Honolulu Transit Task Force Report:
MODIFYING HONOULU AREA RAPID TRANSIT (HART) FOR STREET LEVEL OPERATION IN DOWNTOWN HONOLULU

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EXECUTIVE SUMMARY

It is anticipated that the HART elevated rail project will use up its existing funding (local and federal, totaling $6.57B) shortly after construction to Middle Street. The current estimate for completing construction through the Middle Street station is $6.22B, leaving only $350M in available funds for the final five miles of the project to Ala Moana. Ever-escalating construction costs have caused political leaders and HART officials to consider stopping construction after Middle Street while exploring additional funding methods and design alternatives for the final five miles of the route.

With HART officials now anticipating $3B in additional construction costs for completion to Ala Moana (projected total cost $9.5B), and with the most challenging construction conditions (and associated cost overruns) still ahead, it makes sense for political leaders and HART officials to pause and reassess the project. According to independent transit experts, the rail equipment and station design currently under contract to HART can be modified to allow street level operation in central Honolulu. This would not only save billions of dollars in construction costs but would also allow future extensions to Waikiki and UH Manoa at a fraction of the cost of elevated rail. This would allow HART to satisfy stipulations for the federal funding as well as commuter preferences for a "one-seat ride" to Downtown. Modified for street level operation in central Honolulu, HART would become a mass transit system that better meets the mobility needs of all Oahu residents yet is more affordable and more easily extended. HART could be not only a commuter rail system for those in Leeward Oahu but also an urban rail system used by all to get around central and leeward Honolulu.

The Recovery Plan recently transmitted to HART officials by the Federal Transit Authority (FTA) in June 2016 lists six options for completion in order to receive $1.55B in federal funding. The FTA does not dictate what rail technology is used so long as the end point is Ala Moana. Option 2A in the Recovery Plan reads, "Build to Middle Street as planned and continue with at-grade rail system". This Option becomes particularly attractive if HART trains can be modified to operate at street level rather than creating a separate system that riders must transfer to. The most glaring weakness of HART in its current form is that it does not include the major commuter destinations of Waikiki and UH Manoa. Given the long-stated opposition to elevated rail in Waikiki and the exorbitant cost of extending HART to UH Manoa (discussed in detail below), it is clear that an all-elevated HART will never reach those two destinations. In contrast, a HART system modified for street level operation can be completed four year earlier, will cost $2 - 5B less than an elevated project, and can be extended easily at reasonable cost.

HART CONSTRUCTION COSTS: PROJECTED COST VS. COST OVERRUNS

There are two aspects of construction cost for large one-of-a-kind infrastructure projects: **projected cost** and **cost overruns**. The two are obviously related but looking at the two components separately highlights the tremendous difference in total cost between elevated and street level rail transit.

PROJECTED COST & COST OVERRUNS: ALL-ELEVATED

In 2006 the projected cost of HART was **$4.6B** ($224M/ mile), to be paid through federal funds ($1.55 B) and a .5% GET add-on levied for 15 years (2007-2022). In 2010 the cost was revised to **$5.4B** and in 2014 it was raised to **$6.57B**. In 2015 the State Legislature extended the GET levy for another 5 years (2022-2027). In September 2016, the projected cost was raised to **$8.6B**; in December 2016 it was raised to **$9.5B** ($463M/ mile). Since the beginning of construction in 2011, with only 25-35% completion (guideway completion 50%, station completion 0%) the projected cost of HART has risen 76% from start-of-construction cost ($5.4B) and 106% from its original cost ($4.6B). Given a 76% cost escalation in the first one-third of construction, one could reasonably expect a similar cost escalation (2 x 76%) for the final two-thirds of the project, yielding a total cost escalation of 228% and a potential total cost of $12.3B ($5.4B x 2.28). In their June 2016 revised cost estimate, HART officials included new "risk model data" for the project with an "upper bound" cost for the project of **$10.79B**. Given the potential of cost overruns in the final 5 mile of construction (discussed below), even this "upper bound" cost will likely be exceeded.

Intertwined with projected cost is the issue of cost overruns. So far, there have been over one hundred change orders from Kiewit Pacific and Kiewit/Kobayashi for the first 10 miles of the project totaling $246M. Based on the experience of these ten miles, which included construction on five miles of vacant agricultural land and five miles of suburban highways, **the risk of cost overruns for the remaining ten miles is extremely high.** Construction in the final five miles will be particularly challenging for at least three reasons: 1) unstable coral soils and a high water table requiring larger and deeper foundations, 2) the dense urban environment will require more extensive traffic management and coordination with existing businesses for dust and noise control and 3) the presence of historic sites and iwi (native Hawaiian burials) will require extensive mitigation measures that HART officials (according to the Historic Hawaii Foundation) have still not identified or budgeted for. One example of unforeseen problems is the recent request from Hawaiian Electric Company (HECO) that HART relocate existing high-voltage lines along Dillingham Boulevard which are too close to the elevated guideway. The relocation costs are tentatively estimated at $400M.

PROJECTED COST & COST OVERRUNS: MODIFIED FOR STREET LEVEL

The cost components of a modified HART project are:

1. The projected cost of the current elevated system to Middle Street -- $6.22B.

2. 5 miles of dual rail tracks at street level. Using the cost of a recent (2008) similar system in Phoenix ($70M per mile), the current cost multiplier for Hawaii (1.79 times Phoenix costs) and the rise in COLA since 2008 (11.1%), street level rail in Honolulu would cost $139M/ mile -- $695M for five miles

3. Changing the 80 rail cars form high-floor to low-floor type. Based on the total car contract amount ($200M) and using a 1/3- of- total change order charge - $66M.

4. Modification of maintenance yard equipment to service low-floor rail cars - $100M

5. Preparation of EIS Technical Memorandum -- $10M

6. A/E redesign of the street level route (typically 20% of construction cost) -- $139M

Using the above figures, the total cost of a modified HART project would be $7.2B. This is $**2.3B** below the current projected HART cost of $9.5B and **$3.6B less** than the "upper bound" cost ($10.79B) cited by HART in June 2016. Most significantly, it is **$5.1B less** that the extrapolated total cost ($12.3B) based on current cost overruns at 30% completion of construction. In contrast to elevated rail, street level rail construction carries a **very low risk of cost overruns.** Whereas elevated guideways and stations are structurally complex with a high risk of complications and unforeseen problems, a rail line at street level has virtually no structural risk: steel rails embedded in a concrete pad 12"–18" thick in existing streets, with overhead power wires held in place with steel poles similar to those used for streetlights. The possibility of unforeseen construction problems and corresponding cost overruns is drastically reduced. The issue of requiring the relocation of utility lines, for example, will not occur with street level rail.

COMPLETION DATE: ALL-ELEVATED VS. MODIFIED

According to current projections, the first 10 miles of HART (East Kapolei to Aloha Stadium) will be completed by 2020. The next segment (Aloha Stadium to Middle Street) is scheduled to be completed by 2022, with completion to Ala Moana scheduled for **April 2025.**

Construction time for a street level rail line from Middle Street eastward in Honolulu would be similar to that experienced by dozens of mid-size cities in the US in the last 30 years. For example, the 20-mile street level system recently completed in Phoenix took 4 years (2004-2008) to build. Allowing for additional construction time due to the greater density of central Honolulu, a five mile section of street level rail should take approximately two years to construct. Allowing two years for preparation of an EIS Technical Memorandum and (in the 2nd year) new design and construction drawings, followed by 2 years of construction, street level rail from Middle

Street to Ala Moan a could be **completed in 4 years (2020)**, five years earlier than the current HART completion date (2025).

MODIFICATIONS REQUIRED FOR STREET LEVEL OPERATION

In order to allow operation at street level, the train cars and elevated stations currently under contract must be modified in 7 ways:

1. A **driver cab** must be installed at the head of each train. As currently designed, HART trains utilize driverless cars, whereas trains operating at street level require drivers.

2. A **secondary power pickup** called a pantograph must be installed on one car of each train. As currently designed HART trains utilize an outboard paddle which draws power from a "hot" (electrified) third rail next to the main rails. For street level operation, trains are most commonly powered from an overhead wire using a spring-loaded contact apparatus (pantograph) mounted on top of the lead car.

3. All rail cars must be redesigned to be **"low-floor" type**. As currently specified, HART rail cars are "high-floor", with floors 36" above the rails. For street level rail operation, train cars typically are "low-floor" (14" above rails) so that riders may easily exit onto existing sidewalks with a minimum of level change. With the change to low-floor cars, the maintenance equipment in the rail maintenance and service complex will also need to be modified or replaced to be compatible with low-floor rail cars.

4. The design of the elevated stations must be modified to **"low-platform" configuration**. As currently designed, the stations are "high platform" (36" above rails); these must be lowered 22" (to 14" above rail) to accommodate "low-floor" rail cars.

5. In order for trains to fit into Downtown city blocks without blocking intersections, the cars must be reconfigured from four-car to **two-car trains**. Having trains run every three minutes instead of every six minutes during peak use periods will maintain the current capacity of the system.

6. With trains changed to a two-car maximum, the overall **length of the elevated stations can be reduced** from approximately 400 feet (the length of a four-car train) to 200 feet. Construction cost savings from this change will more than pay for redesign costs.

7. With trains operated by drivers, the **Control Center for driverless trains can be significantly downsized** or eliminated.

Making these modifications will require additional time and costs for redesign and re-bidding but entail minimal changes to existing construction. At this point (fall 2016) no elevated rail stations have been constructed, and only 4 rail cars have been manufactured. With a total value of $8.8M, the 4 delivered cars will not be used but can be kept for parts. Low-floor rail cars are commonly

found in urban rail systems around the world and can be designed and manufactured before the first operating segment to Aloha Stadium is due to open in 2020.

As for modifying the platform height at elevated stations, this can be handled as a change order within the existing station contracts prior to the start of construction.

MODIFIYING THE ENVIRONMENTAL IMPACT STATEMENT (EIS)

According to independent transit experts with experience on transit projects nationwide, once an EIS has been submitted and accepted for a major infrastructure project, a new or Supplemental EIS is not required for changes to the project. Instead, a Technical Memorandum is submitted, explaining what is being changed and why. For example, in 2010, after the HART route had already been documented in the EIS and accepted by the FTA, the Federal Aviation Authority (FAA) notified HART officials that the guideway and trains would be too close to an airport runway. The route was realigned one block inland and a Technical Memorandum was added to the EIS in a matter of three or four months.

Changing HART from elevated to street level operation, even for a portion of the already documented route, will require a Technical Memorandum analyzing the impact on existing traffic and activities in the area. Depending on the final route chosen (assuming minor route changes may occur to better utilize the existing street grid) this process could take one to two years.

TRAFFIC CONFLICTS WITH STREET LEVEL OPERATION

Potential surface traffic conflicts have been cited by City officials as a primary reason for the selection of elevated rail for the HART project. Studies by independent transit experts have noted that in certain areas of leeward Oahu, traffic congestion and limited roadway space make street-level rail impractical if not impossible. However, the experts have noted that in Downtown and the urban center, the existing street grid allows multiple routes for travel in any direction, so that street traffic can divert to alternate routes. The impact of trains at street level can be mitigated using signal synchronization and/or a traffic preempt system. A traffic preempt system alters signals at intersections to give priority to any train approaching the intersection It also permits trains to only stop at stations to prevent traffic delays.

Assertions that street level rail operation is “impossible” in Honolulu are contradicted by the facts: street level rail systems have been installed in 35 U.S. cities, large and small, in varied geography and climates in the last 30 years. Many of these cities, including Portland, Phoenix, Seattle, Los Angeles, Denver, Milwaukee, Dallas and Houston are now extending their systems and adding new lines. In the center of the city, all these systems use a combination of dedicated lanes and shared traffic lanes in existing streets. There is typically a “break-in” period during which local drivers learn to adapt to train traffic after which traffic and street-level trains function smoothly together. Train tracks can be paired on the same street or separated and put on different streets to minimize traffic conflicts.

Pedestrian safety is also a concern with rail operation at street level. Trains can be put in exclusive-use lanes or pedestrian malls to protect passengers from at-grade traffic as they disembark. Pedestrian barriers are also used, particularly in median (center of street) stations to force pedestrians to slow down and take notice as they approach traffic lanes or intersections.

ROUTE EXTENSIONS

Any elevated extensions beyond Ala Moana will cost at least as much ($395M/ mile) as the projected construction between Middle Street and Ala Moana. Extending elevated rail to UH Manoa will require, in addition, major engineering and construction challenges due to conditions on Kona Street. As currently designed, HART trains will "dead-end" at the Ala Moana Station 35 feet above Kona Street because existing ramps and parking structures spanning Kona Street prevent continuation of the guideway. In order to extend the route to UH Manoa, a second guideway starting at Pensacola Street and located above the first guideway will have to be built, ramping up to nearly 90 feet above Kona Street in order to pass above existing ramps and structures. To service this new line, a new Ala Moana station will have to be built at the 90-foot level, after which another 1800-foot long ramped guideway will be required to take trains down to 35 feet above street level and on to UH Manoa. In light of the major engineering and construction challenges (and costs) involved in building a second guideway and a station 55 feet above an existing station, **the likelihood of elevated rail being extended to UH Manoa is virtually nil.**

By contrast, street level rail could be extended to Waikiki and UH Manoa at a cost of $139M/ mile (see p. 3) with very low risk of cost overruns, using existing street lanes.

OTHER ISSUES ASSOCIATED WITH STREET LEVEL RAIL OPERATION

Land acquisition costs (particularly in the Pearl City corridor) have been cited as a reason for choosing elevated rail for Honolulu, but this issue is largely moot for the final five miles of the route. In the Dillingham corridor, street level rail can utilize the ten foot wide strip on the makai side of the Dillingham Boulevard which was to be taken for elevated rail. In Downtown and the center of Honolulu, street level rail would fit into existing traffic lanes on King Street, Beretania Streets or Kapiolani Boulevard. Street-level stations require only a sidewalk area 6 feet wide and 150 feet long on one side of the tracks.

Operating and maintenance costs (OMC) for street-level rail are significantly lower per mile that those for elevated rail. According to HART figures, the annual OMC for the elevated rail route is projected to be $4.8M per mile ($100M for the 20.5-mile route). According to the Light Rail Industry website, the typical OMC for street-level rail, including the cost of train drivers, is $1.5M/ mile, or $2.7M/ mile based on a cost multiplier of 1.79 for Honolulu. The higher OMC for elevated rail reflects the cost of operating and maintaining elevators, escalators and lighting and providing security at elevated stations. With the exception of lighting, none of these are required at street-level stations.

Due to the **visual and environmental impacts** involved, many community and professional organizations have opposed elevated rail in the urban core of Honolulu since it was first proposed by Mayor Fasi in 1992. An elevated rail system will have “moderate” to ”high” impact (according to the EIS) on several neighborhoods in the center of Honolulu. The guideway and stations will block existing mauka-makai views on at least two dozen streets in the center of the city. The views to Honolulu harbor enjoyed by thousands of workers and residents in Downtown and Chinatown will be especially impacted by the elevated guideway and stations on Nimitz Highway. These critical impacts would be entirely absent if the project was to be modified for street level operation.

SUMMARY

Modifying the HART project to allow street level operation for the final five miles will save money ($2.9 - $4.2B), will save time (completed in 2020 vs. 2025) and will provide a much more environmentally acceptable system Downtown that can be easily extended to Waikiki and UH Manoa.

ABOUT THE AUTHORS

This report was written by a group of Hawaii-based architects and planners, with the assistance of chief technical advisor Douglas Tilden.

Douglas A. Tilden, FAIA
AIA Project Manager and Senior Architect; URS, New York City

The report's chief technical advisor, Douglas Tilden, has compiled a distinguished 45-year career designing rail transit throughout the United States (e.g., Chicago, New York City, Washington D.C., Miami), as well as the Republic of Korea, Taiwan, and Greece.

Notable assignments include Architect, Washington D.C. METRO, 1970 – 73; Corporate Vice President and Architect, Miami METRORAIL, 1976 – 82; Joint Development Director, Taipei METRO, 1989 – 92; Chief Architect, Athens METRO, 1993 – 97; Chief Architect, Korean High Speed Rail System, South Korea, 1997 – 99.

In 2007, Mr. Tilden was Chief Architect for InfraConsult, a principal consultant to the Honolulu Area Rapid Transit (HART). After reviewing the project, Mr. Tilden objected to the plan for two reasons: first, construction was to begin in the countryside and proceed into the urban core; second, throughout it was to be on a fixed elevated guideway.

He argued that transit should be designed to enhance, not degrade the urban core, and that as it gained support and ridership it should extend outward to destinations of greatest need. When his design principles were overridden, he resigned his post. From 2008, he served as the Program Manager and Chief Architect of the underground expansion of Grand Central Station in New

York City. He has continued to follow the unfolding events of HART with an eye toward salvaging the greatest value from the project and preserving the cityscape.

In 2016, he was voted into membership of the AIA College of Fellows for his contribution not only to the profession but to society in general.

Scott Wilson, AIA
Contributing author Scott Wilson has been part of the AIA Honolulu efforts to research rail transit since 2009. He was Chair of the AIA Transit Task Force from 2009 - 2012 and Chair of the AIA Regional & Urban Design Committee from 2011-2016. Owner and Sole Proprietor of Scott R. Wilson AIA since 1993, specializing in residential and small commercial projects, licensed in Hawaii, California and Maine. Professional degrees in Architecture (B. Arch, University of Hawaii at Manoaa, 1984) and Regional & Urban Planning (Professional Certificate, DURP, University of Hawaii Manoa, 1999). Former Project Architect at TRB Hawaii, Long & Associates Inc., and Onuma Design Office (Yokohama, Japan). President-elect and President of Honolulu Chapter, American Institute of Architects, 2014-2015.

Terry Tusher, AIA
Currently with Tusher Architectural Group, Terry Tusher's architectural career spans four decades in California, Guam and Hawaii.

His professional experience ranges from project conception, development and feasibility studies to architectural and land use design, construction administration as well as evaluation of completed projects. Project diversity ranges from single-family residences to major commercial centers, hotels, and new project land planning in both rural and urban areas.

Terry has received multiple recognitions from the National Association of Home Builders and was a City and County of Honolulu Project of the Year Honoree.

Robert Crone, AIA
Bob Crone has been a member of the AIA Honolulu and Honolulu Transit Task Force efforts from 1990 to the present. He was chair of the AIA Regional & Urban Design Committee (RUDC) from 1987 to 1992. His professional degrees are in Architecture (B. Arch., Cornell, 1965) and Urban and Regional Planning (Professional Certificate, DURP, UH Manoa, 1988). Licensed in Hawaii and Maryland, he has been involved in the planning and design of numerous residential, commercial, institutional and resort projects in Maryland, Washington D.C., Hawaii, Australia and Malaysia.

Peter N. Vincent, FAIA, NCARB
Managing Partner, Peter Vincent Architects

Peter N. Vincent, AIA, NCARB, founded Peter Vincent Architects, an award-winning architecture and interior design firm, in Honolulu in 1992. He has an extensive background in a variety of residential, commercial, industrial and resort projects in the Pacific Rim, North America, Europe and the Middle East.

Peter served as the 2007 President of the Honolulu Chapter of The American Institute of Architects (AIA), was Vice President/President Elect in 2006, and was Chair of the AIA Transit Task Force Committee from 2006-2008. He was President of the 501(c)(3) non-profit Hawaii Architectural Foundation (HAF). In 2014, Peter was elevated to the AIA's prestigious College of Fellows.

His technical background includes a former position as the Building Official for the County of Kauai, where he was responsible for the code enforcement of the $1.6 billion construction effort in the aftermath of Hurricane Iniki.

The remaining members of the Honolulu Transit Task Force wish to remain anonymous so as to not jeopardize existing contracts and working relationships with local and federal government agencies.