIN
CO.	4" DIAM. CLEANOUT

GRAPHIC SCALE
0m 5m 10m 15m
SCALE 1:200

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LCDO. JORGE E. MATTA GONZÁLEZ, MHSA DIRECTOR EJECUTIVO
ADMINISTRACIÓN DE SERVICIOS MÉDICOS DE PUERTO RICO (ASEM)

PROYECTO DE REHABILITACIÓN DE LA PLAZA PEDRO ARZUAGA BERAZA

DIVISIÓN AMBIENTE DE CUIDADO Y MANEJO DE RIESGOS

ISSUED FOR CONSTRUCTION

ISSUE CHART

NO.	DESCRIPTION	DATE	APPROVED

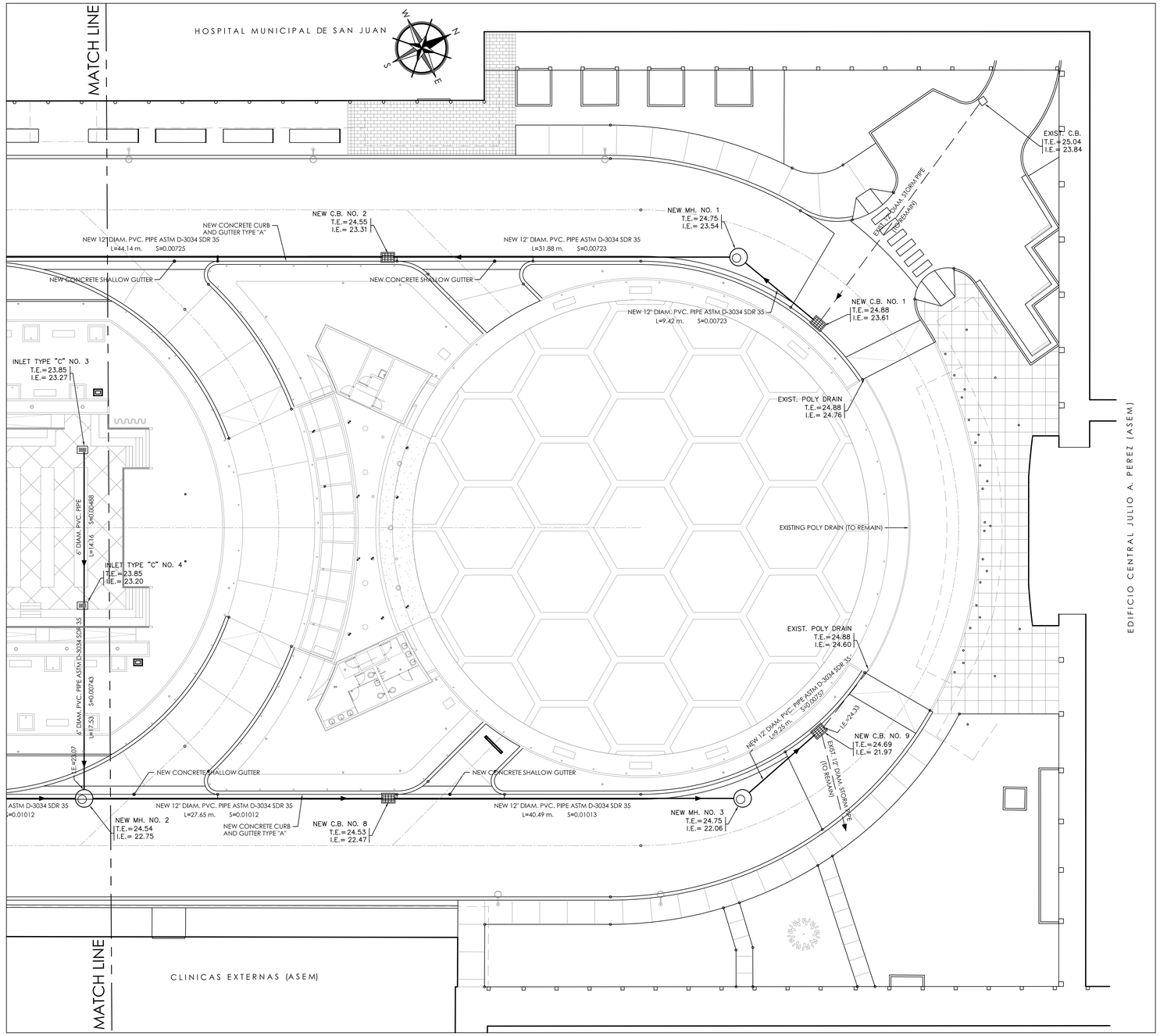
JORGE RIGAU ARQUITECTOS PSC
URB. HYDE PARK, 855 AVE. LAS MARÍAS, SAN JUAN PR 00927
TEL: (787) 982-0002 | EMAIL: RIGAU@JORGERIGAU.COM

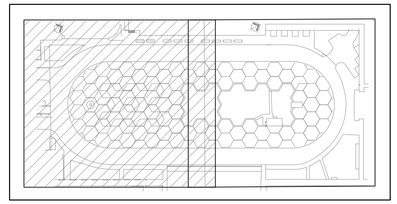
TITLE

STORM SEWER PLAN

SCALE 1:200	PRINTED ON	SHEET NO. CU-105
DRAWN BY G. MEDINA		
PHASE **ISSUED FOR CONSTRUCTION**		DATE **OCTOBER 12, 2023**

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KEY MAP
NOT TO SCALE

NOTES:

1- DIMENSIONS AND/OR ELEVATIONS ARE SHOWN IN METRIC SYSTEM, UNLESS OTHERWISE NOTED.

2- THIS PLAN AND OTHER RELATED ONES, HAVE BEEN PREPARED CONSIDERING THE INFORMATION INCLUDED IN THE PLANIMETRIC SURVEY PLAN PREPARED BY ALEXIS OCASIO AGOSTO, (PROFESSIONAL LAND SURVEYOR) LIC. NO. 14879, DATED MARCH 31, 2016

3- CONTRACTOR SHALL COMPLY WITH THE RECOMMENDATIONS INCLUDED IN THE SUB-SOIL STUDY PREPARED FOR THIS PROJECT. IF CONFLICT BETWEEN PLANS AND THE SUB-SOIL STUDY ARISES, THE SUBSOIL STUDY RECOMMENDATIONS SHALL PREVAIL.

4- THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTROLLING SOIL EROSION AND SEDIMENT RUNOFF FROM THE CONSTRUCTION AREA. THE CONTRACTOR SHALL OBTAIN ALL PERMITS AND ABIDE TO APPLICABLE STORM WATER RUNOFF AND/OR DISCHARGE REQUIREMENTS SET BY ENVIRONMENTAL QUALITY BOARD (EPA), OR ANY OTHER REGULATORY AGENCY.

5- CONTRACTOR SHALL REPAIR AND MAINTAIN IN ACCEPTABLE CONDITIONS ANY EXISTING PAVEMENT AND UTILITIES THAT WILL REMAIN IN USE AFTER THE COMPLETION OF THE PROJECT. ALSO, CONTRACTOR SHALL REPAVE ANY AFFECTED AREA OF PAVEMENT WITH 1" ASPHALT TYPE IV-B.

KEY:

	NEW CATCH BASIN
	NEW CATCH BASIN (TYPE "B")
	NEW STORM SEWER LINE (DIAMETER AS INDICATED)
	NEW CONCRETE MANHOLE
T.E.	TOP ELEVATION
I.E.	INVERT ELEVATION
	NEW CONCRETE SHALLOW GUTTER
	NEW EARTH SWALE
	NEW 1.22 m. CONCRETE GUTTER
L	LENGTH
S	SLOPE
EXIST.	EXISTING
MH.	MANHOLE
C.B.	CATCH BASIN
CO.	4" DIAM. CLEANOUT

GRAPHIC SCALE
0m 5m 10m 15m
SCALE 1:200

frank collazo
Professional Engineer
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PROFESSIONAL CERTIFICATION LAW

I, JORGE RIGAU PÉREZ, LICENSE 7650, CERTIFY THAT I AM THE PROFESSIONAL WHO DESIGNED THESE PLANS AND THE COMPLEMENTARY SPECIFICATIONS. I ALSO CERTIFY THAT I UNDERSTAND THAT SUCH PLANS AND SPECIFICATIONS COMPLY WITH THE APPLICABLE PROVISIONS OF THE JOINT REGULATIONS AND APPLICABLE PROVISIONS OF THE REGULATIONS AND CODES OF AGENCIES, REGULATORY BOARDS AND/OR PUBLIC CORPORATIONS WITH JURISDICTION.

I ACKNOWLEDGE THAT ANY FALSE DECLARATION OR FALSIFICATION OF THE FACTS WHICH HAVE BEEN PRODUCED WITHOUT KNOWLEDGE OR NEGLIGENCE EITHER BY ME, MY AGENTS OR EMPLOYEES, OR BY OTHER PERSONS WITH MY KNOWLEDGE, MAKES ME RESPONSIBLE FOR ANY JUDICIAL AND DISCIPLINARY ACTION BY THE OIGPE AND OTHER COMPETENT AUTHORITIES, INCLUDING, BUT NOT LIMITED TO, THE TERMINATION OF THE PARTICIPATION IN PROFESSIONAL CERTIFICATION PROCEDURES IN THE OIGPE.

IMPORTANT INFORMATION FOR THE CONTRACTOR

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TITLE

STORM SEWER PLAN

SCALE 1:200	PRINTED ON	SHEET NO. CU-106
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