Project Completion Schedule and Project Milestones

No. 2 - The completion date for this Contract is **Friday, November 17, 2017**. Engineering and inspection services will be provided free of charge for all construction covered under this project until **Friday, November 17, 2017**. After **Friday, November 17, 2017**, engineering and inspection fees and liquidated damages in the amount of One Thousand dollars ($1,400.00) per day will be charged to the Contractor for any days beyond the completion date.

Project Milestone:
The construction on Meadowbrook Road and the flood mitigation work (including intersections) must be substantially complete by **Friday, November 17, 2017**. After **Friday, November 17, 2017**, liquidated damages in the amount of Five Hundred dollars ($1,400.00) per day will be charged to the Contractor for any days beyond the project milestone date.

No. 3 - Typical work hours shall be 7:00 a.m. to dusk. If the Contractor or Subcontractors deems it necessary to work outside of normal working hours or on Saturdays, Sundays, or Holidays, they shall notify the Engineer 48 hours in advance to obtain permission and inspection for such work. If said work is approved and the Contractor does not work or does work which, in the opinion of the Engineer, did not require inspection, the Contractor will be charged a $500.00 inspection and supervision fee.

No. 4 - The Contractor will not be permitted to suspend work once it has begun. It is expected that each phase of the construction work on the project will be promptly followed by the next phase. Extended delays between water main, sanitary sewer, storm sewer, street light conduit, bases and pull boxes, grading, concrete work, paving, traffic signals and landscaping shall be avoided. The Contractor shall coordinate crews/subcontractors so other work can progress.

No. 5 - A preconstruction meeting involving the Contractor, all Subcontractors, the City Engineering Division, Utility company representatives, and a DNR representative must be held prior to the beginning of the project. Three days prior to the preconstruction meeting the Contractor shall submit the project schedule, a list of all materials (including the names of all material suppliers) and traffic control/staging plans.

No. 6 - The Contractor shall submit to the Owner, for approval, a list of all materials he/she intends to use prior to ordering and delivery to the job site, including the names of all material suppliers.

No. 7 - The Contractor shall submit a schedule detailing the timeline for all phases of the project for approval by the project Engineer. The project schedule shall be updated as needed (i.e. delays occur) or as requested by the project Engineer. At a minimum, the project schedule shall be updated and submitted bi-weekly.

No. 8 - The Contractor shall hold weekly meetings with all subcontractors and businesses as needed to coordinate construction activities.

TRAFFIC SIGNAL SPECIAL PROVISIONS

1. Traffic Signals, General.

Work under this item shall consist of furnishing and installing all materials for traffic signals and interconnect at the following intersections in the City of Waukesha, WI, in accordance with the plans and the State of Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction, 2017 Edition, and these special provisions.

The Contractor will furnish all materials, which include but are not limited to, the traffic signal controller, the traffic signal cabinet, and traffic signal control equipment as listed in the plans (such as, pedestal bases, transformer bases, traffic signal standards, poles, monotube signal poles and arms, traffic signal faces, backplates, pedestrian signal faces, pedestrian push buttons, traffic signal mounting hardware, video detection system, emergency vehicle preemption system, concrete foundations, etc.).

Furnish the engineer with material lists and specifications of all traffic control equipment for approval prior to installation.

The Contractor shall obtain the necessary electrical permits from the City of Waukesha Building Department prior to beginning the work. The Contractor is responsible for all application fees and for any fines, penalties, damage done to property, etc., billed by the City of Waukesha.

The Contractor is responsible for requesting the electrical service installation or relocation from the power company and the City shall pay the installation costs.

The Contractor shall stake the proposed locations of traffic signal items 10 days prior to starting work so that the locations of the proposed facilities can be approved by the City of Waukesha. Any field changes regarding the location of the signal poles, pull boxes, etc. shall be approved by the City of Waukesha.

The Contractor shall request a signal inspection of the completed signal installation. This request shall be made to the City at least three working days prior to the time of the requested inspection.

Note that failure to comply with the state standards and specifications may result in the cost of the corrections to be made at the Contractors expense.

2. Electrical Conduit.

Append 652.3.1.2 of the standard specifications with the following:

The Contractor shall directional bore, not trench, in areas of trees, shrubbery, and under driveways, sidewalks and streets unless otherwise noted. Boring limits in areas of trees and shrubs depend on the diameter of the tree or shrub trunk. For example, directional boring is

required if a conduit will be installed within 12 inches of the face of the trunk of a 2-inch diameter tree, or installed within 15 feet of the face of the trunk of a 20-inch diameter tree. Methods and boring limits must be approved by the Engineer and City of Waukesha Forester prior to construction. A copy of the root zone limits can be viewed at the Public Works department, City Hall Annex, 130 Delafield St., Waukesha. Trenching or excavation for pull boxes, signal bases and controller cabinets within the root zone of a tree shall not be permitted. The minimum depth of bored conduit within the root zone, as described above, shall be 30 inches.

The contractor shall strip the minimum length of jacket necessary to make terminations in a neat and technically proficient manner.

3. Electrical Service Meter Breaker Pedestal, Intersection of Meadowbrook Rd and Rolling Ridge Dr, Item 656.0200.01.

Append 656.3.4 of the standard specifications with the following:

The Contractor will be responsible for electrical service installation or relocation requests. The City of Waukesha will be responsible for any charges from We Energies.

Electrical utility company service installation or relocation and energy cost will be billed to and paid for by the maintaining authority.

Install the cabinet base and meter breaker pedestal first, so the electrical utility company can install the service lateral. Finish grade the service trench, replace topsoil that is lost or contaminated with other materials.

Append 656.5(3) of the standard specifications with the following:

Payment is full compensation for grading the service trench and replacing topsoil; and for fertilizing, seeding, and mulching to restore the disturbed area of the service trench if necessary.

4. Traffic Signal Faces, 3-12 Inch Vertical, Item 658.0110, and 4-12 Inch Vertical, Item 658.0115.

Append 658.2.2 of the standard specifications with the following:
All Light Emitting Diode (LED) traffic signal modules shall meet the Final Approved Version of the LED Circular Signal Supplement Purchase Specification produced by ITE. The manufacturer shall provide the minimum warranty as stated in the ITE Specifications. If the LED fails to function as intended due to workmanship or material defects the LED shall be replaced or repaired within the first 60 months from delivery. Also, if the LED signal modules exhibit luminous intensities less than the minimum values specified within the first 36 months the LED shall be replaced or repaired.

All signal head assemblies shall be equipped with LED, cutaway visors (or tunnel visors, is so specified in the plans) and backplates. The visor and backplate shall be a dull black. Signal head housings shall be yellow.

Vehicular signal indications shall be 12-inch LED modules as indicated on material list. All faces shall give an appearance of an incandescent lamp. The signal face shall be an 18 count Dialight DuraLED signal or approved equal.

5. Temporary Traffic Signals for Intersections, Intersection of Meadowbrook Rd and Rolling Ridge Dr, Item 661.0200.01.

Replace 661.2.1 (3) of the standard specifications with the following:
Contractor shall use existing underground electric service and meter breaker pedestal for the operation of the Temporary Traffic Signal. The City will pay for all Energy Costs for the operation of the Temporary Traffic Signal.

Furnish and install temporary stop signs to operate the intersection for the time required to switch the existing permanent traffic signal over to the temporary traffic signal as well as the time required to switch the temporary traffic signal over to the new permanent traffic signal.

Furnish and install temporary Emergency Vehicle Preemption equipment and programming for all active intersection approaches.

Contractor shall contact the local electrical utility at least four (4) days prior to making the switch from the existing permanent traffic signal to the temporary traffic signal. The contractor shall contact the local electrical utility at least four (4) days prior to making the switch from the temporary traffic signal over to the new permanent traffic signal.

6. Concrete Bases Type 10, Item SPV.0060.XX, and Type 13, Item SPV.0060.XX.

A Description

This special provision describes constructing concrete bases, including the use of contractor supplied anchor bolts and anchor rod templates.

B Materials

B1. Concrete Bases

Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to 501.2 as modified in section 716 of the standard specification. Provide QMP for class III ancillary concrete as specified in section 716.

Furnish bar steel reinforcement conforming to 505.2.

Use schedule 40 PVC electrical conduit conforming to the electrical conduit specified in section 652.

B2. Anchor Bolts
Provide anchor bolts conforming to AASHTO M 314, grade 55 and Supplementary Specification S1, or ASTM F1554 Grade 55. Threads on bolts shall be formed by rolling.

Hot-dip galvanize the entire length of the anchor rods according to AASHTO M111. Hot-dip the nuts and washers according to AASHTO M232. Use zinc coated nuts manufactured with sufficient allowance to allow nuts to run freely on the threads.

B3. Anchor Rod Template
Furnish a steel top and bottom template conforming to ASTM A709, grade 36 as part of each anchor assembly. Provide a top template of sufficient gauge to hold the anchor rods securely in position at the top, and resist racking or twisting during the pour. Use a ½-inch thick bottom anchor plate-template and secure it to each anchor rod. Templates shall not be welded to the anchor rods.

C Construction

C1. Concrete Bases Construct concrete bases, including necessary hardware, as specified in section 501 of the standard specification and plan details, and provide the surface finish specified in 502.3.7.2 of the standard specification. Inspect the forming and applicable reinforcement for concrete bases before pouring the concrete. Cure exposed portions of concrete bases as specified for concrete pavement in 415.3.12 of the standard specification except the contractor may use curing compound conforming to 501.2.9 of the standard specification. Wait at least 7 days before installing poles.

C2. Anchor Bolts
Lubricate anchor bolt threads and nuts with bees wax or other high-wax lubricant. Set leveling nuts to the required elevation before installing the structure. Adjust top nuts and leveling nuts to align and plumb the structure. Ensure that all nuts are snug-tight with no gaps. Tighten each top nut 1/3 turn past snug for bolts 1 1/2 inch or smaller in diameter and 1/6 turn for larger diameter bolts conforming to the tightening sequence specified on department form DT 2321. If required, install jamb nuts wrench tight.

Complete department form DT 2321 for each structure. Indicate the parties responsible for the installation and submit the form to the engineer for inclusion in the permanent project record.

C3. Anchor Rod Templates
Secure the anchor rod template to all anchor rods at one time in its correct position as the plan details show. Ensure relative movement and misalignment does not occur. If any twisting, racking, or other movement of the anchor rods out of plumb, projection, or pattern, or any damage to the threads exists the engineer will reject the entire base.

Maintain the clear distance between the soil and the reinforcing steel cage using the means the plan detail shows. Do not weld the anchor rods to each other, the reinforcing steel cage, and the templates or to any other component of the foundation.

If an anchor rod template is located above the concrete surface, it may be removed 24 hours after placing the concrete.

D Measurement
Concrete Bases Type 10 and Type 13 will be measured by each unit acceptably installed.

E Payment
Concrete Bases Type 10 and Type 13 will be paid for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.XX	Concrete Bases Type 10	Each
SPV.0060.XX	Concrete Bases Type 13	Each

Payment is full compensation for providing concrete, reinforcing steel, and electrical conduit; for providing anchor rods, templates, nuts, and washers; for excavating; for driving steel piling if required; for installing electrical conduit, electrical ground, templates; for placing and curing concrete; for backfilling; and for disposing of surplus material and restoring the site.

7. Luminaire Arms Steel 15-FT, Item SPV.0060.XX.

A Description
Work under this item consists of furnishing and installing steel luminaire arms.

B Materials
Design support structures conforming to the minimum wall thickness the plan details show and to AASHTO design and fabrication standards for structural supports for highway signs, luminaires, and traffic signals. Use a design life of 50 years. Design to withstand a 3 second gust wind speed of 90 mph (145 km/h). Do not use the methods of appendix C of those AASHTO standards.

Use category III criteria if mounted on top of a Type 10 pole and category II criteria if mounted on top of a Type 13 pole.

For structures requiring a fatigue analysis, use 45 mph (72 km/h) for truck-induced gusts.

Base the designs on the completed maximum loading configuration the standard detail drawing shows. Along with the materials list, submit a certificate of compliance certifying that the arms as furnished conform to the above structural performance requirements. Ensure that the certificate of compliance is on the manufacturer's letterhead, signed by an authorized company officer, and notarized. Send a copy of the

certificate and a copy of the luminaire arm shop drawings to the department electrical engineer.

Furnish luminaire arms conforming to the following:

1. Consist of zinc coated steel round or oval members.

2. Have a mounting device welded to the pole end of the luminaire arm that allows the attachment of the arm to a pole as the plans show.

3. Have stiffeners or gussets if required between the arm tube and the arm mounting device to provide adequate strength to resist side loads.

4. Have a clean, uniform natural finish. No paint or other corrosion preventive maintenance coating is required.

After welding and before zinc coating, clean exterior surfaces of each arm free of all loose rust and mill scale, dirt, oil or grease, and other foreign substances.

Apply zinc coating as specified for sign bridge components in 641.2.8. Ensure that the zinc coating is tight, free from rough areas or slag, and presents a uniform appearance.

After manufacturing is complete, clean the exterior surfaces of each pole free of all loose scale, dirt, oil, or grease, and other foreign substances.

C (Vacant)

D Measurement
Luminaire Arms Steel 15-FT will be measured as each individual luminaire arm is acceptably completed.

E Payment
Luminaire Arms Steel 15-FT will be paid for measured quantity at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.XX	Luminaire Arms Steel 15-FT	Each

Payment is full compensation for providing and installing luminaire arms including all hardware and fittings necessary to install the luminaire arms.

8. Poles Type 10 Item SPV.0060.XX, and Type 12, Item SPV.0060.XX.

A Description
Work under this item consists of furnishing and installing monotube poles.

B Materials

Design support structures conforming to the minimum wall thickness the plan details show and to AASHTO design and fabrication standards for structural supports for highway signs, luminaries, and traffic signals. Use a design life of 50 years. Design to withstand a 3 second gust wind speed of 90 mph (145 km/h). Do not use the methods of Appendix C of those AASHTO standards.

Use Category III criteria for Type 9 and Type 10 Poles. Use Category II criteria for Type 12 and Type 13 Poles.

For structures requiring a fatigue analysis, use 45 mph (72 km/h) for truck-induced gusts.

After welding and before zinc coating, clean the exterior surface of each steel pole free of all loose rust and mill scale, dirt, oil or grease, and other foreign substances.

Apply a zinc coating conforming to the process specified for steel sign bridges in 641.2.8. Ensure that the zinc coating is tight, free from rough areas or slag, and presents a uniform appearance.

After completing manufacturing, clean the exterior surfaces of each pole free of all loose scale, dirt, oil or grease, and other foreign substances.

Provide a reinforced hand hole measuring 4 inches by 6 inches (100 mm by 150 mm) as the plans show. Locate the hand hole 18 inches (450 mm) from the bottom of the pole base to the center of the door.

For the hand hole, include an access cover mounted to the pole by two ¼”-20 x ¾” (m6 x 1.00 x 19 mm) hex-head stainless steel bolts.

Provide a grounding lug complete with mounting hardware, as required, inside the pole as the plans show.

Provide access to the grounding lug from the hand hole. Weld the ground lug directly opposite the hand hole on the inside wall of the pole.

Equip the top of the shaft with a removable, ventilated cap held securely in place by at least 3 ¼” -20 x ¾” (m6 x 1.00 x 19 mm) hex-head stainless steel set screws.
Ensure that all castings are clean, smooth, and with all details well defined and true to pattern.

Attach base plates firmly to the pole shaft by welding or other approved method.

Include anchor bolts meeting AASHTO standards applicable to the pole type and loading. Provide a mounting template that ensures correct installation of anchor bots in foundation.

C Construction
Install poles as specified in the plan details and using appropriate contractor-furnished anchor bolts and hardware. Use the appropriate anchor bolt template to ensure correct installation. Secure pole to anchor assembly and document tensioning procedures conforming to 641.3.1.2.

After completing erection using normal pole shaft raking techniques, ensure the centerline of the shaft appears vertical.

D Measurement
Poles Type 10 and Type 12 will be measured as each individual pole acceptably completed.

E Payment
Poles Type 10 and Type 12 will be paid for measured quantity at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.XX	Poles Type 10	Each
SPV.0060.XX	Poles Type 12	Each

Payment is full compensation for providing and installing poles including all hardware and fittings necessary to install the poles.

9. Monotube Arms 20-FT, Item SPV.0060.XX, 25-FT, Item SPV.0060.XX, 40-FT, Item SPV.0060.XX, and 45-FT, Item SPV.0060.XX.

A Description
Work under this item consists of furnishing and installing monotube arms.

B Materials
Design support structures conforming to the minimum wall thickness the plan details show and to AASHTO design and fabrication standards for structural supports for highway signs, luminaires, and traffic signals. Use a design life of 50 years. Design to withstand a 3 second gust wind speed of 90 mph (145 km/h). Do not use the methods of appendix C of those AASHTO standards.

Use category III criteria for 15 to 30-foot arms. Use category II criteria for 35 to 55-foot arms.

For structures requiring a fatigue analysis, use 45 mph (72 km/h) for truck-induced gusts. Base the designs on the completed maximum loading configuration the standard detail drawing shows. Along with the materials list, submit a certificate of compliance certifying that the arms as furnished, conform to the above structural performance requirements. Ensure that the certificate of compliance is on the manufacturer's letterhead, signed by an authorized company officer, and notarized. Send a copy of the

certificate and a copy of the monotube arm shop drawings to the department electrical engineer.

Furnish monotube arms conforming to the following:

5. Consist of zinc coated steel round or oval members.

6. Have a mounting device welded to the pole end of the monotube arm that allows the attachment of the arm to a pole as the plans show.

7. Have stiffeners or gussets if required between the arm tube and the arm mounting device to provide adequate strength to resist side loads.

8. Have a clean, uniform natural finish. No paint or other corrosion preventive maintenance coating is required.

After welding and before zinc coating, clean exterior surfaces of each arm free of all loose rust and mill scale, dirt, oil or grease, and other foreign substances.

Apply zinc coating as specified for sign bridge components in 641.2.8. Ensure that the zinc coating is tight, free from rough areas or slag, and presents a uniform appearance.

After manufacturing is complete, clean the exterior surfaces of each pole free of all loose scale, dirt, oil, or grease, and other foreign substances.

C (Vacant)

D Measurement
Monotube Arms will be measured as each individual arm acceptably completed.

E Payment
Monotube Arms will be paid for measured quantity at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.XX	Monotube Arms 20-FT	Each
SPV.0060.XX	Monotube Arms 25-FT	Each
SPV.0060.XX	Monotube Arms 40-FT	Each
SPV.0060.XX	Monotube Arms 45-FT	Each

Payment is full compensation for providing and installing all materials, including all hardware, fittings, mounting devices, shims, and attachments necessary to completely install the arms.

10. Traffic Signal Controller and Cabinet 8-Phase Fully Actuated, Item SPV.0060.XX.

A. General. This work shall consist of furnishing and installing traffic signal controller(s) and cabinet(s) as shown on the plans and as hereinafter provided.

The controller shall be Eagle Signal Control EPAC M52 Series and shall provide a functional Ethernet port.

The traffic controllers and cabinets at the intersection shall include any necessary provisions to accommodate fiber optic interconnect.

The contractor shall submit two copies of the following to the City of Waukesha: Detection wiring diagrams, cable and routing diagrams, pole to pull box wiring diagrams, conductor layout standards and the associated head arrangements and other pertinent details.

Equipment will be examined and tests will be performed to insure that proper and sufficient equipment is furnished as is required to complete the signal plan operation and sequence in compliance with the intent of the contract specifications.

All testing and equipment examination shall be in the presence of the contractor's representative furnishing the equipment. The contractor's representative will be notified of any needed modifications or corrections to be accomplished by the contractor.

The cabinet shall not be installed until it is in proper working order and approved by City of Waukesha personnel or their designee.

After the contractor has mounted the cabinet on the cabinet foundation, he shall connect all the field wiring inside the controller cabinet and test the signal circuits for correct operation. The contractor shall connect and test the signal circuits outside the controller cabinet as directed by the engineer. Connecting and testing signal circuits shall be considered part of this item of work.

The controller shall be a fully traffic actuated, solid state, digital microprocessor controller, capable of providing the number and sequence of phases, overlaps, and any special logic as described herein and shown on the accompanying plan.

The controller shall be fully programmed and shall be mounted in a control cabinet to operate as a complete and functioning intersection traffic signal control system. The equipment items included shall be, but not necessarily limited to, cabinet, microprocessor controller, monitor, detector amplifiers, power supply, power distribution panel, interior cabinet wiring, and other associated electrical and electronic equipment interior to the control cabinet that is necessary to provide the type of operation described in these specifications.

Dual ring, programmable for both single and dual entry concurrent timing, eight-phase frame or equivalent shall be provided. Volume density and pedestrian timing shall be provided for all phases. MUTCD flashing capability shall be provided. All controls shall be in accordance with the accompanying plans and with NEMA Standards Publication No. TS2-2003.

The intersection controller unit shall be capable of up to 8-phase operation plus four (4) programmable overlaps regardless of whether preemption, coordination or the special programming is used. The intersection cabinet shall be wired for a minimum of twelve and include twelve 3 circuit load switches.

B. Electrical and Operational Aspects. (1) **Buffering**. All logic circuit inputs shall be internally buffered to withstand transients and noise, such as might result from normal usage, without damage to any mechanism components.

(2) **Timing Features**. All controller timing parameters shall be fully programmable from the front panel using switches and/or keyboard inputs, and memory storage features shall be nonvolatile under power off conditions for at least 30 days. The locking, nonlocking detection mode and recall switches shall also be accessible on the front panel.

(3) **Minimum Green Timing**. The passage timer shall time concurrently with the minimum green timer, so that the duration of the minimum green time is directly adjustable and is independent of the passage time setting.

(4) **Dual Ring Timing**. In the dual ring application, no more than two phases shall be permitted to time concurrently, and no more than one phase per ring. The controller shall provide barrier protection against concurrent timing of two conflicting phases; no phases assigned to one side of the barrier shall be permitted to time concurrently, if a conflict will occur. The controller shall service calls on a single entry basis, and both rings shall cross the barrier simultaneously in accordance with the following logic: (a) Phases timing concurrently shall terminate simultaneously if both have a gap out due to excessive time between actuations. (b) Phases timing concurrently shall terminate simultaneously if both have a maximum time out. (d) In the event that one phase has not achieved a gap out or maximum time out, the other gapped out phase shall be Permitted to leave the gapped out condition and retime an extension when an actuation is received.

(5) **Manual (Police) Control**. If manual control is used, actuation of the manual control shall permit manual advance of the Walk, Pedestrian Clearance, and Green interval terminations only. Manual termination of Yellow or All Red clearance intervals shall not be permitted.

(6) **Red Revert**. An adjustable red revert control shall be provided to assure adequate red display when recycling a phase during call-away or red rest mode operation. A call for service to a different phase shall be preceded by an all-red clearance interval, as programmed.

(7) **Coordination**. The controller shall be capable of operation in progressive coordination systems and mutual coordination and shall contain, but not be limited to, the following external inputs, with all functions brought out (continued next page):

- Vehicle/Pedestrian Detectors per phase
- Phase Omit per phase
- Omit Red Clearance per ring
- Maximum II per ring
- Stop Timing per ring
- Select Minimum Recall per controller
- Semi-Mode per controller
- Pedestrian Omit per phase
- Hold per phase
- Internal Maximum Inhibit per ring
- Red rest per ring
- Force-Off per ring
- Manual Control per controller
- External Start per controller

(8) **Minimum Safe Timings Control**. Controllers shall not accept any operator input or stored timing parameters that would result in intervals shorter than the following: yellow clearance - 3.0 seconds, minimum walk - 4.0 seconds, minimum pedestrian clearance - 6.0 seconds. At the beginning of each of the above intervals, the controller shall check the previously stored data against these minimums. If an operator attempts to load an incorrect timing parameter, the controller unit shall output a unique error code on the front panel display. As an alternate to minimum timing control, a coded keyboard entry security feature may be provided.

(9) **Indicator Lights and Switches**. Indicator lights shall be provided to show the status of each signal phase on. Indicator lights shall also be used to show interval status, phase termination information, and presence of vehicular and pedestrian calls for each phase. An indicator light shall also be provided to show the status of the backup battery charging circuit.

The controller shall have an on off switch and fuse for AC power.

(10) **Data Display**. The data panel shall be a removable hand held unit. The panel shall contain a display panel consisting of LED display characters. The face of the display shall be scratch, chemical, and solvent resistant. In the case of writing data or parameters into the controller there shall be a visual indication that the data has been accepted. The number of characters shall be adequate to read or write all data and parameters in decimal format together with a data descriptor in either alpha numeric format, or thumbwheel switch display. A data key shall be provided.

(11) **Diagnostic Program**. A diagnostic program shall be prepared by the manufacturer of the controller unit which will demonstrate the proper operation of all the inputs, outputs, controls and indicators in the controller, and shall have visual conformation on the front panel. The diagnostic program shall be either resident in the controller or furnished as a separate plug in module. A flow chart and listing of the diagnostic routine shall be furnished with the controller unit.

(12) **Preemption**. (1) **General**. These specifications detail a preemptor program for use with 2 through 8 phase actuated controller.

a) The preemptor shall be capable of being adaptable to meet the various types of applications such as railroad, fire station, and bridge preempts.

The preemptor shall be internal to the controller and shall not alter controller capability or interchangeability under normal operation. The preemptor shall be completely programmable by the user.

b) **Preempt Program**. 1**. Preempt Registration**. The preempt call input shall initialize preempt registration and start preempt sequence unless a priority call input is activated which would treat the current controller preemptions state as normal operation and reinitiate call registration.

2. **Preempt Delay**. As soon as the preempt call is registered the preempt delay will begin timing unless preempt delay is set zero or preempt delay omit was active during preempt call registration. Delay shall be programmable from 0 to 255 seconds minimum.

3. As soon as preempt delay is timed out, current running phases not next to be common in preempt sequence are cleared. If the running phases are green and must be cleared, special programmable values of minimum green, walk and pedestrian intervals will time normal times. Concurrently a special preempt clearance is generated. This clearance is designed for advance track signals and any overlaps that may be green and require yellow clearance.

4. **Entry Clearance Phase(s) Select**. Two sequential phases or phase pairs shall be available to be run as programmable fixed time intervals as an entry sequence. Two entry options shall be available, each programmable. The entry sequence shall be capable of being omitted entirely.

5. **Dwell Sequence**. After the entry sequence, the preemptor shall enter the dwell sequence. During the dwell sequence the controller shall cycle between selected phases on a pre-timed or actuated basis. Pedestrian phasing may be normal or omitted entirely. When the dwell sequence is entered, a preempt dwell output shall be generated. The preemptor shall remain in dwell for the length of the dwell extension timer which shall be capable of being held in reset by the preempt call input. Dwell extension shall be omittable by setting the timer to zero.

6. **Exit Sequence**. After leaving dwell, the controller shall enter one or two programmed exit phases(s) or phase pairs sequences. The sequence will time programmed minimum green and place a vehicle call on all phases not omitted. After timing exit phase minimum green the controller shall time and sequence normally.

(13). **Time Base Coordination**. These specifications detail a Time Base Coordinator program for use with 2 through 8 phase actuated controller.

The units shall allow traffic control equipment to be coordinated without requiring the use of interconnection cables. The units shall coordinate traffic control equipment based on signals from a precise time base which will allow output control signals to be changed at the proper pre-programmed time to achieve the coordinated operation of an intersection with other intersections or the desired operation of an isolated intersection. The coordinators may also used a programmer for a master intersection controller which in turn is interconnected with secondary intersection controllers. The units shall also be capable of providing a command for MUTCD flash, and shall allow a full year program to be initiated and carried out without the necessity of field adjustment for anticipated special events, etc.

The time base coordinator shall be internal to the controller and shall not alter controller capability or interchangeability under normal operation. The time base coordinator shall be completely programmable by the user.

C. **Monitoring**. A conflict monitor meeting the following requirements shall be provided:

(1) **General** Each cabinet assembly shall be wired to operate with one Malfunction Management Unit (MMU). The MMU shall be a Type 16.

This specification sets forth the minimum requirements for a shelf-mountable, sixteen channel, solid-state Malfunction Management Unit (MMU). The MMU shall meet, as a minimum, all applicable sections of the NEMA Standards Publication No. TS2-2003. Where differences occur, this specification shall govern.

(2) **Monitoring Functions** The following monitoring functions shall be provided in addition to those required by the NEMA Standard Section 4.

a) **Dual Indication Monitor** Dual Indication monitoring shall detect simultaneous input combinations of active Green (Walk), Yellow, or Red (Dont Walk) field signal inputs on the same channel. In Type 12 mode this monitoring function detects simultaneous input combinations of active Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red field signal inputs on the same channel.

When voltages on two inputs of a vehicle channel are sensed as active for more than 450 msec, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the DUAL INDICATION fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on two inputs of a vehicle channel are sensed as active for less than 200 msec, the MMU shall not transfer the OUTPUT relay contacts to the Fault position.

When operating with Port 1 communications enabled, Bit #68 (Spare Bit #2) of the Type #129 response frame shall be set to indicate a Dual Indication fault has been detected.

Dual Indication Monitoring shall be disabled when the RED ENABLE input is not active.

i) **Dual Indication Programming** Programming shall be provided to enable the Dual Indication monitoring function for the Green and Red, Green and Yellow, and Yellow and Red combinations for each individual channel. In the Type 12 mode, the Walk inputs shall be logically OR'ed with the Green inputs for purposes of Dual Indication programming.

b) **Field Check Monitoring** The Field Check Monitor function shall provide two modes of operation, Field Check Fault and Field Check Status.

Field Check Monitoring shall be disabled when the RED ENABLE input is not active.

i) **Field Check Monitor** In the Field Check Fault mode, when the field signal input states sensed by the MMU do not correspond with the data provided by the Controller Unit in the Type #0 message for 10 consecutive messages, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the FIELD CHECK FAIL fault. Bit #67 (Spare Bit #1) of the Type #129 response frame shall be set to indicate a Field Check fault has been detected. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

ii) **Field Check Status** The Field Check Status mode shall work in combination with the other fault monitoring functions of the MMU. When a Conflict, Red Fail, Clearance Fail, or Dual Indication Fail triggers the MMU, the Channel Status Display and Fault Status Display shall correspond to that detected fault. If Field Check errors were detected while the fault was being timed, the inputs on which the Field Check errors were detected shall be reported on the Channel Status display. Bit #67 (Spare Bit #1) of the Type #129 response frame shall also be set to indicate Field Check errors have been detected.

iii) **Field Check Programming** Programming shall be provided to enable the Field Check monitoring function for each Green, Yellow, and Red input individually. Programming shall be provided to enable the Field Check monitoring function for channel 2, 4, 6, and 8 Walk input individually when operating in the Type 12 with SDLC mode.

c) **Recurrent Pulse Monitoring** The Signal Monitor shall detect Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs. These recurring pulses shall result in a latching fault with the RECURRENT PULSE STATUS indicated along with the resulting Conflict, Red Fail, or Dual Indication status. An option shall be provided to disable the RP detect function for testing purposes.

When operating with Port 1 communications enabled, Bit #69 (Spare Bit #3) of the Type #129 response frame shall be set to indicate a Recurrent Pulse status has been detected.

d) **External Watchdog Monitoring** The MMU shall provide the capability to monitor an optional external logic level output from a Controller Unit or other external cabinet circuitry. If the MMU does not receive a change in state on the EXTERNAL WATCHDOG input for 1500 msec (±100 msec), the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the WATCHDOG fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the WATCHDOG fault state of the monitor. The EXTERNAL WATCHDOG input shall be wired to connector MSB-S.

When operating with Port 1 communications enabled, Bit #70 (Spare Bit #4) of the Type #129 response frame shall be set to indicate an External Watchdog fault has been detected.

e) **Type Fault Monitor** The MMU shall verify at power-up that the Type 12 or Type 16 operating mode as determined by the TYPE SELECT input is consistent with the mode set by the last external reset.

Detection of a Type Fault shall place the MMU into the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the TYPE 12/16 fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the Type Fault state of the monitor.

f) **Flashing Yellow Arrow PPLT Support** The MMU shall be designed to monitor an intersection with up to four approaches using the four section Flashing Yellow Arrow (FYA) movement outlined by the NCHRP Research Project 3-54 on Protected/Permissive signal displays with Flashing Yellow Arrows. Two cabinet configurations shall be supported for both the MMU Type 16 and Type 12 modes depending on the number of load switches provided and the capabilities of the Controller Unit. In both modes the MMU shall be designed to provide the same fault coverage for the FYA approaches as it does for conventional protected left turn phases including Conflict, Red Fail, Dual Indication, and both Minimum Yellow and Minimum Yellow Plus Red Clearance monitoring.

(3) **Configuration Options**

a) **RYG ONLY Red Fail Option** The MMU shall provide the capability to exclude the Walk inputs from the Red Fail fault detection algorithm when operating in the Type 12 mode. When the option is selected, the absence of signals on the Green, Yellow, and Red field outputs of a channel will place the MMU unit into the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the RED FAIL fault.

b) **LED Signal Threshold Adjust** The MMU shall provide the capability to sense field inputs signals with the following thresholds:

Conflict, Dual Indication Low Threshold Signal Inputs (Green, Yellow, and Red)

No Detect	less than 15 Vrms
Detect	greater than 25 Vrms

Red Fail High Threshold Signal Inputs (Green, Yellow, and Red)

No Detect	less than 50 Vrms
Detect	greater than 70 Vrms

c) **CVM LOG Disable Option** The MMU shall provide a means to disable the logging of CVM fault events.

(4) **Display Functions** The following display functions shall be provided in addition to those required by the NEMA TS-2 Standard Section 4. A PC shall not be required to display the following parameters.

a) **Field Signal Voltages Display** A mode shall be provided to display the RMS voltage of each field signal input. If the MMU is not in the fault mode, the displayed voltage will be the currently applied RMS voltage. If the MMU is in the fault mode, the displayed voltage will be the applied RMS voltage at the time of the fault.

b) **Cabinet Control Signal Voltages Display** A mode shall be provided to display the RMS voltage of the AC Line and Red Enable, the frequency of the AC Line, and the ambient temperature measured at the MMU. If the MMU is not in the fault mode, the displayed values will be the currently applied values. If the MMU is in the fault mode, the displayed values will be the applied values at the time of the fault.

c) **Field Check Status Display** When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Field Check status.

d) **Recurrent Pulse Status Display** When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Recurrent Pulse status.

e) **Configuration Display** A display mode for the front panel display shall be provided that allows the setting and viewing of all MMU configuration parameters. The configuration parameters provided on the program card shall be viewable only. A PC shall not be required to completely program or view the MMU configuration parameters.

f) **Event Logs Display** A display mode for the front panel display shall be provided to review all details of the Previous Fail log, AC Line log, and the Monitor Reset log.

g) **Clock Set Display** A display mode for the front panel display shall be provided to view and set the time and date of the MMU real time clock.

(5) **Operating Modes** The MMU shall operate in both the Type 12 mode and Type 16 mode as required by the NEMA Standard.

a) **Help System** A context sensitive Help system shall be provided that is activated by a separate Help button. The Main Status display shall respond with text messages relevant to the position in the menu navigation level. When the MMU is in the fault mode the Help system shall respond with the Diagnostic mode described in 0.

b) **Setup Wizard** A built-in setup mode shall be provided that automatically configures the Dual Indication enable, Field Check enable, Red Fail enable, and Minimum Yellow Plus Red Clearance enable parameters from user input consisting only of channel assignment and class (vehicle, ped, pp-turn, etc) responses.

c) **Diagnostic Wizard** A built-in Diagnostic Wizard shall be provided that displays detailed diagnostic information regarding the fault being analyzed. This mode shall provide a concise view of the signal states involved in the fault, pinpoint faulty signal inputs, and provide guidance on how the technician should isolate the cause of the malfunction. The Diagnostic Wizard shall be automatically invoked when the MMU is in the fault mode and the HELP button is pressed. It shall also be automatically invoked when the MMU is in the Previous Fail (PF) event log display and the HELP button is pressed.

d) **TS-1 Type 12 With SDLC Mode** The MMU shall be capable of operating in the Type 12 mode with SDLC communications enabled on Port 1. The Channel Status display shall operate in the Type 12 configuration and provide the field check function for up to four pedestrian Walk inputs.

HARDWARE

(1) **Enclosure**

a) **Size** The MMU shall be compact so as to fit in limited cabinet space. It shall be possible to install on a shelf that is at least 7" deep. Overall dimensions, including mating connectors and harness, shall not exceed 10.5" x 4.5" x 11" (H x W x D).

b) **Material** The enclosure shall be constructed of sheet aluminum with a minimum thickness of 0.062", and shall be finished with an attractive and durable protective coating. Model, serial number, and program information shall be permanently displayed on the top surface.

(2) **Electronics**

a) **Microprocesor Monitor** A microprocessor shall be used for all timing and control functions. Continuing operation of the microprocessor shall be verified by an independent monitor circuit, which shall force the OUTPUT RELAY to the de-energized "fault" state and illuminate the DIAGNOSTIC indicator if a pulse is not received from the microprocessor within a defined period not to exceed 500 ms. Only an MMU Power Failure shall reset the DIAGNOSTIC fault state of the monitor.

b) **RMS Voltage Measurement** High speed sampling techniques shall be used to determine the true RMS value of the AC field inputs. Each AC input shall be sampled at least 32 times per line cycle. The RMS voltage measurement shall be insensitive to phase, frequency, and waveform distortion.

c) **Sockets** In the interest of reliability, no IC sockets shall be used.

d) **Battery** All user programmed configuration settings shall be stored in an electrically erasable programmable read-only memory (EEPROM). Designs using a battery to maintain configuration data shall not be acceptable. If a battery is used, it shall provide power only to the real time clock.

e) **Field Input Terminals** All 120 VAC field terminal inputs shall provide an input impedance of at least 150K ohms and be terminated with a discrete resistor having a power dissipation rating of 0.5 Watts or greater.

f) **Component Temperature Range** All electrical components used in the MMU except the front panel Status LCD shall be rated by the component manufacturer to operate over the full NEMA temperature range of -34oC to +74oC.

g) **Printed Circuit Boards** All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:

i) All plated-through holes and exposed circuit traces shall be plated with solder.

ii) Both sides of the printed circuit board shall be covered with a solder mask material.

iii) The circuit reference designation for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin #1 for all integrated circuit packages shall be designated on both sides of all printed circuit boards.

iv) All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

(3) **Front Panel and Connectors**

a) **MMU Status Display** four line by 20 character alpha-numeric LCD display shall be provided to report MMU status, time and date, menu navigation, etc. This display shall be separate from the full intersection channel status display.

b) **Full Intersection Channel Status Display** A separate Red, Yellow, and Green indicator shall be provided for the channel status LCD display for each channel to show full intersection status simultaneously. For Type 12 mode operation a separate Red, Yellow,

Green and Walk indicator shall be provided for each channel to show full intersection status simultaneously. Individual icons shall also be provided to indicate channels involved in a fault.

c) **LED Display Indicators** The following LED display indicators shall be provided:

i) **Power Indicator** The green POWER indicator shall flash at a rate of 2Hz when the AC LINE voltage is below the drop-out level. It shall illuminate steadily when the AC LINE voltage returns above the restore level. It shall extinguish when the AC Line voltage is less than 75 Vrms.

ii) **Fault Indicator** The red FAULT indicator shall illuminate when the MMU is in the fault mode and the OUTPUT relay has transferred to the Fault position.

iii) **Port 1 Receive Indicator** The yellow RECEIVE indicator shall illuminate for a 40 msec pulse each time a Port 1 message is correctly received from the Controller Unit.

iv) **Port 1 Transmit Indicator** The yellow TRANSMIT indicator shall illuminate for a 40 msec pulse each time a Port 1 message is transmitted from the MMU.

v) **EIA-232 Receive Indicator** The yellow COMM indicator shall illuminate for a 40 msec pulse each time a message is correctly received on the EIA-232 port.

vi) **Diagnostic Indicator** The red DIAGNOSTIC indicator shall illuminate when the MMU has detected an internal diagnostic failure.

d) **Controls** All displays, controls, and connectors shall be mounted on the front panel of the MMU.

i) **Help Button** A momentary contact button shall be provided the initiates the context sensitive help system described in 0.

e) **MS Connectors** The MS connectors on the MMU shall have a metallic shell and be attached to the chassis internally. The connectors shall be mounted on the front of the unit in accordance with the following: Connector A shall intermate with a MS 3116 22-55 SZ, and Connector B shall intermate with a MS 3116 16-26 S.

In the interest of reliability and repair ability, printed circuit board mounted MS connectors shall not be acceptable. Internal MS harness wire shall be a minimum of AWG #22, 19 strands.

f) **EIA-232 Port** The EIA-232 port shall be electrically isolated from the MMU electronics using optical couplers and shall provide a minimum of 2500 Vrms isolation. The connector shall be an AMP 9721A or equivalent 9 pin metal shell D subminiature type with female contacts. Pin assignments shall be as shown in the following table:

g)

PIN	FUNCTION
1	DCD*

2	TX DATA
3	RX DATA
4	DTR (Data Terminal Ready)
5	SIGNAL GROUND
6	DSR*
7	DSR*
8	CTS*
9	NC

*Jumper options shall be provided to allow the connection of Pin #4 to be made with Pin #7, and the connection of Pin #8 to be made with Pin #1 and or Pin #6.

(4) **Monitor Configuration Parameters** All Nema standard configuration parameters shall be provided by a program card meeting the requirements of clause 4.3.6 of Nema TS-2. All configuration parameters for functions and options beyond the requirements of the standard shall be stored in non-volatile memory within the MMU. This memory shall be programmable from the front panel menu driven interface, data downloaded via the EIA-232 port, or loaded from shadow memory located on the program card (see 0).

(5) **Program Card Memory** The program card supplied with the MMU shall provide non-volatile memory that contains the configuration parameters for the enhanced features of the MMU, such that transferring the program card to a different MMU completely configures that MMU. The non-volatile memory device used on the program card shall not utilize any I/O pins designated as "Reserved" by Nema TS-2.

EVENT LOGGING FUNCTIONS

(1) **General** The MMU shall be capable of storing in non-volatile memory a minimum of 100 events. Each event shall be marked with the time and date of the event. These events shall consist of fault events, AC Line events, reset events, and configuration change events. The capability to assign a four digit identification number and 30 character description to the unit shall be provided. The event logs shall be uploaded to a PC using the serial port of the MMU and Windows based software provided by the manufacturer.

Each event log report shall contain the following information:

a) Monitor ID#: a four digit (0000-9999) ID number and 30 character description assigned to the monitor.
b) Time and Date: time and date of occurrence.
c) Event Number: identifies the record number in the log. Event #1 is the most recent event.

(2) **Reports**

a) **Monitor Status Report (CS)** The Current Status report shall contain the following information:

i) Fault Type: the fault type description.

ii) Field Status: the current GYR(W) field status and field RMS voltages if the monitor is not in the fault state, or the latched field status and field RMS voltages and fault channel status at the time of the fault.

iii) Cabinet Temperature: the current temperature if the monitor is not in the fault state, or the latched temperature at the time of the fault.

iv) C Line Voltage: the current AC Line voltage and frequency if the monitor is not in the fault state, or the AC Line voltage and frequency at the time of the fault.

v) Control Input Status: the current state and RMS voltages of the Red Enable input & Load Switch Flash bit input if the monitor is not in the fault state, or the status latched at the time of the fault.

b) **Previous Fault Log (PF)** The Previous Fault log shall contain the following information:

i) Fault Type: the fault type description.

ii) Field Status: the latched field status with RMS voltages, fault channel status, RP Detect status and Field Check status at the time of the fault.

iii) Cabinet Temperature: the latched temperature at the time of the fault.

iv) AC Line Voltage: the AC Line voltage & frequency at the time of the fault.

v) Control Input Status: the latched state of the Red Enable input at the time of the fault.

c) **AC Line Event Log (AC)** The AC Line log shall contain the following information:

i) Event Type: describes the type of AC Line event that occurred.

Power-up - AC on, monitor performed a cold start

Interrupt - AC Line < Brownout level

Restore - AC restored from AC brown-out or AC interruption (AC Off), no cold start

ii) AC Line Voltage: the AC Line voltage & frequency at the time of the event.

d) **Monitor Reset Log (MR)** The Monitor Reset log shall contain the following information:

i) The monitor was reset from a fault by the front panel Reset button, or External Reset input, or a non-latched event clear.

e) **Configuration Change Log (CF)** The Configuration Change log shall contain the following information:

i) The status of all configuration programming including the contents of the Program Card.

ii) Any configuration programming inputs such as 24V Inhibit, Port 1 Disable, Type Select.

iii) Configuration Check Value: A unique check value that is based on the configuration of items #a and #b above.

The log shall also indicate which items have been changed since the last log entry.

f) **Signal Sequence Log (SSQ)** A minimum of five logs shall be provided that graphically display all field signal states and Red Enable for up to 30 seconds prior to the current fault trigger event. The resolution of the display shall be at least 50 milliseconds.

(3) **Remote Monitor Configuration**

a) **Setup Wizard** A setup mode shall be provided by the Windows based software that automatically configures the Dual Indication enable, Field Check enable, Red Fail enable, and Minimum Yellow Plus Red Clearance enable parameters from user input consisting only of channel assignment and class (vehicle, ped, pp-turn, etc) responses.

b) **Upload From File** All configuration parameters for functions and options beyond the requirements of the standard shall be programmable by transferring a file from a PC to the MMU via the front panel EIA-232 port. These parameters shall be stored in nonvolatile memory in the MMU.

c) **Download to File** All configuration parameters for functions and options beyond the requirements of the standard shall be downloadable to a PC by transferring a file from the MMU to a PC via the front panel EIA-232 port.

D. Cabinet and Cabinet Equipment.

a. Each controller shall be furnished completely housed in a door-in-door ground mounted metal cabinet that meets the requirements for a TS2 Type 2 traffic control cabinet assembly. The cabinet assembly shall meet, as a minimum, all applicable sections of the NEMA Standard Publication No. TS2-1992. Where differences occur, this specification shall govern.

b. Each eight phase cabinet shall consist of a size P cabinet capable of being base mounted, type three configuration main panel, 8 position (16 loop) detector rack, and auxiliary equipment as defined this specification.

c. Cabinet Construction

Each cabinet shall be constructed from type 5052-H32 aluminum with a minimum thickness of 0.125 inches.

Each cabinet shall be designed and manufactured with materials that will allow rigid mounting, whether intended for pole, base or pedestal mounting. The cabinet must not flex on its mount.

A rain channel shall be incorporated into the design of the main door opening to prevent liquids from entering the enclosure. Each cabinet door opening must be a minimum of 80 percent of the front surface of the cabinet. A stiffener plate shall be welded across the inside of the main door to prevent flexing.

The top of each cabinet shall incorporate a 1-inch slope toward the rear to prevent rain accumulation.

Each cabinet shall be supplied with a natural aluminum finish unless otherwise noted. Sufficient care shall be taken in handling to ensure that scratches are minimized. All surfaces shall be free from weld flash. Welds shall be smooth, neatly formed, free from cracks, blowholes and other irregularities. All sharp edges shall be ground smooth.

All seams shall be sealed with RTV sealant or equivalent material on the interior of the cabinet.

All cabinets shall be supplied with two easily removable shelves manufactured from 5052-H32 aluminum. Shelves shall be a minimum of 10 inches deep.

The shelf shall have horizontal slots at the rear and vertical slots at the front of the turned down side flange. The shelf shall be installed by first inserting the rear edge of the shelf on the cabinet rear sidewall mounting studs, then lowering the shelf on the front sidewall mounting studs. The shelf shall be held in place by a nylon tie-wrap inserted through holes on the front edge of the shelf and around the front sidewall mounting studs.

The front edge of the upper shelf shall have holes punched every 6 inches to accommodate tie wrapping of cables/harnesses.

One set of vertical "C" channels shall be mounted on each interior wall of the cabinet for the purpose of mounting the cabinet components. The channels shall accommodate spring-mounted nuts or studs. All mounting rails shall extend to within 7 inches of the top and bottom of the cabinets. Sidewall rail spacing shall be 7.88 inches center-to-center. Rear wall rail spacing shall be 18.50 inches center-to-center. (Size 5 and 6 cabinets) or 7.88 inches in size 3 cabinets. The rails shall be mounted to the cabinet with bolts (pressed into plates welded to interior of cabinet) to form a modular assembly.

The main door and police door-in-door shall close against a weatherproof and dust-proof, closed-cell neoprene gasket seal. The gasket material for the main door shall be a minimum of 0.250 inches thick by 1.00 inch wide. The gasket material for the police door shall be a minimum of 0.250 inches thick by 0.500 inches wide. The gaskets shall be permanently bonded to the cabinet.

The lower section of the cabinet door shall be equipped with a louvered air entrance. The air inlet shall be large enough to allow sufficient airflow per the rated fan capacity. Louvers must satisfy the NEMA rod entry test for 3R ventilated enclosures. A non-corrosive, vermin- and insect-proof, removable air filter shall be secured to the air entrance. The filter shall fit snugly against the cabinet door wall.

The roof of the cabinet shall incorporate an exhaust plenum with a vent screen. Perforations in the vent screen shall not exceed 0.125 inches in diameter.

The main door hinge shall be a one-piece, continuous piano hinge with a stainless steel pin running the entire length of the door. The hinge shall be attached in such a manner that no rivets or bolts are exposed.

The main door of a size 5 or larger cabinet shall include a mechanism capable of holding the door open at approximately 90, 125, and 150 degrees under windy conditions. Manual placement of the mechanism shall not be required by the field technician. The main door of a size 3 cabinet shall include a mechanism capable of holding the door open at approximately 90 and 150 degrees under windy conditions.

The main door shall be equipped with a Corbin tumbler lock number 1548-1. Two keys shall be supplied.
The police door-in-door shall be provided with a treasury type lock Corbin No. R357SGS or exact equivalent and one key.

All cabinet inside and outside surfaces shall be primed with phosphate treatment and primer. After priming, all exterior surfaces shall receive a minimum of 2 coats of rust resistant silver grey enamel and interior surfaces shall be furnished with rust resistant high gloss white enamel.

Each cabinet shall be of sufficient size to accommodate all equipment. At a minimum, the minimal cabinet size is as follows:
- Size P cabinet - 52" H x 44" W x 24" D

d. TERMINALS AND FACILITIES/MAIN PANEL DESIGN AND CONSTRUCTION

The main panel shall be constructed from 5052-H32 brushed aluminum of 0.125 inches minimum thickness and formed so as to minimize any flexing when plug-in components are installed.

All position main panels shall be hinged at the bottom to allow easy access to all wiring on the rear of the panel.

The main panel shall be fully wired in the following configuration:

Type 3 Configuration - Twelve load switch sockets, six flash transfer relay sockets, one flasher socket and two main panel BIU rack slots.

All load switch and flash transfer relay socket reference designators shall be silk-screen labeled on the front and rear of the main panel to match drawing designations. Socket pins shall be marked for reference on the rear.

Up to eight load switch sockets may be positioned horizontally or stacked in two rows on the main panel. Main panels requiring more than eight load switch sockets shall be mounted in two horizontal rows.

All load switches shall be supported by a bracket extending at least half the length of the load switch.

Rack style mounting shall be provided to accommodate the required BIUs per the configuration listed in section 3.3 above. A dual-row, 64-pin female DIN 41612 Type B connector shall be provided for each BIU rack position. Card guides shall be provided for both edges of the BIU. Terminal and facilities BIU mounting shall be an integral part of the main panel. Detector rack BIU mounting shall be an integral part of the detector rack.

All BIU rack connectors shall have pre-wired address pins corresponding to the requirements of the TS2 specification. The address pins shall control the BIU mode of operation. BIUs shall be capable of being interchanged with no additional programming.

The 12- load switch position main panels shall have all field wires contained on two rows of horizontally mounted terminal blocks. The upper row shall be wired for the pedestrian and overlap field terminations. The lower row shall be reserved for phase one through phase eight vehicle field terminations.

All field output circuits shall be terminated on a barrier type terminal block with a minimum rating of 60 amps.

All field input/output I/O) terminals shall be identified by permanent alphanumerical labels. All labels shall use standard nomenclature per the NEMA TS2 specification.

All field flash sequence programming shall be accomplished at the field terminals with the use of a screwdriver only.

Field terminal blocks shall be wired to use four positions per vehicle or overlap phase (green, yellow, red, flash). It shall not be necessary to de-bus field terminal blocks for flash programming.

It shall also be possible to program which flasher circuit the phase shall be connected to.

The main panel shall contain at least one flasher socket (silk screen labeled) capable of operating a 15-amp, 2-pole, NEMA solid state flasher. The flasher shall be supported by a bracket that extends at least half its length.

One RC network shall be wired in parallel with each group of three flash-transfer relays and any other relay coils.

All logic-level, NEMA-controller and Malfunction Management Unit input and output terminations on the main panel shall be permanently labeled. Cabinet prints shall identify the function of each terminal position.

At a minimum, two 20-position terminal blocks shall be provided at the top of the main panel to provide access to the controller unit's programmable and non-programmable I/O. Terminal blocks for DC signal interfacing shall have a number 6-32 x 7/32 inch screw as minimum.

All main panel wiring shall conform to the following wire size:

Green/Walk load switch output	- 14 gauge
Yellow load switch output	- 14 gauge
Red/Don't Walk load switch output	- 14 gauge
MMU (other than AC power)	- 22 gauge
Controller I/O	- 22 gauge
AC Line (power panel to main panel,(1 for each 4 LS)	- 10 gauge
AC Line (main panel)	- 14 gauge
AC Neutral (power panel to main panel)	- 10 gauge

Earth ground (power panel)	- 8 gauge
Logic ground	- 22 gauge
Flash programming	- flasher terminal - 14 gauge - field terminal - 14 gauge

All wiring, 14 AWG and smaller, shall conform to MIL-W-16878/1, type B/N, 600V, 19-strand tinned copper. The wire shall have a minimum of 0.010 inches thick PVC insulation with clear nylon jacket and rated to 105 degrees Celsius. All 12 AWG and larger wire shall have UL listed THHN/THWN 90 degrees Celsius, 600V, 0.020 inches thick PVC insulation and clear nylon jacketed.

All controller and Malfunction Management Unit cables shall be of sufficient length to allow the units to be placed on either shelf or the outside top of the cabinet in the operating mode. Connecting cables shall be sleeved in a braided nylon mesh. The use of exposed tie-wraps or interwoven cables are unacceptable.

All cabinet configurations shall be provided with enough RS-485 Port 1 communication cables to allow full capabilities of that cabinet. Each communication cable connector shall be a 15-pin metal shell D subminiature type. The cable shall be a shielded cable suitable for RS-485 communications.

All main panels shall be pre-wired for a Type-16 Malfunction Management Unit.

Provide necessary terminal for video detection.

All wiring shall be neat in appearance. All cabinet wiring shall be continuous from its point of origin to its termination point. Butt type connections/splices are not acceptable.

All control cables shall be protected by a nylon jacket or equivalent protection to prevent any contact with cabinet metal shelves, doors and any other sharp corners.

All connecting cables and wire runs shall be secured by mechanical clamps. Stick-on type clamps are not acceptable.

The grounding system in the cabinet shall be divided into three separate circuits (AC Neutral, Earth Ground, and Logic Ground). These ground circuits shall be connected together at a single point as outlined in the NEMA TS2 Standard.

All pedestrian pushbutton inputs from the field to the controller shall be opto-isolated through the BIU and operate at 12 VAC.

All wire (size 16 AWG or smaller) at solder joints shall be hooked or looped around the eyelet or terminal block post prior to soldering to ensure circuit integrity. Lap joint soldering is not acceptable.

e. POWER PANEL DESIGN AND CONSTRUCTION

The power panel shall consist of a separate, wholly enclosed module, securely fastened to the right sidewall of the cabinet. The power panel shall be wired to provide the necessary power to the cabinet, controller, Malfunction Management Unit, cabinet power supply and auxiliary equipment.

f. AUXILIARY CABINET EQUIPMENT

The cabinet shall be provided with a thermostatically controlled (adjustable between 80-150 degrees Fahrenheit) ventilation fan in the top of the cabinet plenum. The fan shall be a ball bearing type fan and shall be capable of drawing a minimum of 100 cubic feet of air per minute. The fan unit shall not crack, creep, warp or have bearing failure within a 7 year duty cycle. The maximum noise level shall be less than 40 decibels. The fan unit shall be corrosion resistant.

A 25-watt incandescent lamp shall be included. The lamp shall be wired to a door activated switch mounted near the top of the door.

Provide a 15 amp circuit breaker for auxiliary equipment, 20 amp circuit breaker for street lights and a non-GFI outlet for additional equipment.

Provide all necessary hardware to accommodate fiber optic interconnect and Ethernet communications.

Provide a photocell and contactor for street lighting powered from signal cabinet.

Provide an Ethernet switch and a fiber/Ethernet modem.

Install all additional control units in cabinet per plans. Control units include, but are not limited to, audible pedestrian push button control unit, emergency vehicle preemption control device including card rack, and video detection processor.

Provide a sealable print pouch shall be mounted to the door of the cabinet. The pouch shall be of sufficient size to accommodate one complete set of cabinet prints.

Provide two sets of complete and accurate cabinet drawings shall be supplied with each cabinet.

Provide one set of manuals for each controller supplied.

g. VEHICLE DETECTION

A vehicle detector amplifier rack shall be provided in each cabinet. Detector racks shall be in the following configuration.

Shall support up to 16 channels of loop detection and one BIU.

Each cabinet shall contain detector interface panels for the purpose of connecting field loops and vehicle detector amplifiers. The panels shall be manufactured from FR4 G10 fiberglass, 0.062 inches thick, with a minimum of 2 oz. of copper for all traces.

One 16-position interface panel shall be provided for each 16-channel rack. The interface panel shall be secured to a mounting plate and attached to the left sidewall of the cabinet.

Each interface panel shall allow for the connection of eight or sixteen independent field loops. A ground bus terminal shall be provided between each loop pair terminal to provide a termination for the loop lead-in cable ground wire.

Lightning protection device mounting holes shall be provided to accommodate an Edco SRA-16C, or Edco SRA-6, or Edco LCA-6, or a varistor lightning protection device. Lightning protection devices shall not be provided.

A cable consisting of 20 AWG twisted pair wires shall be provided to enable connection to and from the panel to a detector rack. The twisted pair wires shall be color-coded red and white wires.

All termination points shall be identified by a unique number and silk screened on the panel.

Each detector rack shall be powered by the cabinet power supply (refer to section 9.6 of this specification).

h. CABINET TEST SWITCHES AND POLICE PANEL

A test switch panel shall be mounted on the inside of the main door. The test switch panel shall provide the following:

(1) AUTO/FLASH SWITCH. When in the flash position, power shall be maintained to the controller and the intersection shall be placed in flash. The controller shall not be stop timed when in flash.

(2) STOP TIME SWITCH. When applied, the controller shall be stop timed in the current interval.

(3) CONTROL EQUIPMENT POWER ON/OFF. This switch shall control the controller, MMU, and cabinet power supply AC power.

The police door switch panel shall contain the following:

(1) SIGNALS ON/OFF SWITCH. In the OFF position, power shall be removed from signal heads in the intersection. The controller shall continue to operate. When in the OFF position, the MMU shall not conflict or require reset.

(2) FLASH/NORMAL SWITCH. In the flash position, power shall not be removed from the controller and stop time shall be applied.

All toggle type switches shall be heavy duty and rated 15 amps minimum. Single- or double-pole switches may be provided, as required.

Any exposed terminals or switch solder points shall be covered with a non-flexible shield to prevent accidental contact.

All switch functions must be permanently and clearly labeled.

All wire routed to the police door-in-door and test switch pushbutton panel shall be adequately protected against damage from repetitive opening and closing of the main door.

All test switch panel wiring shall be connected to the main panel via a multiple pin type connector.

i. AUXILIARY DEVICES

Load Switches

Load switches shall be solid state and shall conform to the requirements of Section 6.2 of the NEMA TS2 Standard.

Load switches shall be dedicated per phase. The use of load switches for other partial phases is not acceptable.

Flashers

The flasher shall be solid state and shall conform to the requirements of section 6.3 of the NEMA TS2 Standard.

Flash Transfer Relays

All flash transfer relays shall meet the requirements of Section 6.4 of the NEMA TS2 Standard.

The coil of the flash transfer relay must be deenergized for flash operation.

Bus Interface Units

All Bus Interface Units (BIUs) shall meet the requirements of Section 8 of the NEMA TS2 Standard.

The full complement of Bus Interface Units shall be supplied with each cabinet to allow for maximum phase and function utilization for which the cabinet is designed. BIU's shall be from the same manufacture as the controller manufacture used in the City.

Each Bus Interface Unit shall include power on, transmit and valid data indicators. All indicators shall be LEDs.

Cabinet Power Supply

The cabinet power supply shall meet the requirements of Section 5.3.5 of the NEMA TS2 Standard.

The cabinet power supply shall provide LED indicators for the line frequency, 12 VDC, 12 VAC, and 24 VDC outputs.

The cabinet power supply shall provide (on the front panel) jack plugs for access to the +24 VDC for test purposes.

One cabinet power supply shall be supplied with each cabinet assembly.

E. **Equipment List and Drawings**. Detailed shop drawings of the control cabinet, equipment layout drawings and wiring diagrams of all equipment installed in the controller cabinet shall be submitted to the City for approval. Two sets of cabinet wiring diagrams shall be contained in a heavy duty clear plastic envelope mounted on the inside of the front door.

At the time of delivery, the contractor shall furnish one set of instruction manuals and an itemized price list for each type of equipment, their subassemblies, and their replacement parts. The instruction book shall include the following information: a) Table of Contents, b) operating procedure, c) step-by-step maintenance and troubleshooting information for the entire assembly, d) circuit wiring diagrams, e) pictorial diagrams of parts locations, f) parts numbers, and g) theory of operation. The instructional manuals shall include itemized parts lists. The itemized parts lists shall include the manufacturer's name and parts number for all components (such as IC', diodes, switches, relays, etc.) used in each piece of equipment. The list shall include cross references to parts numbers of other manufacturers who make the same replacement parts.

F. **Warranty**

(1) The contractor shall certify that the equipment meets the required specification and shall supply a complete catalog description. The following documents shall also be provided.

a. A warranty statement which stipulates that equipment to be supplied shall be warranted for two years from the date of purchase.

b. Operations manuals.

c. Maintenance manuals.

d. Schematic diagrams.

e. Component and equipment locations within the cabinet.

(2) If a malfunction in the controller unit, or its auxiliary equipment occurs during the warranty period, the supplier shall, within 24 hours after notification (excluding Saturday and Sunday), furnish a like controller unit module, or auxiliary equipment, for use while the warranted unit is being repaired. The isolation of any malfunction during the warranty period shall be the responsibility of the supplier. After the supplier has repaired and returned the equipment, the City shall then return the spare component to the supplier.

(3) Controller Operation. Consistent with customary trade practices, the manufacturer shall furnish a warranty for all electrical or mechanical equipment described herein. The contractor shall turn such warranty over to the owner for potential dealing with the guarantor.

If the contractor is the guarantor, he specifically waives the requirements of Section 289.14(2), Wisconsin Statutes, and agrees as a condition of the contract that the owner may maintain an action against him at anytime during the warranty period for recovery of damages which the City may have sustained by reason of the failure of the contractor to comply with the provisions of the warranty provided to the owner.

(4) During the installation and testing of the controller, the contractor shall provide, at his own expense, a competent representative to oversee, direct and manage the installation and testing of the controller. In the final stages of the installation and testing, the manufacturer's representative shall be available at the job site for consultation until such time as the controller operation is tested and accepted.

If a malfunction in the controller unit or its auxiliary equipment occurs during the warranty period, the supplier shall, within 24 hours after notification (excluding Saturday and Sunday), furnish a like controller unit, module, or auxiliary equipment, for use while the warranted unit is being repaired. The isolation of any malfunction and the repair and/or replacement of any device within the warranty period shall be the responsibility of the

supplier. After the supplier has repaired and returned the equipment, the City shall return the spare component to the supplier.

G. **Method of Measurement**. Traffic Signal Controller and Cabinet 8-Phase Fully Actuated will be measured as a complete unit of work.

H. **Basis of Payment**. Traffic Signal Controller and Cabinet 8-Phase Fully Actuated will be paid for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.XX	Traffic Signal Controller and Cabinet 8-Phase Fully Actuated	Each

Payment is full compensation for furnishing and installing the signal controller and conflict monitor together with cabinet, all required control units, all additional harnesses for preemption, switches for flashing operation, and fittings as are necessary to assure that the controller will perform the said functions; and for furnishing all labor, tools, equipment and incidentals necessary to complete the contract work.

11. Emergency Vehicle Preemption System, Intersection of Meadowbrook Rd and Rolling Ridge Dr, Item SPV.0105.XX.

A Description

This work shall consist of furnishing and installing an Emergency Vehicle Preemption (EVP) System at a single intersection, as shown on the plans and as hereinafter provided.

B Materials and Construction Methods

The Emergency Vehicle Preemption System shall include GTT Opticom discriminator Model 454, Model 711 detectors, and Model 138 detector cable. This equipment shall be furnished and installed by the contractor.

Detectors shall be mounted on the mast arms and signal poles as shown on the Plans.

The traffic signal mast arms and poles shall be drilled, and tapped to accommodate the mounting of the detector units as shown in the Plans. The installation method shall be approved by the City traffic engineer.

In the event, at installation, a noticeable obstruction is present in line with the detector, the contractor shall be obligated to advise the engineer before installation.

Unless otherwise directed by the City, the detector shield tube shall be installed with the drain hole at the bottom.

There shall be NO detector cable splices from the detector assembly to the controller terminations.

The EVP detector cables shall be routed to the controller. Each lead shall be appropriately marked as to which street or avenue it is associated. The contractor will perform all terminations inside the cabinet.

The EVP as specified and shown in the Plans shall be complete in place, tested, and in full operation.

C Measurement

Emergency Vehicle Preemption System will be measured as a lump sum complete in place per intersection.

D Payment

Emergency Vehicle Preemption System will be paid for measured quantities at the contract lump sum price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.XX	Emergency Vehicle Preemption System, Intersection of Meadowbrook Rd & Rolling Ridge Dr	LS

Payment is full compensation for furnishing and installing all equipment, cabling, necessary additional items, testing and setting up the system, and for all labor, tools, equipment, and incidentals necessary to complete the work.

12. Temporary Non-Intrusive Vehicle Detection System for Intersections, Intersection of Meadowbrook Rd and Rolling Ridge Dr, Item SPV.0105.XX.

A Description

This work shall consist of furnishing, installing, maintaining and placing into operation a temporary non-intrusive vehicle detection system (NIVDS) as shown on the plans, and as directed by the engineer in the field.

B Materials

This specification sets forth the minimum requirements for a system that detects vehicles on a roadway and provides detection outputs to a traffic signal controller. The materials shall also include all brackets, mounting hardware, cable, terminations, interface panels, and all other incidentals for the installation of the non-intrusive vehicle detection equipment. This equipment shall meet the NEMA environmental, power and surge ratings as set forth in NEMA TS2 specifications.

All detection equipment, components, and terminations supplied under this item shall be fully compatible with the temporary traffic signal controller supplied for the project. The system architecture shall fully support Ethernet networking of system components. All required interface equipment needed for transmitting and receiving data shall be provided with the NIVDS.

The NIVDS shall provide flexible detection zone placement anywhere and at any orientation. Preferred detector configurations shall be detection zones placed across lanes of traffic for optimal count accuracy, detection zones placed parallel to lanes of traffic for optimal presence detection accuracy of moving or stopped vehicles. Detection zones shall be able to be overlapped for optimal road coverage.

C Construction

The temporary NIVDS shall be installed by supplier factory-certified installers and as recommended by the supplier and documented in installation materials provided by the supplier.

In the event, at installation or turn on date, a noticeable obstruction is present in line with the detection zone(s), the contractor **shall** be obligated to advise the engineer before setting the zone.

The non-intrusive vehicle detection system, as shown in the traffic signal construction plans, **shall** be complete, in place, tested, and in full operation during each stage of construction.

Maintain all temporary vehicle detection zones as the plans show or as the engineer directs. The temporary vehicle detection zones shall be set near the vicinity and with approximate distance from the stop bar as shown on the plans. Check temporary vehicle detection zones every other week and at the opening of each stage of temporary traffic signal operation to ensure that they are working properly and aimed properly. Periodic adjustment of the detection zones and/or moving of the temporary vehicle detection sensors may be required due to changes in traffic control, staging, or other construction operations.

Ensure the non-intrusive vehicle detection system stays in clean working order. Periodic cleaning of the equipment may be required due to dirt and dust build-up.

D Measurement

Temporary Vehicular Video Detection System for Intersections (Location) will be measured as a single lump sum unit of work, acceptably completed.

D Payment

Temporary Vehicular Video Detection System for Intersections (Location) will be paid for the measured quantity at the contract unit price under the following bid item.

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.XX	Temporary Non-Intrusive Vehicle Detection System for Intersections, Intersection of Meadowbrook Rd and Rolling Ridge Dr	LS

Payment is full compensation for furnishing and installing the temporary non-intrusive vehicle detection system, including cabling, mounting brackets, mounting hardware, terminations, interface panels, testing and set up; for periodic checking and resetting of detection zones; for periodic cleaning for dirt and dust build-up; and for removing all equipment at the completion of the project.

13. Remove Traffic Signals and Street Lighting, Intersection of Meadowbrook Rd and Rolling Ridge Dr, Item SPV.0105.XX.

A Description
This special provision describes the removing of all above- and under-ground existing traffic signal equipment at the signalized project intersection.

This item includes removing, transporting, delivering, and/or legally disposing of traffic signal hardware, conductors, wire, concrete bases, pull boxes, etc. Contact Mike Grulke, (262)524-3590 for disposition of poles, arms, heads, cabinet and controller, EVP equipment, video cameras, pull box rims and lids, and other signal hardware. Dispose of all conductors and wire. Dispose of all concrete bases. Remove conduit that interferes with new equipment or presents a hazard.

This item also includes removal and restoration of sidewalk, curb and gutter, landscaping, and any other disturbed finishes or materials required to remove the existing signal equipment,.

B (Vacant)

C Construction
Arrange for the removal of the traffic signal equipment after receiving approval from the engineer that the existing equipment can be removed.

All work shall be in accordance with the latest Standard Specifications, City of Waukesha Standards, and the plans.

D Measurement
Remove Traffic Signals and Street lighting, (Intersection) will be measured as a single lump sum unit of work for each intersection acceptably completed.

E Payment
The measured quantity will be paid at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.XX	Remove Traffic Signals and Street Lighting, Intersection of Meadowbrook Rd and Rolling Ridge Dr.	Lump Sum

Payment is full compensation for removing and disassembling traffic signals and street lighting, scrapping of some materials, disposing of scrap material, and for delivering materials to the City.

Traffic Control & Construction Phasing

No. 21 - The proposed traffic control and staging is included in the plan. The Contractor will be required to provide any changes to the traffic control plan and any other information on the traffic control procedures being used to the Project Engineer for approval three days prior to the pre-construction meeting. The traffic control procedures must be approved and in place prior to the start of any work.

The Contractor will be required to provide traffic control in accordance with part VI of the "Manual on Uniform Traffic Control Devices" and supply any personnel necessary to flag traffic. The Contractor will be required to supply and maintain adequate barricades and signs to properly close off the construction area. The Contractor shall submit a schedule detailing all phases of the project for approval.

The traffic control and staging will be paid by the lump sum under the Unit Bid Item "Traffic Control." This shall include all barricading, signing, temporary markings, staging, detour and traffic control necessary throughout this contract. The Contractor shall follow the guidelines as set forth in the "Manual on Uniform Traffic Control Devices" Part VI, published by the Federal Highway Administration. As part of this contract, the Contractor shall furnish flasher barricades along the project in the following manner:

- Type III Barricades at all construction limits.
- Temporary stop signs at all intersections as needed.
- Road Closed and Advance warning signs for any side streets that intersect the street under construction.
- Road Work Ahead signs at any side streets that intersect the street under construction.
- One flasher for each end of radius at intersections along the excavated ditch for curb and gutter.
- One flasher for every two hundred feet within a block along the excavated ditch for curb and gutter.
- One flasher at each end of all walk excavations, and "Walk Closed" signs as necessary.

During the work on this Contract, the following traffic control and phasing requirements shall be met:

- Access must be maintained for emergency vehicles and for residents living on the street at all times.
- Safe access must be maintained through the construction site for pedestrian access at all times. The walking paths shall be a smooth hard surface and shall be maintained as necessary. Temporary HMA pavement may be necessary in areas as directed by the Engineer. The cost of temporary HMA pavement will be paid for under the Unit Bid Item "Asphaltic Surface Temporary". Orange construction fence may be necessary to direct pedestrian on a safe route through or along the construction project. The phasing of the sidewalk construction may be necessary. The cost for this work (not temporary HMA pavement) shall be included in the lump sum price for traffic control.
- Meadowbrook Road must remain open to one lane of traffic in each direction at all times.
- Construction staging and traffic control must be coordinated with the concurrent Waukesha County/WisDOT project to the south (WisDOT Project ID 2788-00-72)

- Stage 1A – Construct southbound lanes of Meadowbrook Road. Appropriate traffic control must be in place no later than May 1, 2017.
    - Joanne Drive will remain open.
    - Lancaster Drive will be closed to through traffic. Local access must be maintained.
    - The west leg of Woodridge Lane will be closed.
    - The east leg of Woodridge Lane will remain open.
    - Rolling Ridge Drive will remain open.
- Stage 1B – Construct southbound lanes of Meadowbrook Road. This stage must be completed no later than July 31, 2017.
    - Joanne Drive will be closed.
    - Lancaster drive will remain open.
    - Woodridge Lane will remain open.
    - The west leg of Rolling Ridge Drive will be closed.
- Stage 2A – Construct northbound lanes of Meadowbrook Road. Appropriate traffic control must be in place no later than August 1, 2017.
    - Joanne Drive will remain open.
    - Lancaster Drive will remain open.
    - The west leg of Woodridge Lane will remain open.
    - The east leg of Woodridge Lane will be closed.
    - Rolling Ridge Drive will remain open.
- Stage 2B – Construct northbound lanes of Meadowbrook Road. This stage must be completed no later than October 12, 2017.
    - Joanne Drive will remain open.
    - Lancaster Drive will be closed.
    - Woodridge Lane will remain open.
    - The west leg of Rolling Ridge Drive will remain open.
    - The east leg of Rolling Ridge Drive will be closed. This closure is limited to a maximum of __ days.
- Stage 3 – Complete construction in median of Meadowbrook Road. Appropriate traffic control must be in place no later than October 13, 2017. This stage must be completed no later than November 17, 2017.

Lighting Control Cabinet, Item SPV.0060.XX.

A Description

This special provision describes furnishing and installing lighting control cabinet, associated electrical equipment and concrete base as shown on the plans and hereinafter provided.

B Materials

B.1 Contactor

Provide an electrically held multi-pole contactor with coil capable of operating at the nominal voltage specified integral. Provide Square D, Type S series (open type) or equal by General Electric or Cutler-Hammer.

B.2 Photocell

Provide a button type photocell that is rated for 240V, 1800W with 30-60 second delay between “on-off” operation.

B.3 Circuit Breakers and Fuses

The circuit breakers shall be capable of surface mounting with line and load lugs by Square D, F-Frame type or equal by Cutler-Hammer or General Electric. Provide appropriate AIC ratings.

Provide a 1 pole, 15 amp, control breaker for the control circuit.

All breakers shall be from the same manufacturer.

B.4 Bus Bars

Provide aluminum or copper ground and insulated neutral bus bars with wire range capabilities as indicated on the plans.

B.5 Hand-Off-Auto Switch

Provide a 3-position manual return selector switch in a NEMA 1 enclosure with legend plate as manufactured by Square D Type K, or equal by Cutler-Hammer or General Electric.

B.6 Enclosure

Provide a NEMA 4X enclosure made from .125" Type 5052-H32 aluminum. Provide a double flanged doorframe. Provide stainless steel for all exterior hardware. Provide a 3/4" diameter stainless steel door handle with three point latching system and hasp. Provide a natural aluminum mounting panel at back (interior) of enclosure. Do not provide louvers. Cabinet secured by a contractor furnished weatherproof padlock. The enclosure shall have an aluminum mill finish. Provide an enclosure manufactured by APX Enclosures, Cleveland Manufacturing or Southern Manufacturing.

B.7 Power Distribution Blocks

Provide aluminum power distribution blocks with lug wire ranges on the main and branches as indicated on the plans with clear plastic covers as manufactured by Square D Type LB or equal by Cutler-Hammer or General Electric.

B.8 Concrete Base
Conform to section 654.2 of the Standard Specifications.

C Construction
Use a UL Listed Panel Builder to assemble the lighting control cabinet. The control cabinet requires service entrance rating. Assemble the lighting control cabinet with all of its electrical components, wiring and parts in a neat and orderly fashion and as shown on the plans. Pretest the cabinet prior to shipment to the site.

Mount all equipment to panel in enclosure. Train the cables in straight horizontal and vertical directions and be parallel next to and adjacent to other cables whenever possible. Secure all wiring using screw attachment type straps; adhesive type will not be allowed.

Install photocell in the overhang of the control cabinet facing down and apply silicon caulk to maintain integrity of the enclosure.

Construct concrete base in conformance with section 654.3 of the Standard Specifications.

Cabinet and components shall be designed as Service Equipment. No service disconnect exterior of the Lighting Control Cabinet shall be allowed.

Lighting Control Cabinet will be 480/240 volt single phase, 100 amps.

D Measurement
The department will measure Lighting Control Cabinet as each individual unit, acceptably completed.

E Payment
The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.XX	Lighting Control Cabinet	Each

Payment is full compensation for photocontrol, contactor, circuit breakers, fusing, distribution blocks, enclosure, bus bars, selector switch, grounding and electrical components, concrete base; and for all labor, tools, equipment and incidentals necessary to complete the work.

Luminaires Utility 21 Count LED 75 Watt Type III, Item SPV.0060.XX

A. Description

This special provision describes furnishing and installing luminaires in accordance to sections 651 through 660 of the standard specifications, as shown on the plans or as approved by the engineer, and as hereinafter provided.

B. Materials

Cooper Lumark LDRC-T3-E03-E. Heavy-duty cast aluminum housing and removable door 3G vibration tested to ensure strength of construction and longevity in application. Die-cast aluminum door frame features integral hinges for tool-less maintenance access.

C. Construction

Furnish and install LED luminaires together with hardware and fittings as the plans show. Install luminaires on luminaire arms with an initial rake of plus 3-degrees, this measurement includes the rake of the arm. Install luminaires on luminaire arms level in the longitudinal direction of the roadway except on segments where the profile is sloped greater than 3-degrees. In this case the engineer will determine the longitudinal level of the luminaires.

D. Measurement

The department will measure Luminaires Utility 21 Count LED 75 Watt Type III by the unit, acceptably completed.

E. Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.XX	LUMINAIRES UTILITY 21 COUNT LED 75 WATT TYPE III	EACH

Payment is full compensation for the providing all materials including luminaires, ballasts, lamps, fittings, brackets, hardware and attachments; for luminaire fusing f required.

SPECIAL PROVISIONS

The following Special Provisions are Revisions of and Additions to certain Sections and Sub sections or Parts Thereof of the

CONTRACT DOCUMENTS FOR MEADOWBROOK STORM SEWER IMPROVEMENTS

No. ## - The work contained in this Contract is to be done in accordance with the regulations of the Wisconsin Department of Natural Resources (WDNR), AWWA Specifications, Manufacturers' Recommendations, State of Wisconsin Standard Specifications for Highway and Structure Construction, Current Edition, City of Waukesha Standard Construction Specifications (for sewer construction), Standard Specifications for Sewer and Water Construction in Wisconsin, Sixth Edition, and the City of Waukesha Standard Construction Specifications, 1972 Edition as revised, except as provided for within this document.

All applicable sections of the revised City of Waukesha Standard Construction Specifications (for sewer construction) are available to bidders at no cost at the office of the Director of Public Works. Copies of the City of Waukesha Standard Construction Specifications, 1972 Edition, are available at the Office of Director of Public Works, Waukesha City Hall Annex, 130 Delafield Street, at a cost of $5.00 each.

Project Completion Schedule

No. ## - The work included in this contract involves:

- Abandoning sections of storm sewer;
- Installation of new sections of the storm sewer system;
- Installation of new and adjusting existing storm manholes and inlets;
- Installation of new storm manholes, catch basins, and inlets;
- Adjusting an existing storm manhole;
- Installation of new storm sewer end sections;
- Installation of new rip rap channels;
- Installation of Bio-Filtration Basins;
- Installation of Bio-Filtration storm sewer;
- Installation of Bio-Filtration Engineered material;
- Installation of Landscaping and final Restoration;

No. ## - The storm sewer work included in this Contract (excluding manufacturers warranties which may be longer) shall be and is warranted meeting the standards within the Standard Specifications for highway and structure construction Current Edition, or for a period of one (1) year from the completion date of work and as further detailed in the Standard Specifications for Sewer and Water construction in Wisconsin, whichever is more stringent.

Bio-Filtration Basin Erosion Control

No. ## - Erosion control measures will be a part of this construction contract. The Contractor shall, as a minimum, follow the Wisconsin Department of Natural Resources (DNR) Technical Standards for Construction Site Erosion Control.

The downstream project limits shall be protected by ensuring that sediment cannot leave the construction site. This shall be accomplished by the placement of silt fence.

Tracking of sediment onto adjacent paved roadways must be minimized during construction. Stone Tracking Pads of sufficient width and length must be constructed early in the grading process to prevent sediment from being tracked onto adjacent streets. Any sediment reaching adjacent streets must be removed by vacuum type street sweepers (not flushing) before the end of the workday. The cost of a tracking pad, including materials, shall be included in the prices of other items in the project.

All erosion control measures in place on this contract must be inspected within 24 hours after each rainfall or daily during prolonged rainfall. Repair or replacement shall be made immediately. Sediment deposits should be removed from silt fences after each storm event. Sediment deposits shall be removed when deposits reach one half the height of the barrier. The Contractor shall remove any sediment deposits reaching storm sewers as a result of construction on this contract by cleaning of the sewers.

The Contractor shall have a Geotextile Bag for any water being pumped from the excavated trench at all times. The geotextile bag must be appropriately sized according to Wisconsin DNR technical standards. The geotextile bag must be approved by the Engineer and the cost shall be included in the linear foot of pipe.

If dewatering (dewatering wells) are necessary, the Contractor shall contact the Wisconsin DNR, Private Water Supply Section (PO BOX 7921, Madison, WI. 53707) for a permit for all wells installed or operated for which the single or aggregate capacity may be in excess of 70 gallons per minute.

The Contractor shall follow the DNR approved erosion control plan for this site. The Contractor shall also fill out the DNR's Construction Site Inspection Report weekly or after precipitation events. A copy of the form is included with these specifications.

The Contractor is required to remove all erosion control measures installed after the site has been sufficiently stabilized.

General Underground

No. ## - Sidesloping of trenches will not be allowed where damage to sidewalk, curb, structures and underground utilities would be caused by such sidesloping.

No. ## - The Contractor is responsible for damage to adjoining buildings and grounds caused in the construction.

No. ## - The location of structures and obstacles shall not be taken as conclusive. Verification to the satisfaction of the Contractor shall be assumed as a condition of his/her bid; and therefore, the Contractor shall be solely responsible for all damages resulting from his/her activities.

No. ## - The Contractor shall be solely responsible for providing trench support in accordance with all applicable State and Federal regulations. The Owner and Inspector shall be held harmless in all matters regarding shoring and bracing.

No. ## - The Contractor is responsible for the disposal of excess dirt. The dump site used must be approved by the Engineer.

No. ## - Backfill:
Compacted granular backfill is required throughout. Granular backfill must meet the gradation requirements according to Section 607 in the State of Wisconsin Standard Specifications for Highway and Structure Construction, Current Edition, unless otherwise noted.

Storm Sewer

No. ## - The Contractor shall use reinforced concrete sewer pipe (S.S.P.R.C) for the proposed storm sewer meeting the Standard Specifications for highway and structure construction Current Edition, Section 608. The cost for the storms sewer shall be paid for under the Unit Bid Items for 12-Inch to 48-Inch Storm Sewer. The Contractor will be required to use the following pipe classes:

- Class V for 12-Inch diameter pipe
- Class V for 15-Inch diameter pipe
- Class III for 18-Inch diameter pipe
- Class V for 21-Inch diameter pipe
- Class III for 24-Inch diameter pipe
- Class V for 42-Inch diameter pipe
- Class III for 48-Inch diameter pipe

No. ## - The Contractor shall use reinforced concrete box culverts for the proposed storm sewer as indicated on the plans. All box culverts shall meet ASTM C1433 and ASTM C1577. The Contractor will be required to use the following interior box culvert sizes:

- 4'x8'
- 4'x12'
- 5'x12'

All reinforced concrete box culverts shall meet the Standard Specifications for Sewer and Water Construction in Wisconsin, Sixth Edition, chapter 8.8.0 Precast Reinforced concrete Box Sections.

All reinforced concrete box culverts shall be installed per the Standard Specifications for Sewer and Water Construction in Wisconsin, Sixth Edition, chapter 3.2.7 Precast Concrete Box Installation. Backfilling of box culverts shall meet the City of Waukesha Standard Construction Specifications, 1972 Edition as revised.

All reinforced concrete box culverts shall be measured and paid for according to the Standard Specifications for Sewer and Water Construction in Wisconsin, Sixth Edition, chapter 2.9.1 Pay Measurement For New Sewers And Drains.

No. ## - All storm sewer must be inspected and marked prior to delivery to the job by an accredited testing laboratory. The cost for this work shall be included in the bid items for storm sewer.

No. ## - All reinforced concrete sewer pipe (S.S.P.R.C) shall be installed in accordance to Standard Specifications for highway and structure construction Current Edition, Section 608.

No. ## - All pipe must be inspected and marked prior to delivery to the job by an accredited testing laboratory. The cost for this work shall be included in the bid items for storm sewer pipe.

The cost for bedding, cover and mechanically compacted granular backfill shall be included in the Unit bid items for storm sewer pipe.

No. ## - 42-inch Apron end section and 4'x12' end section shall be reinforced concrete.

42-inch Apron end section shall conform to Standard Specifications for highway and structure construction Current Edition, Section 522.2.4.

4'x12' end section shall be approved by state of Wisconsin structural professional engineer.

42-inch Apron end section and 4'x12' end section shall have bar protection. Contractor shall use multiple flat mount hinged grates across the 4'x12' box culvert.

Contractor shall submit outfall protection shop drawings to The City of Waukesha for review and approval prior to furnishing and installing at 42-inch Apron and 4'x12' box culvert End Section.

The cost for furnishing and installing the steel bar protection shall be included in the bid items for 42-inch Apron and 4'x12' box culvert End Section.

No. ## - 4x12-FT riprap outfall stabilization shall be EXTRA HEAVY RIPRAP, conforming to Standard Specifications for highway and structure construction Current Edition, Section 606.

4x12-FT riprap outfall stabilization shall be installed as indicated on the drawings.

4x12-FT riprap outfall stabilization geotextile filter fabric shall be MIRAFI, or approved equal. Geotextile filter fabric shall be installed per manufactures instructions. The cost for furnishing and installing geotextile fabric shall be included in the bid items for Extra Heavy RipRap w/Fabric.

This item shall be paid on a cubic yard basis according to the Unit Bid price per cubic yard.

~~No. ## - The Contractor is required to remove or abandon existing storm sewers and structures as indicated on the plans. The cost for this work shall be included in the bid price per linear foot of storm sewer.~~

No. ## - All manholes, catch basins, inlets, and inline structures are to be built to proposed grade and alignment. The cost for adjusting and backplastering new structures shall be included in the bid items for new storm manholes, catch basins, inlets, and inline structures.

No. ## - All manhole and catch basin structure and frames, grates, and lids shall be installed in accordance to Standard Specifications for highway and structure construction Current Edition, Section 611.

All manhole construction shall conform to SDD MANHOLES 3-FT, 4-FT, 5-FT, 6-FT, 7-FT AND 8-FT DIAMETER.

All manholes shall be precast concrete structures, no block manholes.

All diameter catch basin construction shall conform to SDD CATCH BASINS 3-FT, 4-FT, 5-FT, AND 6-FT DIAMETER.

All diameter catch basins shall be precast concrete structures, no block catch basins.

All box catch basin construction shall conform to SDD CATCH BASINS 2X3-FT AND 2.5X3-FT DIAMETER.

All box catch basins shall be precast concrete structures, no block catch basins.

All catch basins shall have a 2-foot sump. Pay measurement will include these sumps.

All frame, grates, and lids, shall conform to SDD INLET AND MANHOLE COVERS.

All catch basins 2.5x6-FT shall have a Neenah R-3292-2 frame and grate with type L grate.

All manholes and catch basins shall be paid on a vertical feet basis according to the Unit Bid price per vertical foot. Costs for the frame, grates, and lids will be separate from the manhole and catch basin costs.

No. ## - All manholes and catch basins are to be sized according to plan, unless manufacturer recommendations differ. Manhole and catch basin structures are to be precast and will be paid for under the Unit Bid Items for storm Manholes and catch basins.

No. ## - Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 may be cast in place.

No. ## - Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 shall meet the following design specifications and structural notes.

Design Specifications

- All structural construction shall conform to notes indicated on drawings in structural notes section.
- Mortar shall conform to ASTM C 270 Type S
- Testing???

Structural Earthwork Notes

- All structural earthwork shall conform to notes indicated on drawings.

Structural Concrete Notes

- Formwork shall be designed in accordance with the ACI manual of standard practice
- Reinforcing steel shall be detailed and placed in accordance with the ACI manual of standard practice unless otherwise noted
- Concrete protection for reinforcing bars shall be in accordance with ACI
- Do not place cut holes in concrete slabs without prior approval of the engineer
- Concrete shall be air-entrained. Minimum air content shall be 6 percent
- Concrete shall be tested by the owner's testing lab. See specifications for requirements.
- Calcium chloride shall not be used in concrete mix.
- Contractor shall provide concrete mix design and test results.
- A precast structure is allowed.
- Precast contractor shall be responsible for the proper design and reinforcing of precast concrete for handling and erection stresses.
- Precast members shall be attached and supported by the structure as indicated on the drawings.
- Contractor shall design precast top reinforced for self-weight, soil weight, ad HS-20 truck loading.
- Precast members shall be capable of safely supporting any concentrated loads indicated by the structural, mechanical, and architectural drawings.
- Precast contractor shall furnish and install all hangers, clips, or plates which must be precast into the concrete for material handling.
- Provide precast shop drawings stamped by Wisconsin Professional Engineer for review.

Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 shall have flow line grouted into the bottom of the structure.

All storms sewer pipes and box culverts connecting to Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 shall be grouted.

Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 shall have Bentonite seals at each key connection.

All frame, grates, and lids for Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 shall be as indicated on drawings and shall be installed per manufactures instructions.

All frame, grates, and lids for Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 construction shall conform to Standard Specifications for highway and structure construction Current Edition, Section 611.3.3.

All structure steps construction shall meet the following requirements.

- Steps shall meet AASHTO M199.
- Be installed 16-inches center to center maximum spacing.

- Project a minimum clear distance of 4-inches from the wall at the point of embedment.
- Minimum length of 10-inches.
- Minimum wall embedment of 3-inches.
- Ferrous metal steps not painted or treated to resist corrosion shall have a minimum cross section dimension of 1-inch.
- Steps of approved polypropylene plastic coated reinforcement bar are acceptable. Reinforcing bar must be a minimum of 1/2 –inches and meet the requirements in ASTM A615.
- Certification shall be provided that installed steps when tested in accordance with section 10 of AASHTO T280 can withstand a vertical load of 800 LBS. and a Horizontal load of 400 LBS.

Bedding for Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 shall be constructed as indicated on drawings and shall conform to Standard Specifications for highway and structure construction Current Edition, Section 611.3.1.

Excavation and backfilling for Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 shall conform to Standard Specifications for highway and structure construction Current Edition, Section 611.3.1.

Wood weir board grooves for Manholes Diversion Structure 8 shall be as indicated on drawings and installed per manufactures instructions.

The cost for Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8 will be included in the unit bid price for Manholes Structure 41, Manholes Structure 42, Manholes Structure 4, and Manholes Diversion Structure 8. Costs for the frame, grates, and lids for Manholes Structure 41, Manholes Structure 42, and Manholes Structure 4 shall be separate. Cost Manholes Diversion Structure 8 shall include all frames, grates, lids, weir board grooves, and weir boards.

No. ## - All inline manholes and inlets shall to Standard Specifications for highway and structure construction Current Edition, Section 611.3.1 for backfilling around casting.

All inline manholes and inlets shall to Standard Specifications for highway and structure construction Current Edition, Section 611.3.3 for installing frame, grates, and lids.

All inline manholes and inlets will be included in the unit bid price for Manholes/Inlets Inline.

No. ## - The connections to the existing manholes or sewers shall be in a method approved by the Engineer.

The cost for connecting existing sewer lines into proposed sewers or manholes will not be paid for separately, but will be included in the unit bid price for proposed sewers and manholes.

No. ## - The Contractor is responsible for protecting the proposed storm sewer and structures during all stages of construction. Prior to paving, the Contractor shall inspect the storm sewer and structures for damage. All repairs needed shall be at the cost of the contractor to the satisfaction of the City.

Bio-Filtration Basins

No. ## - Contractor shall furnish and install Riffle as indicated on drawings.

The cost for installing Riffles will be paid on an each basis according to the Unit Bid Price for each riffle. Cost should include all materials and work necessary to install each riffle including, excavation, providing and placing limestone, restoring adjacent work, disposal of surplus material, furnishing all labor, tools, and equipment, and incidentals necessary to complete the contract work.

No. ## - Contractor shall furnish and install W-Weir as indicated on drawings.

The cost for installing W-Weir will be paid on an each basis according to the Unit Bid Price for each W-Weir. Cost should include all materials and work necessary to install each W-Weir including, excavation, providing and placing limestone, restoring adjacent work, disposal of surplus material, furnishing all labor, tools, and equipment, and incidentals necessary to complete the contract work.

No. ## - Contractor shall furnish and install engineered soil for the bio-filtration basins, as shown on drawings and conform to the Standard Specifications for highway and structure construction Current Edition, specification section 612 and as provided.

Contractor shall reference the following:

- ASTM International (American Society for Testing and Materials)
  - ASTM C33 – Specification for Concrete Aggregates.
  - ASTM D2434 – Standard Test Method for Permeability of Granular Soils (Constant Head).
- Wisconsin Department of Natural Resources: (WDNR)
  - Conservation Practice Standard (1002) – Site Evaluation for Stormwater Infiltration.
  - Conservation Practice Standard (1004) – Bio-retention for Infiltration.
  - Wisconsin Department of Natural Resources, Specification S100, Compost.
  - Chapter NR 151 – Runoff Management. 1300-13-74 144 of 385

Submittals shall meet the following:

- Shop Drawings: Indicate dimensions of engineered soil areas, piping, pipe inverts, and gradient of slope between corners and intersections.
- Product Data: Submit data on engineered soil, including composition, gradation, and source.
- Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- Provide sample of engineered soil. Provide one 5-gallon container for each 500 cubic feet of material supplied.

For closeout submittal, contractor shall record location of pipe runs, connections, cleanouts, manholes, and principal invert elevations.

Products shall meet the following:

- Engineered Soil: The engineered soil shall conform to the following Specifications:
  - Engineered soil shall consist of a mixture of 70 percent to 85 percent sand and 15 percent to 30 percent compost, by volume.
- Sand
  - The sand shall meet gradations identified in standard spec 501.2.5.3.4 Fine Aggregates, Size Requirements, or ASTM C33 Fine Aggregates, Concrete Sand. The preferred sand component consists of mostly SiO2, but sand consisting of dolomite or calcium carbonate may also be used. Manufactured sand or stone dust is not allowed. The sand shall be washed and drained to remove clay and silt particles prior to mixing.
- Compost
  - Compost material shall meet Wisconsin DNR Specification S100, and the following requirements:
  - Particle Size – 98 percent of the compost shall pass through a 0.75-inch screen.
  - Physical Contaminants – less than 1 percent combined glass, metal and plastic.
  - Organic Matter/Ash Content – At least 40 percent organic matter and less than 60 percent ash content.
  - Carbon to Nitrogen Ratio – 10-20:1 C:N ratio.
  - pH – Between 6 and 8.
  - Soluble Salts – Electrical conductivity below 10dS m-1 (mmhos cm-1).
  - Moisture Content – Between 35 percent and 50 percent by weight.
  - Maturity – The compost shall be aged and resistant to further decomposition and free of compounds, such as ammonia and organic acids, in concentrations toxic to plant growth.
  - Residual Seeds and Pathogens – Pathogens and noxious seeds shall be minimized. 1300-13-74 145 of 385

- The engineered soil mix shall be free of rocks, stumps, roots, brush or other material over 1 inch in diameter. No other materials shall be mixed with the engineered soil that may be harmful to plant growth or prove a hindrance to planting or maintenance. The engineered soil mix shall have adequate nutrient content to meet plant growth requirements.

- Storm Sewer System
  - Underdrain shall be perforated Polyvinyl Chloride (PVC)
    - Pipe: ASTM D3034, Type PSM, Polyvinyl Chloride (PVC) material; inside diameter as indicated on the drawings.
    - Joint Device: Bell and spigot style with ASTM F477 gasket. Joint shall conform to ASTM D3212.
    - PVC underdrain shall have pre manufactured holes.
  - Underdrain Flared End Sections shall be reinforced concrete and confirm to Standard Specifications for highway and structure construction Current Edition, Section 612.2.9.
  - Cleanouts
    - Wye shall be 6x6-inch for 6-inch ASTM D3034, SDR-35, cleanout pipe riser.
    - Riser pipe shall end in solvent welded Genova Products 30340 adaptor and Genova Products 31839 threaded plug, or approved equal.
    - Encase top of cleanout assembly in cast iron casting. Top of cleanout assembly shall be 2-inches below bottom of cover to prevent loads being transferred from frame and cover to piping.
    - Casting shall be Neenah Foundry R-1976 Bolted, or approved equal, cast into 12x12x6-inch thick concrete pad set flush with adjacent grade.
    - Cast-in-place concrete Pad: ASTM C150, Portland cement, and ASTM C33, ¾-inch coarse aggregate and small and large grained sands, 6 percent air-entrained concrete with minimum compressive strength of 3,500 psi.
    - Install cleanouts in accordance with State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for installation of the Work.
    - Form and place cast-in-place concrete pad with provisions for frame and cover.
    - Establish elevations and inverts for cleanouts as indicated on drawings.
    - Mount cleanout surface hub level in grout, to elevation indicated on drawings.
  - Manhole 4-FT diameter shall conform to Standard Specifications for highway and structure construction Current Edition, Section 611 and to SDD MANHOLES 3-FT, 4-FT, 5-FT, 6-FT, 7-FT AND 8-FT DIAMETER.
  - All manholes shall be precast concrete structures, no block manholes.
  - Manhole casting shall be as indicted on drawings and conform to SDD INLET AND MANHOLE COVERS.
  - Storm sewer shall be Polyvinyl Chloride (PVC) Pipe
    - Pipe: ASTM D3034, Type PSM, Polyvinyl Chloride (PVC) material; inside diameter as indicated on the drawings.
    - Joint Device: Bell and spigot style with ASTM F477 gasket. Joint shall conform to ASTM D3212.
    - Install PVC pipe in accordance with ASTM D2321 and ASTM F1668.
    - Install pipe, fittings, and accessories in accordance to the manufacture's instructions.
    - Conform to Standard Specifications for highway and structure construction Current Edition, Section 607.3 for general construction, excavation, backfilling, cleaning out, and restoring site.
  - 12-Inch Flared End Section shall conform to Standard Specifications for highway and structure construction Current Edition, Section 522.2.4.
  - RipRap at 12-Inch Flared End Section shall conform to Standard Specifications for highway and structure construction Current Edition, Section 606.
- Construction
  - Examination
    - Verify trench cut and excavated base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

        - The drainage area shall not contain significant sources of soil erosion that could impact the engineered soil.
    - Preparation
        - Provide a person trained and experienced in the construction, operation, and maintenance of bio-filtration areas and who shall be responsible for construction of the bio-filtration area.
        - The contractor shall not allow construction site runoff from disturbed areas to enter the bio-filtration area during construction.
        - Runoff from pervious areas shall be diverted from the basin area until the pervious areas have undergone final stabilization.
        - Suspend construction during periods of rainfall or snowmelt. Construction shall remain suspended if ponded water is present or if residual soil moisture contributes significantly to the potential for soil smearing, clumping or other forms of compaction.
        - Minimize compaction and smearing of the soils beneath the floor and side slopes of the bio-filtration area, and over-compaction of the engineered soils.
        - During construction, cordon off the area dedicated to the bio-filtration area to prevent access by heavy equipment.
        - Acceptable equipment for constructing the bio-filtration area includes excavation hoes, light equipment with turf type tires, marsh equipment or wide-track loaders.
        - If compaction occurs at the base of the bio-filtration area, re-fracture the soil shall to a depth of at least 12 inches.
        - If soil smearing occurs, correct the smeared areas of the interface by raking or roto-tilling. 1300-13-74 146 of 385
    - Subdrainage Installation
        - Install geotextile fabric as along base and sidewalls of engineered soil area as indicated on drawings.
        - Install underdrain in conformance with requirements of ASTM D2321 and conforming to the requirements specified in Standard Specifications for highway and structure construction Current Edition, specification section 612.
        - Lay pipe to slope gradients noted on Drawings; with maximum variation from indicated slope of 1/8-inch in 10 feet.
        - Place underdrain with perforations facing down. Join pipe with integral bell gasketed joint.
        - Provide and install pipe couplings as required for specific fitting applications.
        - Install stone around underdrain cover and wrap with fabric, as shown on drawings.
- Installation
    - Placement and Settling Of Engineered Soil
        - Prior to placement in the bio-filtration area, pre-mix the engineered soil shall and ensure the moisture content is low enough to prevent clumping and compaction during placement. Place the engineered soil in multiple lifts, each approximately 12 inches in depth.
        - Steps may be taken to induce mild settling of the engineered soil bed as needed to prepare a stable planting medium and to stabilize the ponding depth. The contractor shall not use vibrating plate-style compactors to induce settling.
- Field Quality Control
    - Completed bio-filtration basin shall have no standing water 24 hours after cessation of precipitation. Failure to meet this criterion shall be cause for remediation, as directed by the engineer.
- Permeability Testing
    - Perform a permeability test on each completed bio-filtration basin.
- Protection of Installed Construction
    - Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.
- Cost:
    - The cost for perforated PVC underdrain will be paid for separately, but will be included in

the unit bid price per linear feet for proposed Perforated PVC Underdrain item. This will include providing and installing underdrain, excavation; for wrapping, laying, and back filling.

- The cost for underdrain Flared End section will be paid for separately, but will be included in the unit bid price per Each for proposed Flared End Section item. This will include excavating and backfilling; for providing and placing all materials, including concrete, and reinforcement at each unit, and for the disposal of all surplus material.
- The cost for underdrain cleanout will be paid for separately, but will be included in the unit bid price per Each for proposed underdrain cleanout item. This will include excavating and backfilling; for providing and placing all materials, installing pipe, fittings, and caps, including concrete, and reinforcement at each unit, and for the disposal of all surplus material.
- The cost for PVC storm Sewer will be paid for separately, but will be included in the unit bid price per linear feet for proposed PVC storm Sewer item. This will include providing and installing all materials, including all storm sewer, fittings, materials for sealing joints and making connections to new storm sewer and end sections, excavation, granular bedding and backfill, cleaning pipes, and restoring site.
- The cost for 12-inch Flared End Section will be paid for separately, but will be included in the unit bid price per Each for proposed 12-inch Flared End Section item. This will include providing and installing all materials, including providing, transporting, and installing the apron endwalls; for excavation, including forming bed; and for backfilling; maintaining temporary drainage.
- The cost for Precast Manhole will be paid for separately, but will be included in the unit bid price per Each for proposed Precast Manhole item. This will include providing and installing all materials, including all masonry, conduit for storm sewer connections, steps, and other fittings; for all excavation, backfilling, disposing of surplus material, and for cleaning out and restoring the work site; providing and installing the frame and grate.
- The cost for RipRap Outlet Protection will be paid for separately, but will be included in the unit bid price per Each for proposed RipRap Outlet Protection item. This will include providing and installing all materials, including preparing the bed, riprap, restoring adjacent work, excavation, installing geotextile fabric, disposing of surplus material.
- The cost for furnishing and placing the engineered soil; installing all materials; excavation, and cleaning up any material left over.

No. ## - Contractor shall furnish and install Bio-Filtration Overflow Weir as indicated on drawings.

Bio-Filtration Overflow weir Matting shall be in accordance of Pryamat high performance turf reinforcement mat, or approved equal.

Bio-Filtration Overflow weir shall be installed per manufacturer's instructions.

The cost for Pryamat Overflow Weir will be paid for separately, but will be included in the unit bid price per Each for proposed Pryamat Overflow Weir item. This will include providing and installing all materials, including excavation, preparing the bed, installing matting, anchor trenches, disposing of surplus material, and restoring adjacent site.

No. ## - Contractor shall furnish and install Vegetated Mechanically Stabilized Earth as indicated on drawings.

The cost for installing Vegetated Mechanically Stabilized Earth will be paid on a Linear foot basis according to the Unit Bid Price for Linear foot Vegetated Mechanically Stabilized Earth. Cost should include all materials and work necessary to install Linear foot Vegetated Mechanically Stabilized Earth including, excavation, providing and placing coconut erosion control blanket, restoring adjacent work, disposal of surplus material, furnishing all labor, tools, and equipment, and incidentals necessary to complete the contract work.

Bio-Filtration Basin Landscaping

No. ## - Plant Plugs and Live Whips shall meet the following:

Description
This section describes furnishing and planting plants of the species, varieties and sizes specified and includes furnishing all necessary materials, excavating plant holes, backfilling, watering, heeling in, disposing of surplus and waste materials, and as necessary, care and required replacements pending acceptance at the locations shown on the plans.

Materials
All plant materials shall conform to WisDOT standard specification Section 632.2. Topsoil shall be provided for all planting areas and conform to WisDOT Standard specification Section 625. Topsoil thickness shall be 12-inches thick.

Plant Plugs: Plant plugs shall be container-grown, minimum 2-inch size plugs, tubers, or rhizomes that are a minimum of one year old. Plants shall be from nursery-propagated materials derived from source plants, not wild-collected, and have a healthy, well-developed root system, and grown within a 200-mile radius of the project site. Container-grown plants or plugs must have a minimum shoot height of 6-inches at the time of planting. Plants that show evidence of mold or rot will be rejected. No species substitutions shall be made without written authorization of Landscape Architect.

Live Whips: Whips shall be living woody plant cuttings capable of rooting in moist soils. Whips shall be 1/4 to 1-inch in diameter and 3 to 5-feet in length. Whips shall be fairly straight and have no side branches. Wood shall be 2-7 years old with smooth bark that is not split or furrowed. Whips shall have clean cuts with no damage to bark. Whips shall have been collected in the dormant season after the first hard frost and leaf drop in fall and before buds swell in spring (the beginning of November though the end of April). Whips shall be sprayed with water to keep them moist prior to bagging for storage. Keep cuttings cool and moist in bags, with the addition of peat moss, and in the dark at temperatures approximately 33-40 degrees Fahrenheit prior to planting.

Construction
Delivery, Handling, and Storage: Deliver plants after preparations for planting have been completed and install immediately after delivery. Keep plants moist at all times, water daily or as needed, and provide adequate drainage. If planting is delayed more than six (6) hours after delivery, set plant materials in shade, protect from weather and mechanical damage, and keep moist. Plants shall remain on project site only 32 hours prior to being planted or placed in approved storage. Planting activities for live plants shall be performed no earlier than Mid-April and no later than July 1st or Mid-August through late October under favorable conditions, with required water levels as specified. Supplemental watering may be necessary to ensure survival, at no additional cost to owner. Do not remove container-grown plants from containers until planting time.

Soil Conditions: Neither planting nor other site work shall be carried out in saturated or muddy ground conditions or under other climatic conditions which will inhibit proper execution. No planting shall occur until an acceptable time has expended beyond all application of herbicides or other vegetative controls.

Planting Plant Plugs: All plants shall be handled with care and skill to prevent damage, and shall be packed in a manner to ensure arrival at project site in good condition. Plants shall be arranged in single-species groups or in drifts a minimum 3 and maximum 5 plants per group.

Planting Live Whips: Soak cuttings in water 1-2 days prior to planting. Keep cuttings cool and moist during planting operations. Whips shall be planted vertically with buds pointing upward. Approximately 75% of the whip length shall be inserted into the soil. Two buds or bud scars shall be above the ground after planting. Live plant whips shall be spaced 5’ O.C. minimum.

Measurement
The City will measure plant plugs and live stakes by the number of each individual perennial acceptably completed.

Payment
The City will pay for measured quantities at the contract unit price under the following bid items:

- Per Each *Allium cernuum* (Nodding Pink Onion), Plant Plug
- Per Each *Asclepias incarnata* (Red Milkweed), Plant Plug
- Per Each *Aster novae-angliae* (New England Aster), Plant Plug
- Per Each *Cacalia atriplicifoia* (Pale Indian Plantiain), Plant Plug
- Per Each *Eupatorium maculatum* (Joe Pye Weed), Plant Plug
- Per Each *Eupatorium perfoliatum* (Boneset), Plant Plug
- Per Each *Helenium autumnale* (Dogtooth Daisy), Plant Plug
- Per Each *Heliopsis helianthoides* (Ox Eye Sunflower), Plant Plug
- Per Each *Iris versicolor* (Blue Flag Iris), Plant Plug
- Per Each *Liatris pycnostachya* (Prairie Blazingstar), Plant Plug
- Per Each *Liatris spicata* (Dense Blazingstar), Plant Plug
- Per Each *Monarda fistulosa* (Bergamot), Plant Plug
- Per Each *Ratibida pinnata* (Yellow Coneflower), Plant Plug
- Per Each *Rudbeckia hirta* (Black Eyed Susan), Plant Plug
- Per Each *Rudbeckia subtomentosa* (Sweet Black Eyed Susan), Plant Plug
- Per Each *Rudbeckia triloba* (Brown Eyed Susan), Plant Plug
- Per Each *Silphium perfoliatum* (Cupplant), Plant Plug
- Per Each *Silphium terebinthinaceum* (Prairie Dock), Plant Plug
- Per Each *Solidago ohioensis* (Ohio Golenrod), Plant Plug
- Per Each *Solidago rigida* (Stiff Goldenrod), Plant Plug
- Per Each *Verbena hastata* (Blue Vervain), Plant Plug
- Per Each *Vernonia fasciculata* (Ironweed), Plant Plug
- Per Each *Zizia aurea* (Golden Alexanders), Plant Plug
- Per Each *Cassia hebecarpa* (Wild Senna), Plant Plug
- Per Each *Desmodium canadense* (Canada Tick Trefoil), Plant Plug
- Per Each *Andropogon gerardi* (Big Bluestem), Plant Plug
- Per Each *Carex comosa* (Bottlebrush Sedge), Plant Plug
- Per Each *Carex hystericina* (Porcupine Sedge), Plant Plug
- Per Each *Carex scoparia* (Lance Fruited Oval Sedge), Plant Plug
- Per Each *Carex stipata* (Awl Fruited Sedge), Plant Plug
- Per Each *Carex vulpinoidea* (Fox Sedge), Plant Plug
- Per Each *Elymus canadensis* (Canada Wild Rye), Plant Plug
- Per Each *Elymus virginicus* (Virginia Wild Rye), Plant Plug
- Per Each *Panicum virgatum* (Switchgrass), Plant Plug
- Per Each *Scirpus atrovirens* (Dark Green Bulrush), Plant Plug
- Per Each *Sorghastrum nutans* (Indiangrass), Plant Plug
- Per Each *Spartina pectinata* (Prarie Cordgrass), Plant Plug
- Per Each *Cornus sericea* (Red Osier Dogwood), Live Whip
- Per Each *Salix discolor* (Pussy Willow), Live Whip

Payment is full compensation for providing, transporting, handling, storing, placing and replacing plant materials; for excavating all plant holes, salvaging topsoil, mixing and backfilling; for providing and applying all required mulch; and for disposing of all excess and waste materials.

No. ## - Native Prairie Seed Mixes shall meet the following:

Description

This specification describes custom seed mixes and temporary seeding to be used in lieu of the seed mix options provided in the Standard Specifications. All other portions of Section 630 Seeding from the WisDOT Standard Specifications shall apply to this special provision.

Materials
Seed mixes shall be Detention Basin – Bioswale Seed Mix, and Tall Prairie for Medium Soils as produced by Prairie Nursery, www.prairienursery.com, (800) 476-9453. No Substitutions allowed. Topsoil shall be provided for all planting areas seeded with Tall Prairie Seed Mix and conform to WisDOT Standard specification Section 625. Topsoil thickness shall be 12-inches thick.

Construction
Construction shall be as defined in Section 630 Seeding from the WisDOT Standard Specifications. All existing weed species shall be removed from the seed bed prior to installation. Install seed mixes using WisDOT Standard Sowing Method A and sow at the time of year and seeding rate recommended by the seed producer.

Measurement
The City will measure the seeding bid items by the pound acceptable completed.

Payment
The City will pay for the measured quantity at the contract unit price under the following bid items:

- Sq. Ft. of Detention Basin Seed Mix
- Sq. Ft. of Tall Prairie Seed Mix

Payment for seed mixes is full compensation for providing, handling, and storing all temporary and permanent seed; for providing the required culture and inoculating seed as specified; and for preparing the seed bed including the elimination of all existing weed species, sowing, covering and firming the seed.

No. ## - Manicured Turf Seed Mix shall meet the following:

Description
All portions of SECTION 630 Seeding from the WisDOT Standard Specifications shall apply to this specification.

Materials
Manicured Turf Seed Mix shall be No. 40 WisDOT Standard Seed mix. Topsoil shall be provided for all planting areas seeded with manicured turf seed and conform to WisDOT Standard specification Section 625. Topsoil thickness shall be 6-inches thick.

Construction
Construction shall be as defined in Section 630 Seeding from the WisDOT Standard Specifications. All existing weed species shall be removed from the seed bed prior to installation. Install seed mixes using Sowing Method A.

Measurement
The City will measure the seeding bid items by the pound acceptable completed.

Payment
The City will pay for the measured quantity at the contract unit price under the following bid items:

- Sq. Ft. of Manicured Turf Seed Mix

Payment for seed mixes is full compensation for providing, handling, and storing all seed; for providing the required culture and inoculating seed as specified; and for preparing the seed bed including the elimination of all existing weed species, sowing, covering and firming the seed.