HONOLULU HIGH-CAPACITY TRANSIT CORRIDOR PROJECT

Draft Environmental Impact Statement/ Section 4(f) Evaluation

Appendix C:
Construction Approach

November 2008

Appendix C—Construction Process

This appendix describes the general construction process and methods likely to be used in the construction of the Project. The exact design, process, method of construction and timeline would continue to be refined through the start of construction. Temporary effects of construction to the transportation system and the environment are discussed in Chapters 3 and 4 of the Draft EIS.

The fixed guideway and stations would largely be aerial structures throughout the system. Prior to beginning construction on the facility, existing utilities that conflict with the Project's construction would be relocated. The four main components of the fixed guideway system include foundations, piers (support columns), superstructure (the elevated guideway structure), and stations. Typical pier spacing would be 150 feet, with shorter or longer spans used where needed. The guideway width would generally be between 28 and 32 feet, with wider areas to accommodate track cross-overs, switches, and center-platform stations.

Construction staging areas would be needed throughout the project area to provide adequate space for construction equipment, construction materials, materials stockpiling and transfer, parking, and other construction-related activities. While future park-and-ride lots and the maintenance and storage facility have been identified as potential staging areas, additional locations would be needed. It would be the responsibility of the contractor to obtain these additional locations.

Support facilities, such as traction power substations, a maintenance and storage facility, and park-and-ride lots, would be at-grade unless the technology selected or local site conditions demand otherwise. The locations of these facilities are shown in Chapter 2 of the Draft EIS.

Many utilities are located below and above ground along the fixed guideway alignment. Prior to major construction in an area, utility relocations would be needed. In some cases, a utility may be moved temporarily to allow for construction and then returned to its original location. In other cases, the utility would be permanently moved to allow for construction. Where conflicts between aboveground utilities and the guideway would occur, the existing aboveground utilities may either be relocated aboveground or be placed underground.

The construction industry uses a variety of specialized terminology. The following terms are used in the description of the construction process:

- **"Tremie" is a method to place concrete underwater using a submerged pipe from the bottom to the top of a hole to ensure minimal contamination with water.**
- **"Slurry" is a wet cementitious mix (bentonite or polymer) that is placed in an excavation to support the excavation until concrete is placed.**
- **"Battered piles" are piles that are driven at an angle to improve horizontal resistance, resulting in a stronger foundation.**
- **A "pile cap" is a concrete foundation linking the tops of piles and bottom of a pier column.**
- **A "gantry" is an overhead trestle structure supported at both ends and includes a hoist to lift and place materials.**
- **"Falsework" is a temporary structure that supports an elevated structure during construction.**

Foundations

Foundations for the various system components would be dictated by structural demands and existing subsurface conditions. Two foundation construction methods would be used to support the aerial guideway structure: drilled shafts, which would be integral with columns; and driven piles, which would require pile caps for connection to columns. Test holes will be bored at anticipated foundation locations to determine soil conditions.

Drilled shafts (Figure C-1) would be used for the majority of the alignment because they can be installed faster; a smaller area of soil is disturbed; and it is quieter than driving piles. The drilled shafts generally would be 6 to 10 feet in diameter. The depth of the shaft depends on local soil conditions and would likely range between 50 and 150 feet below the ground surface. Generally, a drilled shaft foundation can be completed in one week. The procedure for constructing drilled shafts is as follows:

1. Drill hole of prescribed size to the design depth.
2. Stabilize unstable ground conditions by suitable means to achieve design completion depth.
3. Use slurry or water for drilled shafts completed below the prevailing groundwater level to counterbalance the adverse effect of an inward seepage gradient.
4. Clean bottom of drilled shaft thoroughly and, where water or slurry is used, clean out the medium to verify that there is no excess detritus in suspension that could compromise the quality of the placed concrete.
5. Install a rebar cage in the completed shaft.
6. Fill the shaft with concrete from the bottom up by the tremied placing method using strict tolerances on means and methods. The tremied concrete displaces the drilling fluid (slurry or water) upward and scours any raveling materials upward.
7. Treat and manage drilling slurry, if used, in accordance with local requirements. Slurry would be recycled through a de-sander and reused. Water would be collected and treated as needed prior to disposal or reuse.

In cases where lateral loads are too large for drilled shafts or where geotechnical or other site conditions prohibit their use, foundations would consist of multiple drilled or driven piles with pile caps (Figure C-2). Piles around the perimeter of the foundation may be battered to improve the foundation's lateral load-bearing capacity. A drilled-pile foundation would include multiple small drilled

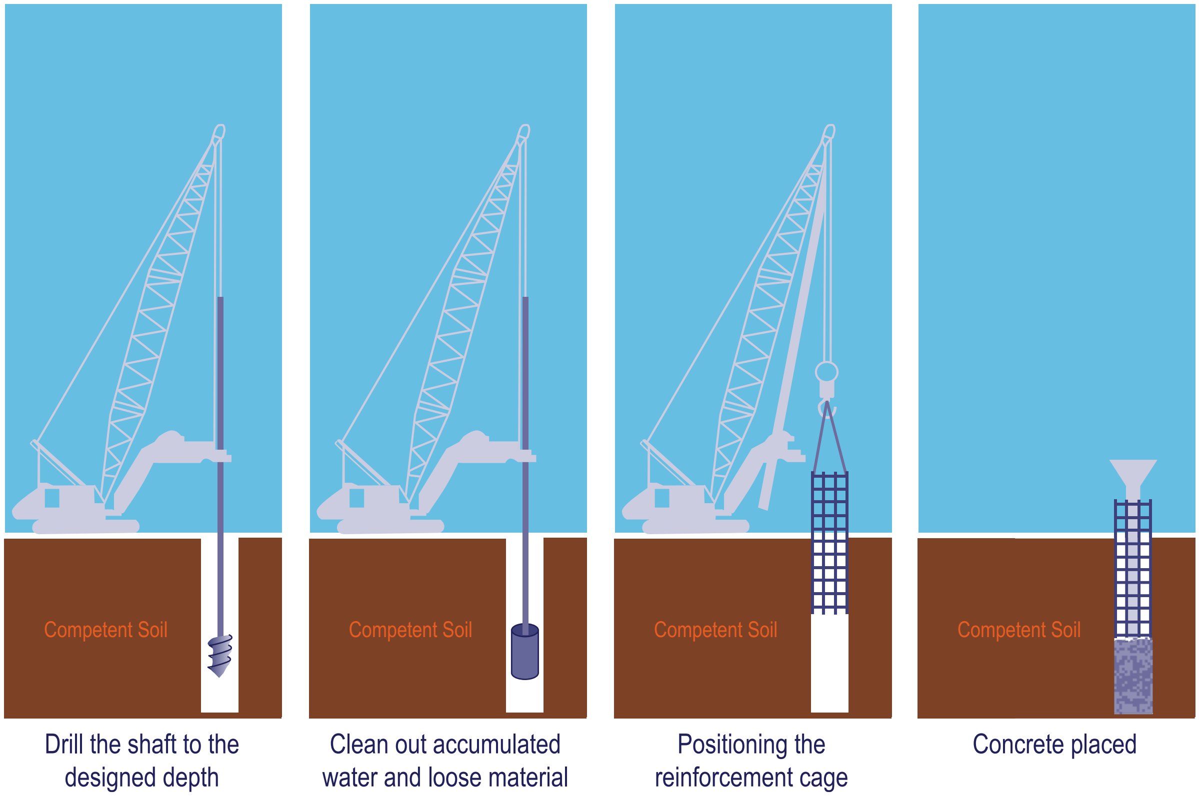

Figure C-1 Drilled Shaft Foundatioin Construction

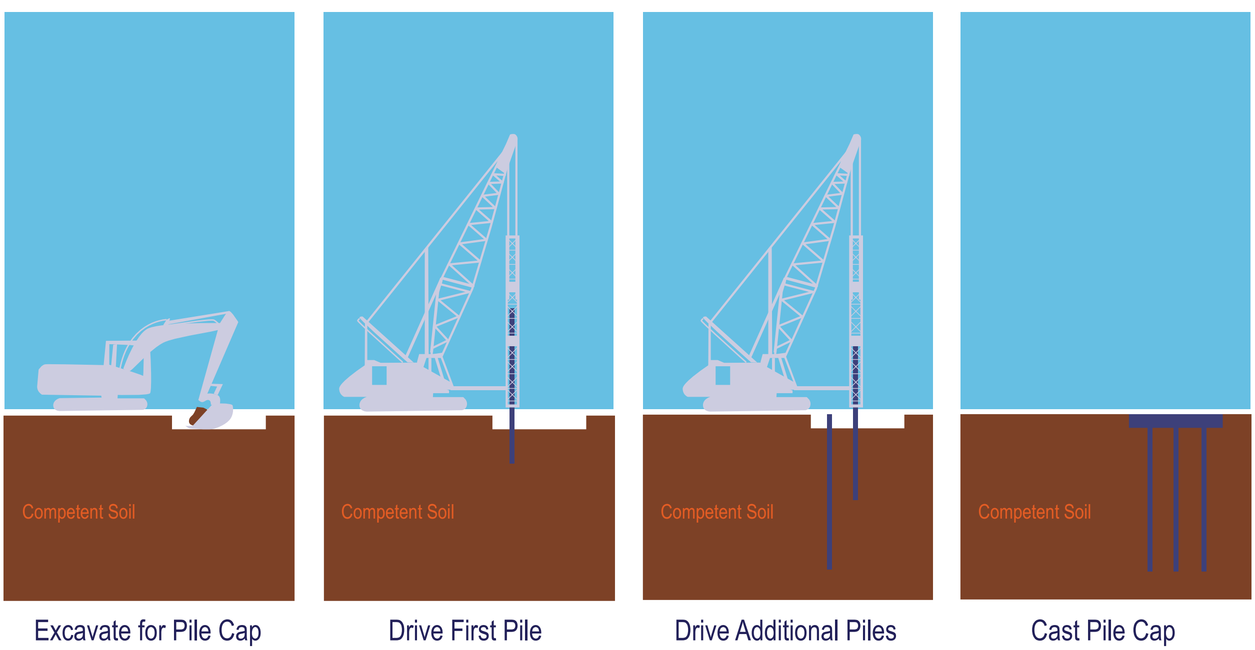

Figure C-2 Driven-pile Foundation Construction Piers shafts, each constructed as described above and connected with a pile cap as described for the driven-pile foundation. Piles may be driven by striking the pile with a heavy weight, vibrating the pile, or jacking the pile into the ground.

The following process describes construction of driven-pile foundations:

1. Excavate to accommodate the pile cap. It may be necessary to support the excavation with sheet piling in high congestion areas to limit the construction area. Additionally, dewatering would be required where ground water is at levels above the base of the pile caps.
2. Drive each pile. Pre-drilling may be required in areas where hard layers or strata otherwise impenetrable to driven piles are encountered above targeted depth.
3. Splice additional pile lengths in instances where pile capacities are not achieved and further driving may be necessary to achieve design capacity.
4. Conduct field-verification testing, including restrike, to ensure minimum design pile capacity is being achieved.
5. Form, cast, and cure the pile cap.
6. Backfill over the foundation.

Piers

The piers, or columns, may be precast or cast-in-place on top of the foundations. The structure includes the column and pier table, to which the superstructure attaches. Work on the piers can begin once the foundation has cured, approximately one week after it is poured. The following process describes construction of piers:

1. Construct and support three sides of form on top of completed foundation.
2. Position reinforcement cage inside form.
3. Close remaining side of form.
4. Place concrete in form either pumped from ports in the form or from the top.
5. Allow concrete to cure and remove form.

Superstructure

Because of the repetitive nature of the spans and the desire to minimize impacts on surrounding areas, the majority of the guideway structure would consist of precast, span-by-span segments, most likely erected using an overhead erection gantry (Figure C-3). The falsework required for cast-in-place concrete structures would close the area below the guideway for the duration of the superstructure construction, and full-length precast girders are limited in the span lengths that can be achieved. Span-by-span segmental bridges for transit have been constructed with spans of up to 180 feet, although spans between 120 and 150 feet are more common. Construction of the superstructure can begin once the two supporting piers have cured for about four weeks. Initial erection and final disassembly of the gantry would require additional working space.

The segmental precast bridge method generally proceeds as follows:

1. An overhead erection gantry is installed on top of two completed piers and positioned above what will become the guideway deck.
2. Superstructure segments are delivered to the job site and are erected into place by the gantry and temporarily held in place by the gantry until the span is fully assembled.
3. Post-tensioning tendons are threaded through ducts that run the length of each span.
4. The tendons are tensioned to tie together all segments within a given span.
5. The truss is launched to span the next gap, and the process is repeated.

For longer spans, another precast segmental construction method—commonly referred to as balanced cantilever construction—would most likely be used (Figure C-4). This would be necessary when spanning wide obstructions, such as large intersections, freeways, or streams. Various construction methods may be used for erecting

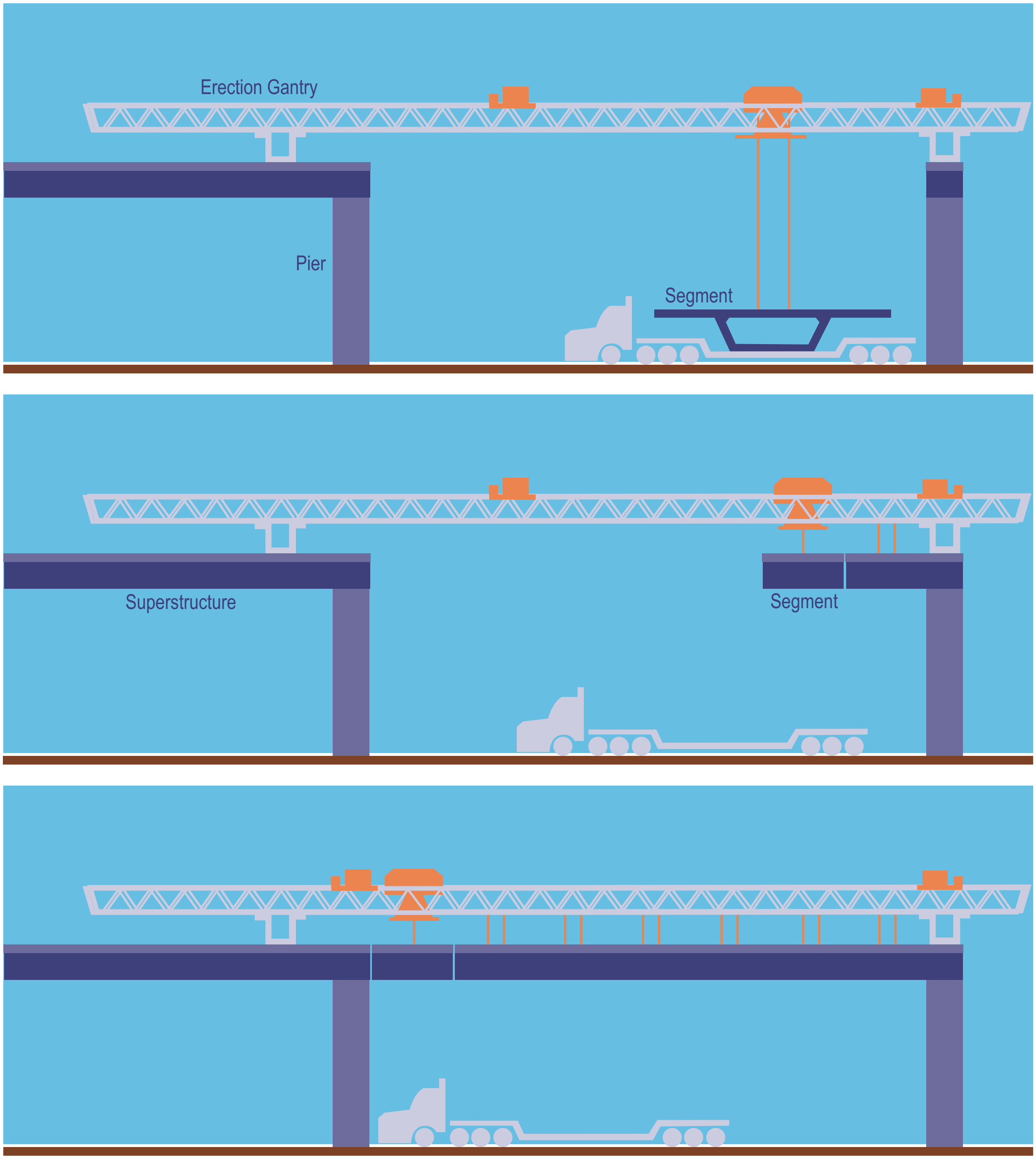

Figure C-3 Segmental Precast Bridge Construction

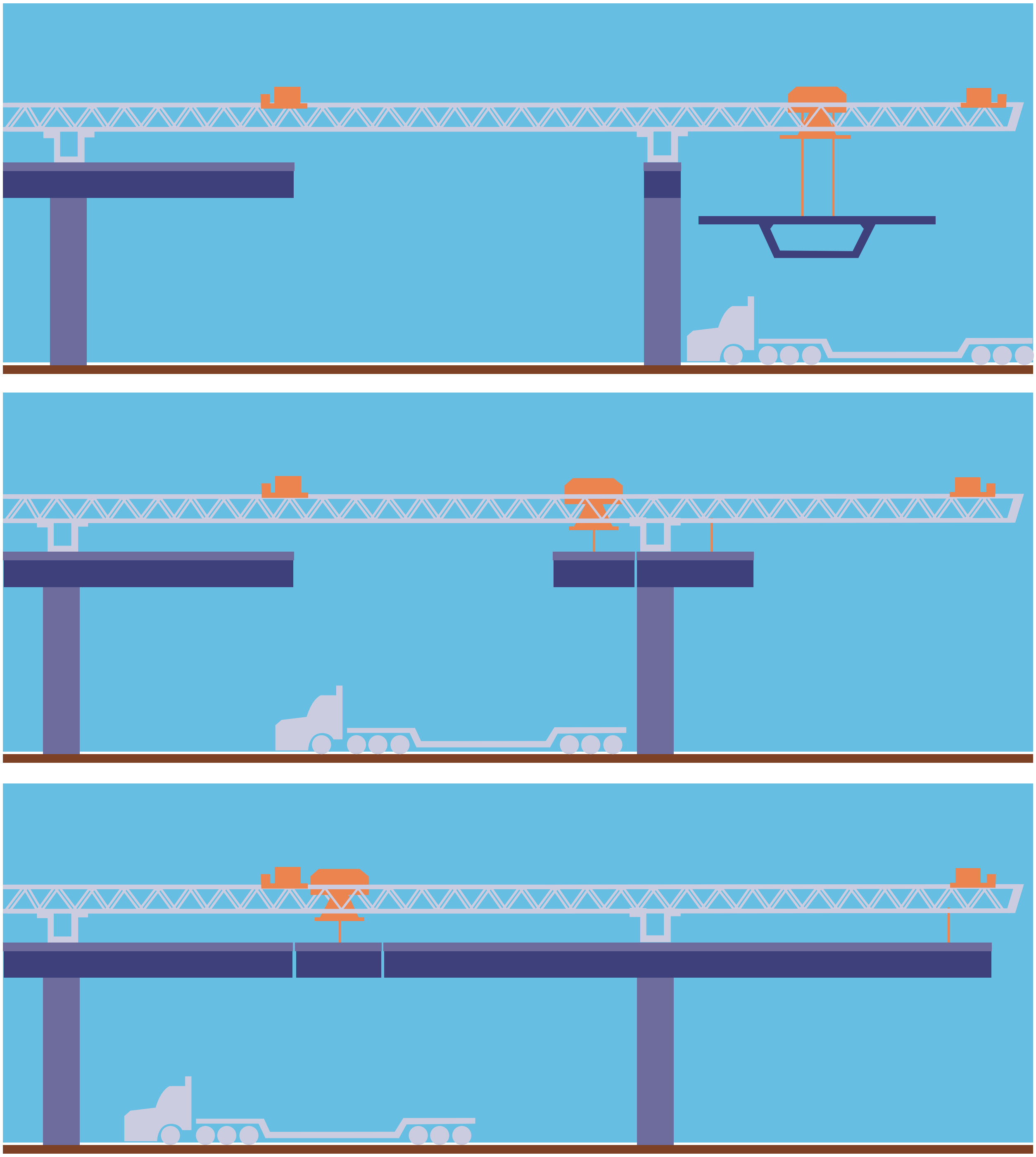

Figure C-4 Balanced Cantilever Construction Stations balanced cantilevers. Common methods include using a crane on either the ground or on the structure being constructed, a beam and winch system on the structure, or an overhead gantry. For any of those methods, the typical construction sequence would be as follows:

1. A pier table is cast in place on top of the pier column.
2. Two segments are delivered to the job site and are erected on each side of the pier table.
3. Post-tensioning tendons are threaded through ducts that run between the two segments that were erected and through the pier table.
4. The tendons are tensioned to tie the segments to the pier table.
5. Two more segments are delivered to the site and are erected similarly.
6. The segments are erected in pairs, as described above, until the cantilevers are complete.
7. A mid-span closure point is cast in place between this cantilever and an adjacent cantilever to complete the span.
8. Continuity post-tensioning tendons are placed and tensioned across the mid-span closure joint to tie both cantilevers together.
9. The equipment is moved to the next location, and the process is repeated.

After the superstructure is completed, the remaining work would include items such as installation of concrete plinths and steel rails, systemwide conduits and pull boxes, drainage scuppers and downspouts, handrails, noise barriers, and any other superstructure accessories. Then, under separate follow-on system(s) contracts, power, communication, and train-control cables and equipment are installed. Follow-on activities can be undertaken with little impact on the surrounding area relative to the civil work of foundations, columns, and guideway.

Construction would be more complex in station areas. The erection gantry would typically erect spans through the station area followed by construction of the platforms, mezzanines, elevators, escalators, stairs, roofing, and architectural items. It is expected that stations would include a combination of precast, cast-in-place, and structural steel elements that would vary from station to station.

Other Activities

Construction of park-and-ride lots would include grading and paving. The maintenance and storage facility would require grading, paving, trackwork, and building construction. After completion of major construction activities, landscaping, paving, sidewalk construction, and other activities would be completed to restore areas disturbed during construction.