



Traffic Signal Design Manual

ORIGINATOR Director, Bureau of Highway Operations		6-1-2
CHAPTER 6	Signal Infrastructure Design	
SECTION 1	Permanent Signals	
SUBJECT 2	Signal Head Layout	

The layout and display of traffic signal heads are two of the most important elements in the design of a traffic signal installation. Traffic signals must be clearly visible (have good target value) and convey the proper message to the driver and pedestrian. Certain basic principles **shall** be followed at all times when developing the traffic signal head layout. These principles, explained in detail in the *Wisconsin Manual On Uniform Traffic Control Devices (WisMUTCD)*, include the following:

1. *WisMUTCD* Section 4D.15(a) states, *There **shall** be at least three signal faces controlling each through movement at an intersection, two on the far side of the intersection, including one on the far left and one on the far right in relation to the approach roadway. A near right signal face shall also be provided located approximately at the stopping point.*
2. At least one, preferably both, far side signal heads **shall** be located within a 20-degree cone of vision from center of approach 10 feet behind stop bar as defined and illustrated in Figure 4D-2 by the *WisMUTCD*. Except where the width of an intersecting street or other conditions make it physically impractical, at least one and preferably both of the far side signals **shall** be located not less than 40 feet or more than 180 feet beyond the stop line (a 50-foot minimum is recommended for post-mounted signals and a 75-foot minimum for mast arm mounted signals).
3. State maintained signals **shall** have twelve-inch indications
4. Far right mast arm mounted signal heads are typically mounted horizontally.
5. Far left signal heads mounted on a reverse mast arm *may* be mounted vertically or horizontally at the discretion of the Regional Traffic Engineer. When using far left signal heads mounted on a reverse mast arm, care *should* be given to

maintain the minimum 8-foot horizontal separation between adjacent signal heads.

6. All pole mounted signal heads **shall** be mounted vertically.
7. *WisMUTCD* Section 4D.15(b) states, *when a separate left-turn phase is provided, at least two signal faces **shall** be provided to control that movement. One left-turn signal **shall** be located on the far side of the intersection (far left or far median); the other **shall** be located on the near left in the case of the existence of a near side median, or the far right if there is none.*

Due to knockdown potential and for added conspicuity, a supplemental far left turn indication may be used for protected-only left turns. This will typically be at locations where there is an existing median on the opposing lane.

8. Pedestrian signal heads **shall** be located as nearly in line with the crosswalk as possible. If the signal pole is located such that the pedestrian signal will be blocked by stopped vehicles or if it is more than 20 feet outside of the crosswalk line extended, then an alternative means of mounting *should* be designed. Pedestrian heads **shall** be mounted at a minimum of 7 feet (to the bottom of the head) above the walking surface on the side of the pole away from conflicting vehicular traffic. Pedestrian heads are typically mounted on the pole alongside the vehicular signal controlling the corresponding through movement.

Pedestrian push buttons, when needed, **shall** be located for convenient use by pedestrians. In some situations, it *may* be necessary to install a pedestrian push button standard to make the buttons accessible (Refer to SDD 9E7-3). Every push button must be accompanied by a R10-3 series sign explaining its use.

Pedestrian signals *should not* be installed in the medians of divided highways unless vision and timing conditions require it.

9. Backplates **shall** be used on all indications for added visibility.
10. *WisMUTCD*, Section 4D.15(c) states, *When right-turn signalization is used for a channelized right-turn lane, two signal faces **shall** be installed, one near the right side and one far side.*

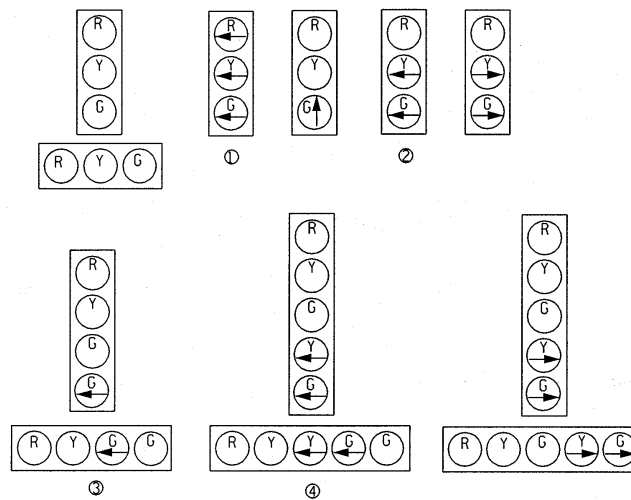
A supplemental right turn indication **shall** be used for dual right turn lanes, and *may* be used for single right turn lanes where recommended by the Regional Traffic Engineer. Refer to Figure 6.

11. *WisMUTCD*, Section 4D.15(d) states, *The far side signals on the stem approach to a "T" intersection **shall** be post mounted and one of them **shall** be placed directly in line with the center of the approach lane or lanes.*

12. *WisMUTCD*, Section 4D.15(e) states, *all traffic signals shall be either post-mounted or mast arm-mounted. Permanent traffic signals shall not be installed on overhead cables (or any other means, which would permit significant movement under windy conditions). Temporary traffic signals may be installed on overhead cables if construction or maintenance operations would not make post or mast arm mounting possible. If installed on overhead cables, temporary traffic signals should be converted to post or mast arm mounting as soon as possible after the construction operation permits.* Temporary signal installations **shall** only be used for road construction purposes and should be removed upon completion of the project. If a signal will be placed for a long-term duration, a permanent signal should be considered. LEDs **shall not** be used for temporary signal indications.

These guidelines are intended to establish minimum design criteria for traffic signal head layout. Additional consideration must be given by the signal designer to the unique conditions associated with a specific location and an appropriate design developed in response to these conditions. Specifically, consideration must be given to left-turn movements, right-turn overlaps, pedestrian activity, preemption, and median locations. All of these aspects must be evaluated to achieve the best design.

In establishing the traffic signal head layout, particular attention must be given to signal head displays. Signal head displays will have a direct affect on the location and orientation of signal heads. These signal head displays must be consistent with the intersection geometrics, vehicular demands, and desired operation. Signal head displays **shall** conform to *WisMUTCD* requirements. Signal face arrangements e, f, o, q, and s shown in Figure 4D-3 of the *WisMUTCD* are not to be used. Signal heads typically consist of three, four, and five sections. No more than five indications are allowed in each display. The specific signal head displays for each will depend upon the characteristics of the signalized location. Figure 1 illustrates recommended signal displays.



- 1) Used for Protected-only Left Turns when opposing traffic is present.
- 2) For T-Intersections
- 3) Horizontal or vertical heads can be used for Split-phased Intersections:
4-Section signal indications should be used at locations with split phasing.
4-Section heads can also be used at "T"- Intersections for lagging left turn phasing only.
- 4) Horizontal or vertical heads can be used for Protected-Permissive Intersections

Figure 1
Recommended Traffic Signal Displays

In addition to the general design criteria already discussed, further consideration *should* be given to the following items:

- Circular indications are to be used unless there is significant reason to use arrow indications. (See notes below.)
- Arrows *should not* be used on near or far right indications for through movements. Arrow displays significantly limit the luminance level and conspicuity compared to circular displays.
- Consideration *should* be given to using visibility limiting or optically programmed heads (lenses, louvers, or baffles) under certain conditions. These conditions might include two closely-spaced intersections where the intent is to limit a driver's ability to see the adjacent intersection display, or for exclusive turn movements. In addition, these types of heads *may* prove beneficial where direct sunlight causes drivers problems in determining which indication is actually illuminated.
- The use of all arrow indications for protected left turn only phasing shall be used. This eliminates the need for most signing and for programmed heads and their associated maintenance problems and cost.

- A green ahead arrow **shall** be used in place of the circular green for the through movement in the far-left indication when a separate 3-section head is used for the left-turn indications. A green ahead arrow shall also be used if the optional near left indication is installed.
- Traffic movements, with a conflicting pedestrian movement, *should* be controlled by circular green, not green arrows.
- The bottom housing of a vehicle signal face, not mounted over a roadway, **shall** be at least 8 feet but no more than 15 feet above the sidewalk or, if none, above the pavement grade at the center of the highway.

*WisMUTCD, Section 4D.17 states, The lowest part of a signal assembly and all other signal components suspended over a roadway **shall not** be less than 17 feet nor more than 19 feet above the pavement grade of the highest point on the roadway. (WisMUTCD)*

- Poles **shall** be located such that all portions of the poles and attached equipment have clearances from overhead utilities in accordance with the requirements of the local utility and the National Electrical Safety Code (NESC).

The following figures illustrate common geometric configurations and corresponding general traffic signal head layouts and displays. Adjustments *may* be necessary depending on actual field conditions and *should* be verified in the field by the maintaining authority prior to installation.

If it is determined that a protected only left-turn arrow is needed for a particular direction then the opposing left-turn *should* be made protected only as well.

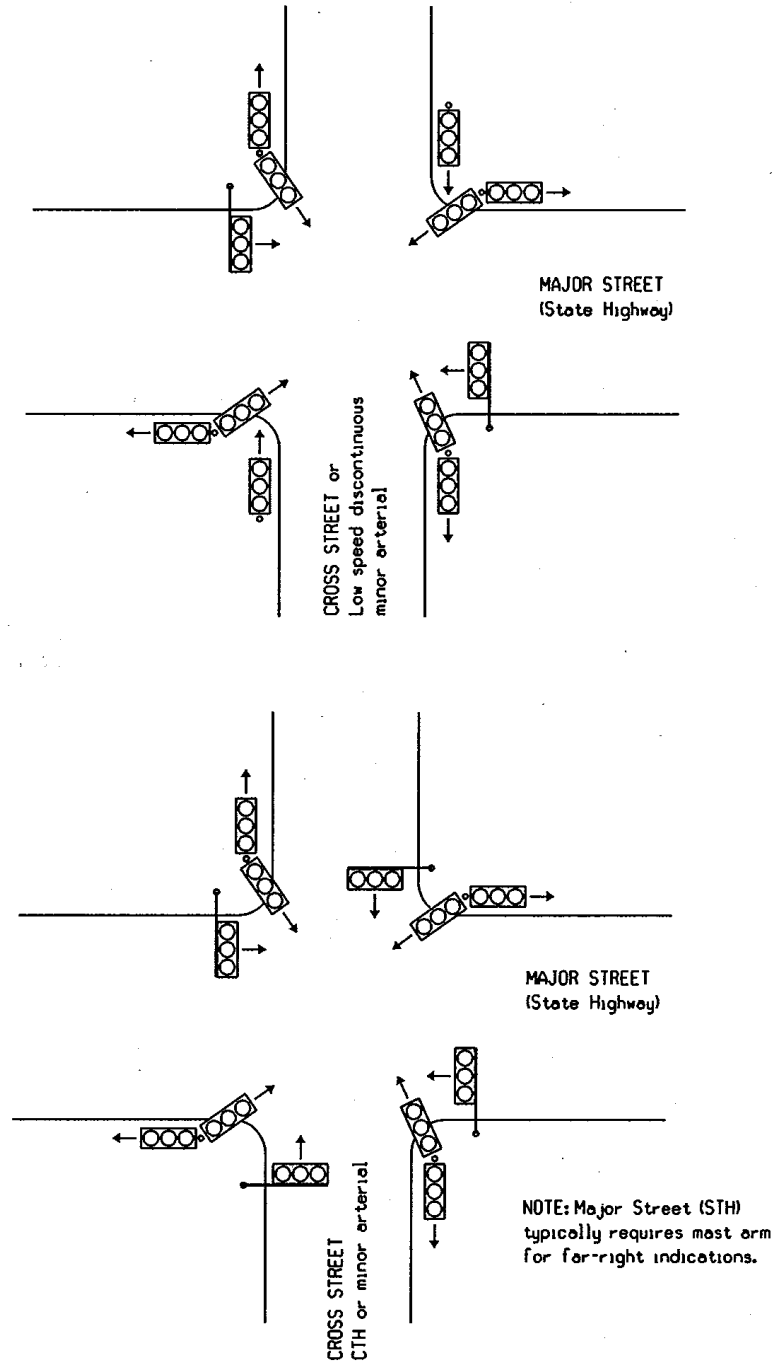
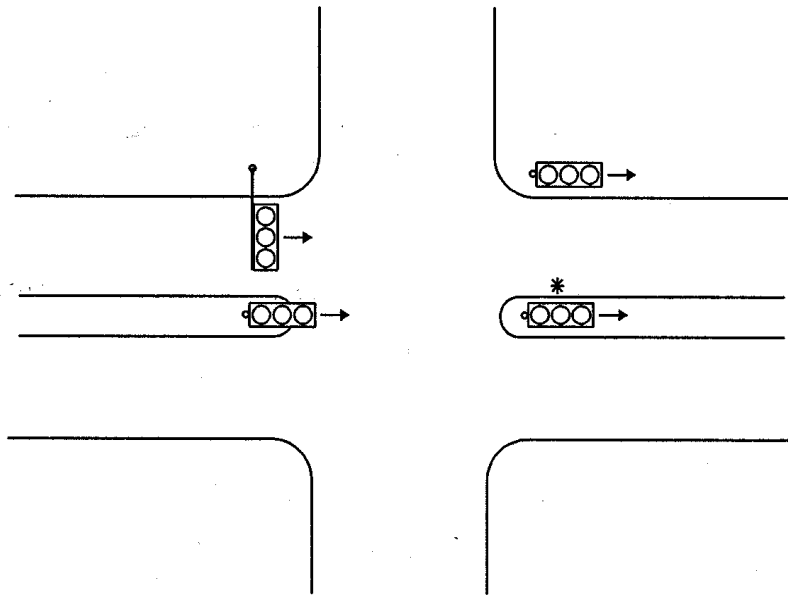
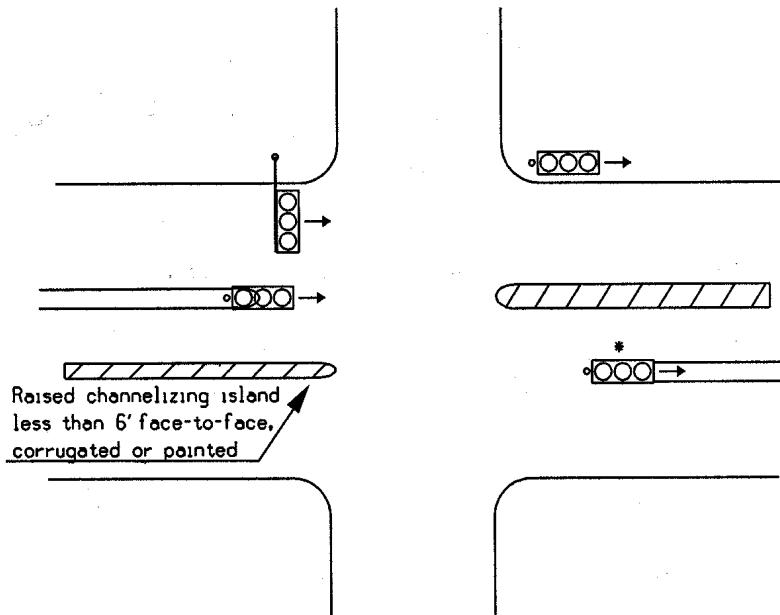


Figure 2a
Typical Layout - 3 Section Heads
Non-divided Roadways



NOTE: Signal layout shown for one mainline approach only.
 Mount for left signal indication in median.
 * Optional based on width of approach.

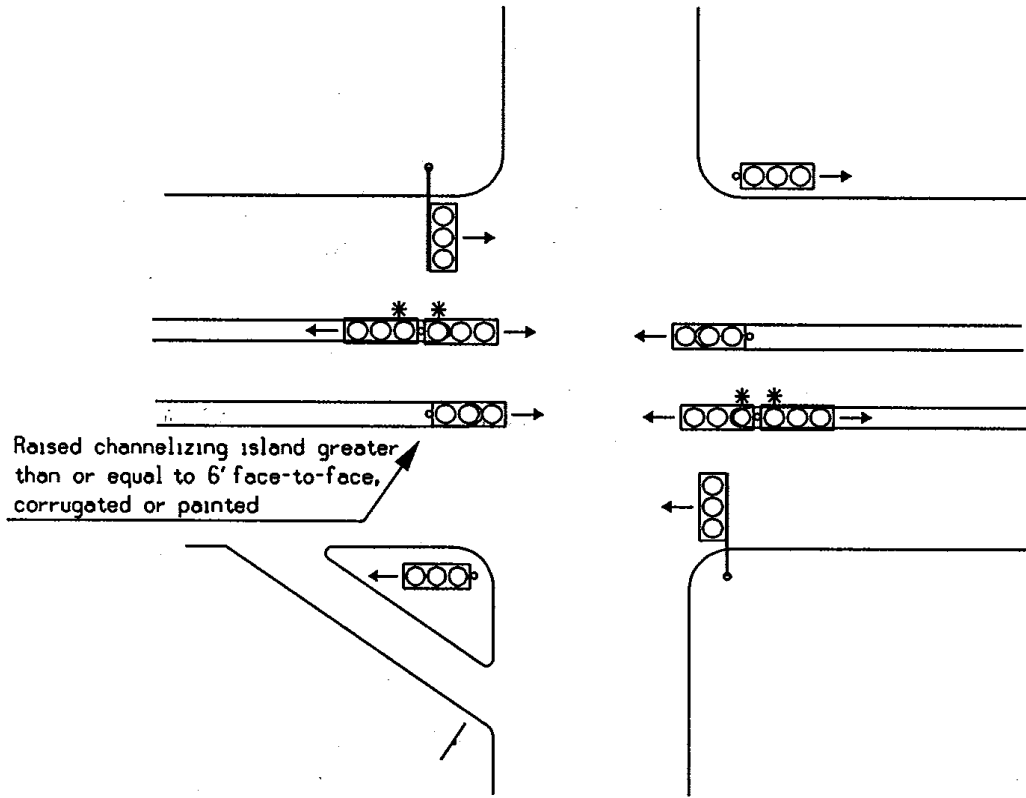
Figure 2b
 Typical Layout - 3 Section Heads
 Divided Roadway



Raised channelizing island
 less than 6' face-to-face,
 corrugated or painted

NOTE: Signal layout shown for one mainline approach only.
 * Optional signal head

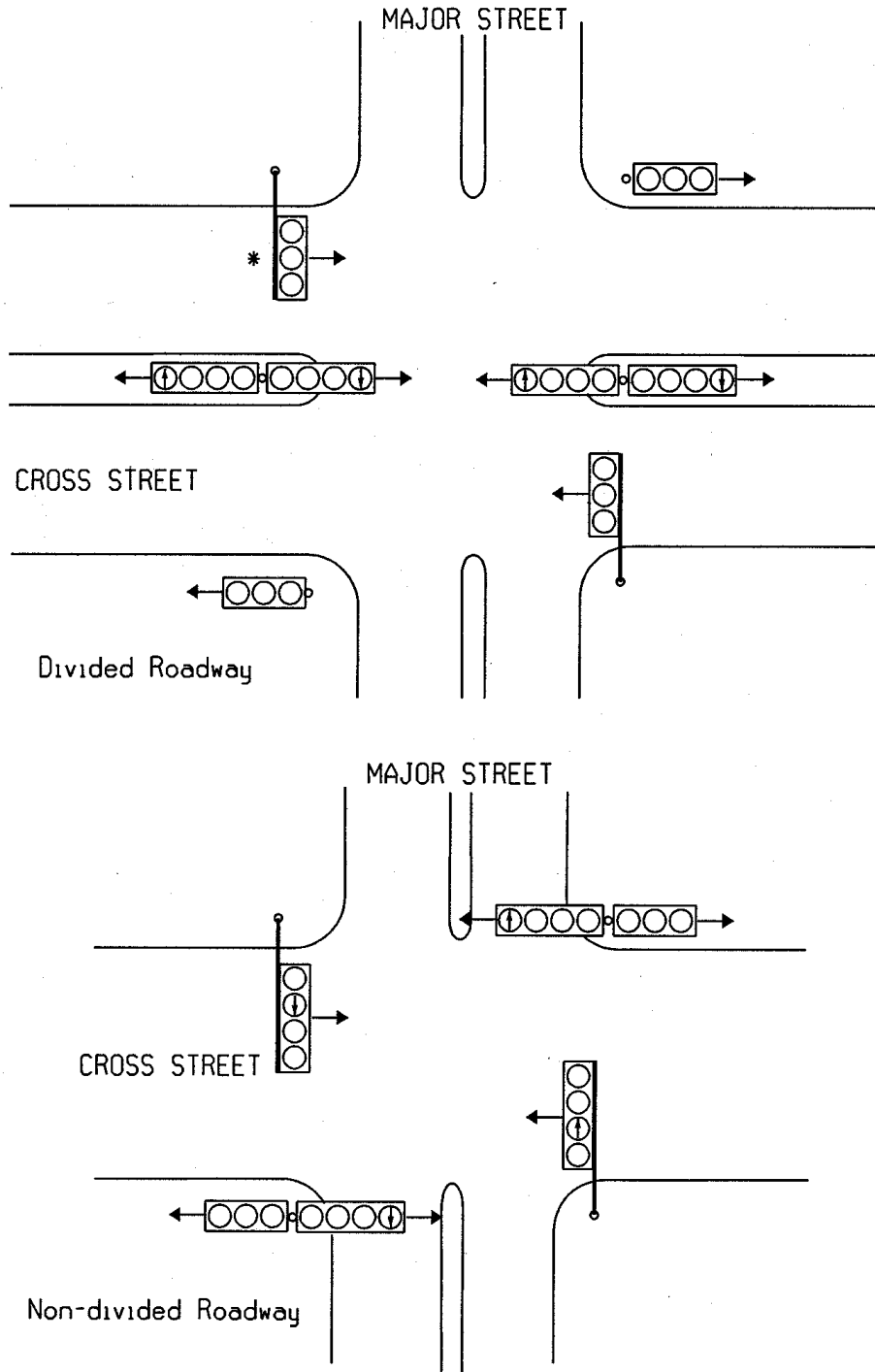
Figure 2c
 3 Section Heads - Divided Roadway
 No Left Turn Phasing



Raised channelizing island greater than or equal to 6' face-to-face, corrugated or painted

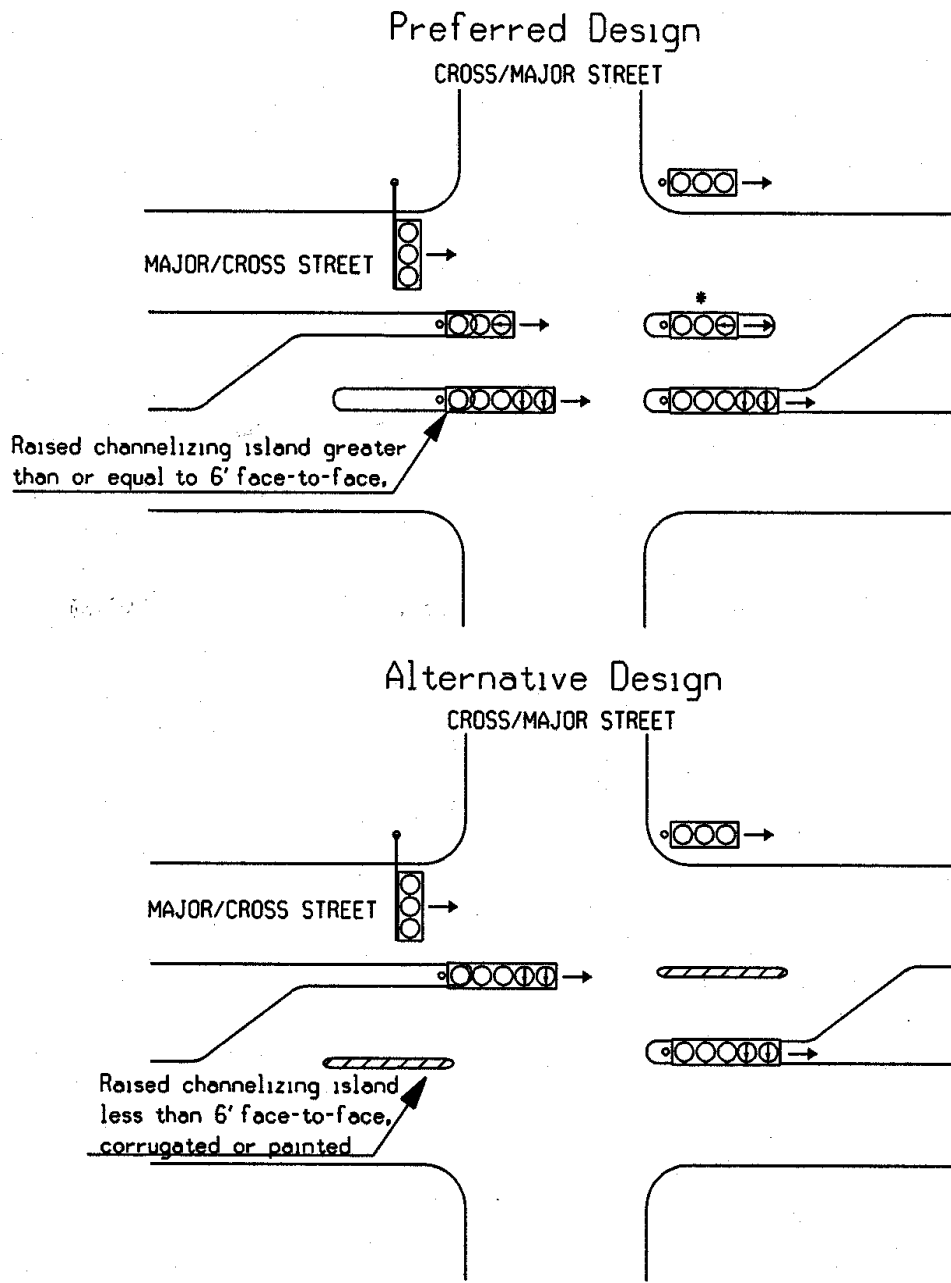
NOTE: Cross street signal heads not shown.
 • Optional signal head

Figure 2d
 3 Section Heads - Divided Roadway
 No Left Turn Phasing



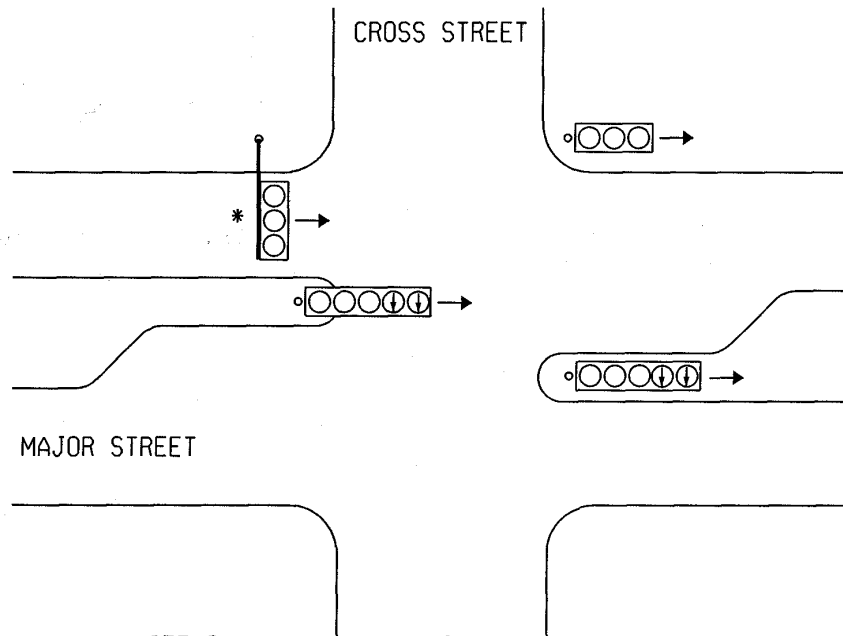
NOTE: Split phasing on the mainline shall not be used.
 * 5-section head may be used

Figure 3
 Typical Layout - 4 Section Heads



NOTE: Signal layout shown for one mainline approach only.
 Offset differences for left turn bays, this affects signal head placements.
 •Optional Signal Head

Figure 4a
 Typical Layout - 5 Section Heads
 Protected-Permitted Left Turn Operation
 with Islands Separating Left Turns



NOTE: Cross street signal heads not shown.
 These geometric layouts are not recommended.
 Positively offset left-turn bays are more desirable.
 * 5-section head may be used

Figure 4b
 Typical Layout - 5 Section Heads
 Protected-Permitted Left Turn Operation
 without Islands Separating Left Turns

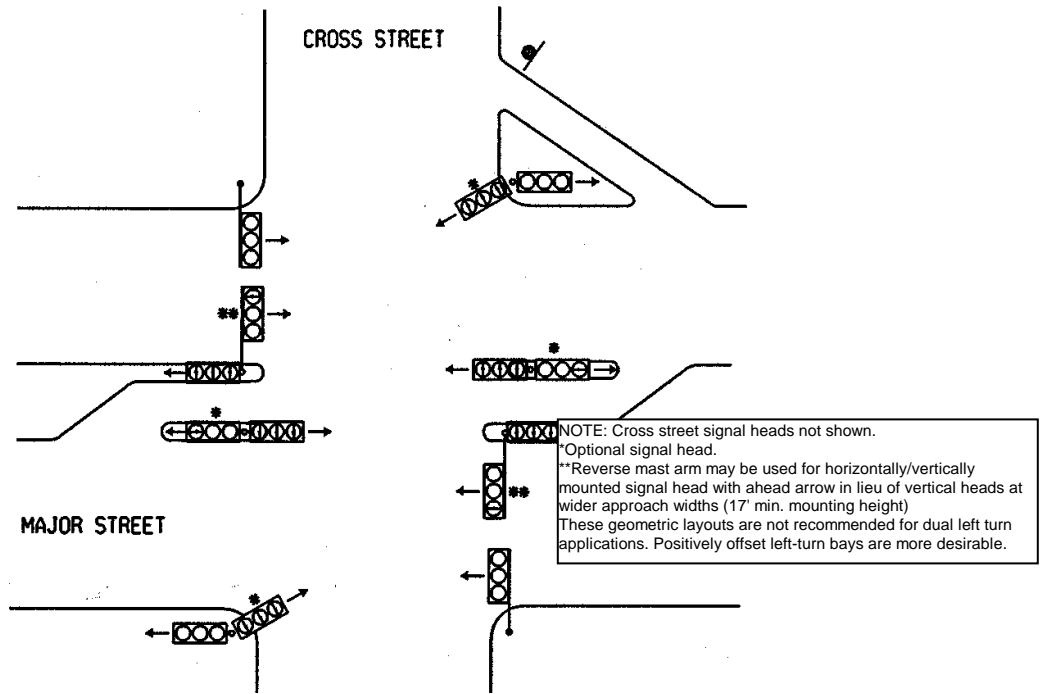


Figure 5a
 Typical Layout - Protected Only Left Turn
 with and without Right Turn Bypass -
 with Slotted Left Turn Bays for Single & Dual Left Turn Applications

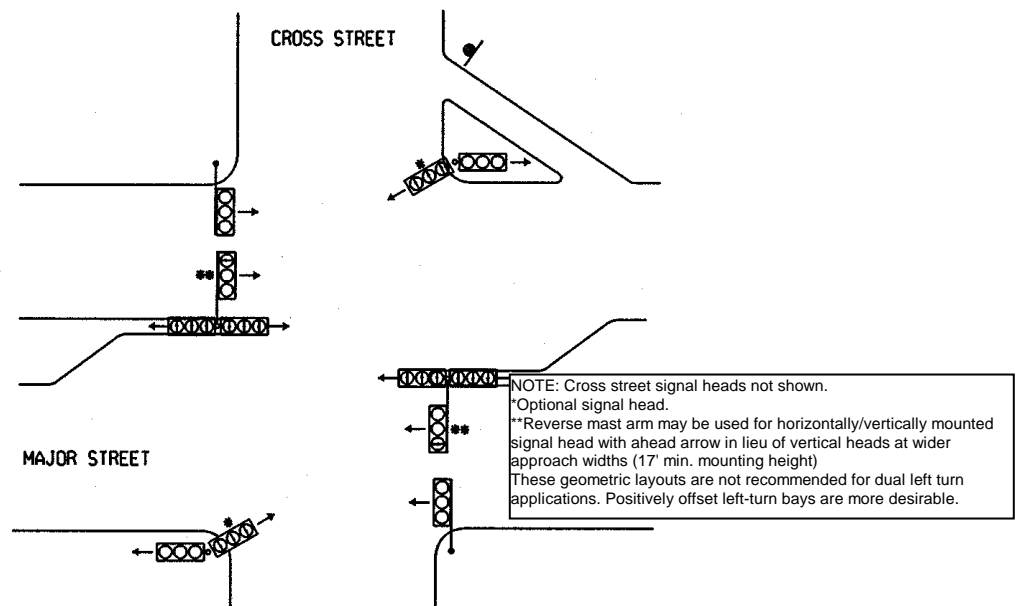
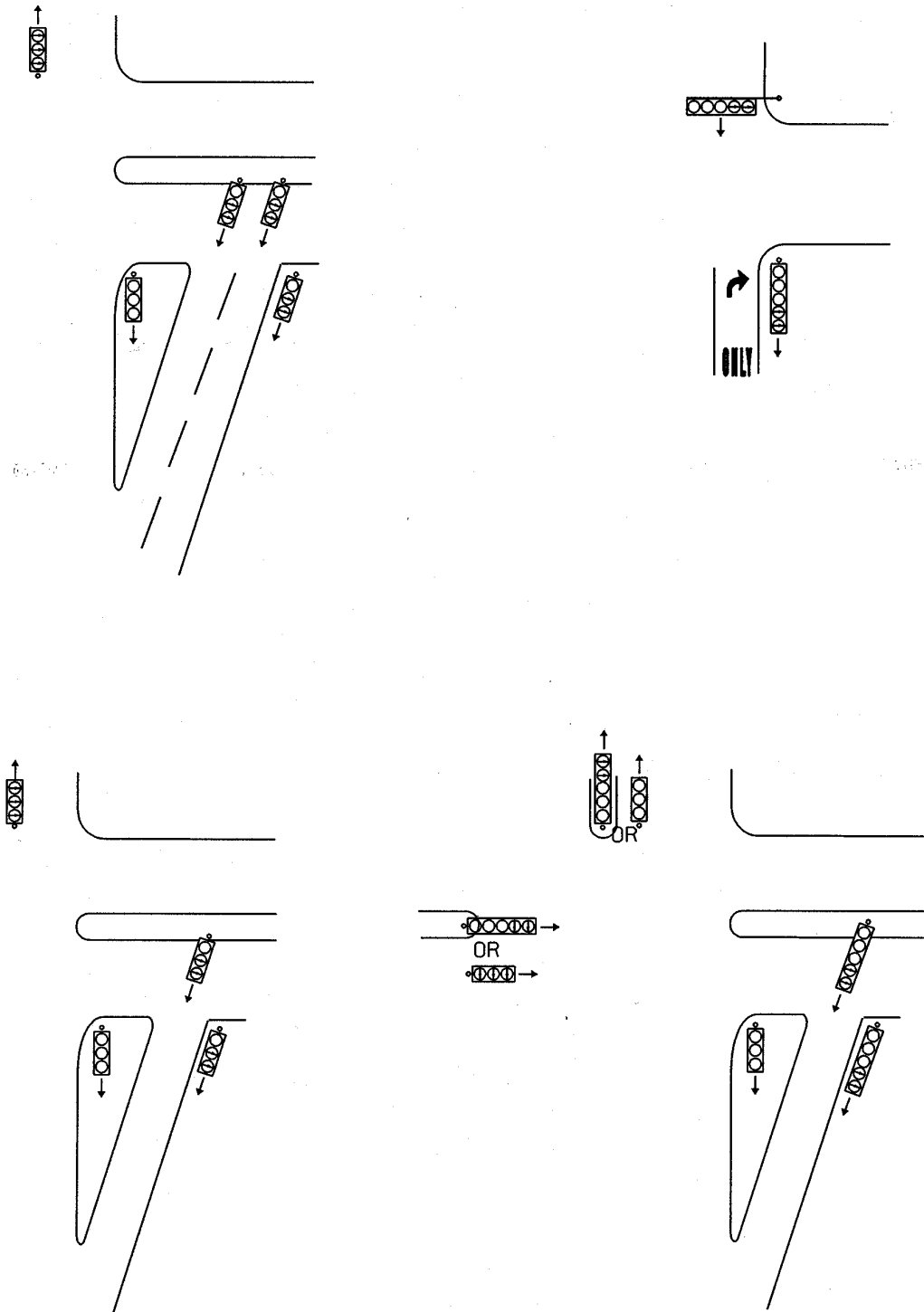
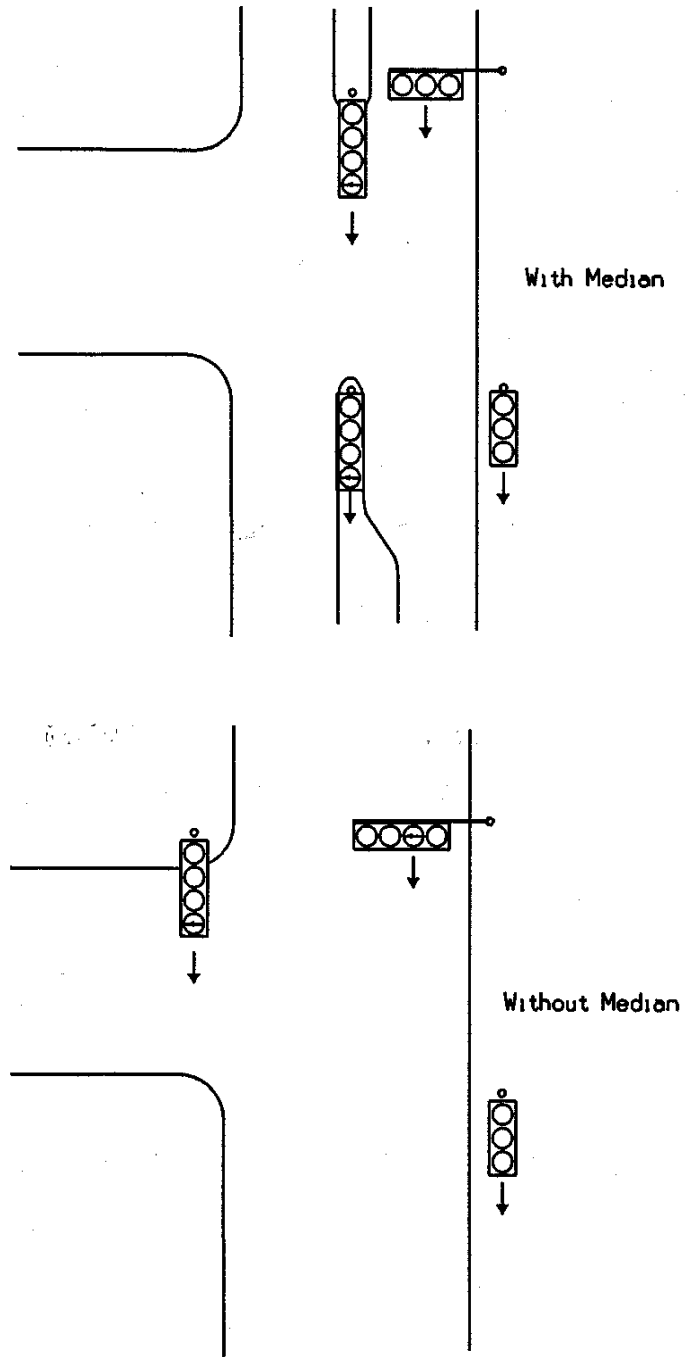


Figure 5a
 Typical Layout - Protected Only Left Turn
 with and without Right Turn Bypass -
 with Left Turn Bays for Single Left Turn Applications



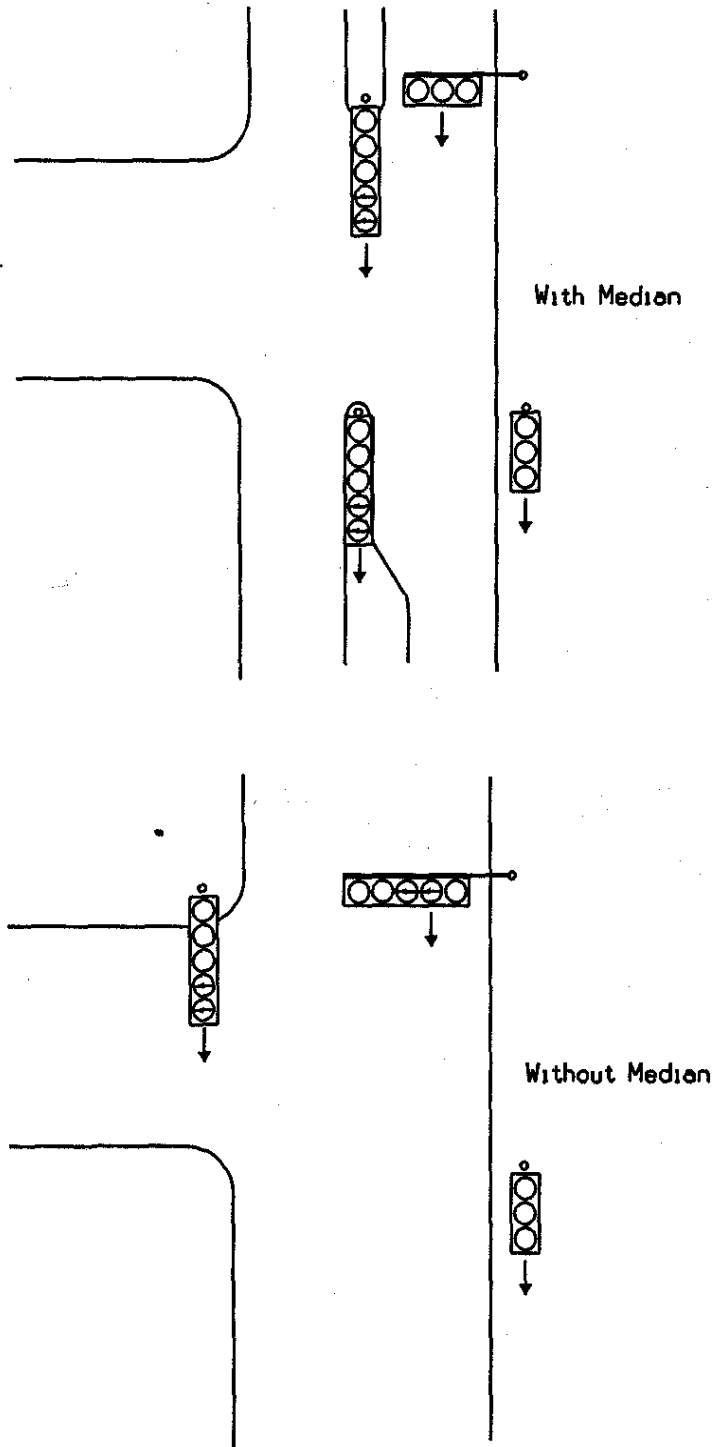
NOTE: Control for protected-only right turn movements may be dependent on opposing left turn control intersection turning movement volumes, intersection geometrics and signal phasing.

Figure 6
Typical Layout – Signalized Right Turn Bypass



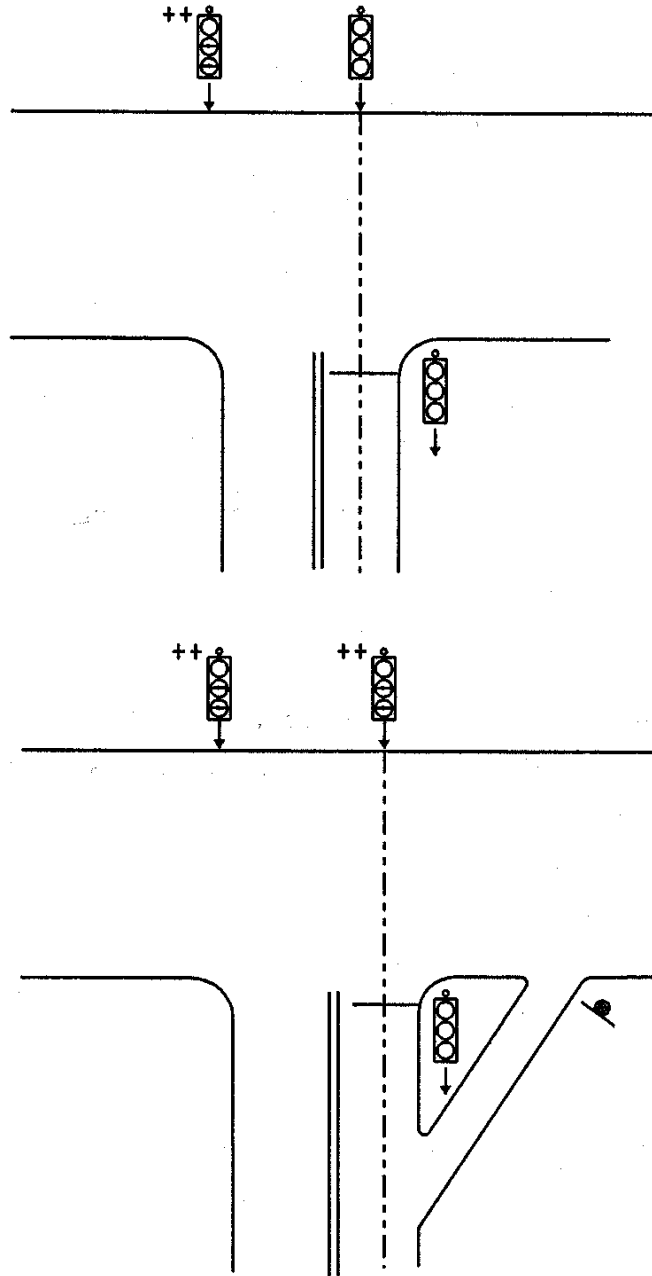
NOTE: Signal layout shown for one mainline approach only.

Figure 7a
Typical Layout - 4 Section Heads
Lagging Left Turn at "T"- Intersection



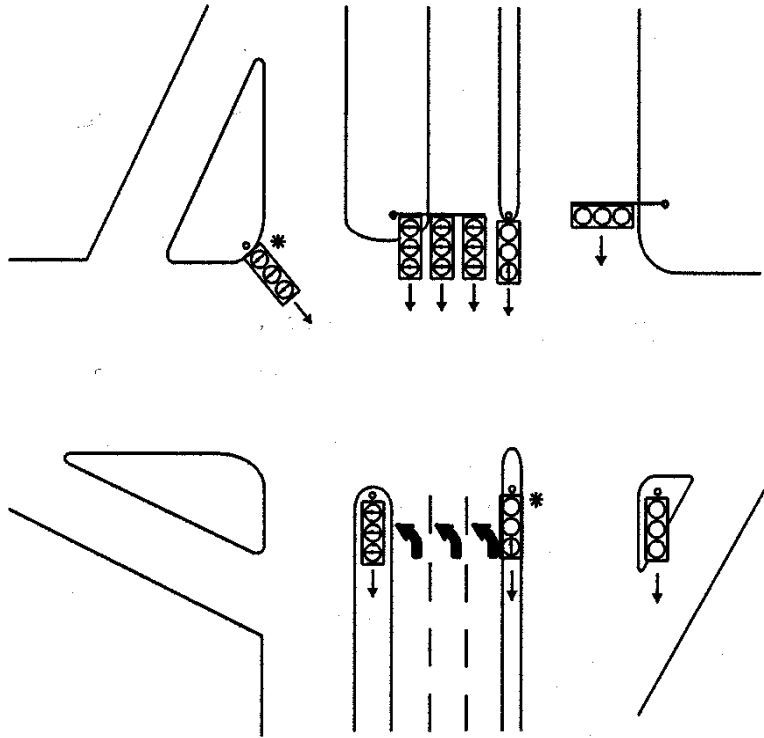
NOTE: Signal layout shown for one mainline approach only.

Figure 7b
Typical Layout - 5 Section Heads
Protected/Permitted Left Turn at "T"- Intersection



NOTE: Through street signal heads not shown.
 Head placement is centered with respect to the approach lane(s)
 (in accordance with the WisMUTCD)
 ++ Pedestrian volumes should be considered when determining to use arrows.

Figure 7c
 Typical Layout - "T"- Intersection
 with and without Right Turn Bypass



NOTE: Signal layout shown for one mainline approach only.
• Optional signal head.

Figure 8a

Typical Layout - Triple Left Turns