Geology, Soils, Farmlands, and Natural Hazards Technical Report
Honolulu High-Capacity Transit Corridor Project

October 16, 2008

Prepared for:
City and County of Honolulu

Preface

This technical report supports the Draft Environmental Impact Statement (EIS) prepared for the Honolulu High-Capacity Transit Corridor Project. It provides additional detail and information as it relates to:

- Methodology used for the analysis
- Applicable regulations
- Results of the technical analysis
- Proposed mitigation
- Coordination and consultation (as appropriate)
- References
- Model output (as appropriate)
- Other information/data

As described in the Draft EIS, the Locally Preferred Alternative, called the “Full Project,” is an approximate 30-mile corridor from Kapolei to the University of Hawai‘i at Mānoa with a connection to Waikīkī. However, currently available funding sources are not sufficient to fund the Full Project. Therefore, the focus of the Draft EIS is on the “First Project,” a fundable approximately 20-mile section between East Kapolei and Ala Moana Center. The First Project is identified as “the Project” for the purpose of the Draft EIS.

This technical report documents the detailed analysis completed for the Full Project, which includes the planned extensions, related transit stations, and construction phasing. The planned extensions and related construction planning have not been fully evaluated in the Draft EIS and are qualitatively discussed in the Cumulative Effects section of the Draft EIS as a foreseeable future project(s). Once funding is identified for these extensions, a full environmental evaluation will be completed in a separate environmental study (or studies), as appropriate.

Figure 1-3 through Figure 1-6 (in Chapter 1, Background) show the proposed Build Alternatives and transit stations, including the areas designated as planned extensions.

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ALISH	Agricultural Lands of Importance to the State of Hawai‘i
BMP	best management practices
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
City	City and County of Honolulu
DPP	City and County of Honolulu Department of Planning and Permitting
EIS	environmental impact statement
‘Ewa (direction)	toward the west (see also Wai‘anae)
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FPPA	Federal Farmland Protection Policy Act
FTA	Federal Transit Administration
GIS	Geographic Information System
H-1	Interstate Route H-1 (the H-1 Freeway)
HRS	Hawai‘i Revised Statutes
IBC	International Building Code
Koko Head (direction)	toward the east
makai (direction)	toward the sea
mauka (direction)	toward the mountains
MSL	mean sea level
NEPA	National Environmental Policy Act
NOAA	U.S. Department of Commerce National Oceanic and Atmospheric Administration

NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
O‘ahuMPO	O‘ahu Metropolitan Planning Organization
RTD	City and County of Honolulu Department of Transportation Services Rapid Transit Division
TPSS	traction power substation
UH	University of Hawai‘i
USC	United States Code
USGS	U.S. Geological Survey
Wai‘anae (direction)	toward the west (see also ‘Ewa)

Summary

The City and County of Honolulu Department of Transportation Services Rapid Transit Division (RTD), in coordination with the U.S. Department of Transportation Federal Transit Administration (FTA), is preparing a Draft Environmental Impact Statement (EIS) to evaluate alternatives that would provide high-capacity transit service on O‘ahu. The Honolulu High-Capacity Transit Corridor Project’s purpose and need focus on meeting the area’s current and future regional transportation needs. The project study area is the travel corridor between Kapolei and the University of Hawai‘i at Mānoa (UH Mānoa).

Geology

The geology of O‘ahu is diverse and complex and would have a major effect on construction methods for some portions of the Project. The island was built by the extrusion of basaltic lavas from two shield volcanoes. The travel corridor is located along the southern flank of the volcanoes, and the geomorphology and subsurface conditions are directly related to glacial-eustatic fluctuations of sea level. Ancient coral-algal reefs are interbedded with layers of alluvial, marine sedimentary deposits, pyroclastics, and lava flows covered with modern surface fills. Detailed subsurface investigations would be required prior to final design.

Soils and Farmlands

The ‘Ewa Plain was once a major agricultural area primarily used to cultivate sugar cane. The ‘Ewa region is planned for substantial urbanization, including residences, commercial establishments, institutions, parks, and recreational resources. Since some of the area affected by the project is classified as “prime agricultural,” according to the Agricultural Lands of Importance to the State of Hawai‘i (ALISH), the requirements of the Federal Farmland Protection Policy Act (FPPA) apply. The Project does not score above the threshold on the National Resources Conservation Service (NRCS) Form CPA-106 “Farmland Conversion Impact Rating” which would require alternatives to be evaluated. However, in the near future, much of the ‘Ewa Plain will likely change from “Agriculture” to “Urban” state land use classifications and will likely be re-zoned by the City for urban uses as part of planned future developments. There are no State of Hawai‘i or City plans for diversified agriculture in ‘Ewa.

Natural Hazards

Floods, hurricanes, earthquakes, and tsunami can all affect Hawai‘i. The International Building Code (IBC) and the American Association of State Highway and Transportation Officials (AASHTO) provide minimum design criteria to address the potential for damages caused by these hazards.

Tsunamis are a concern for coastal portions of Oʻahu. The State Civil Defense publishes a series of maps showing areas that should be evacuated in the event of a tsunami warning. None of the Build Alternatives evaluated in the Draft EIS are located in a tsunami evacuation area.

The Flood Insurance Rate Maps (FIRM) show that several parts of the alternatives are located in floodplains associated with streams, estuaries, and canals. Flooding, a natural hazard in Hawaiʻi, is discussed in detail in the *Honolulu High-Capacity Transit Corridor Project Water Resources Technical Report* (RTD 2008c).

1 Background

1.1 Introduction

The City and County of Honolulu Department of Transportation Services Rapid Transit Division (RTD), in cooperation with the U.S. Department of Transportation Federal Transit Administration (FTA), is evaluating fixed-guideway alternatives that would provide high-capacity transit service on O‘ahu. The project study area is the travel corridor between Kapolei and the University of Hawai‘i at Mānoa (UH Mānoa) (Figure 1-1). This corridor includes the majority of housing and employment on O‘ahu. The east-west length of the corridor is approximately 23 miles. The north-south width is, at most, 4 miles because the Ko‘olau and Wai‘anae Mountain Ranges bound much of the corridor to the north and the Pacific Ocean to the south.

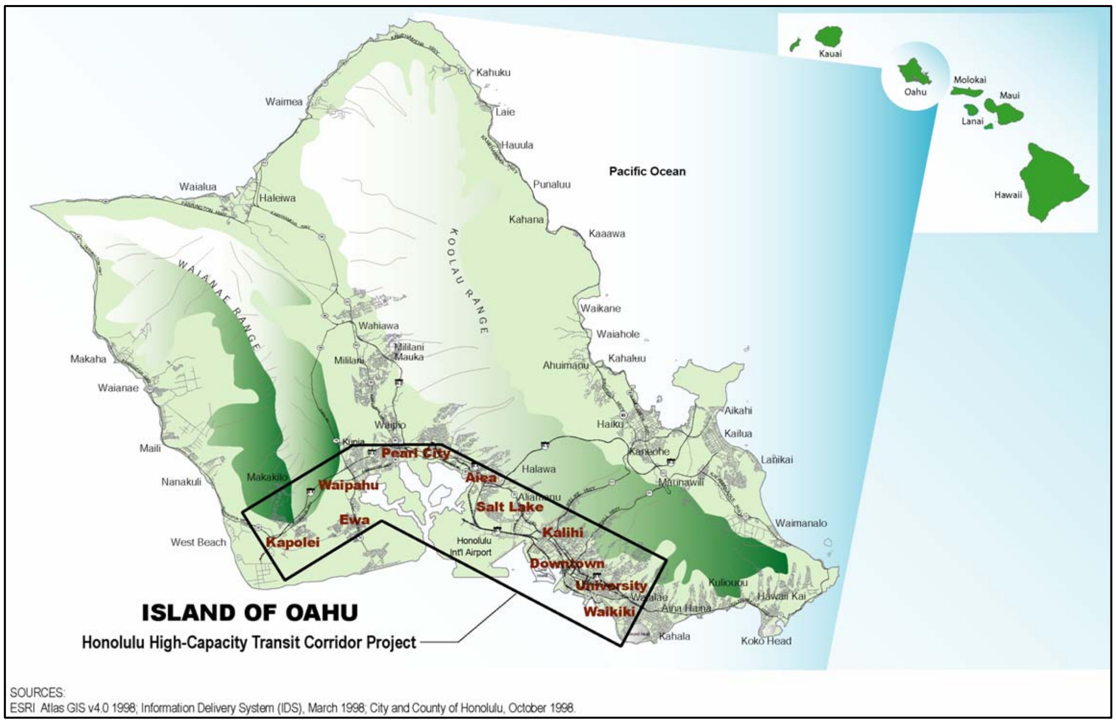


Figure 1-1: Project Vicinity

1.2 Description of the Study Corridor

The Honolulu High-Capacity Transit Corridor extends from Kapolei in the west (Wai‘anae or ‘Ewa direction) to UH Mānoa in the east (Koko Head direction) and is confined by the Wai‘anae and Ko‘olau Mountain Ranges in the mauka direction (towards the mountains, generally to the north within the study corridor) and the Pacific Ocean in the makai direction (towards the sea, generally to the south within the study corridor). Between Pearl City and ‘Aiea, the corridor's width is less than 1 mile between Pearl Harbor and the base of the Ko‘olau Mountains (Figure 1-2).

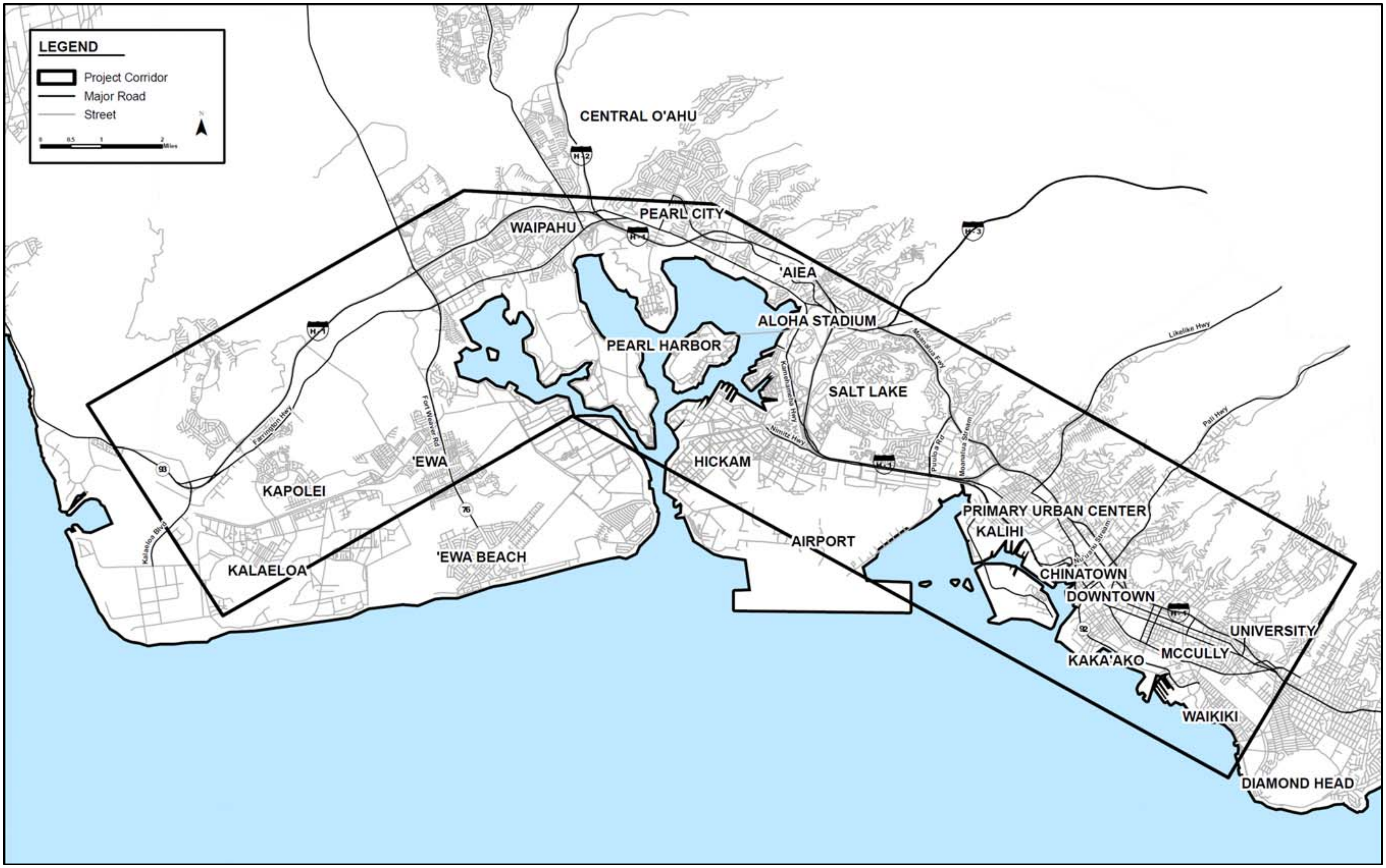


Figure 1-2: Areas and Districts in the Study Corridor

1.3 Alternatives

Four alternatives are being evaluated in the Environmental Impact Statement (EIS). They were developed through a screening process that considered alternatives identified through previous transit studies, a field review of the study corridor, an analysis of current and projected population and employment data for the corridor, a literature review of technology modes, work completed by the O‘ahu Metropolitan Planning Organization (O‘ahuMPO) for its *O‘ahu Regional Transportation Plan 2030* (ORTP) (O‘ahuMPO 2007), a rigorous Alternatives Analysis process, selection of a Locally Preferred Alternative by the City Council, and public and agency comments received during the separate formal project scoping processes held to satisfy National Environmental Policy Act (NEPA) (USC 1969) requirements and the Hawai‘i EIS Law (Chapter 343) (HRS 2008). The alternatives evaluated are as follows:

1. No Build Alternative
2. Salt Lake Alternative
3. Airport Alternative
4. Airport & Salt Lake Alternative

1.3.1 No Build Alternative

The No Build Alternative includes existing transit and highway facilities and committed transportation projects anticipated to be operational by 2030. Committed transportation projects are those identified in the ORTP*,* as amended (O‘ahuMPO 2007). Highway elements of the No Build Alternative also are included in the Build Alternatives. The No Build Alternative would include an increase in bus fleet size to accommodate growth, allowing service frequencies to remain the same as today.

1.3.2 Build Alternatives

The fixed guideway alternatives would include the construction and operation of a grade-separated fixed guideway transit system between East Kapolei and Ala Moana Center (Figure 1-3 to Figure 1-6). Planned extensions are anticipated to West Kapolei, UH Mānoa, and Waikīkī. The system evaluated a range of fixed-guideway transit technologies that met performance requirements, which could be either automated or employ drivers. All parts of the system would either be elevated or in exclusive right-of-way.

Steel-wheel-on-steel-rail transit technology has been proposed through a comparative process based on the ability of various transit technologies to cost-effectively meet project requirements. As such, this technology is assumed in this analysis.

The guideway would follow the same alignment for all Build Alternatives through most of the study corridor. The Project would begin by following North-South Road and other future roadways to Farrington Highway. Proposed station locations and other project features in this area are shown in Figure 1-3. The guideway would follow Farrington Highway Koko Head on an elevated structure and continue along Kamehameha Highway to the vicinity of Aloha Stadium (Figure 1-4).

Between Aloha Stadium and Kalihi, the alignment differs for each of the Build Alternatives, as detailed later in this section (Figure 1-5). Koko Head of Middle Street, the guideway would follow Dillingham Boulevard to the vicinity of Ka‘aahi Street and then turn Koko Head to connect to Nimitz Highway in the vicinity of Iwilei Road.

The alignment would follow Nimitz Highway Koko Head to Halekauwila Street, then along Halekauwila Street past Ward Avenue, where it would transition to Queen Street and Kona Street. Property on the mauka side of Waimanu Street would be acquired to allow the alignment to cross over to Kona Street. The guideway would run above Kona Street through Ala Moana Center.

Planned extensions would connect at both ends of the corridor. At the Wai‘anae end of the corridor, the alignment would follow Kapolei Parkway to Wākea Street and then turn makai to Saratoga Avenue. The guideway would continue on future extensions of Saratoga Avenue and North-South Road. At the Koko Head end of the corridor, the alignment would veer mauka from Ala Moana Center to follow Kapi‘olani Boulevard to University Avenue, where it would again turn mauka to follow University Avenue over the H-1 Freeway to a proposed terminal facility in UH Mānoa’s Lower Campus. A branch line with a transfer point at Ala Moana Center or the Hawai‘i Convention Center into Waikīkī would follow Kalākaua Avenue to Kūhiō Avenue to end near Kapahulu Avenue (Figure 1-6).

Salt Lake Alternative

The Salt Lake Alternative would leave Kamehameha Highway immediately ‘Ewa of Aloha Stadium, cross the Aloha Stadium parking lot, and continue Koko Head along Salt Lake Boulevard (Figure 1-5). It would follow Pūkōloa Street through Māpunapuna before crossing Moanalua Stream, turning makai, crossing the H-1 Freeway and continuing to the Middle Street Transit Center. Stations would be constructed near Aloha Stadium and Ala Liliko‘i. The total guideway length for this alternative would be approximately 19 miles and it would include 19 stations. The eventual guideway length, including planned extensions, for this alternative would be approximately 28 miles and it would include 31 stations.

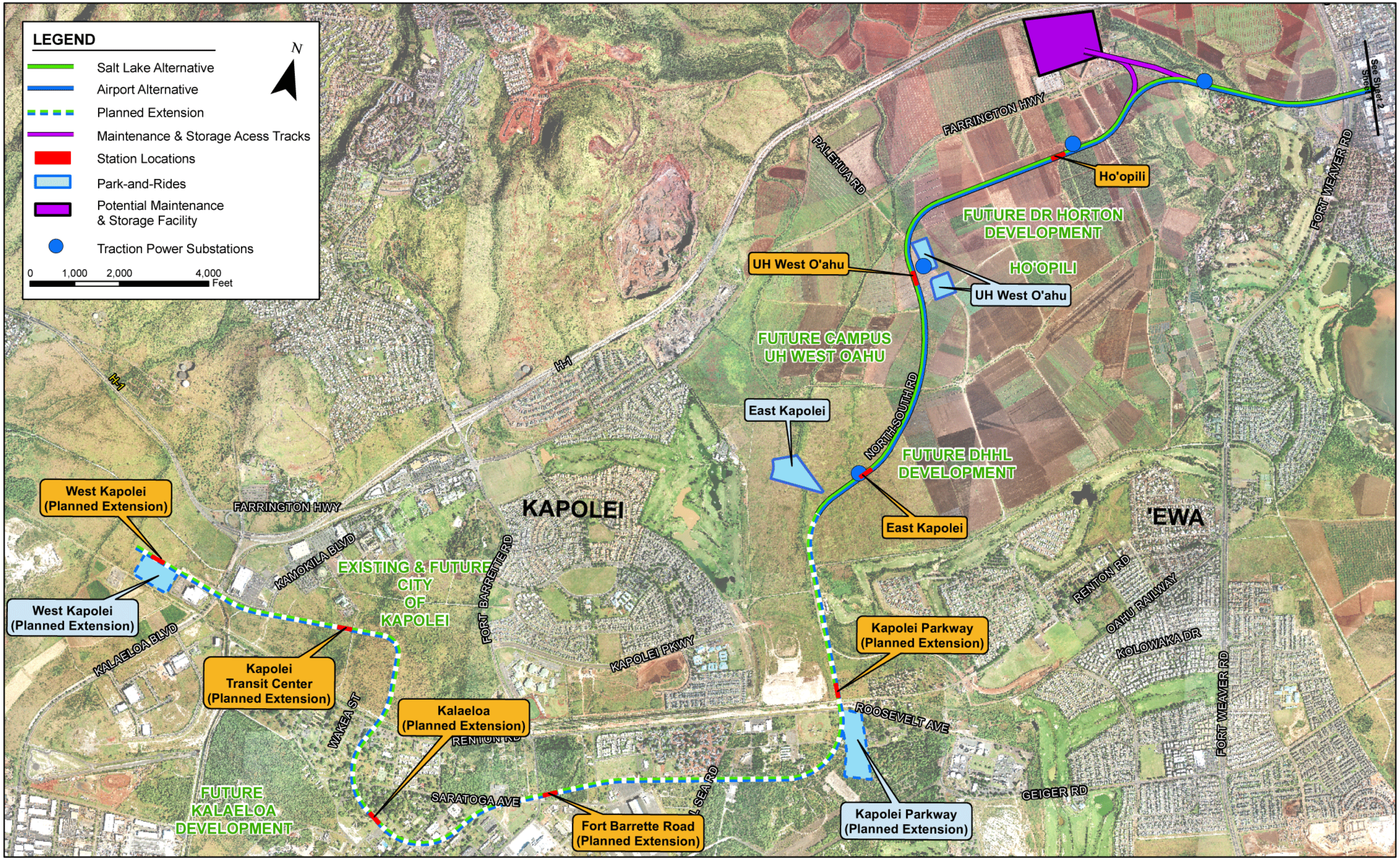


Figure 1-3: Fixed Guideway Transit Alternative Features (Kapolei to Fort Weaver Road)

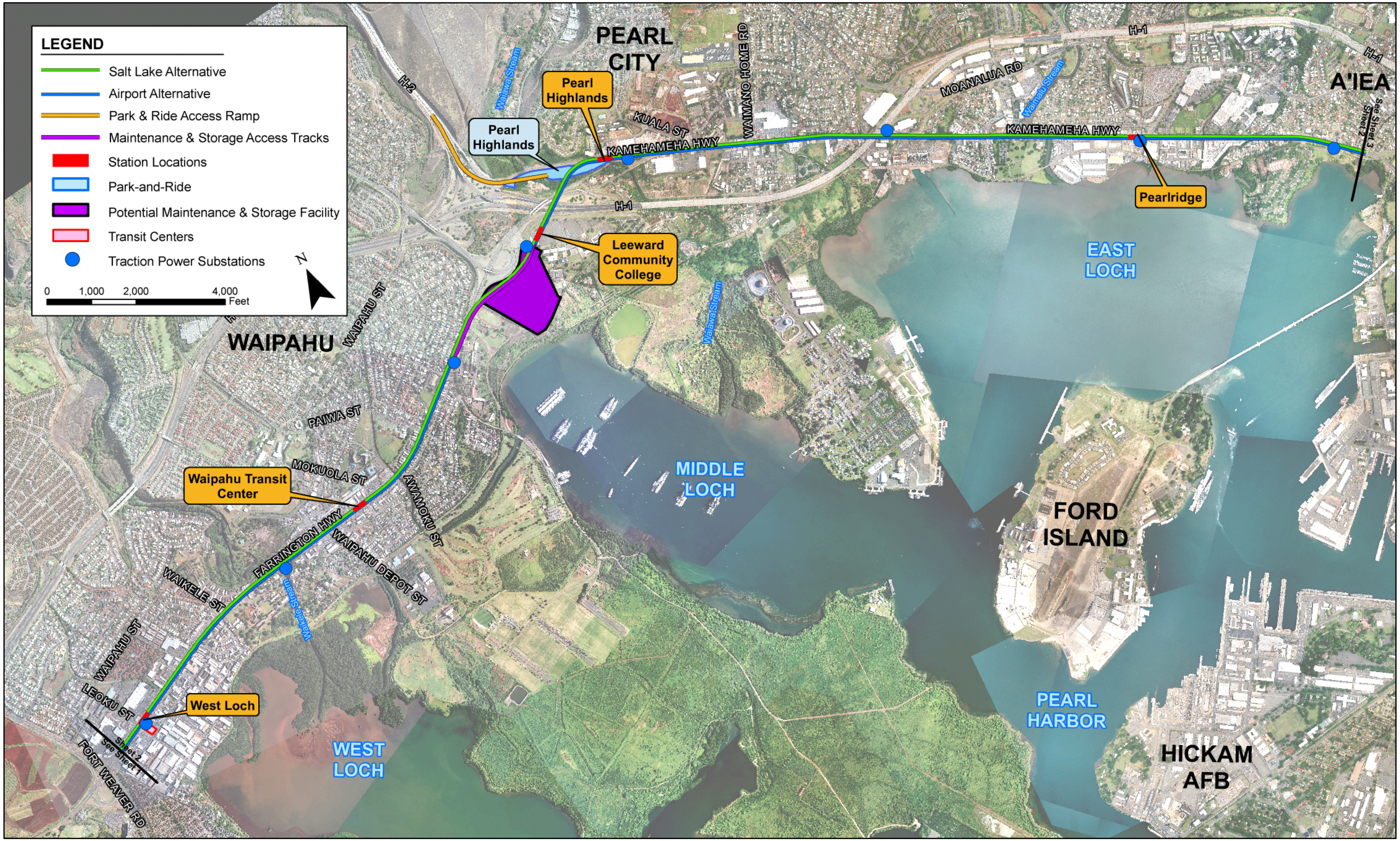


Figure 1-4: Fixed Guideway Transit Alternative Features (Fort Weaver Road to Aloha Stadium)

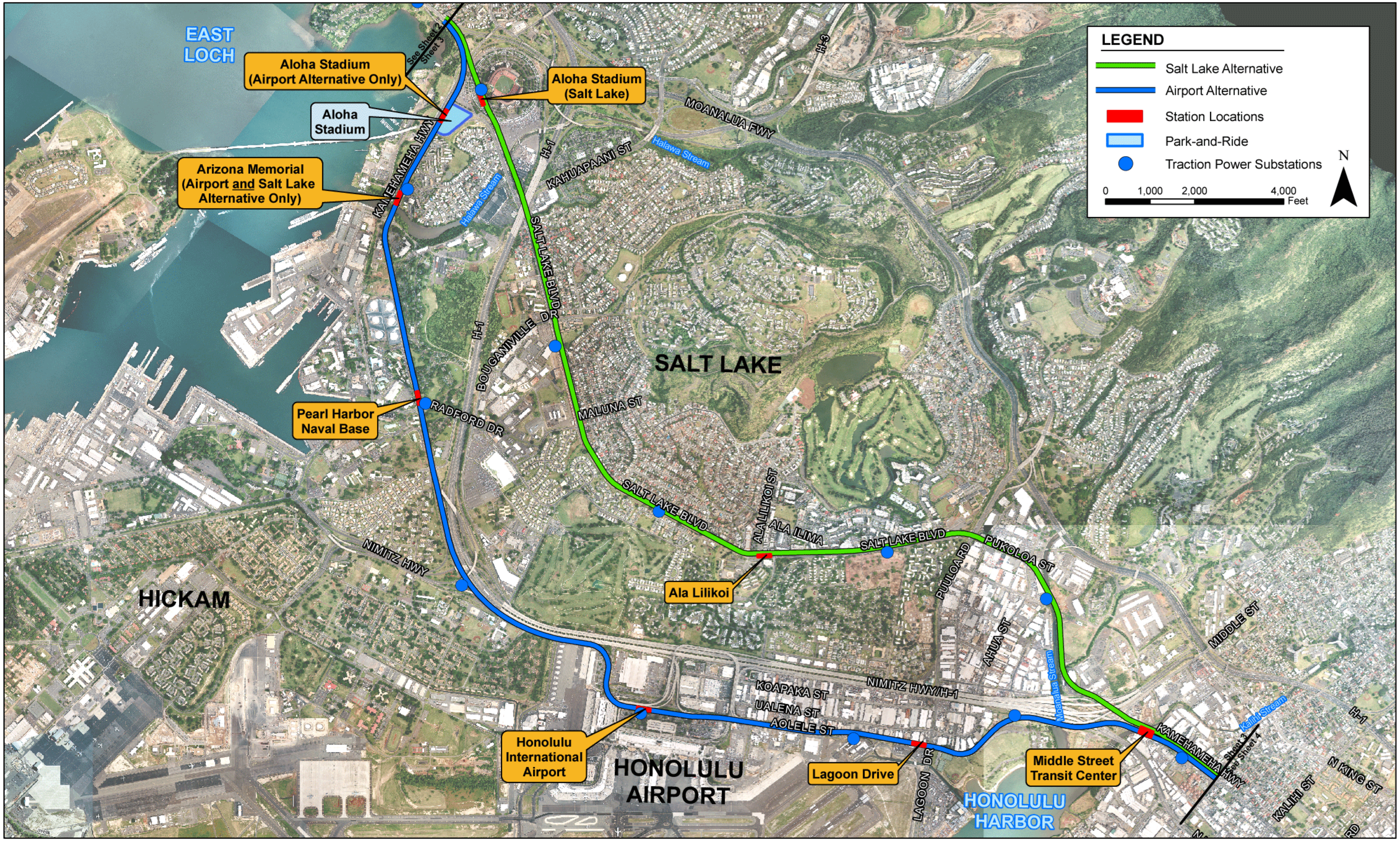


Figure 1-5: Fixed Guideway Transit Alternative Features (Aloha Stadium to Kalihi)

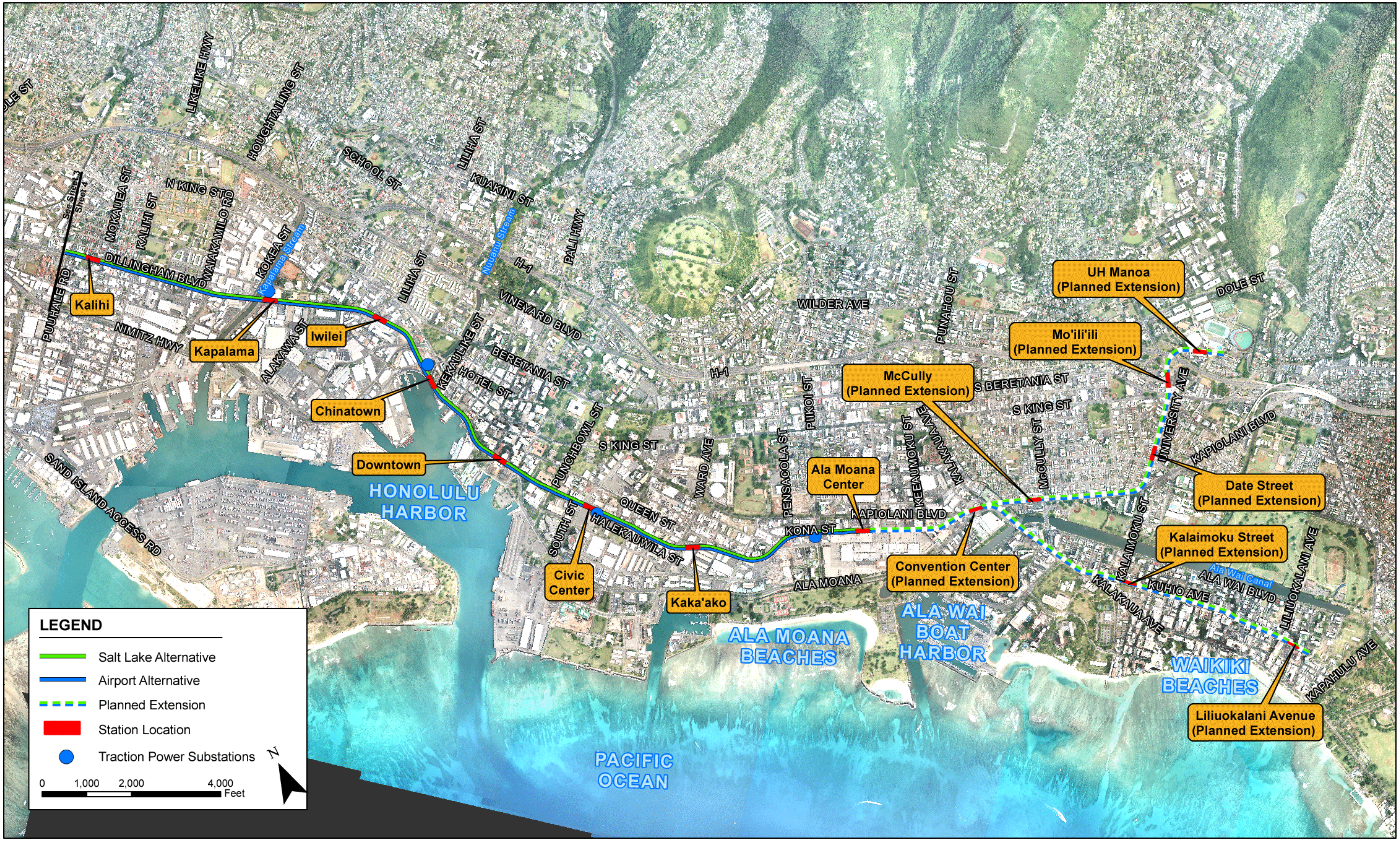


Figure 1-6: Fixed Guideway Transit Alternative Features (Kalihi to UH Mānoa)

Airport Alternative

The Airport Alternative would continue along Kamehameha Highway makai past Aloha Stadium to Nimitz Highway and turn makai onto Aolele Street and then follow Aolele Street Koko Head to reconnect to Nimitz Highway near Moanalua Stream and continuing to the Middle Street Transit Center (Figure 1-5). Stations would be constructed at Aloha Stadium, Pearl Harbor Naval Base, Honolulu International Airport, and Lagoon Drive. The total guideway length for this alternative would be approximately 20 miles and it would include 21 stations. The eventual guideway length, including planned extensions, for this alternative would be approximately 29 miles and it would include 33 stations.

Airport & Salt Lake Alternative

The Airport & Salt Lake Alternative is identical to the Salt Lake Alternative, with the exception of also including a future fork in the alignment following Kamehameha Highway and Aolele Street at Aloha Stadium that rejoins at Middle Street. The station locations discussed for the Salt Lake Alternative would all be provided as part of this alternative. Similarly, all the stations discussed for the Airport Alternative also would be constructed at a later phase of the project; however, the Aloha Stadium Station would be relocated makai to provide an Arizona Memorial Station instead of a second Aloha Stadium Station. At the Middle Street Transit Center Station, each line would have a separate platform with a mezzanine providing a pedestrian connection between them to allow passengers to transfer. The total guideway length for this alternative would be approximately 24 miles and it would include 23 stations. The eventual guideway length, including planned extensions, for this alternative would be approximately 34 miles and it would include 35 stations.

1.3.3 Features Common to All Build Alternatives

In addition to the guideway, the project will require the construction of stations and supporting facilities. Supporting facilities include a maintenance and storage facility, transit centers, park-and-ride lots, and traction power substations (TPSS). The maintenance and storage facility would either be located between North-South Road and Fort Weaver Road or near Leeward Community College (Figure 1-3 and Figure 1-4). Some bus service would be reconfigured to transport riders on local buses to nearby fixed guideway transit stations. To support this system, the bus fleet would be expanded.

2 Studies and Coordination

2.1 Geology

O‘ahu’s geology is diverse and complex, and will have a significant effect on construction methods along the proposed Build Alternatives. Geologic and hydrogeologic information has been compiled from a literature review and previously completed studies. The principal published sources of information include the following: Sterns 1967, Macdonald 1983, and Hunt 1996. These and additional sources are included in the *References* section of this report. Site-specific geotechnical investigations were also performed in early 1990 to support earlier planning studies in characterizing subsurface conditions along the travel corridor (Geolabs 1990, Geolabs 1991). Subsurface geotechnical sampling will be required prior to final design to determine a foundation design appropriate for the soil conditions. A minimum of one boring will be required for each deep foundation location.

2.2 Soils and Farmlands

Under the Farmland Protection Policy Act (FPPA), Federal agencies must formally assess their project’s impact on agriculture. FPPA requires Federal agencies to identify and consider the adverse effects of their programs on the preservation of farmland; consider alternative actions that could lessen adverse effects; and ensure that their programs, to the extent practicable, are compatible with State, local government, and private programs and policies to protect farmland. Since “prime” or “unique” farmlands would be affected by the Project, coordination is being conducted with the U.S. Department of Agriculture’s Natural Resources Conservation Service (NRCS).

Coordination with NRCS has been initiated by the preparation and submittal of Form AD-1006 or CPA-106, the “Farmland Conversion Impact Rating” form, in accordance with 7 CFR 658.4(a). A Farmland Conversion Impact Rating score has been determined for each Build Alternative under consideration. Because of the availability and quality of the area for agriculture, some former sugar-cane fields at the ‘Ewa end of the study corridor have been converted to small-scale, diversified farms that cultivate a variety of vegetables, fruits, and herbs. However, much of this land is planned for development in the *City and County of Honolulu ‘Ewa Development Plan* (DPP 1997b). Discussion of expected land use changes is provided in the *Honolulu High-Capacity Transit Corridor Project Land Use Technical Report* (RTD 2008a).

2.3 Natural Hazards

Hurricanes, tsunami, earthquakes, and floods are natural phenomena that can all affect Hawai‘i.

The National Oceanic and Atmospheric Administration (NOAA) defines hurricanes as a type of tropical cyclone and as “*an intense tropical weather system with a well defined circulation and sustained winds of 74 mph (64 knots) or higher.*” A tropical storm, distinguished by maximum sustained winds of 39 to 73 mph, and its associated system of strong thunderstorms can be equally devastating in many respects. Prevailing building codes and AASHTO Design Guide Specifications contain specific provisions addressing wind effects on project improvements. However, wind speed is only one factor. Tropical cyclones can also produce storm surges in coastal areas and inland flooding from associated intense rainfalls. These factors are considered in the developed flood maps.

Tsunamis are enormous ocean waves produced by underwater disturbances such as earthquakes, landslides, volcanic eruptions, or meteorites—any of which can displace a relatively large volume of water in a very short period of time. Although tsunamis are sometimes referred to as *seismic sea waves*, they are not tidal waves. The extent of impact is a function of wave properties and shoreline characteristics. From the area where the tsunami originates, waves radiate outward in all directions, approaching speeds of several hundred miles per hour in open water. Once the waves approach shore, they build in height. Depending on the topography of the ocean floor and coastline, these waves can reach 100 feet or more in height. There may be more than one wave, and succeeding waves can be larger than the preceding. Tsunami waves and the receding water are very destructive to structures in the run-up zone. Areas are at greatest risk if they are less than 25 feet above mean sea level (MSL) and within a mile of the shoreline. The O‘ahu Civil Defense provides maps of areas that could be impacted by a tsunami.

Earthquakes are sudden and violent earth movements that occur without warning. The U.S. Geological Survey (USGS), in cooperation with State agencies, maps historical and current seismic activity throughout the Hawaiian Islands. O‘ahu, although not seismically active, is subject to earthquakes associated with the Big Island of Hawai‘i. Hawai‘i’s earthquakes, which are associated with volcanism rather than plate tectonics, have had a measurable effect on O‘ahu. The potentially adverse effects of earthquakes on project elements are addressed in part by building code requirements and AASHTO guidelines, and by implementing project-specific design criteria for prevailing ground conditions.

Floods, one of the most common hazards in the United States, are the overflow of an expanse of water, such as a river or lake that exceeds the water body’s total capacity and thereby submerges land outside its normal perimeter. Floods can also occur due to tidal inflows, which create backwaters that overflow stream banks or inundate areas that are not usually submerged. Some floods develop slowly, and others (e.g., flash floods) can develop within minutes. Flood effects can be local, impacting just a neighborhood or community, or very large, affecting entire river basins.

Protection of floodplains and floodways is required by Executive Order 11988, Floodplain Management; U.S. DOT Order 5650.2 Flood Management and Protection), FHPM-6-7-3-2; and 23 CFR 650. Therefore, existing floodways and floodplain limits within the study area have been identified using Federal Emergency Management Agency (FEMA) FIRMs and other existing data. Locally, the Hawaiʻi National Flood Insurance Program staff has been consulted, and these discussions are described in the Water Resources Technical Report (RTD 2008c). Land use in flood zones is described in the City and County of Honolulu's Flood Ordinance (Revised Ordinances of Honolulu, Chapter 21, Article 9). Risks associated with the installation of a fixed guideway transit system, impacts on natural and beneficial floodplain values, the support of probable incompatible floodplain development, measures to minimize floodplain impacts associated with the Project, and measures to restore and preserve the natural and beneficial floodplain values affected by the Project are discussed in this report.

3 Methodology

3.1 Geology

The information provided in this report was compiled from previous studies, discussions with local professionals, and geological maps of the study area. It includes a discussion of the geologic history and conditions of the corridor, as well as any potential impacts from construction. No drilling or field sampling is being undertaken for the Draft EIS.

3.2 Soils and Farmlands

This report includes a brief description of existing conditions to broadly characterize soils and farmlands in the study area. Existing Geographic Information System (GIS) data have been used to identify potential conflicts with “prime” and “unique” farmlands, as identified by ALISH data. Land use and soils data also were consulted to support or verify the designation as “prime” or “unique” farmland. For example, if an area is currently designated as “prime” or “unique” farmland according to ALISH, but existing or planned land use indicates that the area is or will be developed; such information was considered when determining the suitability of the property for use as part of the transit system.

Coordination has been initiated with the NRCS by preparing and submitting Form CPA-106 to determine the Farmland Conversion Impact Ratings for each alternative (Appendix A). The size and location of the Project’s footprint and its impacts on prime and unique farmlands have been documented on this form. If the Farmland Conversion Impact Rating exceeds the regulatory threshold of 160 points, alternatives would have to have been evaluated to avoid or mitigate impacts to farmland.

3.3 Natural Hazards

The Island of O‘ahu is subject to flooding, hurricanes, earthquakes, and tsunamis. The potential effect of these natural hazards on the Project is described in this report. Building codes, zoning, or other considerations necessary for construction have been noted. Flooding, although a natural hazard in Hawai‘i, is evaluated in the Water Resources Technical Report (RTD 2008c). Since portions of the Project are located within floodplains, detailed analyses are included in this report, as specified in U.S. Department of Transportation Order 5650.2 (USDOT 1979).

4 Affected Environment

4.1 Geology

4.1.1 Regional Geology

The Island of Oʻahu was built by the extrusion of basaltic lavas from two shield volcanoes, Waiʻanae and Koʻolau (Figure 4-1). The older Waiʻanae Volcano is estimated to be middle to late Pliocene in age and forms the bulk of the western one third of the island. The younger Koʻolau Volcano is estimated to be late Pliocene to early Pleistocene in age and forms the majority of the eastern two-thirds of the island. The Waiʻanae Volcano became extinct while the Koʻolau Volcano was still active, and its eastern flank was partially buried below the Koʻolau lavas.

The study corridor is located along the southern flank of the volcanoes, and the geomorphology and subsurface conditions of this area are directly related to glacial-eustatic fluctuations of sea level during the Pleistocene Epoch.

Evidence from deep wells indicates that the Island of Oʻahu has subsided by as much as 6,500 to 13,000 feet since the cessation of this early volcanic activity (Moore 1987, Nichols 1996). During that period of subsidence, coral-algal reefs began to grow on the southern coast of Oʻahu forming bays with barrier reefs across the mouth of the bays. The growth of the reefs related to the rate of subsidence. A series of lagoons formed behind the barrier reefs, and both terrigenous and marine sediments accumulated in the lagoons.

During the Pleistocene Epoch, sea level changed as a result of widespread glaciations on the continents. As the continental glaciers accumulated, the level of the ocean fell because there was less water available to fill the oceanic basins. Conversely, as the glaciers receded, or melted, global sea levels rose because more water was available.

The higher sea level stands caused the formation of deltas and fans of terrigenous sediments in the bays, accumulation of reef deposits at high elevations, and the deposition of lagoonal/marine sediments in the quiet waters protected by fringing reefs.

The lower sea level stands caused streams to carve valleys in the sediments and reef deposits. Subaerial exposure of the sediments and calcareous materials caused consolidation of the soft deltaic materials and lagoonal deposits and induration of the calcareous reef materials. In addition, renewed subaerial erosion of these upper areas of the volcanic dome deposited terrigenous alluvial soils under relatively high energy conditions.

LIST OF MAP UNITS

SURFICIAL DEPOSITS COMMON TO SEVERAL OF THE ISLANDS

Qf	**Fill (Holocene)**
Qa	**Alluvium (Holocene)**
Qbd	**Beach deposits (Holocene)**
Qdy	**Younger dune deposits (Holocene)**
Qdo	**Older dune deposits (Holocene and Pleistocene)**
Qcrs	**Calcareous reef rock and marine sediment (Pleistocene)**
QTao	**Older alluvium (Pleistocene and Pliocene)**

Conformable and interbedded to disconformable

VOLCANIC AND INTRUSIVE ROCKS ON THE ISLAND OF O‘AHU

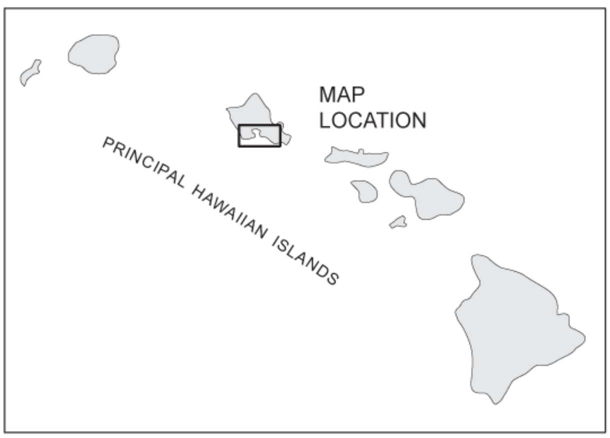
Honolulu Volcanics (Pleistocene)—Divided into:

Deposits from Koko fissure system—Consists of:

Qokl	**Lava flows**
Qokt	**Tuff**
Qoks	**Spatter**

Deposits from Tantalus Peak and Sugar Loaf vents—Consists of:

Qotl	**Lava Flows**
Qott	**Tuff**
Qol	**Lava flows**
Qov	**Cinder vent deposits**
Qobr	**Breccia**
Qot	**Tuff cone deposits**



Disconformity

Ko‘olau Basalt (Pleistocene(?) and Pliocene)—Divided into:

QTkl	**Lava flows**
QTkt	**Vitric and lithic tuff**
QTkdc	**Dike complex**
QTki	**Intrusive rocks**

Kailua Member—Divided into:

QTkkl	**Lava flows**
QTkkdc	**Dike complex within Kailua Member**
QTkkbr	**Breccia deposits**

Conformable, possibly interbedded

Wai‘anae Volcanics (Pliocene)—Divided into:

Kolekole Member—Divided into:

Talel	**Lava flows**
Talev	**Vent deposits**
Talec	**Debris flows**

Pālehua Member—Divided into:

Tapl	**Lava flows**
Tapv	**Vent deposits**

Kamaile‘unu Member—Divided into:

Takl	**Lava flows**
Takv	**Vent deposits**
Takbr	**Breccia**
Takmk	**Mauna Kūwale Rhyodacite Flow**
Takil	**Icelandite lava flows**
Takiv	**Icelandite vent deposits**

Lualualei Member—Divided into:

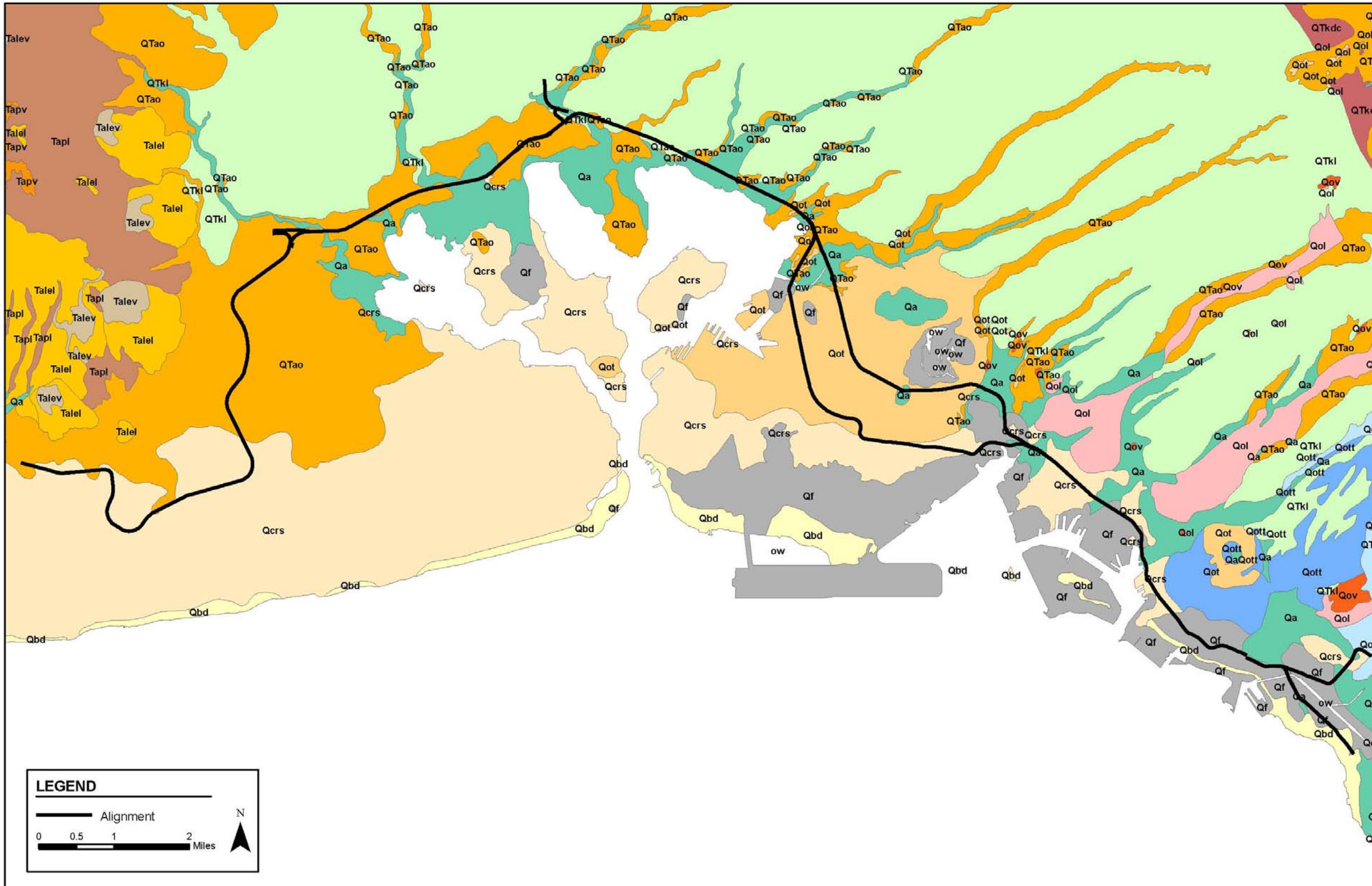
Tall	**Lava flows**
Talv	**Vent deposits**
Tai	**Intrusive rocks**

Contact—Approximately located

Dike—Showing trend of intrusions in units Tai and QTki. Depiction partly schematic owing to exposure mostly in cliffs

Available on World Wide Web at http://pubs.usgs.gov/of/2007/1089/

Key to Figure 4-1



Source: Sherrod, David R.; Sinton, John M.; Watkins, Sarah E.; Brunt, Kelly M.; Geologic Map of the State of Hawai'i; USGS Hawai'i Volcano Observatory

Figure 4-1: Geologic Map of the Project Corridor

The geologic history is complicated further by deposition of recent pyroclastic materials and lava flows resulting from eruptions of the vents of the Honolulu Volcanic Series, including the Āliamanu-Salt Lake-Makalapa, Kamanaiki, Punchbowl, Roundtop-Tantalus-Sugarloaf, and other minor vents. These post-erosional volcanic events were contemporaneous with the Pleistocene sea level fluctuation.

Many of the eruptions were explosive due to the interaction of groundwater with the rising magma, which resulted in steam explosions that expelled large quantities of pyroclastic material—predominantly ash and cinder. These deposits of pyroclastics have consolidated to form volcanic tuff.

Eruptions of the Roundtop-Tantalus-Sugarloaf volcanoes blanketed much of what is now metropolitan Honolulu with a fine black cinder. These eruptions also produced a thick lava flow, which filled the bottom of Mānoa Valley.

About 15,000 years ago, a relatively rapid rise in sea level occurred. During that rise, the deep valleys in the study area were submerged. In the last 10,000 years, sea level has adjusted to its present stand. Terrigenous and marine sediments have continued to accumulate in low-energy estuarine or lagoonal environments, resulting in thick deposits of soft harbor sediments along the coast in areas that were formerly valleys and drainageways.

Land development and reclamation projects within the last 50 to 100 years have brought the ‘Ewa-Honolulu area to its present form, including large areas of re-graded and filled coastal areas. Many of those projects originally were constructed for agricultural, residential, or military development. Many of the resulting fills are of poor quality in terms of supporting large structures.

4.1.2 Geology along the Corridor

The following information describes, in general terms, the geologic conditions that would be encountered along the route.

Geology of Corridor Common to All Build Alternatives

The volcanic rocks exposed toward the ‘Ewa end of the corridor near Kapolei are part of the Wai‘anae Volcanic Series. The surface deposits are interbedded layers of recent alluvium, consisting mainly of clayey organic silt with variable amounts of sand and some pockets of gravel and cobbles, as well as competent coralline materials. Basalt rock can be found at greater depths.

These ancient coral-algal reefs interbedded with layers of alluvial and marine sedimentary deposits are referred to as caprock. The caprock rests on the underlying basalt core of Pliocene-age Wai‘anae Volcanics. The caprock ranges between approximately 0 and 1,000 feet thick in the corridor. As described earlier, these layers were formed as fluctuations in sea level took place after significant mountain-building lava flows ceased. These layers act as a caprock that retards the seaward migration of potable groundwater in the Southern O‘ahu Basal Aquifer, a designated sole-source aquifer that is described in detail in the Water Resources Technical Report (RTD 2008c).

The type of groundwater varies in this area. Brackish groundwater occurs at shallow depths in the caprock. Potable, artesian water occurs below the caprock.

Between Leeward Community College and Aloha Stadium, the geology generally consists of fills placed over soft harbor mud underlain by old alluvium and volcanic tuff. The soft harbor mud may extend to depths of about 40 to 100 feet below ground level. Shallow groundwater levels and artesian groundwater conditions also are expected in this area.

Geologic conditions between Aloha Stadium and Middle Street are discussed for the Salt Lake and Airport Build Alternatives in the next sections.

Following Dillingham Boulevard from Middle Street to Kaʻaahi Street, the geology consists of surface fills placed over soft lagoonal deposits underlain by alluvial soils and coralline detritus materials. Groundwater is anticipated about 10 to 15 feet below the surface.

In the Downtown part of the corridor from Kaʻaahi Street to Bishop Street along Nimitz Highway and Ala Moana Boulevard, the subsurface conditions consist of surface fills placed over relatively thick, soft alluvial deposits underlain by coral formation at greater depths. Groundwater is anticipated at shallow depths of approximately 10 feet.

The next segment along Halekauwila Street generally contains surface fills over lagoonal deposits underlain by alluvial soils and coralline detritus. Groundwater is anticipated at shallow depths of approximately 10 feet.

From Ward Avenue to Ala Moana Center, the subsurface is comprised of surface fills over lagoonal deposits underlain by alluvial soils and coralline detritus interbedded with wedges of hard coral. Groundwater is anticipated at shallow depths of approximately 10 feet.

Between Ala Moana Center and UH Mānoa, the geology consists mainly of surface fills overlying alluvial soils and volcanic ash deposits. Thick lava deposits from the recent Roundtop-Tantalus-Sugarloaf volcanoes are also present. Groundwater is anticipated to range greatly in depth, from being quite shallow near Ala Moana Center to below the depths of the drilled shafts near the terminus at UH Mānoa.

The Waikīkī Branch generally contains substantial amounts of surface fills over lagoonal deposits underlain by alluvial soils and coralline detritus. Groundwater is anticipated at shallow depths of approximately 10 feet.

Geology of Salt Lake Boulevard Alternative

From Aloha Stadium to Māpunapuna, surface fills cover volcanic tuff overlying alluvial deposits at greater depths. The groundwater level is estimated to be below the anticipated foundation depths in this area.

Through the Māpunapuna industrial area and following Moanalua Stream to the southern end of Middle Street at the Ke‘ehi Interchange, the geology consists generally of artificial fills placed over thick marine deposits. Below 80 to 150 or more feet of soft material lie sand, coral, and silty clays. Groundwater is approximately 10 feet below the ground surface.

Geology of Airport Alternative

The geology along the alignment for the Airport Alternative generally contains surface fills over lagoonal deposits underlain by alluvial soils and coralline detritus. Groundwater is anticipated at shallow depths of approximately 10 feet.

4.2 Soils and Farmlands

The majority of the study corridor is currently developed. A portion of the study corridor in the ‘Ewa Development Plan area crosses undeveloped land currently used for agriculture.

The ‘Ewa Plain was once a major agricultural area primarily used to cultivate sugar cane. However, sugar cane has not been cultivated in ‘Ewa since 1995. Despite recent rapid urbanization, much of the ‘Ewa Plain is still classified and zoned for agricultural use by the State of Hawai‘i and City and County of Honolulu (City), respectively. In addition, much of ‘Ewa that is not urbanized is classified as “Prime Agricultural Land” according to the ALISH land classification system (HDOA 1977) by the NRCS. A map of “prime” and “unique” lands under ALISH is provided in Figure 4-2 and Figure 4-3, which show the Kapolei-‘Ewa and Waipahu-Pearl City areas, respectively. The remainder of the project corridor does not have known agricultural uses or lands designated as “prime” or “unique.”

Because of the availability and quality of the area for agriculture, some former sugar-cane fields in the ‘Ewa Plain have been converted to small-scale, diversified farms growing a variety of vegetables, fruits, and herbs, as detailed in the Land Use Technical Report (RTD 2008a). Active farms in the area are located between the H-1 Freeway and Farrington Highway on both sides of Pālehua Road and south of Farrington Highway to the east and west of North-South Road. These farms have short-term leases. Figure 4-4 shows the location of these tenant farms in East Kapolei. Other potential agricultural lands are either fallow or inactive; much of the area has already been developed.

Although currently designated as prime or unique farmland according to ALISH, some areas have existing or planned land uses for development. For example, East Kapolei is designated “prime” land and is still actively farmed, but long-term plans for East Kapolei do not include agricultural use. As discussed in the Land Use Technical Report (RTD 2008a), all of East Kapolei is slated (zoned or planned) for development along with the rest of the ‘Ewa-Kapolei region, in accordance with the *City and County of Honolulu General Plan (as amended)* (DPP 1997a) and the ‘Ewa Development Plan (DPP 1997b). The UH has already begun planning its West O‘ahu campus on the site along the west side of North-South Road. Tenant farms in

East Kapolei have short-term leases with the understanding that these lands are not intended for indefinite agricultural use.

In the more urbanized corridor along Farrington Highway and Kamehameha Highway in Waipahu and Pearl City, some limited areas are still designated as “prime” or “unique” (Figure 4-3). Part of the City’s Waipahu Cultural Garden Park located slightly mauka of Farrington Highway in the heart of Waipahu is designated as “unique” land. Makai of Kamehameha Highway in Pearl City, active cultivation of taro and potentially other crops is occurring on coastal property along Pearl Harbor, directly ‘Ewa of the Hawaiian Electric Company’s Waiau Power Plant. The UH’s O‘ahu Urban Garden Center is located behind Home Depot off of Kamehameha Highway.

Two active watercress farms are located along or near Kamehameha Highway: Watercress of Hawai‘i is just mauka of the Pearl City Peninsula and is part of an area designated as “unique” but otherwise filled with non-agricultural land uses; Sumida Farm is on the mauka side of Kamehameha Highway near Pearlridge Center and is designated “unique.”

4.3 Natural Hazards

4.3.1 Tsunamis

Tsunamis are ocean waves produced by earthquakes or underwater landslides. They are often incorrectly referred to as tidal waves, but a tsunami is actually a series of waves that can travel at speeds averaging 450 (and up to 600) miles per hour in the open ocean. Areas at greatest risk are less than 25 feet above sea level and within 1 mile of the shoreline.

Existing ground elevations along the study area vary from a low of 5 feet above MSL to well over 100 feet MSL. Most of the alignment lies along areas above elevation 20. Tsunamis are a concern for coastal portions of O‘ahu. The State Civil Defense publishes a series of maps showing areas that should be evacuated in the event of a tsunami warning. None of the Build Alternatives are located in a tsunami evacuation zone (Figure 4-5). According to the Civil Defense Maps, where the boundary of the Tsunami Evacuation Zone is drawn along a road or street, the roadway is outside the evacuation zone. NOAA’s Pacific Tsunami Warning Center in ‘Ewa Beach provides warnings of tsunamis to Hawai‘i.

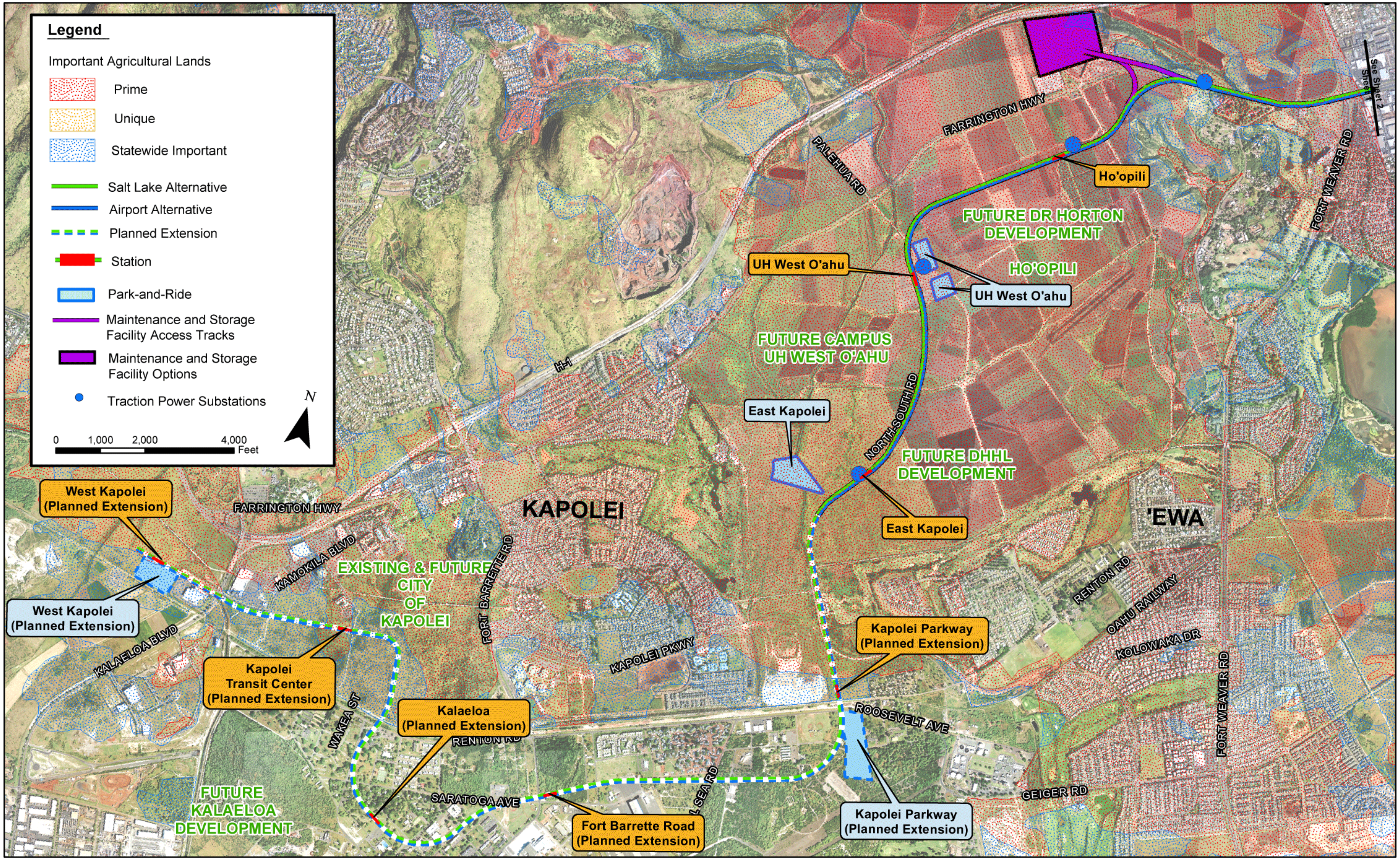


Figure 4-2: Prime and Unique Soils in the Kapolei-'Ewa Area

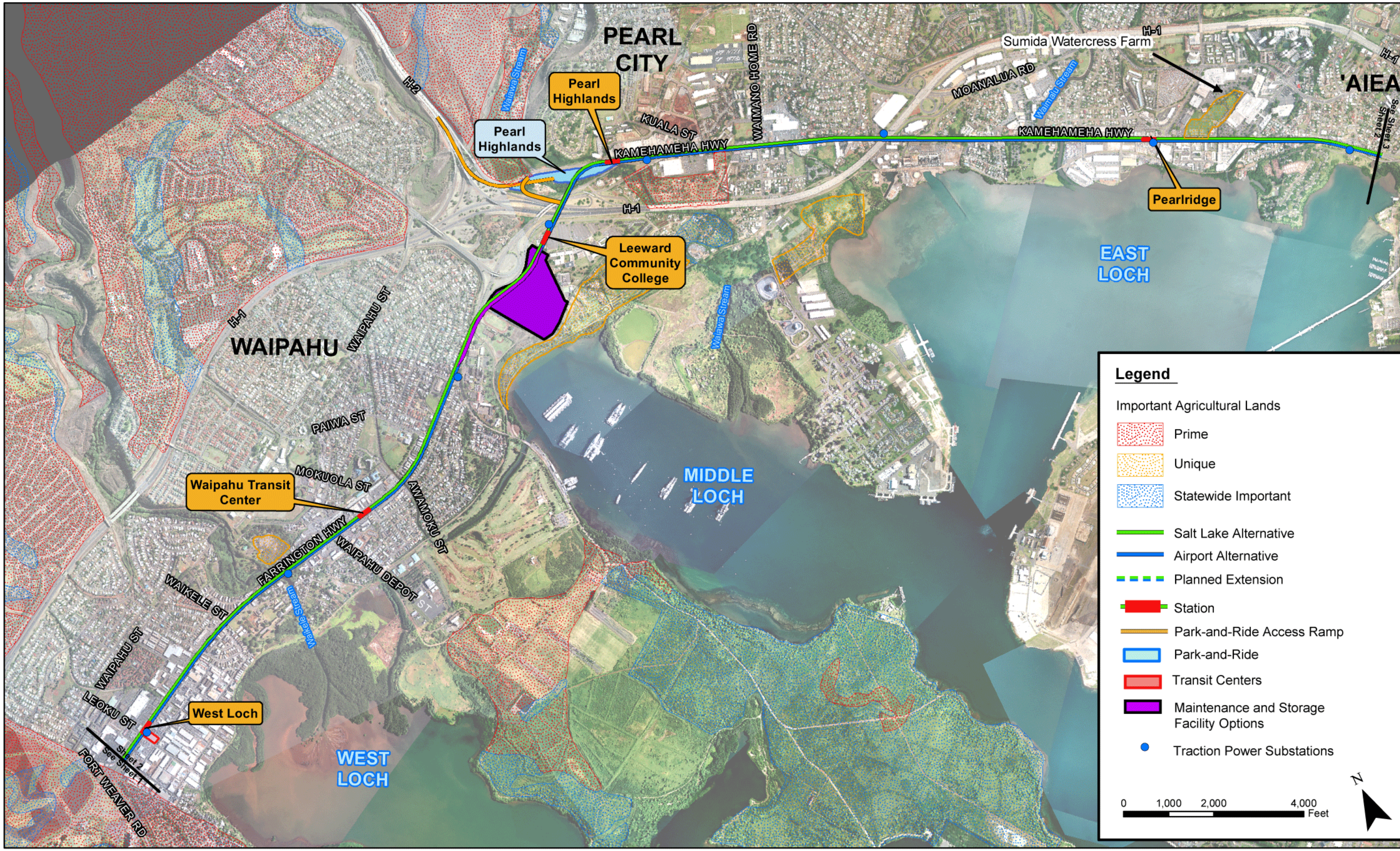


Figure 4-3: Prime and Unique Soils in the Waipahu-Pearl City Area

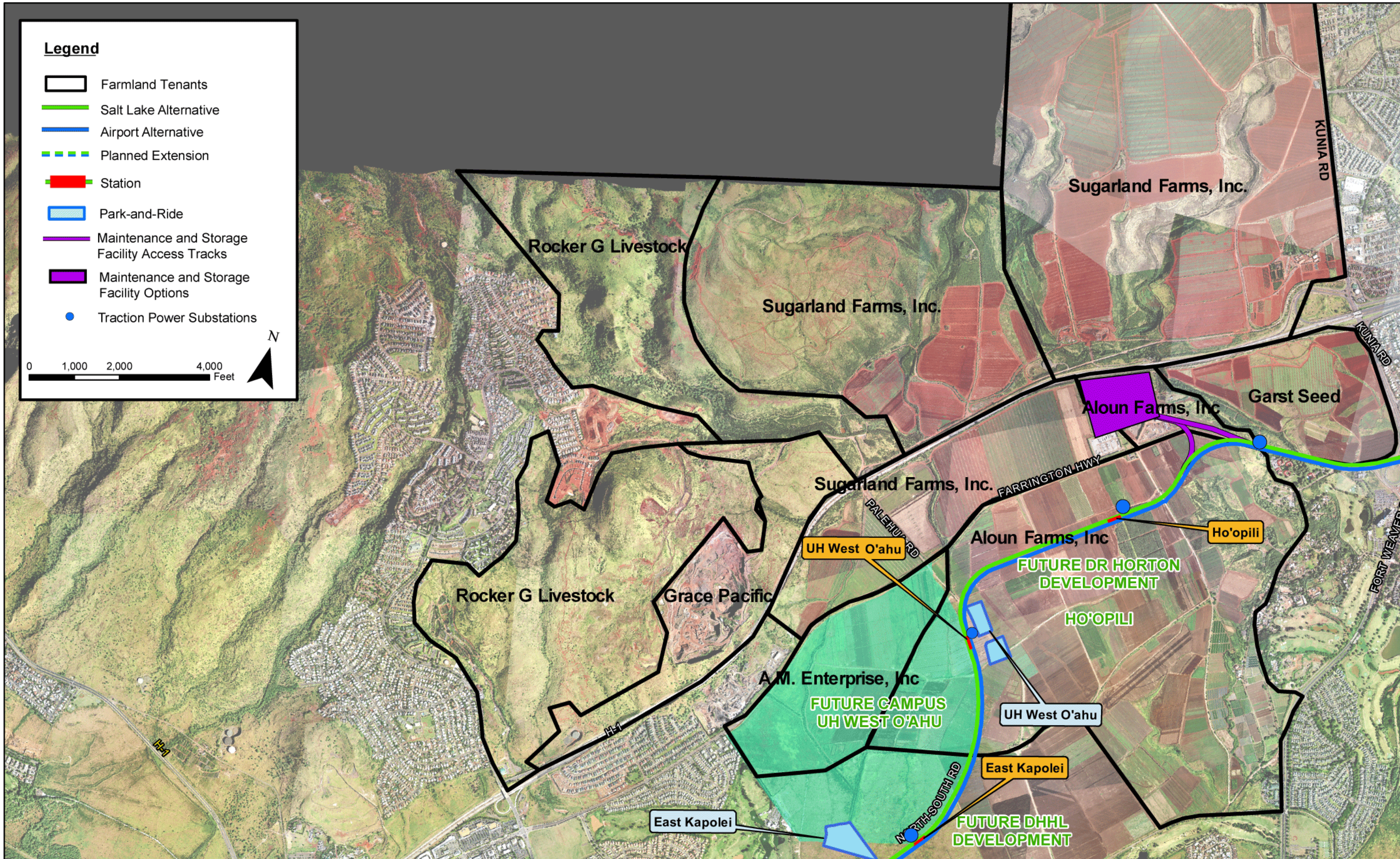


Figure 4-4: Tenant Farms in East Kapolei

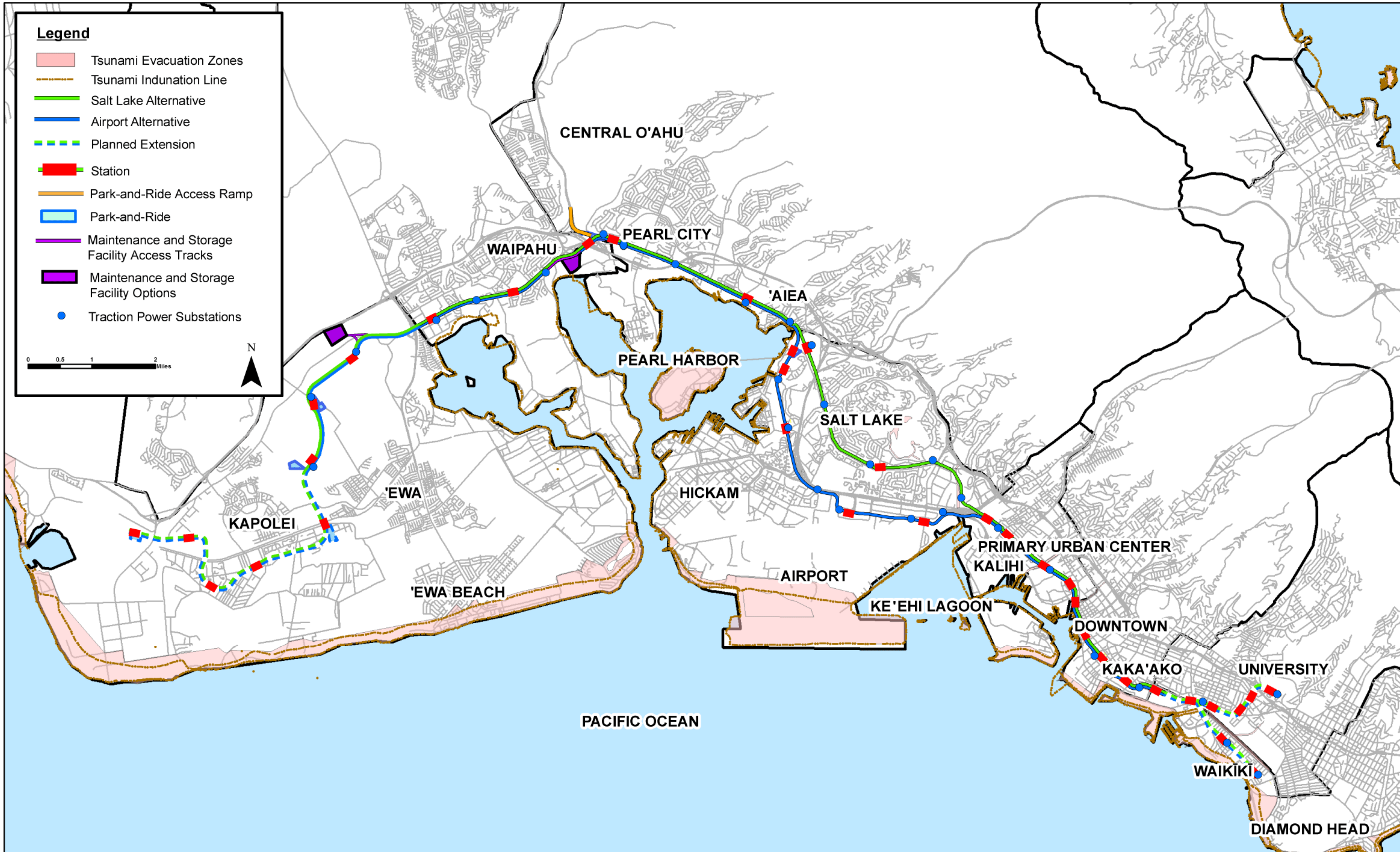


Figure 4-5: Tsunami Evacuation Area for O'ahu

4.3.2 Earthquakes

Earthquakes are sudden and violent earth movements that occur without warning. The IBC and AASHTO guidelines provide minimum design criteria to address the potential for damages resulting from these seismic disturbances.

Small earthquakes are common in Hawai‘i, but predominantly in areas of active volcanism. As the volcanoes on O‘ahu are dormant, only minor earthquakes have been recorded.

4.3.3 Flooding

Tropical storms and hurricanes are common in the Pacific. The FIRMs indicate that several parts of the alignment are located in floodplains associated with streams, estuaries, and canals. Flood zones are summarized and described along with their associated water bodies in the Water Resources Technical Report (RTD 2008c).

5 Consequences

5.1 No Build Alternative

5.1.1 Geology

With the No Build Alternative, there would be no construction of the Project; therefore, the geology of the area will stay the same.

5.1.2 Soils and Farmlands

The soils and farmlands that are currently used for agriculture purposes will be converted to urban uses independently of the Project.

5.1.3 Natural Hazards

The No Build Alternative would not result in additional exposure to geologic hazards, tsunamis, or other natural hazards, such as tropical storms and hurricanes. However, the public would be deprived of an alternative mode of transportation to evacuate the area in the event of an emergency.

5.2 Build Alternatives

5.2.1 Consequences Common to All Build Alternatives

Geology

All of the Build Alternatives would require deep foundations to support the aerial guideway and stations. Deep foundations would entail drilling variously sized holes for cast-in-place shafts and/or pile driving. Excavations would also be required where pile caps are needed, such as bents with multiple pile supports, excavations for utility relocations, and drainage improvements. These short-term, construction-related impacts are discussed later in this section and further detailed in the Water Resources Technical Report (RTD 2008c). The overall physiographic nature and topography of the area would not be affected by the Build Alternatives. The long-term impact would generally be a single drilled shaft approximately 6 to 10 feet in diameter extending 50 to 150 feet below the existing ground surface and integrated into the support column. Generally, bents would be spaced at between 120 to 180 feet along the guideway, depending on the superstructure type, subsurface conditions, and site constraints. The Project would not alter the geology of the project corridor.

Generally, in so-called “good” ground, adequate structural support for structural loads can be achieved with a single, suitably sized reinforced drilled shaft as the foundation. In areas where soft ground exists, one or more drilled shafts or driven piles with pile caps would likely be required to achieve the necessary axial and lateral load resistance imposed by structures. Soft ground conditions generally occur in areas with deep, soft deposits, which are typically associated with old drainageways that have been infilled with recent alluvium or estuarine deposits. These conditions are known to occur at the mouths of some of the major drainages extending across or through the coastal plain.

Soils and Farmlands

In the near future, much of the ‘Ewa Plain will change from agriculture to urban State land use classifications and will likely be re-zoned for urban uses, consistent with planned future developments.

There are no State of Hawai‘i or City plans for future diversified agriculture in ‘Ewa. The ‘Ewa region is planned for substantial urbanization, including residences, commercial establishments, institutions, parks, and recreational resources. Urban development is normally incompatible with agriculture. Therefore, agriculture in ‘Ewa is not viable in the long-run, except in limited specified locations or as a means to preserve open space or urban buffers. For example, the ‘Ewa Development Plan (DPP 1997b) recommends that diversified agriculture be protected on lands outside of the Urban Growth Boundary, mauka of the H-1 Freeway and Wai‘anae of Kunia Road.

Since some of the area affected by the Project is classified as “prime agricultural” according to ALISH, the requirements of FPPA apply. The amount of farmland to be converted is the same for all the alternatives, including the Salt Lake & Airport Alternative. Per FPPA regulations (7 CFR 658), a Form NRCS-CPA-106 (Appendix A), “Farmland Conversion Impact Rating”, was submitted to the NRCS for a score on “relative value of farmland to be converted.” The form was then completed by calculating a corridor assessment score. If this combined score (Land Evaluation and Site Assessment) equals or is greater than 160 points, alternatives that avoid farmland impacts must be evaluated. The combined score for the Project on the form was 120 points, below the threshold of 160 points. Of the 147 acres of land converted, 86 acres are prime, unique, or statewide important farmlands.

The fixed guideway system could affect planted areas adjacent to the guideway by shading the plants. Shade could be an issue at the Sumida Watercress Farm on the mauka side of Kamehameha Highway near Pearlridge Center. This is discussed in more detail in the *Honolulu High-Capacity Transit Corridor Project Ecosystems and Natural Resources Technical Report* (RTD 2008b).

Natural Hazards

The guideway and other structures could be subjected to earthquakes and hurricanes and would be designed and constructed per AASHTO and IBC requirements. Facilities in flood areas are discussed in the Water Resources Technical Report (RTD 2008c)

5.2.2 Construction Impacts on Geology, Soils, Farmlands, and Natural Hazards

Subsurface conditions along the defined alternatives are highly variable. A single, suitably sized drilled shaft is recommended and preferred for the aerial guideway and stations. Pile foundations with a poured concrete cap would be used in areas where soil conditions and/or site constraints are incompatible with drilled shafts.

In areas where drilled shafts extend down close to or into the aquifer and artesian heads are considerably above existing ground, special measures may be necessary to mitigate excessively high artesian water levels. These measures may include temporary dewatering to lower groundwater levels to workable levels or localized grouting to stem the inflow.

Dewatering, ground amendment, a combination thereof, or other ground stabilization would likely be required where excavations extend over several feet below static groundwater levels. Dewatering removes groundwater from an excavation. Although a dewatering method would be determined during later design stages, it would likely consist of pumping from a sump. To achieve satisfactory drawdown, a more sophisticated technique (e.g., a well point system) may be required if a sump cannot keep up with the recharge. Pile caps, utility trenches, and partially or fully embedded structures are possible dewatering scenarios, depending on groundwater conditions at particular sites.

Dewatering disturbs the natural level and flow characteristics of groundwater. Depression of the natural groundwater table can induce consolidation of subsoils and subsequent ground settlement, called subsidence. Subsidence can cause cracking and other damage to buildings and facilities. Any ground stabilization method would be performed in a manner that protects existing conditions, whether by controlled dewatering, ground modification, installing sheet piling, or reinjection. Performance criteria will be established to limit the extent of any adverse influences beyond the work zone to acceptable and time-proven limits. Induced settlement or movement of nearby facilities will not be permitted. Where this possibility may exist, pre- and post-construction monitoring will be required to monitor for any unexpected movements or displacements.

Casing would be required at drilled shaft excavations that extend through soft or loose surficial deposits. Where unstable deposits extend to considerable depth, the casing may be incorporated into the shaft’s structural design. Where drilled shaft completion depths extend below static water levels, excavation stability also would require maintaining fluid levels within the excavation until concreting is complete. The counterbalancing fluid may simply be water and naturally derived cuttings or specially formulated drilling mud. In either case, the fluid will be managed in accordance with best management practices (BMP) to protect the environment from uncontrolled releases. At a minimum, this would entail removing sediments and reusing or recycling fluid for continued drilling operations. Any construction waste would be managed in accordance with prevailing environmental standards. Soil erosion could occur during construction and would be mitigated by BMPs implemented by the contractor, as discussed in the Stormwater Control section of the Water Resources Technical Report (RTD 2008c).

5.3 Indirect and Cumulative

The President’s Council on Environmental Quality (CEQ) regulations implementing NEPA (42 USC 4321-4347) define indirect effects as those:

> “which are caused by the proposed action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to the induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.”

Cumulative effects are those impacts:

> “which result from the incremental consequences of an action when added to other past and reasonably foreseeable future actions” (40 CFR 1508.7)

The indirect and cumulative effects analysis considers the full range of consequences of actions related to project activities. NEPA, the CEQ regulations, and Hawai‘i’s EIS law (HRS 343), require analysis of cumulative issues within the context of the action, alternatives, and effects.

5.3.1 No Build Alternative

Geology

No indirect or cumulative effects are anticipated to the geology of O‘ahu as a result of the No Build Alternative.

Soils and Farmlands

The cumulative effect of planned growth and development on O‘ahu will result in the loss of prime farmland on the island. This farmland is expected to be lost with or without construction of the Project.

Natural Hazards

With increased population, the number of people at risk from natural hazards also increases.

5.3.2 Build Alternatives

Geology

No indirect or cumulative effects are anticipated to the geology of O‘ahu as a result of any of the Build Alternatives.

Soils and Farmlands

The proposed developments identified in the Land Use Technical Report (RTD 2008a) would occur regardless of which alternative is selected. The fixed guideway would facilitate development along its route, but would not induce secondary effects separate from the previously planned development. The ‘Ewa region is planned as a Secondary Urban Center for O‘ahu, with the expansion of the City of Kapolei and the surrounding area as the focal point for this development.

The area surrounding the Project is planned for non-agricultural uses, and the existing short-term agricultural leases would not be continued. Between approximately 141 and 160 acres of undeveloped land would be lost, mainly due to the Project’s maintenance facilities. All planned projects involve the conversion of fallow agricultural land to urban use. This conversion is consistent with the ‘Ewa Development Plan (DPP 1997b) for the development of this area as a Secondary Urban Center for O‘ahu.

Although the Project would not directly cause any substantial loss of farmland, it would provide infrastructure to support planned development that would result in the loss of farmland.

Natural Hazards

Transit-oriented development would occur near the alignment, and increased population density could occur in areas near the transit stations. If this development occurs in areas with increased natural risks, such as floodplains or in the tsunami evacuation zone, the cumulative risk level would increase. Facilities in flood areas are discussed in the Water Resources Technical Report (RTD 2008c).

6 Mitigation

6.1 Geology

Detailed borings would be required prior to final design of the fixed guideway. Construction techniques and specifications, such as the depths for drilled shafts, would have to be determined depending on local conditions.

In areas of loose sands or soft clays, casings or drilling fluids, such as a polymer slurry, may be necessary to maintain the integrity of the drilled hole during construction. If drilling fluids are used, the quantity of spoils generated that require disposal would increase. Construction-derived wastes (e.g., soil and liquids) would be managed in accordance with prevailing regulations. Uncontrolled releases would not be allowed. Slurry would be recycled through a de-sander and reused. Water would be collected and treated as needed prior to disposal or reuse.

If driven piles are necessary in any area because of geologic conditions, restrictions could be placed on the times pile driving would occur to mitigate the noise and vibration effects on adjacent residences, businesses, and other land uses.

Pile driving would require excavation for the pile cap, and it may be necessary to support the excavation with sheet piling in highly congested areas to limit the construction area.

Additionally, dewatering may be required where groundwater is above the base of the pile caps. In areas where subsidence could be induced by dewatering, a structural survey of buildings, roadways, and other facilities adjacent to the site may be required prior to construction. During construction, disturbance to existing facilities would be monitored. Recharging the groundwater outside the excavation and other measures could be used to minimize the effects of dewatering.

6.2 Soils and Farmlands

Because the Project is not anticipated to have a substantial effect on farmlands, no mitigation would be required.

6.3 Natural Hazards

The guideway and other structures would be designed and constructed to withstand earthquakes and wind forces from tropical storms, per IBC and AASHTO requirements.

As discussed in detail in the Water Resources Technical Report (RTD 2008c), some piers and stations would be located on floodplains, but no increased hazards are anticipated because the guideway and stations would be elevated.

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Appendix A: Form CPA-106

U.S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

NRCS-CPA-106
(Rev. 1-91)

FARMLAND CONVERSION IMPACT RATING FOR CORRIDOR TYPE PROJECTS

PART I *(To be completed by Federal Agency)*	3. Date of Land Evaluation Request 8/28/08	4. Sheet 1 of 1
1. Name of Project Honolulu High Capacity Transit Corridor	5. Federal Agency Involved FTA	
2. Type of Project mass transit	6. County and State Honolulu, Hawaii	
PART II *(To be completed by NRCS)*	1. Date Request Received by NRCS	2. Person Completing Form Tony Rolfes
3. Does the corridor contain prime, unique statewide or local important farmland? (If no, the FPPA does not apply - Do not complete additional parts of this form).	YES ☑ NO ☐	4. Acres Irrigated 13,703 | Average Farm Size 89
5. Major Crop(s) Vegetables & seed corn	6. Farmable Land in Government Jurisdiction Acres: 151,860 % 39	7. Amount of Farmland As Defined in FPPA Acres: 94,500 % 24
8. Name Of Land Evaluation System Used STATE of Hawaii, LESA	9. Name of Local Site Assessment System none	10. Date Land Evaluation Returned by NRCS 10/7/08

	Maximum Points	Corridor A	Corridor B	Corridor C	Corridor D
PART III *(To be completed by Federal Agency)* — Alternative Corridor For Segment ______					
A. Total Acres To Be Converted Directly		147			
B. Total Acres To Be Converted Indirectly, Or To Receive Services					
C. Total Acres In Corridor		147	0	0	0
PART IV *(To be completed by NRCS) Land Evaluation Information*					
A. Total Acres Prime And Unique Farmland		78			
B. Total Acres Statewide And Local Important Farmland		8			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		0.1			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		17			
PART V *(To be completed by NRCS) Land Evaluation Information Criterion Relative value of Farmland to Be Serviced or Converted (Scale of 0 - 100 Points)*		93			
PART VI *(To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))*	Maximum Points				
1. Area in Nonurban Use	15	1			
2. Perimeter in Nonurban Use	10	0			
3. Percent Of Corridor Being Farmed	20	10			
4. Protection Provided By State And Local Government	20	0			
5. Size of Present Farm Unit Compared To Average	10	10			
6. Creation Of Nonfarmable Farmland	25	0			
7. Availability Of Farm Support Services	5	5			
8. On-Farm Investments	20	1			
9. Effects Of Conversion On Farm Support Services	25	0			
10. Compatibility With Existing Agricultural Use	10	0			
TOTAL CORRIDOR ASSESSMENT POINTS	160	27	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland (From Part V)	100	93			
Total Corridor Assessment (From Part VI above or a local site assessment)	160	27	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	120	0	0	0

1. Corridor Selected:	2. Total Acres of Farmlands to be Converted by Project:	3. Date Of Selection:	4. Was A Local Site Assessment Used?
Corridor A	147	10/16/08	YES ☐ NO ☑

5. Reason For Selection:

Available property, ROW, location of future development, ridership, and other environmental factors contributed to the selection of the corridor. The farmlands to be converted are leased properties slated for development.

Signature of Person Completing this Part: [signature] DATE 10/16/08

NOTE: Complete a form for each segment with more than one Alternate Corridor

CORRIDOR - TYPE SITE ASSESSMENT CRITERIA

The following criteria are to be used for projects that have a linear or corridor - type site configuration connecting two distant points, and crossing several different tracts of land. These include utility lines, highways, railroads, stream improvements, and flood control systems. Federal agencies are to assess the suitability of each corridor - type site or design alternative for protection as farmland along with the land evaluation information.

(1) How much land is in nonurban use within a radius of 1.0 mile from where the project is intended?
More than 90 percent - 15 points
90 to 20 percent - 14 to 1 point(s)
Less than 20 percent - 0 points

(2) How much of the perimeter of the site borders on land in nonurban use?
More than 90 percent - 10 points
90 to 20 percent - 9 to 1 point(s)
Less than 20 percent - 0 points

(3) How much of the site has been farmed (managed for a scheduled harvest or timber activity) more than five of the last 10 years?
More than 90 percent - 20 points
90 to 20 percent - 19 to 1 point(s)
Less than 20 percent - 0 points

(4) Is the site subject to state or unit of local government policies or programs to protect farmland or covered by private programs to protect farmland?
Site is protected - 20 points
Site is not protected - 0 points

(5) Is the farm unit(s) containing the site (before the project) as large as the average - size farming unit in the County ?
(Average farm sizes in each county are available from the NRCS field offices in each state. Data are from the latest available Census of Agriculture, Acreage or Farm Units in Operation with $1,000 or more in sales.)
As large or larger - 10 points
Below average - deduct 1 point for each 5 percent below the average, down to 0 points if 50 percent or more below average - 9 to 0 points

(6) If the site is chosen for the project, how much of the remaining land on the farm will become non-farmable because of interference with land patterns?
Acreage equal to more than 25 percent of acres directly converted by the project - 25 points
Acreage equal to between 25 and 5 percent of the acres directly converted by the project - 1 to 24 point(s)
Acreage equal to less than 5 percent of the acres directly converted by the project - 0 points

(7) Does the site have available adequate supply of farm support services and markets, i.e., farm suppliers, equipment dealers, processing and storage facilities and farmer's markets?
All required services are available - 5 points
Some required services are available - 4 to 1 point(s)
No required services are available - 0 points

(8) Does the site have substantial and well-maintained on-farm investments such as barns, other storage building, fruit trees and vines, field terraces, drainage, irrigation, waterways, or other soil and water conservation measures?
High amount of on-farm investment - 20 points
Moderate amount of on-farm investment - 19 to 1 point(s)
No on-farm investment - 0 points

(9) Would the project at this site, by converting farmland to nonagricultural use, reduce the demand for farm support services so as to jeopardize the continued existence of these support services and thus, the viability of the farms remaining in the area?
Substantial reduction in demand for support services if the site is converted - 25 points
Some reduction in demand for support services if the site is converted - 1 to 24 point(s)
No significant reduction in demand for support services if the site is converted - 0 points

(10) Is the kind and intensity of the proposed use of the site sufficiently incompatible with agriculture that it is likely to contribute to the eventual conversion of surrounding farmland to nonagricultural use?
Proposed project is incompatible to existing agricultural use of surrounding farmland - 10 points
Proposed project is tolerable to existing agricultural use of surrounding farmland - 9 to 1 point(s)
Proposed project is fully compatible with existing agricultural use of surrounding farmland - 0 points