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Plan Review Techniques for Infrastructure Projects

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Plan Review Techniques for Infrastructure Projects

Engineers convey their intentions on a project through the use of a set of drawings and specifications, assembled in a recognizable format, so that a project may be constructed in a direct manner. No two sets of plans for similar projects are exactly alike. They may both be prepared for a similar type of infrastructure to be constructed beneath a roadway surface, and may differ by a street name, the stationing interval or a single digit in a funding code, but they will not be exactly alike. Using one set as a guide for the review of the other set may not always provide suitable results.

The staff of two design teams or two construction teams working on similar projects might not be the same. They may have the same project manager or superintendent, but it is possible for one of the team members to be re-assigned from another project, and for that member to have more or less experience than the other team members.

No single checklist of items will cover all types of sets of infrastructure or roadway plans. Some checklist phrase or suggested review comment can trigger an awareness of another item that might need to be checked, while other comments might generate revisions on sheets that have not been submitted for review, or change the selection of a construction detail or the title of a pay item. A firm or agency may have a published Quality Guidelines Manual which might indicate that reviews will be performed, could include checklists for verification and might require that reviewers of drawings will use color codes to ensure that items have been checked, corrected or approved. In most instances, the actual process for checking, and the potential anomalies that might occur, are generally not part of the publication.

Each line on each sheet must be followed from edge-to-edge of the sheet, as well as checking at the match lines of each sheet to ensure that the line did not change or get overlooked. The line symbol and label cannot change from sheet to sheet. Using stationing at the match lines for each sheet rather than using sheet numbers will alleviate last minute corrections. The relative size or volume of the item represented by each line needs to be understood, since a two-inch gas service line might look the same as a sixty-inch force main. The two items would not occupy the same space. Conflicts and contradictions can be seen if line work is compiled in the logical order of construction operations. Line symbols added to sheets in the latter stages of development often change from sheet to sheet, or are not labeled the same from one sheet to the next, leading to an apparent contradiction and potential loss of communication to the contractor.

Reviews can be performed by upper management, construction staff or by a team of peers with similar experience. The design team might have anticipated that construction will be sequenced in a particular order, but if that order is not made mandatory by a Special Provision, the contractor may submit a different sequence or staging, the staging might be approved, and a change order may be needed in order to accommodate the approved staging.

Personal pride and ego will often contribute more to contradictions and anomalies remaining in a set of contract documents than anything else. No one wants to have their work shown to be deficient, or have their work questioned. This tendency in some organizations will cause a team to withhold their portion of work until the last minute, hoping that it can get submitted too late for any revisions, or without having to defend their work. This action prevents an objective review of the completed work, and might lead to contradictions within a set of plans. Anyone can agree that “errors”, which may simply be a contradiction or an anomaly in the data displayed differently on two or more sheets of the set of plans for the same location that cannot reasonably be explained are possible in the practice of any discipline of engineering. The key is for those “errors” to be found prior to submittal, and for the firm to refrain

from criticism of the “error’, and to view the finding as a positive action which avoided a potential costly situation.

Even the most objective, best-intentioned review can result in a confrontational situation, most likely caused by a bruised ego or a protective over-reaction to the discovery of a flaw. There are various ways to prevent confrontations, such as: with-holding opinions, commentaries, anecdotes and comparisons; avoiding the urge to justify a review comment or re-design an anomaly; and, ensuring that the observed anomaly is in fact displayed on the final product and does not represent work in progress. A simple circling of an element on a sheet does not convey a message, unless that message relates to a misspelling or contradiction on the same sheet. The use of encouragement rather than criticism will aid the process and may lead to more opportunity for the plan reviewer to render further assistance in the preparation and review of other plan documents. Avoidance of the use of editorial comments in the review, or the use of words such as “never”, “should” and “don’t” will also help foster an educational experience rather than a critical one. The reviewer will be in the position to apply knowledge based on experience, and must not be placed in a position of defending comments that are made on an obvious anomaly.

Field Check

One of the most direct methods that can be used to review a set of contract drawings is to conduct a plan-in-hand field check, verifying every line and symbol that is shown on the sheet, and looking at the project limits to see what is being matched at each end of the construction limits. A second method would involve reviewing a photo-log or video of the project site, but the coverage of the photography may not be as thorough as needed to ensure seeing all items.

If time and budget permitted, the entire design team, or at least the project engineers representing each discipline, and at the very minimum, the project manager, could read the scope of work, and then walk the project from end-to-end prior to beginning design activities. Each person sees the project from the perspective of their design specialty, and would generate ideas, questions or make educated decisions based on the knowledge derived from the field. Pavement designers would note the type of paved surfaces, driveways, parking lots and roadside appurtenances. Drainage designers would note the indications of an enclosed drainage system, standing water or overland flow routes. Landscape designers would see the types of trees or the condition of existing plantings in order to assess the ability of the project site to sustain growth of proposed materials. This single event can avoid many of the review comments that are received from the client, and can preserve labor dollars in the budget.

Team Meetings

An understanding of the intended scope of work is crucial to communicate the nature of the project to each member of the design team. Changes in scope might take place during initial or subsequent negotiations or meetings that could have an effect on the work produced. The design criteria to be followed, the client’s preferences for sheet content, scale and format, and local construction expectations for layout and “incidental work” are all issues that will need to be discussed so that all work can be assembled into one set of documents. Some team members might be more familiar with county projects, others with state projects and still others with federal-funded urban projects. All of the various types of funding programs might have particular preferences for sheet content, symbols and level of redundancy. A team meeting would be the appropriate time to raise questions about conflicting items that appear on the screen or might be shown on a data level that is not used by more than one discipline.

Often a design task will correspond with a budget line item. The budget usually provides the labor required to perform the design task one time. A contingency might be included in the budget for overall revisions, but each design task would not have a contingency. Assignment and follow-up of each

design task will ensure that last minute revisions are avoided. Adding the term "by the Engineer" simply postpones the decision to a later date, and can result in a change order.

Sheet Reviews

When drawings were drafted by hand, each original sheet could be overlaid on another sheet to compare line-work using a light table or a window. This technique might not be feasible with reduced-scale plots that are generated by design software. At this time, computer-aided design and drafting software does not have the ability to verify accuracy. Each sheet will need to be reviewed by eye, and the contents compared with other sheets that show the same view. If a reviewer looks at the sheets in the CADD display, the sheet may not have all of the layers or levels turned on, since for instance a drainage design team member might turn off the water-main layers in order to have less clutter on the screen. If the layer that shows a conflicting item is turned off during design activities, and then the layer is not turned on, the conflict may go un-noticed and not be discovered or resolved.

Drawing review often leads to confrontation. No one wants their work questioned. No one wants their level of expertise exposed. The reviewer can only remark on what is seen, not on what was intended to be shown. Experience can be tapped from within the organization, or it can be gained from the project.

Each sheet in a set of plans will need to be reviewed as a stand-alone item, as well as an integral part of a complete set of contract documents. Cross-referencing to other sheets in the same set, or references to other drawings in other sets of plans needs to be precise.

Constructability or Bid Reviews

Once a set of plans is completed, or once it is sent out for bids, the construction team or the bidders will approach the plans using a variety of methods to ascertain staging, controlling items, access and required manpower to accomplish the work.

A constructability review performed by a member of the design team or by a bidder will concentrate on the plans with a logical approach to such items as staging, traffic control, controlling items, schedules and quantities. Reviews by these types of individuals can result in Requests for Information (RFI) to clarify an issue. The reviews are generally made using the entire set of plans, and for the most part, any anomalies or discrepancies that are found by a constructability review performed by the design team might be assumed to be taken care of during construction, whereas the bidder's discoveries could either be reflected in the bids, or result in change orders during construction. The method used by the bidders differs from that used by the design team, since it concentrates on the work to be performed and the cost to achieve the desired results. In some respects, it is the most direct approach involving individuals skilled in plan review, and can often be performed in a shorter timeframe than that required for reviews during design.

Anomalies

Checklists may vary from firm to firm, or from agency to agency. No single list can be expected to cover all of the possible anomalies, contradictions or conflicting information that can appear in a set of contract documents. The following text illustrates examples of situations that were encountered, often repeatedly, during the reviews of hundreds of sets of preliminary engineering reports and contract plans over a span of nearly three decades. Rather than suggest that each element of a sheet be "checked", "verified" or "reviewed", each sheet is provided with a list of prompts to assist the reviewer in resolving anomalies that have been observed on various project. The reviewer can assemble a checklist or use the following list of prompts as a guide for applicable situations. The caution required involves checking an item thoroughly versus checking that an item exists.

Questions for Reviewers

During the course of a career, a person might have the opportunity to review hundreds of sets of contract plans. Over the years, the number and type of questions that arise can continue to grow. Some plan reviewers prepare checklists. However, the content of a checklist may vary, and often cannot be all-encompassing. No singular class or seminar can produce a complete list of situations that can arise on the various sheets of a set of plans. Questions from the staff, the client and from internal reviewers can help to produce a set of contract documents that contains fewer contradictions, anomalies or conflicts, and the questions can also be used as a training aid.

Questions that can arise at various stages of plan preparation include:

- Who should sign and seal the plans? In most licensing jurisdictions, the person who seals the plans is the person under whose direction the plans were prepared. In some smaller firms, the decision on sealing plans is based on the insurance coverage carried by the firm. A person would be best-served by reading the engineering licensing law that governs their particular jurisdiction. In some situations, the application of a seal remains valid for many years, and can be affected by changes in a firm's ownership. If a person seals a set of plans and leaves the organization, the seal and any professional liabilities attached might remain that person's responsibility.

- Why is a professional seal needed on a set of plans? A set of plans for an infrastructure project is designed to serve the public good. The licensing act or law establishing the jurisdiction for the practice of engineering will be very clear on this issue, as well as on many other issues pertaining to the application of a seal.

- Why can't the client always sign the plans? In some jurisdictions, professional liability insurance is calculated based on the number of sets of plans or the total construction value – the amount of potential liability – that a person might have. It would therefore be in a client's best interest to limit their exposure, in the event that they decided to enter private practice and begin sealing their own plans.

- What difference does it make if the client's title is not exact? For some agencies or jurisdictions, the issue of professional liability takes precedence. There may be a clause in the enabling legislature that mentions a specific stake-holder as the identified party to whom all issues of liability will defer. Identifying a person other than the one intended could result in legal complications that could be costly and time-consuming to resolve.

- What difference does it make if the designation of the project does not match the designation in other documents? Some agencies are very particular when matters of project designations are concerned. For instance, a single digit in a project code might direct all documentation regarding the project to a particular archive, and the loss of documentation as a result of a misfiling could be costly.

- Where does one find the official title of the project? Some project titles change from the design phase to the construction phase, so it is necessary to read the agreement for services in order to identify the exact project title used by the client.

- Who assigns the project number? Typically, the client or agency awarding the project will assign a project number. The engineering firm might have a completely different identification or job number for the project.

- Why should the title of the sheet match the title shown in the Index? In some situations, the title on a sheet may contain details, while another sheet may contain all of the client's standard details.

- Will the next person hired on the project know more about the client's requirements? Conversely, the next person arriving on the team could be a recent graduate without client experience.

- Is it necessary to be exact when referencing external specifications? The current or latest edition of a set of referenced specifications might have a different requirement for methods or materials, and the reviewer will need to check for any resulting impact on the set of plans.

- If work is done in other areas of the world, why might there be a concern for the use of the client's pay item terminology? The workforce represents engineers and technicians from a variety of backgrounds.

- Where is the flow-line in a rip-rap-lined ditch? Some would say it is on the top of the rip-rap, others would place it at a design water level. Still others would select the ditch bottom as the flow-line.

- Can the edge of a gravel road be used as a tie point? A tie would be expected to be recoverable and static.

- Won't the contractor be able to infer what was intended by the plans? The concepts of inference and intent often reveal aspects of the design that can be revised to avoid any misconception or interpretation during construction.

- Do italics convey the inflection that is meant to emphasize a point in the text? It is often difficult for some to say what they mean or to express their intent.

The answers to these questions might not be applicable from one agency to another agency or from agency to agency within the same state. A plan reviewer can still perform a review based on a generalized approach to the task.

In a very general approach, any set of infrastructure plans can be quickly checked for anomalies by selecting a representation of the various views of the same location that are found within the plans. For instance, by selecting a half-dozen locations, and then looking at the depiction for that location on the Title Sheet, the Typical Section Sheet, the Removal Sheet, the Staging Sheet, the Plan Sheet, the Underground, Drainage or Utility Sheet, the Grading Sheet, The Cross-Sections and the Erosion Control Sheet, a reviewer can tell whether anomalies exist, and can determine whether a more in-depth review is warranted.

Plan Review Techniques

Technique Number 1

Select a location at the beginning, middle and end of the project. Compare the views on the Typical Section Sheet, the Layout Sheet, the Removal Sheet, the Staging Sheet, the Plan view, Grading, Erosion Control and Cross-Section Sheets. The comparison of the views of these locations on each of these sheets can take a few minutes. If any sheet displays an anomaly, the plan set is a good candidate for a more in-depth review. If there are no contradictions on any of the sheets, it is not a guarantee that anomalies do not exist. It is merely a quick check to determine if further review is

warranted. Given the nature of CADD preparation of sheets, it is quite common for an anomaly to be found using this review technique.

Technique Number 2

Select a location at both ends of the project, then, select a location at regular intervals, including high and low points along a profile, as well as intersecting streets. Compare the views on the Typical Section Sheet, the Layout Sheet, the Removal Sheet, the Staging Sheet, the Plan Sheet, Grading Sheet, Erosion Control Sheet and Cross-Section Sheets. The comparison of the views of these locations on each of these sheets can be performed within an hour or two, depending on the length of the project. If there are no contradictions on any of the sheets, it is not a guarantee that anomalies do not exist, but it is a good indication that a formal review has taken place, and an in-depth review could be warranted as a guarantee to the client that a more thorough review has been conducted.

Technique Number 3

Perform an in-depth review of each sheet of the set of plans, following all references to specifications, details, external codes or criteria. This is a full and comprehensive quality assurance review, and can be performed within a single work-day, once a plan reviewer has developed a methodology and can devote concentration to the task. Checklists and personal insight are useful, however a sheet by sheet review is as close as is humanly possible to assure that a set of plans has the potential to avoid construction changes due to plan contradictions or anomalies.

Technique Number 4

The most effective plan review method, that is the most comprehensive and most likely to avoid confrontation within a design team, resembles Technique Number 3, but begins with a managed meeting at the start of the project. The team members are informed of the necessity to perform a complete, objective review of the project in order to ensure that the firm is meeting its goals for quality, its mission statement, or reducing its financial exposure due to field changes. The team is advised that a designated individual(s) will be responsible for reviewing everything prior to its submittal to the client. The team is advised that all findings of this review will be presented to the associated discipline, and that all anomalies will need to be resolved.

A review of the entire set of plans, and any other documents, including calculations, is performed at each milestone or pre-submittal date. The reviewer(s) will engage freely in conversation with the design disciplines to discuss the findings, and a markup will be retained as a guide for reference at the next review. In this manner, by the final submittal, all of the sheets will have been reviewed, all aspects will be understood and the end product will be as near-perfect as is possible to achieve.

The following is intended to offer suggestions for issues to be reviewed, for the generation of checklists, or as a guide in the review of various plan sheets.

Title Sheet

The Title Sheet is used by most Agencies as the repository of information associated with specifics, such as the project sponsor, funding source, title, location, persons with responsibilities, and the project or contract identification numbers, as well as governing parameters or design criteria. For projects prepared in CADD, a familiarity with the client's library resources will save labor re-drawing an object. Time can also be saved by ensuring that the correct symbols for common objects are being used, since all agencies do not use the same symbols or line weights for every case and contingency. The design team's creativity and individuality might be appreciated, but it can also be costly to revise if the client does not accept the submittal.

A reviewer can verify that:

The Title of the Project is specific, matches the Agreement, Scope and Special Provisions.

The Funding agency, State or local governing body is listed in proper terms.

The requirements for Design Designation are addressed.

The Design and Posted Speed are listed if required for roadway projects or for coordination with lane width and sign sizes.

The Traffic Data matches the preliminary information or is updated by recent counts.

The Project Limits are consistent with the work shown and the text of the scope of work.

Street names match the topography used on each drawing.

Current mapping is provided, showing major route numbers and sufficient detail.

The gross and net lengths of roads affected by the project are consistent with the scope.

Determine who will sign and seal plans representing the design team and the client.

The total number of sheets included may need to account for Standards, “A” and “B” sheets, mandatory “boilerplate” sheets or other specific agency requirements.

Index of Sheets

The Index of Sheets can be as simple as a few lines on the Title Sheet, or it can take more than one sheet just to list all of the sheets included in the set of plans. Local requirements, legalities and client preferences will all have a role in the arrangement and content of an index. Incorrect references may become an element of a change order, thereby requiring an assurance that the references are both accurate and up to date.

A reviewer can verify that:

Each Title listed matches each title shown on the individual sheet title block.

Titles of referenced material such as Standards and Codes are current and applicable to project.

The number of sheets listed matches the total number of sheets included in plan set.

Sheets such as ROW plans and Soil Borings might need to be included.

Sheets listed as “NOT USED” might not constitute a sheet to be counted in the total.

The sheets listed address the scope of work.

Sheets to be included by others are included in the total number of sheets.

The references on each sheet to details and standards are addressed.

General Notes

The General Notes Sheet often presents the most written information in a set of plans. The text can seem overwhelming, or monotonous, or redundant, or outright inexplicable as to source or intent. The General Notes are sometimes applied to a set of plans without taking the opportunity to read the text, determine applicability or relevance, and the result could be an anomaly or a contradiction that requires more time to resolve than reading the notes would have taken in the first place. The presence of a General Note in a set of infrastructure plans prepared for an agency on one project does not automatically guarantee that the same General Note will be used on another project for the same agency. A General Note in one set of plans might have a title that resembles a topic that appears to apply to a similar case. A thorough reading of each note will determine whether the note is applicable. A General Note could have an impact on the Summary of Quantities if the General Note references an external document which requires additional work items in order to complete the work. Close coordination among all design team members will reduce the potential for a costly oversight, or a revision of a cost estimate, or an addendum to advise bidders of the additional work required

A reviewer can verify that:

The use of terms such as "…directed by the Engineer…", "…meet the approval…", "…incidental…" are clear and do not contradict agency requirements.

References to manuals, standards and memoranda are current.

The need for redundancy varies with each client.

Contradictions can be contained in redundancies.

Clients have preferences for inclusion of preliminary commitments from public meetings.

Notes may apply to both design and construction activities.

Read the notes backwards to check for spelling errors.

Read the notes out loud, or have someone read the notes out loud, without inflection.

Dramatic pauses and inflection cannot convey the design intent to the reader, and neither can quotation marks or references to common practice.

Summary of Quantities

A Summary of Quantities gathers the Pay Items in one location, providing an identification number, basis of measurement and intended total quantity for each item. Some agencies also use the Summary of Quantities Sheet to provide a record of the as-constructed quantity for each Pay Item. The content of the Summary of Quantities Sheet is dependent on a concentrated effort to read every note on every sheet in the set of plans, since some disciplines will treat certain work items as coincidental or included with another item of work. As mentioned above, in the General Notes text, close coordination and a thorough reading of the General Notes is necessary to ensure that a reference does not direct another Pay Item.

A reviewer can verify that:

Pay Item titles match client standards, specifications and special provisions.

Pay Item numbers match the pay item based on method of measurement.

Rounding matches client criteria or is otherwise appropriate for the work item.

Pay items contained in referenced standards and details are included.

The exact listing of pay items and quantities is obtained from each design discipline.

Construction codes match funding participation.

Pay items referenced in special provisions and boiler plate checklists are included.

Percentage of funding participation and local matching may exceed budgets.

The timeframes required for construction of an item match the project duration in months, calendar or working days.

Incidental or ancillary items intended to be included in a Pay Item are not included as a separate Pay Item.

Duplications of titles for some structural items such as curing compound or protective wrapping that might be included in another pay item.

Alternate bid packages may need separate sheets.

Schedules of Quantities

A Schedule of Quantities provides locations for Pay Items so that a bidder can quickly determine whether work is isolated or continuous, whether it is concentrated on one side of a project, or if it is affected by construction staging of other items. The nomenclature for the Pay Items is intended to match the label or identification of the Pay Item shown in the Summary of Quantities, the Typical Sections and the Plan views.

A reviewer can verify that:

Similar work is grouped together, such as concrete work, signing, landscaping.

Inverts, offsets and stations match plan views.

Reflect the quantity calculations, traffic staging and directions of traffic flow.

Use the totals as a lead-in to the Summary of Quantities.

Construction and removal of Temporary items may need to be tabulated.

Units of measure match the calculations, Schedules and Summary.

Designer calculates line item sheet by sheet or stage by stage and enters the total.

Contractor reviews quantities by line item and searches for the location of each item.

Designer prepares total based on addition of all calculations.

Contractor prepares bid price based on location of work.

Typical Sections

A Typical Section may be applicable to an entire project, or it may represent a unique segment, or it may be limited to an intermittent situation. It is "typical" in that it applies to the locations indicated, such as "from Station X to Station Y". A Typical Section can provide a snapshot view of all of the components intended to be constructed as part of a project, at the location(s) indicated. The section remains "typical" as long as it is representative of the infrastructure item at the location indicated. If one or another component of the construction materials are changed, or if the shape of a ditch, the width of a parkway or type of curb changes, a different "typical" section or a note advising the extent of the difference in construction would be needed in order to convey this fact.

A reviewer can verify that:

A Typical Section compares satisfactorily to the preliminary sections in a Design Report or similar funding mechanism.

The direction of view can be mirror-image or can be shown down-station.

Views may be directed by client to face down-station, north or south.

Compare the segments covered by the typical section with the cross sections for the same segment.

Compare traffic data with pavement type on a paving project.

Legends and symbols may vary from existing to proposed sections.

Identify location of Profile Grade Line relative to centerline, survey line or other control line.

The range of a variable width item is needed in all views.

Clear zones are coordinated with roadside barriers.

Follow leaders and line-work from notes to corresponding work item.

Sidewalk may need to be re-aligned around trees that are intended to remain.

ROW width matches plan views, cross sections and ROW plats.

Coordinate with pavement that is shown in Standard Drawings or Special Provisions.

Show layers of pavement composition in relative thicknesses.

Layout and Alignment

The Layout and Alignment Sheet provides construction controls such as stationing, elevations, coordinates and relative distances from known or accessible monuments and markers. Control points are sometimes set for a project during the preliminary design phase, or they may be higher-order survey points established long before the project was conceived. The types of control points vary from state to state, from surveyor to surveyor, and from agency to agency. Ground control for a project might be set years before a project is designed. Ground control could be affected by utility work or ancillary improvements that are unforeseen by the agency requesting the proposed project. In the case

of the use of objects such as trees or fences, it is not unusual for a Tie to be unrecoverable at the time that design surveys are done.

The description of a Tie often originates with the survey crew. Directions can easily be mis-interpreted, such as “the southernmost corner of the north landscape timber”. In the event that the directions were inadvertently reversed, a pictorial view of the Tie and the surrounding topography will clarify the intent of the description.

Ties are shown on an Alignment and Ties sheet against the background of all relative topography, normally acquired by survey methods. The Tie could be provided with coordinates, lengthy descriptions as in the case of a foundation for a specific sign or a tree in a wooded area. The names of streets and the nature of the ground surface – gravel, shoulder, pavement or sidewalk - are required to orient the construction layout crew attempting to find the ties.

A tie can also be used to assist the layout of a proposed construction item. A tie may be given to a proposed back of curb, edge of pavement, center of construction or center of right of way. Two points can use the same tie, with different dimensions. It could be costly to re-establish a tie for construction operations months or years after the design has been completed. A quick verification of the relative dimensions can save labor and retain confidence in the plan quality.

A reviewer can verify that:

The proposed alignment fits within the existing (or proposed) ROW.

Bearings between ROW corners differ from bearings of lines parallel to the ROW.

ROW Plats match cross-sections.

Back of curb and face of curb at gutter are two distinct locations.

Top of rail is not the same as top of track tie or top of ballast.

The location of a control point can be misinterpreted.

Avoid placement of control points in traffic lanes or inaccessible locations.

Any street with stationing needs alignment and ties.

Detention ponds may need control or alignment and ties.

The elevation of the top of a fire hydrant may change if hydrant is opened.

Survey ties often contain more detailed information than topographic survey data.

Define the location of stationing – baseline, survey line, construction line, center of ROW.

Benchmarks

A separate sheet is sometimes used to collect all of the various control points, benchmarks and public monuments that are in the vicinity of a project, and have been used or verified to be applicable for horizontal or vertical control in the layout of the project. Benchmarks that are removed by construction operations required by the project can result in a fee to re-establish the benchmark, since the contractor

might perform removal operations of a prominent feature or clear trees before setting a project control line using the benchmark.

A reviewer can verify whether:

Topography details provided by the survey field crew might not match the topography shown on the Plan View if different survey crews gathered the information or if the benchmarks were altered between the time that the initial controls were set and the topography was collected.

A Field Check might not verify the presence of a benchmark.

Construction operations might be such that they eliminate a benchmark on the first day of the project.

Clearing and tree removal operations may obliterate a benchmark.

Removal Plan

In some instances, a separate sheet or series of sheets covering the project limits will show what is intended to be removed on a construction project. Often the removal takes place in the very early stages of a project. It can very often occur immediately after the contractor has mobilized his forces and begun work.

A reviewer can verify whether:

Property corners or Right-of-Way markers might get obliterated.

Benchmarks can be eliminated, such as cut crosses on sidewalks or curbs, spikes in trees, or flanges on fire hydrants to be relocated.

Buildings to be removed may contain a benchmark

Railroad track might be listed for removal, but the ties and ballast might not be mentioned.

Drainage outlets may be connected to active pipes in a wye connection.

Fire hydrants designated for dust control watering are removed in the early stages of work.

Traffic Control

Traffic Control and Traffic/Construction Staging Sheets depict the process by which the designer envisions the work proceeding while maintaining traffic flow. The sheets often address access to the project and to the properties adjacent to the project, as well as the routing of emergency or transit services. Each type of infrastructure project will have different impacts on the movement of goods and services through the area. An underground utility installation might be performed with minimal impacts to the adjacent roadway, but it might have a substantial impact on pedestrian traffic. A parking lot improvement might result in the displacement of vehicles that could then be forced to find temporary parking within the surrounding neighborhood. A roadway project might include a detour that unintentionally affects business traffic in locations far removed from the work zone. For these reasons, the client might have input to the project that could add a stage of construction or revise the order in which work is performed. Close coordination and communication will help in these matters. An infrastructure improvement might be met with profound objection if the project results in the loss of local business, access, routine functions such as mail delivery and garbage collection, or emergency services.

A reviewer can verify that:

Traffic control devices that are required beyond the project limits are shown and their location has been visited in the field, rather than using a stock dimension which might result in the placement of the advance signing in a driveway, intersection, or in the middle of a parking lot.

Sufficient widths are provided in the work zone to allow a paving operation to produce the desired paved width without reducing the traffic lanes.

Clearance is sufficient between work zones and traffic lanes in order to place barricades and accomplish the work required.

Barricades and other traffic control devices must be moved into traffic lanes to make room for access or construction operations.

Details such as the placement of construction signs in driveways could go unnoticed if sufficient topography is not provided for the area where the sign is intended to be placed.

A support surface for placement of barrier wall, impact attenuators and barrels is sufficient.

Barricades are placed on slopes.

Driveways that are hidden by barricades have signing to alert motorists.

Left turns are prevented by lane reductions.

Placing pavement markings occurs under traffic conditions.

Signs that are not needed are covered or removed and returned or restored later.

Sign panels on overhead trusses are moved over appropriate lanes.

Vehicle recovery, crash investigation and areas to handle vehicle problems are provided.

Changing traffic staging occurs overnight or at the beginning of the day, in contrast to work hours mandated by local ordinances.

Turn lanes that are necessary are able to be provided on detour routes.

Detour route signing is provided for all intersecting roads.

Truck restrictions might be in effect on detour routes.

Traffic signal modifications may be needed for detour routes.

Staging accounts for all work shown on all sheets.

Lane configurations, widths and barricades need to continue through match lines from one sheet to the next.

Taper rates cannot be altered to fit the available topography without violating criteria.

Placement of barricades across structures may be restricted by shoulder width.

Traffic surveillance may be needed to restore signing or re-align barricades bumped by traffic overnight.

Pedestrian traffic and access to local residences needs to be addressed.

Parking for businesses and local residences needs to be provided.

Traffic Protection for specialty work, landscaping and punch list items may be needed.

Locations of entry points for material delivery might contradict detours or traffic flow.

Flagging that is marked at exposed or from obstructed locations needs to be checked.

Flaggers are often forced to move into traffic lanes by paving operations.

Parking of personal vehicles in the work zone is often prohibited.

Line of sight between flaggers on two-lane projects is necessary.

Plan Sheets

A Plan Sheet can represent a variety of surface situations, ranging from a driveway, parking lot or permeable landscaped area, to alleyways, streets, highways and expressways. Often a paving sheet is presented as a combination Plan and Profile Sheet, depending on the scale of the sheet that is used, and the amount of information required to be shown on the sheet by the agency.

A reviewer can verify if:

Each line and each symbol can be followed from one end of the sheet to the other.

Each callout for a work item is covered by a Pay Item.

There may be a widening of existing pavement, and the adjacent curb and gutter, shoulder or other pavement is removed and replaced.

Station and offset noted for each change in width, direction or type of paved item.

Comparison of Pay Item to Special Provision and details is correct.

Stationing of a work item is to be the same in each view.

Saw cuts or other specific work is clarified to match the existing at project limits.

The depth of scoring for patch removal may result in excess removal.

Butt joints may be called for on pavement intended to be broken and seated.

Patching is called for on lanes to be removed.

The proposed paved widths match the existing width at ends of project.

Compacted thickness of asphalt compares with calculated tonnage.

The pavement type at ends of project matches existing in order for jointing to be selected.

Access for the various paving machines, delivery of material, tracking mud.

Construction vehicle weight may damage adjacent pavement intended to remain.

Access or staging is provided for paving in areas surrounded by active traffic lanes..

Vehicle wash-out areas are not beyond erosion control measures.

Profiles

A separate sheet is sometimes used for the display of profiles, perhaps due to the scale of the drawing, the vertical range of the profile, or the need to show the relationship between the project profile and elements of infrastructure that are to be crossed. A profile can be shown for a road, a sewer, a water-main, conduits, ditches, canals, railroads, taxiways, pipelines and bridges. In order to ensure that the project presents a smooth transition between the existing top of pavement and the proposed paved surface, a length of existing profile is often provided beyond the project limits.

The profile of the existing ground can often cross open water, streams or channel lining such as rip-rap or broken concrete. Notation or symbols can be used to define the nature of the ground in order to ensure that a proposed item of construction matches the intended end point. A paving terminus that ends at a bridge or at an unpaved section of roadway might be constructed in a different manner than a terminus that ended at a similar paved segment of road. A ditch flow-line that ends at a rip-rap section of channel might need to be revised if it is shown connecting to the top of a pile of rip-rap. A situation such as this would result in the expenditure of additional labor and could require recalculation of ditch hydraulics, re-setting of structure inverts or revisions to cross sections, grading and earthwork.

A reviewer can verify that:

Paving grades are displayed and labeled to match the same control line used on a Typical Section or Cross-Section.

The profile grade line matches the elevations shown on the cross sections.

The profile for a roadway is continuous or modified as it crosses intersections.

A paving profile matches or continues at existing streets at the ends of the project.

Profiles of intersecting ramps are carried across the intersecting pavement, and account for the intersecting pavement cross-slopes.

Driveways are checked to verify whether the change in profile will scrape the underside of vehicles.

Matching structural elements such as joints, approach pavements and abutments do not affect the profile.

Identifying super-elevation transitions with the beginning and ending points.

Labeling the length of vertical curve and verifying that the profile is carried through the curve.

Check for coordination with horizontal geometry.

Railroad crossings are matched at the top of track level rather than the ties or ground level at the tracks.

Bottoms of adjacent piers and footings might be exposed by grading or ditches.

Clearances under bridges are kept within required dimensions.

Drainage

A Drainage Sheet would involve both the existing and the proposed conditions. Coverage of topography beyond the anticipated ends of the roadway improvement would be essential, especially with respect to incoming flows, or attempts to convey surface flow beyond the limits of a project. The existing view can show all sewers, culverts, collection structures, ditches, swales and bodies of water that are to be affected by the construction operations. It can show grading that conveys overland flow into or out of the project site. The proposed view would show the drainage items that were constructed, the existing items that have been relocated, connections to existing drainage systems or outfalls and the final condition of any overland flow patterns. The sheets match each consecutive sheet using stationing or reference lines similar to other plan sheets. However, since drainage work might not follow the same centerline as the roadway improvements, the topography along the route of a proposed sewer or ditch might not be the same as that for the roadway. It is not unusual for the drainage portion of a project to require separate alignment and ties, benchmarks and stationing. The staging of construction of underground facilities such as drainage items, or any pipeline conveyance system, becomes critical when pavement removal or placement of embankment is involved.

A reviewer can verify that:

Storm sewer construction proceeds from low to high inverts.

Large sewers that are entering existing manholes can be accommodated.

A sewer profile requires introducing a siphon to enter existing openings in structures.

Differentiate between callouts for sewer, pipe and culvert.

Verify whether adjusting frames or reconstructing risers are required.

The presence of a manhole at the property line or at the limits of a proposed improvement can be an indication that excavation will encounter underground facilities that will be affected by the proposed improvement.

Look at the sections and details to rotate manhole cones to align with gutters.

Check the lids in pavement and cone sections under paved areas.

Clearance is maintained between the top of the proposed sewer and the components of proposed pavement above the sewer.

Identify whether frames in gutters match the respective curb types.

Look for a requirement for compaction around cone sections.

Prohibit construction or personal vehicle traffic from crossing trench backfill.

See if the plans require cutting sewers lengths to two-decimal places.

The grade of a structure is set at the edge of pavement, face of curb or gutter line.

Ditches require grading beyond construction limits to match incoming or out-letting flows.

Trench backfill limits are within proposed embankments.

The width of the trench is based on the method of installation.

Trenching in front of retaining walls is accounted for in the staging.

Tree removal that is caused by trenching may results in a Pay Item.

Invert measurements are taken at the proper location on the sewer and not on the top of pipe.

Check for evidence of under drain connections to enclosed systems that are removed.

Look for flow arrows that indicate incoming flow collected by flared end sections.

Clarify a ditch bottom or water surface in rip-rap areas.

Blind or wye connections are sometimes made to dissimilar sewer types.

Sewer bends or radii that are beyond recommended limits for sewers.

There may be a requirement for jointing materials at utility crossings.

Steel casings for crossings may be required beneath railroad ballast.

Calculate the anticipated leakage in a curved layout of sewer.

Notes may require water-main quality sewer, ductile iron, poly vinyl pipe.

The class and type of pipe must match the plans and the intended use.

A structure elevation might be taken at the center of structure or center of frame and lid.

Station point on large appurtenances such as junction chambers and drop manholes.

Flap gates and restrictor plates might be blocked by erosion control measures.

A means to maintain ditch flow during culvert replacement might be required.

There may be unintended connections to combined sewer systems.

A design might attempt the collection of ditch flow into an enclosed storm system.

There may be a range of control of inverts during jacking operations.

Some sewer diameters cannot pass through all appurtenances.

Inlets may be called out in approach slabs or transitional pavements.

Storm sewers and under drains through temporary retaining walls and sheet piling.

Staking beyond construction limits for culverts or other underground facilities.

Restrictor plates and flap gates may exceed structure dimensions.

Grading

A Grading Sheet might present the proposed contours of a project site, extending throughout the improvement area, and meeting the existing contours at the construction limits. Proposed contours would meet existing contours on tangent, or at the same curvature. The sheet might indicate whether an area is to be rough-graded and spread with aggregate or topsoil for future seeding or landscaping. The Grading Sheet will also illustrate abrupt changes in elevation at the project limits.

A reviewer can verify that:

Grading is not designated to significant decimal places for aggregate or soil finishes.

Grade stakes might appear to be set in standing water or in paved areas.

Drainage structures or outlet pipes might be buried by proposed grading.

Manholes might protrude from graded side slopes.

Ditch flow lines might be traced to an elevation above under-drain outlets.

Changes in grades match haul calculations.

Tree removal may be caused by grading slopes.

Back-pitching of driveways might be a result of grading.

Side slopes might block under-drain outlets or pipe culvert end sections.

Embankment could be placed in standing water.

Drainage of sub-grade might present compaction issues.

Water from overland flow routes can be trapped at driveways.

Parkway and driveway slopes might contrast.

Contours lines do not cross.

Utilities

A Utility Sheet might be included in a set of plans. The nature or identity of a utility can appear to change as a project progresses, based on the information available. During the preliminary or programming phase, the existence of a utility might be established during a short-duration site visit or a consultation of the latest written information obtainable. The presence of an above-grade frame and lid could indicate the presence of a facility below grade. A Utility Sheet can also show existing underground utilities that might be impacted or might need to be protected during the construction of drainage systems and appurtenances. In some instances, a series of circumstantial events might lead to the need to revise the plans or perform design revisions at the last stages prior to submittal. For instance, the above-grade frame could be fitted with a lid which might contain the word “water”, but the lid could have been switched with a lid from a storm sewer system, if the original lid had somehow been removed and had to be replaced in an expedient manner. The project survey crew might open the lid

and discover that the underground facility is filled with debris but effuses an odor similar to a sanitary sewer system. Preliminary plans could be sent to utility companies in the area without receiving a response from anyone regarding a water system. The design team might feel that the frame and lid aligns with a force main known to pass beneath the area in the same vicinity. Local safety guidelines might prohibit the physical entry of any person into the underground portion in an attempt to clarify the nature of the facility. The plans could conceivably reach the hands of the contractor, and during some excavation operation in the vicinity of the subject lid, a long-forgotten telephone conduit that once belonged to a company that was sold and re-sold and is currently in bankruptcy proceedings is cut, disrupting the signal, and resulting in a costly repair. While there is no way to foresee all possibilities, or to know the history of interaction with a facility, the need for communication and questioning of information is always present.

The reviewer can check to see whether:

Utility companies changed ownership.

There is a difference between public and private utilities.

Compare utility atlases with survey data.

Utility locates performed by the survey crew may vary from the atlas.

Vertical clearances are needed to overhead wires.

Define a requirement for supporting pipes or utilities that cross.

There may be seasonal requirements for utility relocation.

Service boxes may be exposed by ditch grading.

A local agency might establish a priority ranking for utility relocation.

Service connections from relocated utilities might be overlooked.

Water main might be routed through storm sewer or manholes.

The size of existing water main or sanitary sewer is needed.

Sheet piling is sometimes inadvertently directed through utilities.

Power pole bracing might cross driveways and sidewalks.

Cross-Sections

Cross-sections were originally devised as a means for measuring the excavation and placement of material on a project. They were shown at uniform intervals from end to end of a project. Additional sections were provided at the high and low points of a proposed profile. Each section would show the intended final grading condition super-imposed onto the existing ground condition, thereby allowing a measurement in square feet of the excavation or embankment operations that were to be conducted at that location. A review of the cross-sections at the termini of a project will indicate whether all work matches the existing ground. Often the pavement typical section will need to be modified with paving transitions in order to meet the existing paved surface from edge-to-edge of roadway. Curbing, shoulders, sidewalk, ditches or grading transitions can be checked in similar fashion

A reviewer can verify whether there are situations where:

Clearing and topsoil removal will alter the existing ground.

The cross-sections compare correctly with the Typical Sections.

Stockpiles of borrow material, salvaged topsoil and cleared vegetation are designated.

The economics of hauling have been implemented.

Pavement that is designated to be removed is accounted for with embankment or construction of new pavement.

Unsuitable material is removed and replaced with selected material.

Removal of sidewalk due to back slope or sewer replacement is indicated.

Fine grading is required near bridge abutments.

Compaction takes place on top of installed underground pipes, sewers, water-mains.

Trench backfill deductions have been indicated.

Trenching for sewers results in unintended removal of pavement.

Ditch excavation exposes utilities.

Shrinkage factors vary by region.

Erosion control measure may alter existing ground surfaces.

Structural excavation and pavement removal are separate from earth excavation.

Lifts and benching for embankment on slopes is addressed.

Pavement or structural removal may include sub-grade material.

Lime modification in wetland areas and on porous granular backfill.

Backs of curbs need to match or a transition will be needed.

Elevations at the limits of construction must match.

Trapped water conditions are created.

Definition of ditch bottoms for rip-rap areas.

Flow of water is collected from railroad ballasts.

Sections are provided at detention ponds.

Drainage patterns on grading need to match the cross-sections.

Beginning and end of improvement need to match the existing conditions.

Work beyond ROW requires easement or property acquisition.

Construction Details

A Construction Detail might include standardized drawings that are to be used as a control for the construction of items such as pavement joints, roadside appurtenances and structural features. The list could include driveways, drainage structures, fence, ornamental lighting, and urban enhancement such as benches, planters and shelters. For some projects, the standardized drawing might not be applicable in all situations. This would require the preparation of a drawing that shows the particular elements of an item that differ from the standardized drawing. This could be different dimensions, different materials or a completely revised design that is preferable to the standard. For some situations, a detail might be based on literature or photos of a new product that is available and suitable for a project. Other situations require that the intent of the designer be presented in a sketch to serve as a guide for the construction of a special case that has not been encountered in previous projects. Details may require specific components such as joints, steps, surface treatment that lead to additional Pay Items.

A reviewer can quickly:

Identify where the stationing of a construction item is to be found.

Verify that the dimensions of the elements of roadside barriers have been combined for a specific length.

Check the height of a fence and the type of fence posts.

Compare the dimensions of drainage structures needed beneath proposed pavements.

Verify that pavement patching types match the dimensions shown.

See whether rumble strips on shoulders may be a Pay Item.

Check details for gore areas that may not fit the project limits.

Identify whether bridge approach pavement constructed in stages may need detailing.

Spot concrete barrier base placed on top of aggregate shoulder.

Compare the depth of under drain at proposed ditches.

Check to see if driveway construction requirements differ between communities.

Traffic Signals

A set of plans containing temporary or permanent Traffic Signals may appear to present a situation that requires a thorough understanding of the specialty of traffic signal design. However, a reviewer can verify whether:

Temporary traffic signals are erected in locations of proposed construction.

Visibility of temporary traffic signals is impaired by proposed bridges.

Location of bracing for temporary poles crosses driveways.

Span wires and poles cross private property.

Traffic controllers are in ditches or have obscured lines of sight to the approaches.

Pavement removal disables vehicle detectors.

Emergency pre-emption is provided.

Mast arm foundations are set in ditches or on top of sewers.

Electrical service is in existence and at the anticipated location.

Detector loops are placed on bridge decks, across pavement joints or cracked pavement.

Interconnection paths cross bridges, streams, private driveways.

Hand holes are placed on sloped embankment.

Light duty hand-holes are provided in driveways.

Conduit and cable crosses shallow utilities.

The initial controller timing is based on actual or projected traffic.

Foundation diameters are sufficient for the intended number and size of conduits.

Foundations are centered for the appropriate setback from the face of curb.

Overhead clearances are provided for combination poles.

Visibility is adequate to signal heads from tree-lined approaches.

Alignment of foundation caging produces the required orientation of mast arms.

Orientation and alignment of traffic signals and pavement markings is coordinated.

Grounding a traffic controller with exposed wire is not required through a sidewalk.

Lighting

In the same manner that Traffic Signal Plans might appear to require specialized knowledge for a reviewer, Lighting Plans typically include electrical schematics that might seem daunting; however, a reviewer can verify that:

Unit duct is not placed across bridge decks.

Light poles are not placed through sewers or water-main.

Light foundations are not placed in ponds.

Temporary lighting is not placed in temporary pavement.

Aerial wiring across ramps provides the proper vertical clearance for vehicles.

The length of temporary poles on side slopes provides the adequate mounting height.

Light poles may not violate clear zones without adequate protection.

Tree removal may be caused by conduit trenching.

Light poles cannot be placed on top of manholes.

Erosion Control

Activities such as the displacement of material, the stockpiling of topsoil, or the transfer of components from storage to the jobsite, may loosen surface matter which could unintentionally become dislodged and carried away from the jobsite as storm-water runoff. In these situations, a separate set of Erosion Control Plans representing an interim condition for the control of contaminants or sediment might be required. In the case of temporary seeding, it is not unlikely that the newly-established vegetation would need to be removed prior to using the stockpiled materials.

A reviewer can verify that:

Silt or Erosion Control Fence might not fit between the sidewalk and ROW.

Removal of temporary items at the end of construction might need erosion control.

Disposal of sediment collected in traps might result in erosion.

Erosion control might be needed on intersecting streets.

Seeding could be called for over paved areas.

Erosion control would be needed for concrete truck wash-outs.

Repairs after rainstorms might be required.

Erosion of topsoil stockpiles might need to be contained.

Cleanup of tracked mud is often mandated by local ordinances.

Landscaping

Once a project has been constructed, it may be necessary to provide either permanent erosion control measures or vegetation enhancements that will make the project blend into its environs in a more pleasing manner. Special plantings, trees, sod and seed in parkways, particular grasses around ponds or compensatory storage areas and seeding to restore excavation sites may be placed with stations and offsets that are to be laid out as precisely as a length of curb or a paved area. Landscaping could be added to areas adjacent to paving, to embankment side-slopes, to the sides of ditches and to restore the ground at borrow or stockpile sites. The variety of planting possibilities lends itself to the use of symbols, shading and other drafting techniques such as cross-hatching or dotted patterns that might cover wide or irregularly shaped areas of the plans. If these were to be added to the Roadway Plan or the Drainage Plan or the Erosion Control Plan, vital information could become illegible. It is therefore common practice for some agencies to require that the landscape information be provided on separate sheets. Since a plan view ensures that all areas intended to be planted are covered, the

Landscaping Sheet could be based on the topographic information shown on the Roadway or Drainage sheets. The stationing for layout and measurement would remain unchanged. If all of the landscape items were presented in tabular format, such as on a Schedule of Quantities sheet, the layout and measurement would still require that the landscape workers consult a plan sheet that showed the project stationing or control line in order to perform their work. The project limits for landscaping would not necessarily be the same as those shown on the paving, drainage or erosion control sheets.

A reviewer can verify whether:

Small sections of sod may be needed.

Trees may block signs.

Trees may uproot unit duct.

Topsoil, fertilizer, limestone and supplemental watering are needed.

Selection of plant material is relative to the project climate.

Placement of landscaping is identified for areas that receive salt or snow storage.

Seeding is indicated on driveways and sidewalks.

Class of seeding may change depending on location.

Supplemental watering of sod adjacent to seeded areas might cause seed to be washed away or supplemental watering per plan may result in erosion control issues.

Tree root ball may not fit parkway.

Signing

Sign locations are often regulated by specified dimensions suggested in guide publications such as the MUTCD. The location of the sign will need to be cross-checked with other disciplines such as drainage and lighting to avoid placement of a sign that can damage underground appurtenances, or disrupt the intended lighting coverage for a segment of roadway.

Sign panel dimensions will vary depending on the posted speed limit, the location of the sign and the agency's practice. A stop sign used on one project may look the same, but the size may vary based on the speed limit of the roadway. A stop sign, for instance, can be made in four different sizes, and can be special-ordered with folding capabilities for occasional use. Each size is applicable to a different situation. Certain agencies prefer one type of sign post over another, in order to minimize replacement stock. The legends or wording upon the signs would also vary depending on the size of the sign. The lettering is specifically sized to be legible from regulatory distances. Making last-minute plan revisions can affect calculations of panel sizes, method of mounting and possibly require protection such as guardrail.

The reviewer can verify that:

Sign posts do not pierce lighting unit duct.

Signing is provided on intersecting streets.

Signs are not placed on ditch side-slopes.

Sign trusses are not placed in ditches.

Sign posts in clear zones could require protection.

Signs are strapped on concrete light poles.

Pavement Marking

Pavement markings are usually placed in accordance with legal precedent, and are often based on the published guidelines contained in the Manual on Uniform Traffic Devices (MUTCD). Individual states may have their own supplement to the MUTCD, showing specific preferences for pavement markings.

A reviewer can check for:

Different types of markings, such as thermoplastic or epoxy, on the proper surface.

Temporary markings, short term markings and painted markings are differentiated.

Colors of specialty items such as pedestrian crosswalks and sizes of parking lines that may vary from state to state.

Removal of temporary markings is indicated at the end of a project.

Right-of-Way

Right-of-way for a project might be acquired years prior to the start of design of a project, and might be referenced by coordinates or a survey station system that differs from that used in the design. A comparative check of distances and relationships to existing topography will be required in order to import the necessary information from a set of right-of-way plans into a set of construction documents. The parcel of property necessary to construct an infrastructure improvement might be a small portion of a larger tract of land. The legal description of the large tract might contain a point of beginning that is miles away from the location of the proposed improvement. This further complicates the description of an easement or a property acquisition. The stationing, property corners and ties that may appear in the legal description of property can be affected by the proposed work. In some situations, the restoration of survey monuments is the responsibility of the contractor. In other scenarios, the designer would be required to ensure that proposed work does not alter the property corners or affect the ability of the contractor to find or reset the markers at the end of the work.

A reviewer can verify that:

Property corners might get obliterated.

Names of businesses could change.

Buildings to be removed may contain a benchmark.

Railroad rights-of-way may still be in force.

Drainage outlets may cross into private property.