REVISED MINUTES OF THE FIRST MEETING

TECHNICAL ADVISORY COMMITTEE
FOR THE REVIEW AND REEVALUATION OF THE
REGIONAL CONTROL SURVEY PROGRAM

DATE: July 25, 2007

TIME: 9:00 a.m.

PLACE: Commissioners' Conference Room
Regional Planning Commission Offices
W239 N1 812 Rockwood Drive
Waukesha, Wisconsin

Members Present

Kurt W. Bauer Chairman	Executive Director Emeritus, SEWRPC, County Surveyor for Kenosha, Milwaukee, Walworth, and Waukesha Counties
John M. Bennett	City Engineer-Director of Public Works, City of Franklin
John P. Casucci	Survey Land Development Manager, National Survey and Engineering
Harold S. Charlier	Executive Director, Wisconsin Society of Land Surveyors
John T. Ellingson	Wisconsin State Geodetic Advisor, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geodetic Survey
Thomas M. Grisa	Director of Public Works, City of Brookfield
Gregory G. High	Director; Architectural, Engineering and Environmental Services; Milwaukee County Department of Transportation and Public Works
Marcia G. Lindholm	Civil Engineer Senior, City of Milwaukee Department of Public Works
Cecil F. Mehring	Former Manager of Planning and Engineering Services, Racine County Department of Public Works
George E. Melcher	Director of Planning and Development, Kenosha County
Robert W. Merry	Chief Technical Officer, Aero-Metric, Inc.
Kent B. Pena	State GIS Coordinator, U.S. Department of Agriculture Natural Resources Conservation Service
Glen R. Schaefer	Geodetic Engineer, Wisconsin Department of Transportation
Daniel R. Talarczyk	Survey Services Supervisor, Milwaukee Metropolitan Sewerage District
Thomas J. Tym	Head, Technology Services Department, Ruekert-Mielke, Inc.

Members Absent

Michael R. Duckett	President, Duckett Group; Executive Director, Southeastern Wisconsin Professional Baseball District
William T. Wambach	Former District Director, District 1, Wisconsin Department of Transportation

Guest Present	
David Ulatowski	Engineering Technician VI, City of Milwaukee Department of Public Works
Staff Present	
Earl F. Burkholder	Consulting Geodetic Engineer
Donald P. Simon	Chief Planning Illustrator, SEWRPC; Deputy County Surveyor for Kenosha, Milwaukee, Walworth, and Waukesha Counties
Lynn G. Heis	Staff Secretary, SEWRPC

CALL TO ORDER AND ROLL CALL

Chairman Bauer called the meeting to order at 9:00 a.m. Roll call was taken by circulating an attendance signature sheet, and a quorum was declared present.

INTRODUCTION

Chairman Bauer welcomed the Committee members to the Commission offices; and, on behalf of the Commission, thanked the members for their willingness to serve on the Committee, and to make their experience and knowledge available to the Commission as a public service. He then asked each of the members present to introduce themselves and to provide a short description of their professional interests.

CHARGE TO COMMITTEE

Chairman Bauer presented the Regional Planning Commission's charge to Committee (copy attached.) He noted the charge in essence requests a critical review by the Committee of the Commission promulgated and implemented control survey and mapping program, and the formulation of recommendations for any needed changes in the program. There were no questions raised or comments made with respect to that charge.

PROPOSED PROCEDURE

Chairman Bauer outlined the procedure proposed to be followed in the conduct of the Committee's work. He noted that the Committee is to be staffed by Mr. Earl F. Burkholder, PLS, PE, Consulting Geodetic Engineer and faculty member of New Mexico State University. He indicated further, it was hoped the Committee could complete its work in three meetings.

In this, the first meeting, he said, the Committee would review a paper describing the control survey and mapping program promulgated and implemented by the Commission; and would review, discuss, and comment upon, a presentation by Mr. Burkholder setting forth the issues which needed to be considered by the Committee in order to respond to the Commission's charge to the Committee. Mr. Burkholder would then prepare a staff memorandum setting forth the technical and user concern issues involved, together with potential alternative and recommended Commission responses to those issues, giving due consideration to the Committee's deliberations and directions provided at the first meeting.

At the second meeting, he said, the Committee would review a preliminary draft of the memorandum prepared by Mr. Burkholder; and would direct revisions to be made in the memorandum, which the Committee may find necessary or desirable, with particular attention to the recommendations proposed to be made to the Commission.

At the third, and hopefully last meeting, he said, the Committee would review a revised draft of the staff memorandum, again with particular attention to the recommendations contained therein; direct any further changes in those recommendations found necessary, and consider approval of the Committee's recommendations as set forth in the final draft of the memorandum prepared by Mr. Burkholder. Upon approval of those recommendations, the Committee's findings and recommendations, as expressed in the memorandum, would be transmitted to the Commission for consideration and action.

There were no comments or questions concerning the proposed procedure.

DESCRIPTION AND STATUS OF COMMISSION CONTROL SURVEY AND MAPPING PROGRAM

Chairman Bauer indicated a copy of a paper describing the Commission promulgated and implemented control survey and mapping programs within the Region had been provided to all members of the Committee for review prior to the meeting (copy attached). He then undertook a review of the paper with the Committee. The following questions were raised and comments made during the course of the review.

Mr. Charlier called attention to the statement on page 78 of the paper on which the specifications covering the preparation of the cadastral maps were given, and asked about the origin of the specified 2.5-foot or more gaps or overlaps in adjoining property boundary lines that were to be shown on maps. Chairman Bauer indicated this specification was, intended to specify the gaps or overlaps, which as a practical matter, can be graphically shown on the maps. He noted further that the property boundary line dimensions shown on the cadastral maps were ground level dimensions, and noted the practice reflected was not theoretically correct in that those dimensions should be reduced to the map projection used.

In the discussion that followed, it was noted by Mr. Schaefer that the Wisconsin Department of Transportation (WisDOT) had originally introduced the Wisconsin County Coordinate System (WCCS) to avoid the need to apply the combination factor (scale and sea-level reduction factors) used with the State Plane Coordinate system in moving measured or recorded distances between the map projection and ground level – the so called grid to ground conversion. He also noted that the word "System" was singular in the Wisconsin County Coordinate System and the word "Systems" was plural in the Wisconsin Coordinate Reference Systems.

Mr. Grisa noted he was under the impression that the use of the State Plane Coordinate system in its classic form was widely, if not universally, accepted and expressed surprise at the use of the County Coordinate System. He noted the City of Brookfield required all land subdivision plats and certified survey maps be related to that system and that the City's cadastral maps and related land and public works information systems were based upon the State Plane Coordinate system. He expressed concern about the implications of any departure from this historic, and in his opinion, sound practice.

Chairman Bauer noted that, in his opinion, the creation and promulgation of the use of WCCS was a mistake, and reflected poor surveying and mapping practice. He noted that as originally developed by the WisDOT in 1995, the WCCS was in error, and that this error was corrected in 2006, when the new Wisconsin Coordinate Reference Systems (WISCRS) were developed. Mr. Ellingson indicated the WCCS developed in 1995 was, in fact, not in error, but utilized a nonconventional method to produce the grid coordinates, a method that was problematic to some of the user communities and to some software vendors.

Mr. Schaefer noted that a nonconventional method was indeed used in the development of the original County Coordinate systems, and that that method involved, in effect, raising the reference ellipsoid to near ground level, then developing the map projection; as opposed to the conventional approach of simply raising the map projection to near ground level. As a consequence, some users and some software vendors experienced difficulties in using the County Coordinate systems as originally developed He noted further that the reference ellipsoid used in the development of both the WCCS and the WISCRS was the Geodetic Reference System of 1980 (GRS 80); and not the Clark Spheroid of 1866, which was used nationwide in the original development of the State Plane Coordinate systems. This, he said, leads to the use of two geodetic datums – the North American Datum of 1927 (NAD 27) – used for the original State Plane Coordinate system and adopted by the Regional Planning Commission for use within the Region – and the North American Datum of 1983 (NAD 83) – used by the National Geodetic Survey (NGS) in developing a revised State Plane Coordinate system.

Mr. Ellingson indicated that in spite of the original nonconventional definition of WCCS, and the subsequent revision of the county coordinate system, the system was widely used within the State by the WisDOT and by counties and municipalities in the creation of automated geographic information systems including by Waukesha County. Chairman Bauer indicated, and Mr. Tym confirmed, that the county coordinate system was not used by any of the seven counties or 147 municipalities within the seven-County Southeastern Wisconsin Region as a basis for the creation of geographic information systems, parcel based land information systems, or public works management systems, all such systems within the seven-county Southeastern Wisconsin Region were based upon the State Plane Coordinate System—NAD 27.

Chairman Bauer noted, as Mr. Schaefer had indicated, that both the WCCS and the WISCRS were based upon the NAD 83. He noted further that the NGS had, since abandoning NAD 27 for NAD 83, adjusted data on the NAD 83 datum at least four times producing successively the NAD 83 (1986), NAD 83 (1991), NAD 83 (1997), and NAD 83 (2007) adjustments. Mr. Schaefer indicated that common usage refers to the four adjustments on the NAD 83 datum as different "datums," which is technically incorrect; e.g., the most recent adjustment – NAD 83 (2007) – should be referred to as the "2007 adjustment on the NAD 83 datum," but is often commonly called the "NAD 83 (2007) datum."

Mr. Merry noted that in all areas of Wisconsin outside of the seven-county Southeastern Wisconsin Region, most of his firm's mapping efforts were based upon the county coordinate system. He noted that the use of the two county coordinate systems, combined with and the use of different datums, had resulted in much confusion and difficulties in the conduct and use of control surveys and in the preparation and use of maps.
In answer to a question by Mr. Casucci, Chairman Bauer indicated the Commission was not at this time, proposing any changes to the use of the State Plane Coordinate system or NAD 27 nor in the use of the National Geodetic Vertical Datum of 1929 (NGVD 29) within the Region. Mr. Burkholder's report, he said, would have to address this, among other issues. In this respect he noted that the NGS had also adjusted the vertical datum in use within the United States, abandoning the NGVD 29 -- used as a basis for all of the Commission's work in this area -- for a new datum, the North American Vertical Datum of 1988 (NAVD 88). He noted that the differences in these two datums within the Region were just enough to cause confusion and errors, the differences ranging up to a maximum difference of about two-tenths of a foot within the Region. He indicated that, in his opinion, the United States would have been better served had the NGS followed the practice which he understood was adopted in Great Britain, namely to keep the older datums in use for land surveying and public works engineering purposes, and to use the newer datums for military and scientific purposes.

Mr. Talarczyk noted that the Milwaukee Metropolitan Sewerage District requires all District engineering design work to be conducted utilizing the State Plane Coordinate System – NAD 27. He noted that this appeared to present a problem for some vendors who are not experienced in geodetic surveying, and who attempt to utilize Global Positioning System (GPS) technology in field surveys by calibrating GPS measured coordinate values to NAD 27 coordinate values by calibration rather than making proper conversions. Rob Merry agreed with Mr. Talarczyk indicating that when attempts are made to calibrate GPS readings to existing control survey data, and particularly so when different datums are involved, errors may be introduced in a number of ways, some simply through the occupation of control survey station monuments that have been disturbed. Chairman Bauer observed, with respect to the example cited, that anyone following good surveying practice would know if a Commission monument had been disturbed since the Commission's control survey station recovery forms – the so called dossier sheets – contain tie distances to reference marks, which distances should be checked before a monument is used.

PRESENTATION OF ISSUES REQUIRING CONSIDERATION

Chairman Bauer then asked the Committee to, in effect, continue its discussion under Item 6 of the agenda – the presentation by Mr. Burkholder of the issues requiring consideration in the effort to address the Commission's charge to the Committee. He noted Mr. Burkholder had set forth a preliminary list and attendant descriptions of such issues, and that a copy of this list and descriptions had been provided to all members of the Committee for review prior to the meeting (copy attached.) He then asked Mr. Burkholder to undertake a review of the issues and description document with the Committee.

Mr. Burkholder indicated he had prepared the preliminary list and description of issues that needed to be addressed to elicit discussion of the issues and thereby assist in completing a critical review of the Commission's control survey and mapping efforts. Mr. Burkholder stressed that he was present to listen to the comments of the Committee members, which comments he would then consider in preparing a preliminary draft of the desired report to the Commission. He then proceeded with a presentation of the list. The following questions were raised and comments made during the course of the presentation.

Mr. Burkholder noted that the issue of datum definitions had, at this point in the meeting, already been discussed. He noted that this was a major issue with respect to the Commission program, and noted that the Commission had in the past attempted to address this issue by commissioning the preparation of SEWRPC Technical Report No. 34 "A Mathematical Relationship Between NAD 27 and NAD 83 (1991) State Plane Coordinates in Southeastern Wisconsin," December, 1994 and a companion SEWRPC Technical Report No. 35 "Vertical Datum Differences in Southeastern Wisconsin," December, 1995. Copies of these reports, he noted, were available for examination at this meeting.

In answer to a question by Chairman Bauer, Mr. Merry indicated he had used the State Plane Coordinate conversion methodology presented in SEWRPC Technical Report No. 34, and had found it to provide better conversion results than did NADCON, the method promulgated by the NGS for such conversions.

Mr. Schaefer indicated that the Commission, practicing land surveyors, and public works engineers were in reality faced with the existence of multiple horizontal and vertical datums, and that this "fact of life" should not be expected to change. He indicated further that with the introduction and increasing use of Global Positioning System (GPS) technology, the issue of

these multiple datums was a source of potential confusion and error, and it was therefore essential that practitioners gain a good working knowledge of the problems concerned and the means for their resolution. He indicated further that, in his opinion, those means lay in the development of conversion methodologies that provide the levels of accuracies required for land surveying and public works engineering purposes. For certain applications, he said, the desired conversions may require additional field surveys. He also noted that the use of GPS technology required a working knowledge on the part of land surveyors and civil engineers of geodetic surveying principles and practices, whereas historically knowledge of plane surveying principles and practices was adequate.

Mr. Burkholder observed the need to distinguish between absolute and relative values, absolute values being expressed in terms of coordinate values – albeit those values being based upon differing datums; relative values being expressed in terms of direct measurements. When one moves from one datum to another, he said, the shift is in the absolute values, the relative values remain unchanged. The relative value of the data expressed in terms of NAD 27 and NGVD 29 remain valid; when these values are expressed in the context of different datums a problem may be created for some users.

With respect to the issue of the maintenance of, and continued reliance on, monuments as a basis for the control of land and public works engineering surveys, Chairman Bauer distributed a letter and attachments from Mr. Wambach, a Committee member who was unable to attend today's meeting, noting that Mr. Wambach felt very strongly about the need to continue to maintain the monuments marking the U.S. Public Land Survey System. In the discussion which followed, a strong consensus was expressed in the Committee that the monuments marking the U.S. Public Land Survey System within the Region needed to be maintained for both technical and legal reasons as a basis for the conduct of land and public works engineering surveys within the Region.

Mr. Burkholder called attention to the Height Modernization Program funded by the NGS and carried out within Wisconsin by the WisDOT. Chairman Bauer noted that the Commission made a substantial effort to maintain a network of bench marks within the Region that provide orthometric heights at an accuracy level adequate for land and public works engineering surveys. He noted that the introduction of GPS technology raised a question as to whether or not this network should continue to be maintained if it becomes possible to obtain orthometric heights within the Region with sufficient accuracy by GPS technology. He noted further that some consulting firms within the Region were using GPS technology in conjunction with the Commission bench marks to obtain, in effect, geoid heights, and then to use those heights to obtain orthometric elevations in the conduct of sanitary and storm sewer system maintenance.

Chairman Bauer indicated the Commission had received little information about the extent to which the bench marks are used by land surveyors and public works engineers. Messrs. Bennett, Casucci, Grisa, and Talarczyk all indicated their agencies extensively use the Commission bench marks in the conduct of their surveying activities.

Mr. Burkholder noted that the issues of height modernization could also be extended to include the use of ellipsoid heights in place of orthometric elevations. Chairman Bauer observed that this may be another case of geodesists needlessly complicating the work of land surveyors and civil engineers for no good practical reason.

In answer to a further question by Chairman Bauer, Messrs. Bennett, Grisa, and Talarczyk indicated that the Commission bench marks provide an adequate level of accuracy for public

works engineering purposes. Messrs. Merry and Schaefer indicated GPS technology was being used to develop orthometric heights in areas where there is a minimal amount of vertical control to bring such control to a site and then perform spirit level surveys within the site.

Mr. Bennett indicated that, in his opinion, the control survey and attendant mapping system promulgated by the Commission over the last forty years works very well, and that its use has not presented any significant problems within the City of Franklin, nor apparently within all of Milwaukee County and all of the Milwaukee Metropolitan Sewerage District service area. He indicated the decision by the WisDOT to shift to new datums is a cause for concern and the potential impacts of this shift need to be addressed along with the means for resolution. Mr. Bennett further observed that the City of Franklin no longer uses hard copy analogue maps keeping both topographic and attendant cadastral maps in solely digital format. It may be feasible, he said, to convert such digital maps to a new datum by computer manipulation. Chairman Bauer cautioned against total reliance upon digital formats for maps, indicating such reliance places the agency concerned at the mercy of vendor changes in software and hardware systems. He noted that digital maps prepared for Waukesha County approximately two decades ago could no longer be "read," and the costly data would have been lost if hard copies of the maps concerned had not been kept. Mr. Casucci agreed, indicating that vendors were changing Autocad software on a virtually six-month basis at substantial costs to the users.

Mr. Schaefer observed that the reason cited for maintaining hard copies of maps are analogous to the reasons why monuments should continue to be used to perpetuate the location of control survey stations.

Mr. Ellingson said that in his opinion, continued reliance and use of the old State Plane Coordinate System based on NAD 27 was a mistake and consideration should be given to a data conversion, which would modernize the Commission's control survey system. Mr. Merry indicated that, given the constant revision of the horizontal adjustments by NGS, remaining with the Commission's State Plane Coordinate system based on NAD 27 was not such a bad thing. Mr. Casucci agreed with Mr. Merry noting not only that stability in the coordinate values was highly desirable, but that a shift within the seven-County Region would entail massive and costly adjustments to the automated land information systems which have been created within the Region.

Mr. Melcher also agreed with Mr. Merry, indicating Kenosha County had relied on the Commission's mapping system to create the County automated parcel based land information system, which system performed well, and he did not wish to see money wasted in needless changes.

Mr. Grisa indicated if a shift in the Commission's datum and coordinate values was to be considered, it would be essential that those proposing the shift demonstrated the benefits of the shift would exceed the massive costs entailed.

Mr. Tym indicated that certainly any benefits from such a shift were highly problematic. He noted that the relative positions of the control survey monument and the attendant distances and bearings would not change; therefore, he asked, what benefit would accrue to moving the coordinate positions of property boundaries, street rights-of-way, storm and sanitary sewer system, manholes, water system hydrants and valves, public utility poles, and the myriad of details contained in the new, well developed, land information systems within the Region. Mr. Grisa agreed with Mr. Tym indicating that the shifts Mr. Ellingson was proposing had no practical implication for land surveyors or public works engineers, and the confusion that would

be created in the administration of comprehensive zoning ordinances, and in flood plain and wetland regulation, would become a major problem as seen by elected officials.

Chairman Bauer indicated the matter of multiple datums and the need for conversion of coordinate values based upon differing datums was one of the important issues Mr. Burkholder would have to address in his report to the Commission. He noted that changing technology, such as the use of GPS technology, and the introduction of real time kinematic (RTK) surveying techniques based upon continuous operating reference stations (CORS) within the Region made addressing this issue critical.

Mr. Schaefer noted that the WisDOT was in the process of establishing a network of CORS stations within the State for use by the WisDOT in its surveying work. When the network of such stations is in place and found to be operating properly, it is likely the WisDOT will facilitate their use for the conduct of RTK surveys by other public and by private agencies. Mr. Ellingson noted the system would be based upon NAD 83 (2007).

Mr. Bennett said that, in his opinion, Southeastern Wisconsin had one of the best control survey and mapping systems in the world, or at least in the United States, and he has found, through his professional associations, that the system is in fact, the envy of other public works professionals. He indicated further, that the City of Franklin had established its own CORS station and had experienced no trouble of any kind in the use of the Commission coordinate values in the conduct of RTK and other engineering surveys within the City. If the Federal and State governments are determined upon the use of coordinate systems based on other datums, then the matter of conversion between systems will have to be addressed. The Commission system should not however, in any case, be abandoned.

Mr. Schaefer indicated perhaps some additional background information on WisDOT's work would be helpful to the Committee in its deliberations. He noted WisDOT was establishing a virtual reference system utilizing initially 25 CORS stations based upon NAD 83 (2007). The NGS has promised they would provide the parameters identifying the differences between, and the means for converting between, the NAD 83 (2007) adjustment and previously used NAD 83 datum adjustments. The NGS has not as yet provided those parameters, he said. In addition to the use of RTK technology in horizontal survey work, WisDOT desired to utilize this technology to obtain orthometric elevations on points, and to transfer orthometric elevations between points, but realized in the mid-1990s that the ellipsoid heights required to accomplish this were not available at the accuracy required. Therefore, WisDOT conducted observations in 1997 at 78 of the original 80 HARN stations established in 1991. However, the parameters needed to convert between NAD 83 (1991) and NAD 83 (1997) have to date not been provided by NGS. As a result, a number of WisDOT projects are currently using the NAD 83 (1991) adjustment coordinates and some projects are using the NAD 83 (1997), or NAD 83 (2007) adjustment coordinates. He indicated WisDOT addresses this issue by reoccupying common stations and creating its own conversion parameters. Mr. Schaefer noted further that parameters would have to be provided to move between the newer datums and NAD 27 at desired accuracy levels. Depending upon the accuracy levels desired, this may require, he said, reobservation at some points in the older system so coordinate values are available at the selected points in both the old and new systems.

Mr. Casucci indicated issues involving the horizontal and vertical datums should be separated and indicated he would be concerned about any efforts to convert horizontal locations. Chairman Bauer indicated since multiple datums already exist, it would appear that a means will have to be devised by which conversions can be made between coordinates expressed on the

NAD 83 (2007) datum used by the CORS stations being installed by WisDOT, and the NAD 27 datum with sufficient accuracy for land surveying and public works engineering purposes. Mr. Merry indicated it should be possible to accomplish this without additional field surveys, since GPS positioning essentially provides latitude, longitude, and ellipsoid heights.

Mr. Casucci indicated that perhaps the solution would be to utilize latitude and longitude on the dossier sheets and control survey diagrams. Chairman Bauer observed this would not resolve the issue of multiple datums since the values for latitude and longitude derived from different datums would still be different.

Mr. Ellingson suggested a practice be initiated of simply recording positions in NAD 83 (2007) as they are obtained by surveyors when utilizing existing U.S. Public Land Survey monuments. If this were done, he said, over time it should become possible to do a system readjustment and move, thereby, from NAD 27 to the NAD 83 (2007) coordinate values. Mr. Merry disagreed indicating the accuracy of the derived new coordinate values would be a major issue, since it would be unknown if the field operations associated by different land surveyors and public works surveyors were done in a manner which would meet the desired accuracy values. Chairman Bauer agreed, noting that great care had been taken to meet the Commission specified accuracy levels of Third-Order, Class I for the horizontal control survey network, and Second-Order, Class II for the vertical control survey network. This care required rigidly following NGS practices with respect to instrumentation and procedures.

The meeting was adjourned at 12:00 noon for lunch and reconvened at 12:30 p.m.

Chairman Bauer opened the reconvened meeting by noting that the discussion engendered by Mr. Ellingson just before lunch raised the issue of the need for metadata with respect to the Commission control survey and mapping system. He noted that a careful review of the land surveyor certificate on the Commission Record of U.S. Public Land Survey Control Station, the so called dossier sheets, will show that that certificate provides all of the needed metadata with respect to the U.S. Public Land Survey corner perpetuation involved. The certificate sets forth the "pedigree" of corner monumentation extending as far back in time as possible, often to the original work of the U. S. Government surveyors in 1836. With respect to the coordinate values, the metadata exist in the reference on the sheets to the accuracy levels of the horizontal and vertical control surveys concerned, namely, Third-Order, Class I and Second-Order, Class II, respectively. The field and computational practices involved in the conduct of the surveys follow NGS specifications with respect to both instrumentation and use of that instrumentation. The metadata for the topographic maps consist of the notation on each map sheet that the map meets National Map Accuracy Standards; compliance with those standards having been field checked by the Commission staff. Metadata for the cadastral maps consist of the notation on each map sheet that the map meets published Commission specifications governing the preparation of the map. The issue of the provision of metadata for the attribute data used in the compilation of the parcel based land information and public works management systems is the responsibility of the counties and municipalities involved in the creating of those systems. He noted that the provision of metadata for control survey data developed by the conversion of the existing Commission State Plane Coordinates would be another issue Mr. Burkholder would have to address in his recommendations to the Committee and the Commission.

In answer to a question from Chairman Bauer, Mr. Schaefer indicated with respect to vertical control, WisDOT was utilizing the NAVD 88 datum. Mr. Schaefer noted that the Height Modernization Program was conducted by WisDOT in five phases, to date, covering different geographic areas of the State. Upon completion of those first five phases, it was determined to

adjust all differential level data acquired and the adjustment to be constrained by only two points in southwestern Wisconsin. As a result, the elevations as determined by the adjustment made in 2007 are different from the elevations for bench marks in southeastern Wisconsin which were previously published in 2004. No means for developing and presenting the metadata in a readily useable form has as yet been developed by the NGS. Consequently, WisDOT is using the syntax of NAVD 88 (1991) for the first adjustment and NAVD 88 (2007) for the most recent adjustment. Data adjusted in 2004 are based on the NAVD 88 (1991) adjustment.

Mr. Charlier indicated that there had been no discussion of the potential costs involved in any recommended changes to the Commission system, and asked whether the provision of such costs was a responsibility of the Committee. Chairman Bauer responded that Mr. Burkholder would, in his report, have to include estimates of the costs of the implementation of any of his recommendations, together with potential sources of funding.

In answer to a question by Mr. Tym, Mr. Burkholder indicated his report would have to identify alternative approaches to the resolution of the issues identified, together with a preferred alternative. Chairman Bauer noted in this respect, that doing nothing was always an option, and that even the maintenance of the U.S. Public Land Survey corner monuments could be abandoned and the use of vertical monuments substituted. The actual monuments, he said, were being disturbed or destroyed at the rate of approximately 4 percent a year.

Mr. Grisa indicated he was uneasy about Chairman Bauer's comments concerning a do-nothing option, the implication being that such an option would have zero costs. In reality, he said, that option would carry with it major costs, not only in land and public work engineering survey operations which would be carried out in the absence of a monumented control survey network, but in related potential errors in the administration of land use control ordinances and in the construction of facilities.

Mr. Grisa asked if Mr. Burkholder's report would document what other metropolitan areas in the U.S. may be doing in this respect, and what institutional structures were being used for the programs concerned. Chairman Bauer indicated the scope of work and funding for Mr. Burkholder's efforts did not extend to include a survey of practices elsewhere. He noted that automated geographic information, parcel based land information, and public works management systems were being created in a large number of places and that articles describing those efforts occasionally appear in trade publications such as *Public Works Magazine* and *POB,* but rarely in peer reviewed journals. He noted that it was his experience that the creation of these systems was generally the purview of data management personnel who have very little in-depth understanding of geodesy, survey control, or mapping.

Mr. Merry observed that the Commission has compiled a massive, invaluable database which supports the efficient conduct of land and public works engineering surveys within the Region, and the preparation of the foundational elements of automated land and public works information systems. He also stated that the area stands well ahead of the rest of the nation in this respect, having done for decades what other areas are only now beginning to do.

Mr. Grisa noted that if the Commission discontinued its operations in the control and survey mapping areas, then the question would have to be answered as to how that work would be performed – at the individual county or municipal level, or by the creation of another area-wide entity.

Chairman Bauer asked for comments on the adequacies of the record of U.S. Public Land Survey Control Station sheets – the so called dossier sheets – and the control summary diagrams. He noted that while there are reference bench marks set for every remonumented U.S. Public Land Survey corner, other bench marks exist in the area, including NGS, U.S. Geological Survey, WisDOT, Milwaukee Metropolitan Sewerage Commission, Racine County, City of New Berlin, City of Milwaukee, and Commission bench marks, ranging in order from first through third order, and that the Commission maintains a file of these bench marks that is available to potential users. The dossier sheets, he noted, contained to the extent practicable, an azimuth mark. In addition to these marks – which usually consist of another U.S. Public Land Survey corner visible from the corner concerned, the Commission maintains a file on Commission traverse stations, which are sometimes useful in the conduct of local surveys, and the data for such stations are available from the Commission.

Ms. Lindholm indicated that the control summary diagrams are sometimes reissued with changes in the distances and bearings concerned without accompanying revised dossier sheets, so that the reason for the changes are not readily apparent – being potentially attributable to either resurveys or to changes in monumented corner positions or both. A means for correcting this deficiency would be helpful, she said.

Mr. Ellingson indicated that if the Commission could solicit and obtain data on the coordinate positions of the monumented corners as determined on an ad hoc basis by the field reoccupation and use of the corners from the users, and if the quality of the coordinate data submitted was controlled, this would over time provide a valuable database correlating NAD 27 with the new NAD 83 (2007) positions. A compilation of such data over time would make a future translation possible at minimum cost. Mr. Casucci agreed with Mr. Ellingson indicating that the collection and cataloguing of such GPS observations would be desirable.

Mr. Schaefer cautioned that if a means of converting from NAD 27 to NAD 83 (2007) is developed which provides sufficient accuracies for the uses intended and if new field observations are made through the ad hoc reoccupation of a station using GPS technology, and if such resurvey indicates a discrepancy between the coordinate values concerned, care will have to be taken to determine the reason for the discrepancy; which could lie in, among other sources, the field procedures used, or in some cases, in disturbance of the monument concerned.

There being no further questions or comments, Chairman Bauer attempted to summarize the Committee deliberation in order to assist Mr. Burkholder in the preparation of the preliminary draft of his report. Chairman Bauer indicated he perceived a Committee consensus exists with respect to the following points:

1. Land surveyors and public works engineers practicing within the Region have found the control survey system and attendant large-scale mapping program promulgated by the Commission to be adequate for the conduct of land and engineering surveys within the Region, and as the foundational elements for the creation of good automated parcel based land information and public works management systems; the horizontal datum utilized being NAD 27 and the vertical datum utilized being the NGVD 29.

2. Land surveyors and public works engineers were, in reality, faced with the existence and use of multiple horizontal and vertical geodetic datums within the Region, and that this situation should not be expected to change.

In this respect, four horizontal adjustments on the NAD 83 datum have been made all of which are in use within the seven county Region since the abandonment of the NAD 27 datum by NGS: NAD 83 (1986), NAD 83 (1991), NAD 83 (1997), and NAD 83 (2007). To date, two vertical adjustments on the NAVD 88 datum have been made by NGS upon its abandonment of the NGVD 29 datum; namely NAVD 88 (1991) and NAVD 88 (2007). All of these adjustments result in shifts in the absolute position of the points involved, but do not significantly change the relative positions of the points to other points within the Region; an exception being when a new value is assigned to a monument, which has been subjected to local movement.

The abandonment of the NAD 27 datum and adoption by the NGS of the NAD 83 datum gives rise to the existence of two State Plane Coordinate Systems within the Region. Moreover, the decision by the WisDOT to create and utilize County Coordinate systems in order to eliminate the need to make grid to ground corrections creates a third coordinate system within the Region. All land surveys recording the creation of land subdivision plats and certified survey maps within the Region, and all automated, parcel based land information and public works management systems created within the Region by the seven counties, the Milwaukee Metropolitan Sewerage District, the individual municipalities and the Commission staff are based on the State Plane Coordinate System, NAD 27.

3. The Commission promulgated control survey system based upon the NAD 27 and NGVD 29 datums have been used within the Region for over forty years in the conduct of land and engineering surveys; the preparation of land subdivision plats and certified survey maps; the compilation of large-scale topographic and cadastral maps; and in the creation of extensive parcel based land information and public works management systems.

   The most recent application of the Commission survey control network has been in the operation of the Diggers Hotline Program within the Region which utilizes maps prepared to Commission standards, and are based on NAD 27. The Wisconsin Electric Power Company has indicated it is able to save over $1 million per year through the ability to accurately place, in a timely way, new subdivision plats on Diggers Hotline maps compiled to Commission standards and on the Commission promulgated datums.

4. The introduction of GPS technology makes it imperative the Commission address the issue of the existence of multiple datums and multiple adjustments in order to preserve the utility of its horizontal and vertical control survey network. GPS survey techniques provide highly-accurate horizontal positions in the form of earth centered latitude, longitude, and ellipsoid heights. The ellipsoid heights could be converted to orthometric elevations if geoid heights concerned are known with sufficient accuracy for the purposes intended.

   The use of GPS technology will be further facilitated within the Region by the establishment by WisDOT of continuously operating reference stations (CORS) within the Region that will facilitate the efficient conduct of real time kinematic survey operations within the Region. The CORS stations are to be related to the NAD 83 (2007) datum.

5. Given the changes in geodetic datums and survey techniques, it will be important, if not essential, for the Commission to develop a means for converting between horizontal

positions expressed in NAD 27 coordinates and such positions expressed in NAD 83 (2007), and between NGVD 29 and NAVD 88 (2007). The Commission has already developed a means for such conversion between NAD 27 and NAD 83 (1991) and between NGVD 29 and NAVD 88 (1991). These methods are set forth respectively in SEWRPC Technical Report No. 34, *A Mathematical Relationship Between NAD 27 and NAD 83 (1991), December, 1994* and SEWRPC Technical Report No. 35 *Vertical Datum Differences in Southeastern Wisconsin, December, 1995.* These conversion methods are sufficiently accurate for most land survey and public works engineering purposes, although not for control survey purposes.

6. The continued use of the Commission's control survey network based upon the NAD 27 and NGVD 29 datums will require understanding by land surveyors and public works engineers of the relationship between these datums and the NAD 83 (2007) and NAVD 88 (2007) datums; of the means for converting between these datums; and of accuracies, both absolute and relative, involved in the conversions.

7. The costs and benefits entailed in any proposed conversion of Commission data from NAD 27 and NGVD 29 to NAD 83 (2007) and NAVD 88 (2007), would have to be assessed when consideration of such conversion.

OTHER BUSINESS AND CONSIDERATION OF DATE AND TIME OF NEXT MEETING

Chairman Bauer noted that he had already reported the only correspondence received and addressed to the Committee, namely Mr. Wambach's letter of July 28, 2007, concerning the importance of monuments in the preservation and use of the U. S. Public Land Survey System, (copy is attached to these minutes.)

Chairman Bauer then asked the members of the Committee if there were any further business to consider. There being none, Chairman Bauer then asked the Committee to consider a date and time for the next Committee meeting.

After a brief discussion, it was agreed the next meeting of the Committee would be held on Friday, October 26, 2007, at the Commission offices beginning at 9:00 a.m.

ADJOURNMENT

There being no further business to come before the Committee, on a motion by Mr. Melcher, seconded by Mr. Bennett, and carried unanimously, the meeting was adjourned at 3:45 p.m.

Respectfully Submitted,

Lynn G. Heis
Committee Secretary

KWB/lgh
01/02/08
#129047 v2 - C/S - Minutes 1st Meeting

ATTACHMENT I

COMMISSION CHARGE TO COMMITTEE

COMMISSION CHARGE TO COMMITTEE

The Regional Planning Commission has, for over 40 years, promulgated and been engaged in the establishment of a control survey network within the Region intended to serve as a framework for the conduct of land and engineering surveys; for the preparation of large scale topographic and cadastral maps; and as a sound foundation for the creation of parcel based land and public works information systems within the seven county Southeastern Wisconsin Region. Given that the Commission recommended control survey network has now been in place and in use for some time, and given the major changes that have occurred in surveying and mapping technology over the last approximately twenty years, the Commission believes that a critical review and reevaluation of the status, and continued utility, of the network, and of the Commission's role in the perpetuation of that network to be in order.

Accordingly, pursuant to Section 66.0309(7) of the Wisconsin Statutes, the Commission has established a Technical Advisory Committee to assist it in the desired review and reevaluation of the regional control survey and mapping program. The Commission desires the Committee to:

1. Critically review and reevaluate the status and continued utility of the Commission control survey network;
2. Recommend any needed changes in the network and in the means for its perpetuation, maintenance and use; and
3. Recommend the Commission's role, if any, in the perpetuation, maintenance and use of the network and identify any attendant funding requirements and sources.

In conducting the desired critical review and reevaluation, the Committee should give due consideration to the continued need for the control survey network to provide a framework for the conduct of land and engineering surveys within the Region; and to serve as one of the foundational elements for automated parcel based land and public works information systems within the Region.

* * *

KWB/lgh
06/25/07
#129038 V1 - Commission Charge To Committee

ATTACHMENT II

A CONTROL SURVEY AND MAPPING PROJECT FOR AN URBANIZING REGION

A Control Survey and Mapping Project for an Urbanizing Region

ABSTRACT: In 1964, the Southeastern Wisconsin Regional Planning Commission proposed a large-scale topographic and cadastral mapping program for its 2,689 square-mile seven-county planning area. The integrated maps were to be based upon a then unique system of survey control which combined the U.S. Public Land Survey System with the State Plane Coordinate System, and which could provide a sound basis for the conduct of land and engineering surveys throughout the planning area. The Commission has pursued implementation of the recommended control survey and mapping program for 40 years. Under the program, all 11,753 U.S. Public Land Survey corners within the planning area have been remonumented and placed upon the State Plane Coordinate System by high-order traverse and global positioning system surveys. Elevations of bench marks accessory to the remonumented corners have been obtained by high-order differential level circuits, thus placing a monumented control survey station of known position on both the U.S. Public Land Survey and State Plane Coordinate Systems, and of known elevation, at one-half mile intervals throughout the planning area. Large-scale topographic maps have been completed for about 89 percent of the planning area and companion cadastral maps for about 76 percent of the planning area. The mapping and control survey system has served the area well over time, facilitating area-wide and local planning, engineering, and surveying operations. Importantly, the mapping and control survey system has provided a sound basis for the creation of computerized, parcel-based land and public works information systems within the planning area.

Introduction

Southeastern Wisconsin is one of the large urbanizing regions of the United States. The seven constituent counties comprising the region—Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha—have a combined area of 2,689 square miles, representing about five percent of the total area of the State. The region, however, contains about 36 percent of the resident population of Wisconsin, provides about 37 percent of the total employment in the State, and contains about 40 percent of all the tangible wealth of the State, as measured by equalized assessed valuation. There are 147 cities, villages, and towns within the seven-county region, which increasingly function as a single socio-economic unit.

The extensive land-use development and redevelopment occurring within the region generates a high demand for land and for supporting public works facilities of all types; and, in turn, for the services of the professionals involved in surveying and mapping; transfer of title to land and improvements; assessment and appraisal of real property; and construction and reconstruction of public works facilities. The proper planning and design of land-development projects and of supporting public works facilities within the region require constant attention to two factors: the land itself with its topography and other physical characteristics, and the boundaries of real property ownership. Definitive information about these two factors is essential if land is to be properly developed, and if supporting public works are to be soundly conceived and effectively executed. The need to provide this information, in turn, generates a need for a control survey network, both as a basis for the production of adequate topographic and cadastral maps, and as a basis for the cost-effective execution of land use and engineering surveys which can be properly integrated on an area-wide basis.

Kurt W. Bauer, P.E., RLS, AICP, Executive Director Emeritus, Southeastern Wisconsin Regional Planning Commission, P.O. Box 1607, Waukesha, Wisconsin, 53187-1607: Tel: 262-547-6721; Fax: 262-547-1103; E-mail: <dsimon@sewrpc.org>.

Conceptualization of the Proposed Control Survey and Mapping Program

The Southeastern Wisconsin Regional Planning Commission was created pursuant to State law in 1960 as the official planning agency

for the seven-county southeastern Wisconsin region. From its inception, the Commission recognized the need for accurate large-scale topographic and cadastral maps as a basis for a sound regional planning program; and the concomitant need for the establishment of a control survey network as a basis for the preparation of the needed maps.

In February 1964, the Commission published a report setting forth a recommended large-scale topographic and cadastral mapping program and an attendant—at the time—unique control survey system, both as a basis for the preparation of the needed maps and the conduct of land and engineering surveys within the seven-county region (SEWRPC 1964).

In the report, the Commission held that it was essential that the control survey system meet two basic design criteria if the maps based upon it were to be effective planning and engineering tools. First, the control survey system was to permit the accurate correlation of real property boundary line maps with topographic maps. Second, the control survey network was to be monumented on the ground so that lines on the maps could be accurately reproduced in the field, when planned land-use development and supporting public works projects reach the construction stage. That is, for planning and engineering purposes, the control survey system was to provide not only the foundation for the preparation of maps which accurately reflect both topographic and cadastral conditions, but also maps with lines which could be readily and accurately reproduced upon the ground as well. The topographic and cadastral maps were to be prepared at scales large enough not only for comprehensive planning, but also for detailed site-development planning and preliminary engineering. Importantly, the topographic and cadastral maps were to be based upon a common control survey network so that the two types of maps could be accurately correlated.

Adopted Control Survey and Mapping Program

Based upon the requirements set forth in the conceptualization stage, the Commission adopted a then unique control survey system which combined the U.S. Public Land Survey and the National Geodetic Control Survey Systems. The system required the relocation and monumentation of all U.S. Public Land Survey section and quarter-section corners, including the centers of sections, and the utilization of these corners as stations in Third Order Class I traverse surveys and Second Order Class II differential level surveys; the high-order traverse and level surveys being tied, respectively, to the national horizontal control survey system and the national vertical control survey system.

It was determined that these orders of control survey accuracy would be adequate as a basis, not only for the needed mapping, but also for the conduct of land and engineering surveys throughout the region. The traverse network was to establish reliable grid lengths and grid bearings for all quarter-section lines, as well as the geographic positions, in the form of state plane coordinates, of the U.S. Public Land Survey corners; while the level network was to establish reliable elevations for the monuments marking the U.S. Public Survey corners and of certain accessories thereto. The State Plane Coordinate values were to be based upon the North America Datum of 1927 (NAD 27), while the elevations were to be based upon the National Geodetic Vertical Datum of 1929 (NGVD 29)—the datums at that time promulgated by the federal government.

The adopted control survey system provides a common system of control for real property boundary lines as well as for topographic mapping, and for the conduct of both land and engineering surveys. Since all new land subdivision plats must, by State law, be tied to corners established in the U.S. Public Land Survey, and since the accuracy of these plats can be controlled by local land subdivision regulations, the property boundary line maps can be readily and accurately updated and extended into newly developing areas. By locating and monumenting the U.S. Public Land Survey corners and accurately placing these corners on the State Plane Coordinate System, it becomes at once possible to prevent the future loss of these corners and to make the use of the State Plane Coordinate System practical for land and engineering surveys.

The ability to accurately correlate topographic and real property boundary line data by simple overlay techniques (analogue or digital) provides great savings in research time during the planning and design phases of municipal public works projects. Such correlated information makes possible the consideration and analysis of many alternative configurations for such proposed public work facilities as drainage and flood control works, trunk sewers, water

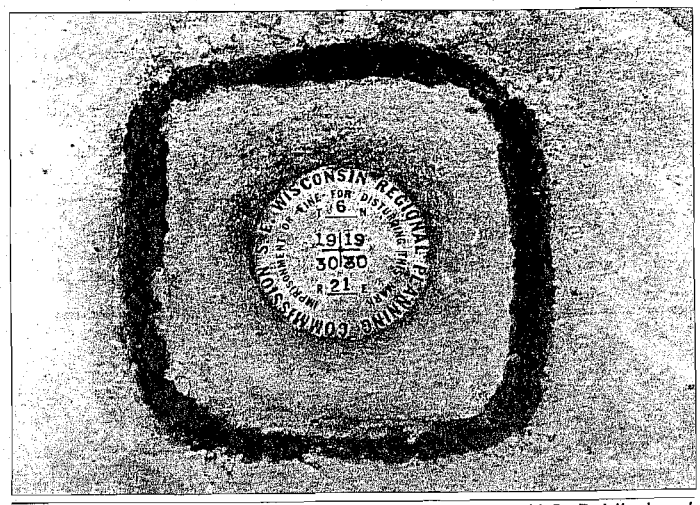


Figure 1. A survey monument installed to mark a U.S. Public Land Survey corner in the traveled way of a road. The monument is set slightly below the surface of the road. In open areas, monuments are set flush with the surrounding surface.

transmission lines, and major traffic ways, and thereby consideration and evaluation of many alternative solutions to drainage, sewerage, water supply, and transportation problems.

The adopted control survey system places a monumented, recoverable control survey station of known position on the U.S. Public Land Survey System and the State Plane Coordinate System, and provides bench marks of known elevation, at approximately one-half-mile intervals throughout the planning area. This monumented control survey network not only expedites the conduct of surveys that are made almost daily, year in and year out, by public work agencies for planning, design, and construction layout purposes, but also correlates and coordinates all survey work throughout the planning area. In this regard, the adopted control survey system is particularly valuable in providing for the preparation of accurate as-built records for the mapping of underground utilities.

The adopted control survey system also makes the State Plane Coordinate System available, as a practical matter, for property boundary survey control, without violating long established principles of boundary law and land survey practice. Importantly, the system provides the foundation for the creation of modern, automated, parcel-based, land information systems and public works management systems.

Specifications for Control Survey and Mapping

The specifications governing the control survey work require that the monuments placed to mark the located public land survey corners consist of pre-cast, reinforced, concrete monuments having engraved brass caps embedded in the tops (Figure 1). The monuments are usually set flush with, or set slightly below, the surface. The set monuments are referenced by measured ties to at least four witness marks. A U.S. Public Land Survey monument record—or dossier sheet—is prepared for each corner monumented so as to facilitate its ready recovery and use. These dossier sheets are prepared in an 8.5 by 11 inch format and identify the corner, the state plane coordinates of the corner, and the elevation of the monumented corner. The sheets contain a sketch showing the monument erected in relation to the salient features of the immediate vicinity—i.e., all witness monuments set together with the attendant ties to the corner, the elevation of supplementary bench-marks, and a bearing to an azimuth mark visible from the station. The dossier sheets also contain a surveyor's affidavit indicating how the corner was located and identifying any discrepancies between the corner as located and any previous locations (Figure 2).

The specifications require that the horizontal control surveys used to determine the State Plane Coordinate positions of the monumented corners meet Third Order Class I accuracy, as defined by the Federal Geodetic Control Committee. Furthermore, they require that the vertical control surveys used to determine beach wash elevations meet Second Order Class II accuracy, as defined by the Federal Geodetic Control Committee.

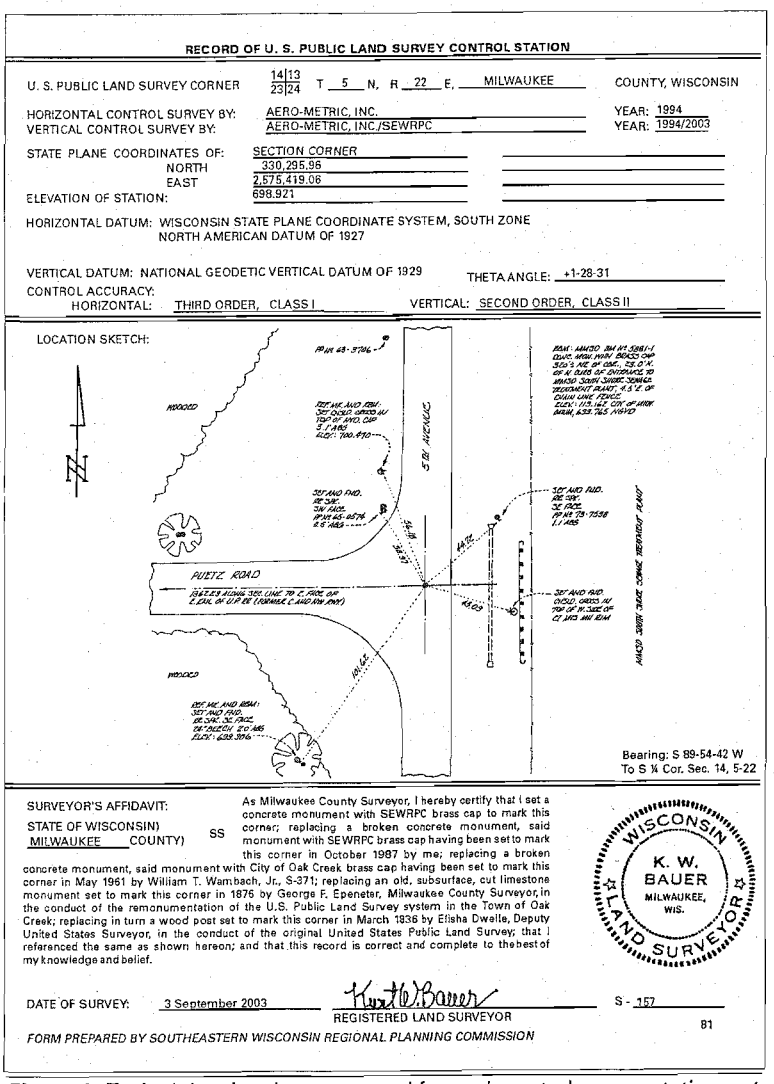
The control survey information is presented in a series of control survey summary diagrams, each diagram covering six U.S. Public Land Survey sections. The diagrams show:

- All monuments erected;
- The ground-level lengths, the sea level-grid lengths, and the grid bearings of the exterior boundaries of each quarter-section surveyed;
- The number of degrees, minutes, and seconds in the interior angles of each quarter-section surveyed;
- The state plane coordinates of all quarter-section corners set, together with their U.S. Public Land Survey System identification;
- The elevations of all monuments set; and
- The basic survey control stations established by the U.S. Coast and Geodetic Survey and

used to tie the public land survey corners to the geodetic control datum, together with the coordinates of those stations.

The angle between the geodetic and grid bearing is given, as is the combination scale and sea-level reduction factor used to convert grid to horizontal ground-level distances. In addition, the diagrams define the area (in acres) of the U.S. Public Land Survey quarter-sections surveyed, as computed using ground-level distances and grid bearings (Figure 3).

Separate specifications are provided to govern the preparation of topographic and cadastral maps. With respect to the topographic maps, these specifications require that the maps be photogrammetrically compiled to National Map Accuracy Standards at a scale of one inch equals 100 feet, with a vertical contour interval of two feet in urban areas or areas proposed to be converted to urban use; and at a scale of one inch equals 200 feet, with a vertical contour interval of two feet in rural areas. The maps are to be constructed upon the Commission-adopted control survey system. The topographic maps, in addition to showing the usual contours, spot elevations, planimetric and hypsometric detail, and coordinate grid ticks, show, in their correct position and orientation, all U.S. Public Land Survey system, corners, and lines established by the control surveys; and the equation between any specified local datum and the National Geodetic Vertical Datum of 1929 NGVD (see Figure 3). The finished topographic maps are field checked to assure compliance with National Map Accuracy Standards (see Figure 4).


RECORD OF U. S. PUBLIC LAND SURVEY CONTROL STATION

U. S. PUBLIC LAND SURVEY CORNER 14|13 / 23|24 T 5 N, R 22 E, MILWAUKEE COUNTY, WISCONSIN

HORIZONTAL CONTROL SURVEY BY: AERO-METRIC, INC. YEAR: 1994
VERTICAL CONTROL SURVEY BY: AERO-METRIC, INC./SEWRPC YEAR: 1994/2003

STATE PLANE COORDINATES OF: SECTION CORNER
NORTH 330,295.96
EAST 2,575,419.06
ELEVATION OF STATION: 698.921

HORIZONTAL DATUM: WISCONSIN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE NORTH AMERICAN DATUM OF 1927

VERTICAL DATUM: NATIONAL GEODETIC VERTICAL DATUM OF 1929 THETA ANGLE: +1-28-31

CONTROL ACCURACY:
HORIZONTAL: THIRD ORDER, CLASS I VERTICAL: SECOND ORDER, CLASS II

LOCATION SKETCH:

PUETZ ROAD

Bearing: S 89-54-42 W To S ¼ Cor. Sec. 14, 5-22

SURVEYOR'S AFFIDAVIT:

STATE OF WISCONSIN) SS
MILWAUKEE COUNTY)

As Milwaukee County Surveyor, I hereby certify that I set a concrete monument with SEWRPC brass cap to mark this corner; replacing a broken concrete monument, said monument with SEWRPC brass cap having been set to mark this corner in October 1987 by me; replacing a broken concrete monument, said monument with City of Oak Creek brass cap having been set to mark this corner in May 1961 by William T. Wambach, Jr., S-371; replacing an old, subsurface, cut limestone monument set to mark this corner in 1876 by George F. Epeneter, Milwaukee County Surveyor, in the conduct of the remonumentation of the U.S. Public Land Survey system in the Town of Oak Creek; replacing in turn a wood post set to mark this corner in March 1836 by Elisha Dwelle, Deputy United States Surveyor, in the conduct of the original United States Public Land Survey; that I referenced the same as shown hereon; and that this record is correct and complete to the best of my knowledge and belief.

WISCONSIN K. W. BAUER MILWAUKEE, WIS. LAND SURVEYOR

DATE OF SURVEY: 3 September 2003 Kurt W. Bauer REGISTERED LAND SURVEYOR S - 157

FORM PREPARED BY SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION 81

Figure 2. Typical dossier sheet prepared for each control survey station, setting forth information necessary for the recovery and use of a station such as the state plane coordinates of the corner, the elevation of the monument, location sketch, detailed description, and a Surveyor's affidavit. The affidavit provides, in effect, a "pedigree" for the corner extending, wherever possible, back to the original location of the corner by the Government Surveyor.

The specifications require that the matching cadastral maps be compiled on the same coordinate grid as the topographic maps, and also show in their correct location and orientation, the U.S. Public Land Survey System quarter-section lines and corners established by the control surveys. The specifications require that the grid ticks and each section and quarter-section corner be plotted to within 1/100 of an inch of the true position as expressed by the coordinate values for the corners. Each real property boundary corner is to be plotted within 1/40 of an inch of the record position. Any gaps or overlaps between adjoining property boundary lines of 2.5 feet or more are to be shown as mapped lines. Overlaps or gaps of less than 2.5 feet are evident only from an examination of the recorded property boundary line dimensions shown on the maps. The constructed location of the property boundary lines must be checked against ground truth provided by the matching topographic maps in the form of building

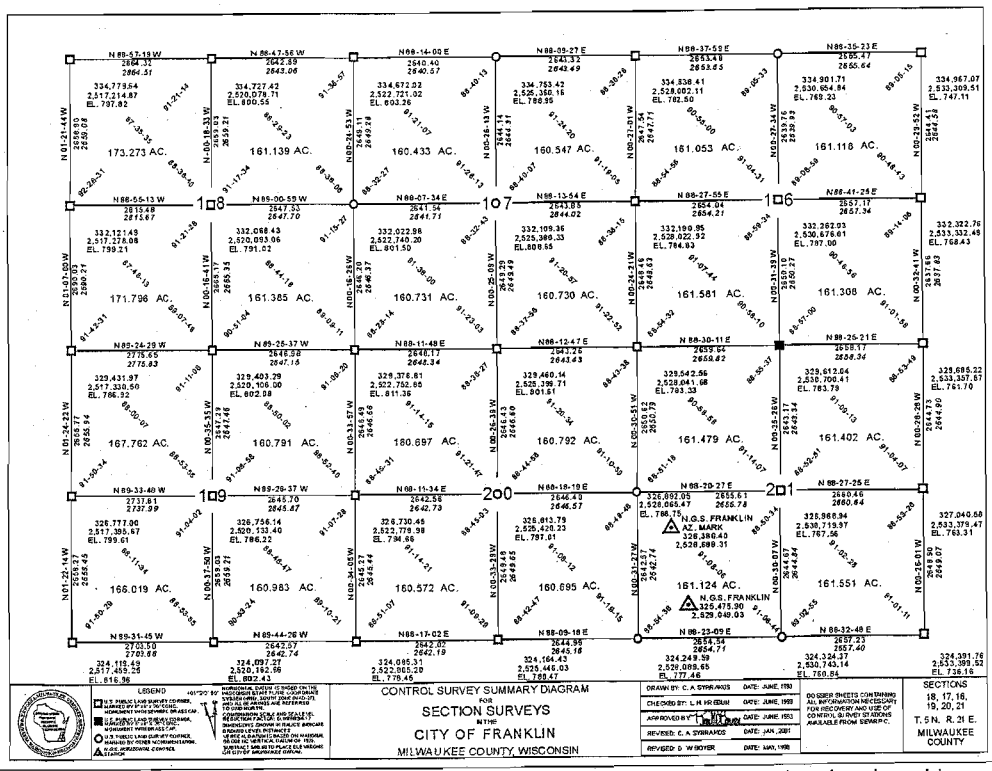


Figure 3. An example of a control survey summary diagram for a six-square mile area showing the grid, ground lengths, and grid bearings of the exterior boundaries of each one-quarter section; the area of each one-quarter section; all monuments erected; the interior angles of each one-quarter section; the state plane coordinates of all section corners, one-quarter section corners, and the center of a section monuments set; National Geodetic control stations utilized to tie the U.S. Public Land Survey corners to the horizontal geodetic control datum, together with the coordinates of these stations; the average angle between the geodetic and grid bearings for the six-square-mile area; and the average combination scale and sea level reduction factor for the area.

outlines, pavement edges, railway tracks, fences, and stream and water course locations. Figure 5 shows the matching cadastral map for the topographic map shown in Figure 4.

Program Status

The Commission has, since 1964, been engaged in the completion of the control survey, topographic mapping and cadastral mapping program as that program was originally envisioned. The work has involved cooperative efforts of, and funding by, the seven counties concerned, a number of cities, villages and towns, private utilities operating in the region, and state and federal agencies. The work of locating and monumenting the U.S. Public Land Survey corners was generally allocated to the cognizant county surveyors, and in some cases by contract to registered land surveyors in private practice. The control survey and topographic mapping work was contracted out to photogrammetric engineering firms. The cadastral mapping was done by Commission staff or contracted to private firms.

As of the end of 2004, all 11,753 U. S. Public Land Survey corners within the southeastern Wisconsin planning region were located, monumented, and placed on the State Plane Coordinate System. Large-scale topographic maps were completed for a total of 2,181 square miles, or 81 percent of the total area of the region; topographic mapping for an additional 204 square miles, or about eight percent of the total area of the region is currently underway. Large-scale cadastral maps have been completed for a total of 2,041 square miles, or 76 percent of the total area of the region. The topographic mapping work is expected to be completed in 2005, with the completion of the cadastral mapping work to follow.

In addition to pursuing completion of the remaining mapping, the Commission has initiated essential maintenance efforts. In the urban and urbanizing counties of the region,

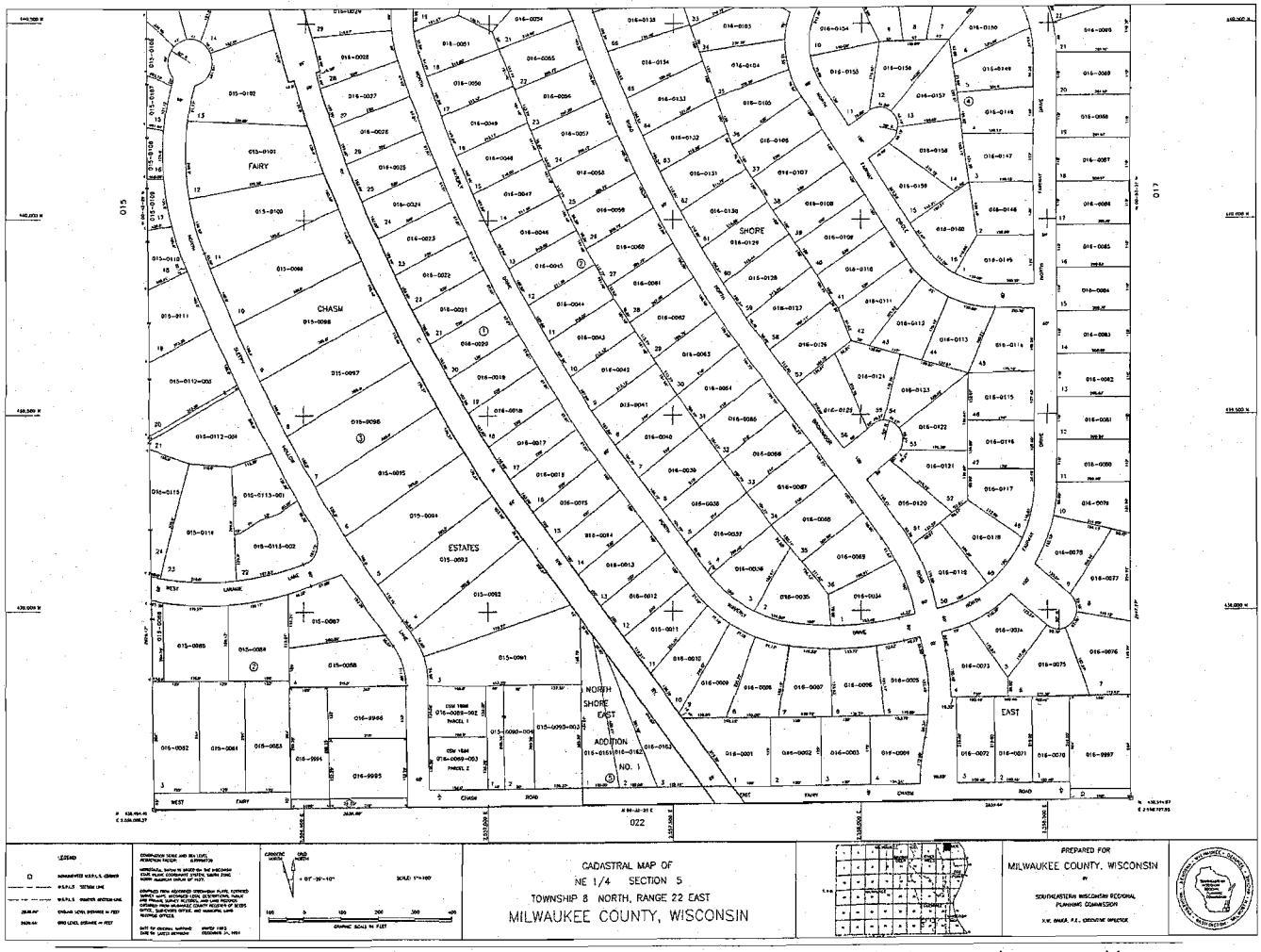


Figure 5. A typical, large-scale cadastral map constructed as an overlay to its companion large-scale topographic map. Cadastral maps show U.S. Public Land Survey corners, the monuments erected at these corners, and the grid lengths and bearings of the section and quarter section lines; well defined planimetric features, including major streams and watercourses, real property boundary lines, street, alley, and public and utility easement lines, widths and rights-of-way, subdivision names or certified survey map numbers; block numbers; lot numbers and dimensions; street names; and parcel identification numbers. The later provide the link between geographic locations and attribute files in parcel-based land information and public works management systems.

pleted topographic and cadastral maps to digital format.

Issues

The Commission control survey and mapping system has performed well: horizontal and vertical control survey networks have been widely and successfully used in the conduct of both land and public works engineering surveys over the forty-year period of the project. Time has proved the adopted system to be sound. Very few discrepancies and disputes have been encountered with respect to the control survey network or the topographic and cadastral maps.

The Commission is aware of only nine disputes concerning the location of the remonumented Public Land Survey corners, which resulted in the relocation of monumented corners—a credit to the county and private surveyors commissioned to locate the corners. In each case, the disputes were resolved collegially between the land surveyors concerned. Only one known discrepancy is known to have occurred with respect to the State Plane Coordinate positions of remonumented U.S. Public Land Survey System corners. This discrepancy was due to the failure to recover a first-order triangulation station during the supplementary horizontal control surveys. The triangulation station, which

had been paved over during land development work, was later recovered, and this necessitated the readjustment of the coordinate positions of some nearby U.S. Public Land Survey corners. Challenges to the accuracy of the hypsometric and planimetric data shown on the topographic maps have been generally resolved in favor of the completed maps. Some cadastral map sheets have had to be recompiled due to errors found in the initial compilation of property boundary lines.

With the adoption by the federal government of the North American Datum of 1983 (NAD-83) and, in Wisconsin, subsequently, NAD-83(91), and following the adoption of the North American Vertical Datum of 1988 (NGVD-88), the Commission was faced with an important issue. Shifts in the positions of stations on NAD-83(91) versus the positions on the North American Datum of 1927 (NAD-27) have a maximum value in latitude within the region of approximately 11 feet, and in longitude of approximated 39 feet.

Within southeastern Wisconsin, replacement of NAD-27 by NAD-83(91) would adversely affect literally tens of thousands of existing maps and associated public records in hard-copy and digital format. Such replacement would require that new horizontal coordinates be computed, utilizing original control survey measurements, for the 11,753 monuments now marking U.S. Public Land Survey corners within the region. The dossier sheets for each of these corners would require revisions, as would the control survey summary diagrams that tie these monuments together into an integrated network. These changes would, in turn, have to be carried over to the approximately 8,500 individual large-scale topographic maps and approximately 7,700 individual large-scale cadastral maps that have been prepared on NAD-27 over the past approximately 40 years.

In addition, the utility of thousands of subdivision plats, certified survey maps, plats of surveys, and survey records referenced to NAD-27 would be affected. Thousands of sets of integrated aerial photographs containing land use, soil, wild life habitat, wetland, floodland, and environmental corridor delineations, again referenced to NAD-27, would also be adversely affected by a conversion to NAD-83(91), as would the parcel-based, digital land information and public works management systems developed by governmental agencies and private utilities within the region. The cost of converting from NAD-27 to NAD-83(91) has been estimated to approximate two million dollars in each of the seven counties of the region. Proponents of the conversion to NAD-83(91) have yet to document any benefits that would offset these conversion costs. For these and other reasons, the Commission determined to continue to utilize NAD-27 in its work.

The differences between elevations referred to NGVD-29 and NGVD 88 within the region range from about 0.1 to about 0.4 foot. For some applications, these differences are small enough to have no significant impact, but for such applications as establishing grades for trunk sewer construction, or for the regulation of development in flood hazard areas—where the State Administrative Code requires flood easements to be acquired if the proposed modification of a bridge or culvert, or of a stream channel, results in upstream or downstream increasing in flood elevation of 0.01 foot or more—the confusion of elevations referenced to these two datums could have costly consequences. The Commission has calculated peak flood flows and stages associated with the 10, 50, and 100 year recurrence interval floods for 831 lineal miles of stream channel within the region and delineated, on large-scale topographic and cadastral maps, flood hazard lines for 676 lineal miles of stream channel. These data are referenced to NGVD-29 and, they have been incorporated into county and municipal floodland zoning ordinances. For these and other reasons, the Commission determined to continue to utilize NGVD-29 in its work.

Nevertheless, in order to facilitate the use of NAD-83(91) and the NGVD-88 datums within the region by such users as may determine to do so in spite of good reasons to the contrary, the Commission, in 1993 and 1994, commissioned Mr. Earl F. Burkholder, Consulting Geodetic Engineer, to develop methodologies that could be used for the ready and reliable bi-directional transformation of coordinates and elevations between the two horizontal and two vertical datums concerned. Since there are no precise mathematical relationships between the datums, the methodologies were developed through mathematical model studies and permit transformations within Third Order Class I horizontal and Second Order Class II vertical control survey accuracies, which are adequate for land survey, and public works engineering purposes (SEWRPC 1994; SEWRPC 1995).

Conclusions

In 1964 the Southeastern Wisconsin Regional Planning Commission proposed the creation of an integrated topographic and cadastral mapping program within its approximately 2,700 square mile planning jurisdiction. The mapping was to be based upon a then unique system of survey control which accurately combined the U.S. Public Land Survey and State Plane Coordinate systems. Through persistent commitment over a period of 40 years, this mapping and control survey system, as originally conceived, has been put into place.

The control survey system places a monumented station of known position on both the U.S. Public Land Survey and State Plane Coordinate systems at one-half mile intervals throughout the planning region. Accessory bench marks provide attendant elevation data. The control survey system and the attendant large scale topographic and cadastral maps provide the foundational elements for the creation at the county and local municipal levels of computerized parcel based land information and public works management systems, as well as the basis for the conduct of coordinated land and engineering surveys within the entire planning area.

The Commission control survey and mapping system has performed well over time. The horizontal and vertical control survey networks have been widely and successfully used in the conduct of both land and public works surveys over a forty year period. The control survey network has been used in the preparation of thousands of subdivision plats, certified survey maps, plats of surveys, and survey records. The control survey networks have been extensively used in the planning, design, and construction of public works of all types within the Region, including such major works as the construction of a seventeen mile deep tunnel sewage conveyance and storage facility serving the greater Milwaukee metropolitan area. The control survey and mapping system has also been used to accurately map land use, soils, wild life habitat, wetlands, floodlands, and environmental corridors throughout the region, and in such special applications as the accurate mapping of major airport approach zones and the location and height of obstructions that constitute hazards to air navigation in the glide paths of such zones.

The completed control survey and mapping system now comprises an integral and invaluable part of the public infrastructure of the seven-county planning region. The system requires, and receives, annual maintenance in the form of replacement of broken, disturbed, buried, or destroyed U.S. Public Land Survey corner monuments and attendant bench marks; the continuous up-dating of the cadastral maps on a generally monthly basis; and the periodic preparation of new topographic maps for subareas of the region exhibiting need.

REFERENCES

SEWRPC (Southeastern Wisconsin Regional Planning Commission). 1964. *Planning Guide No. 2: Official Mapping Guide*. SEWRPC, Waukesha, Wisconsin.

SEWRPC (Southeastern Wisconsin Regional Planning Commission). 1994. *Technical Report No. 34: A mathematical relationship between NAD-27 and NAD-83(91) state plane coordinates in southeastern Wisconsin.* SEWRPC, Waukesha, Wisconsin.

SEWRPC (Southeastern Wisconsin Regional Planning Commission). 1995. *Technical Report No. 3: Vertical Datum Differences in Southeastern Wisconsin*. SEWRPC, Waukesha, Wisconsin.

ATTACHMENT III

REVIEW AND REEVALUATION OF SEWRPC SURVEY CONTROL SYSTEM

White Paper – 2007 – Draft B

Review and Re-evaluation of SEWRPC Survey Control System

Givens:

1. Since the 1960's, the SEWRPC (the Commission) has made a large investment in horizontal and vertical survey control networks in the 7 county region.

2. Those networks have paid excellent dividends over the decades in terms of orderly development of civil infrastructure and administrative stability of cadastral parcels.

3. The value of that investment is threatened by:

    A. Users not being aware of the control systems or knowing how to use them.
    B. Underlying changes in the definition of datums by the federal government.
    C. The technological ability of modern systems to position a point on the ground efficiently – obviating the need to start from a reference monument.
    D. Absence of a legislative mandate to use the existing survey control networks.

4. The Commission has established a Technical Advisory Committee to review both administrative and technical aspects of the existing control systems with the idea of:

    A. Capturing and preserving the value of previous efforts/investment.
    B. Identifying concepts and issues that serve to detract from using the systems.
    C. Recognizing contributions of new technology to the manner in which spatial data are generated, manipulated, and used.
    D. Recommending policies and procedures for enhancing the value of the survey control networks from both:
        1. An administrative perspective and,
        2. The technical perspective.

5. Other:

Goals: Any and all recommendations should conform to and support the following:

1. The value of the existing survey control network should be preserved and enhanced to the extent possible and practicable.
2. The impact of new technology will be evaluated and accommodated as appropriate.
3. The impact of working with digital data will be considered.
4. Any new procedures must be technically rigorous and readily defensible.
5. Policies should be formulated with the idea of keeping it simple.
6. Any changes must be accomplished within the framework of the legal system.
7. New policies and procedures that are adopted will need to be embraced by the user community. An educational effort may be needed.
8. Other

Issues:

1. Datum definitions by NGS:
    a. Horizontal.
    b. Vertical.
2. No datum conversion is exact – what geometrical integrity is required?
    a. Acceptable procedures need to be discussed and identified.
    b. "Standardized" software is most desirable.
3. State plane coordinates – are long-standing and "standard."
4. Low distortion projections – who needs, who benefits, and at what cost?
5. "Big" question – To what extent must the record data be consistent with GPS results?
    a. GPS satellites orbit earth's physical center of mass (WGS84).
    b. GPS results can be displayed in "standard" format.
6. Are GPS results "absolute" or "relative" and with respect to what?
7. At what point, if ever, will satellite orbits replace physical ground monuments?
8. Status of "spatial data" education – surveying/photogrammetry/geography/geomatics.

Concepts:

1. Who needs/uses SEWRPC control?
2. What GPS technology is being used -
    a. For GIS/mapping purposes?
    b. For surveying/engineering applications?
3. Difference between absolute and relative:
    a. Absolute coordinates used for "inventory/location."
    b. Relative measurements used for design/construction.
4. Positioning by GPS:
    a. Autonomous: stand-alone and differentially corrected.
    b. Static relative positioning (potentially very precise).
    c. Kinematic and real-time kinematic – operation and quality of results.
    d. CORS: including private, community, NGS, and/or OPUS and OPUS-RS.
    e. GPS real-time networks – one receiver/person – within 2 cm.
5. In what way does Height Modernization contribute to or impact this review?
6. With the digital revolution, spatial data are now characterized as digital and 3-D – see articles posted at www.globalcogo.com/refbyefb.html (e.g. #47).

Resources (available to and used by consultant):

1. A Control Survey and Mapping Project for an Urbanizing Region (A Study in Persistence) – Kurt Bauer, PE, RLS, AICP
2. SEWRPC Technical Report #34 NAD27 to NAD83(91)
3. SEWRPC Technical Report #35 NGVD29 to NAVD88
4. Definition of a Three-Dimensional Spatial Data Model for SE Wisconsin
5. Recent American Surveyor series of 7 articles on Real-time Networks
6. NGS 10-year plan – see www.ngs.noaa.gov/INFO/tenyearnews.shtml
7. Wisconsin Coordinate Reference System (WISCRC).

ATTACHMENT IV

CORRESPONDENCE FROM COMMITTEE MEMBER WILLIAM T. WAMBACH

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July 18, 2007

K.W. Bauer, Chairman
Technical Advisory Committee on
The Review and Reevaluation of the
Regional Control Survey Program
Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Dr
WAUKESHA WI 53186

Dear Kurt,

Since I can't attend the July 25th meeting, I very much appreciate getting the Notice, agenda & attached information.

Regarding Issue #7: "At what point, if ever, will satellite orbits replace physical ground monuments?" I would like the rest of the committee to discuss my reaction to this question: Why would we want to replace physical ground monuments?

My thought proceeds to: Consider a densely populated urban setting, which usually results in very high land values. Buildings are built concurrent with the property lines, identified by physical ground monuments. In the future, using satellite orbits and more refined measurement & calculation techniques, someone determines that the building is encroaching on a calculated property line. Did the building move? No! The property corners should remain precisely where the physical ground monuments were originally placed, and their positions preserved by physical ground monuments. No improvements in accuracy of computation should ever be permitted to supersede the evidence of the physical ground monument.

I trust the group will take my octogenarian professional opinions into consideration.

Sincerely,

Bill Wambach

Encl.

COORDINATES VERSUS CONFUSION[a]

Discussions by Gerard H. Pesman, John G. McEntyre, and William T. Wambach, Jr.

GERARD H. PESMAN,[3] M. ASCE.—It is indeed unfortunate that the ASCE committee on interaction between Education and Practicioners is not more active so that the author could leave his ivory tower and get into the field. The author's apparent philosophy, as shown by this paper, is a typical example of educational inbreeding that is slowly strangling the country with "educated" hangers on.

These are harsh statements; but after 15 yr of searching for the truth, which includes monuments, and beginning to be able to dent the legal profession slightly in changing "legal" descriptions, the writer takes a very dim view of the proposed ideas, and actually considers them dangerous.

In the writer's opinion, the best title is a strong fence (physical monument), and a shotgun. In the mining states of the West, anyone can start title by planting four posts (physical monuments), claiming a mineral discovery, and filing a recorded notice in the Courthouse. These old timers and new timers, as of the last uranium boom, could not care less about coordinates, and often did not even care what section they were in; but they did know where their claim corners were, and if they had a good claim, they did pertetuate these corners.

Land sales based on paper record only were tried early in the history of the United States and failed miserably. Paper subdivisions have caused unbelievable problems to those of us that are asked to reproduce a physical line on the ground. Now, when we are on the threshold of a physical survey agreement with electronic distance measuring and advanced instrumentation, it is suggested that we go back to the paper system through the use of coordinates. In the writer's opinion, too much paper and not enough monuments have caused much grief and the loss of professional stature.

All of us in the surveying profession use coordinates, but there is still much confusion on the use of the State Grid, even within our own ranks. When a local system is used, values are set on a physical monument that is considered the strongest. The client can see the monument, and is often as thrilled as we are when an old one is found. Clients cannot see coordinates except as numbers on a map. Intended parcels of land have been, and are still a surveyor's nightmare, and intent by coordinates in the hands of land owners, realtors, and attorneys will really make an impossible situation. At the present time, if a land description was qualified as to survey, legal, land owner, realtor, or abstracter's description, it would give us a clue as to the complexity of actually defining the boundaries. Since the aforementioned people are involved in land sales, it behooves us to educate them, and hopefully to the point that

[a] September, 1970, by Robert T. Howe (Proc. Paper 7528).

[3] Surveyor, Survey Engineers Inc., Grand Jct., Colo.

any land description will be prepared by a surveyor, and be fully monumented when sold. When there is a clear cut responsibility, the public can be satisfied, and can see their property lines. Title insurance can delete the exception "what an accurate survey will show." Surveyor's will communicate with each other, instead of talking through lawyers, because they can be explicit, and they have the responsibility of land lines. There is nothing like a monument in the ground, with a surveyor's name or number on it, to accentuate his ability to describe the same, and make sure it is correct.

In construction layout, the same problem often exists. Architectural renderings that are not based on an accurate topographic survey with control monuments on the site are often impossible. It has been the writer's experience that planned condominiums have landed in the middle of a river. For the sake of economy—false economy—an accurate topographic survey was not made. Coordinates which are not field established will lead to the same difficulties. Lack of surveys, self esteem, and not knowing whether we are surveyors, engineers, lawyers, or professors, has seriously curtailed our performance.

Because there is a concept within the legal profession, (without educational background), that they should examine the survey chain of title as well as the people chain of title, firm giant steps must be taken to set up Land Courts that are oriented towards surveys. We also need to assume the responsibility, in every court house in the United States, of having County Surveyor offices that are in charge of land records, and check physical monuments in new subdivisions. A State Coordinate system in conjunction with computers can be an enormous boon, but until paper records are field checked with identifiable, worthwhile monuments (which are also described on record) we are going to have the same chaos. Photogrammetry has been bandied around as a magic panacea for our present confusion. It can be a tremendous aid, and should be used as much as possible, but again, in dense woods, it fits the role of paper records, and hinders rather than helps.

In conclusion, the writer believes that CULDATA and the author are sincerly endeavoring to come up with ideas to help solve the nationwide scramble of land records. With good reason, i.e., lack of qualified field surveyors, they are groping for an answer that can be made in an office. The contract surveyors of the 1890's who worked for $600 for 36-sq mile township surveys in our mountain country were not sincere, and started many of our paper records. Sometimes they were caught, by a field inspector who noted fraudulent calls for monuments that weren't there, but more often their surveys were accepted. At the present time, if we are honest, it is impossible to tell the intent, or to follow the footsteps. If footsteps had been followed of the hatchet claims and land descriptions left in the hands of surveyors, instead of quick buck artists and land companies, there wouldn't have been double patents in Kentucky. It is the writer's opinion that double patents produce overlaps or hiatuses, and are the result of parties outside the surveying profession, or one of our members who is not strong enough in the belief in his own ability to field survey and then describe the land. We need to take the responsibility entirely, live up to it, and therefore sell our increased prestige to the general public.

JOHN G. McENTYRE,[4] F. ASCE.—The presentation of a comprehensive and efficient land data system as proposed in two major reports published by the

[4] Prof. of Land Surveying, Purdue Univ., West Lafayette, Ind.

University of Cincinnati (3,5) is to be commended. The paper presents a good discussion of the aspects of legal descriptions of parcels and the indexing of deeds and other documents relating to land titles as proposed under CULDATA.

The CULDATA system as proposed originally and as presented in the paper involves the same basic principles as proposed in the paper "Land Surveying and Land Registration" (14) which was published in February, 1963. The 1963 paper presents a much more detailed and specific structure for a state organization to administer such a plan and goes into much more detail concerning possible insurance of title. CULDATA does add the feature of using electronic computers which was not as feasible when the proposal published in 1963 was under study (1953-1954). Also the proponents of CULDATA added an excellent idea when they proposed the use of approximate coordinates for quick-use purposes.

The primary purpose for this discussion, however, is to draw the attention of the proponents of the CULDATA system, the author, and the readers to Ref. 14.

Appendix.—Reference.

14. McEntyre, John G., and McNair, Arthur J., "Land Surveying and Land Registration," *Journal of the Surveying and Mapping Division*, ASCE, Vol. 89, No. SU1, Proc. Paper 3437, Feb., 1963, pp. 59-75.

WILLIAM T. WAMBACH, JR.,[5] F. ASCE.—The title of this paper implies that there will be no confusion in the identification on the earth surface of a survey corner if that corner is defined by coordinates. If new corners were selected by choosing a coordinate position, referenced to specified existing control monuments, this could be true. However, that is not the usual way people select the position for a new corner. A buyer and a seller usually agree to a location on the ground, and then write up a contract which describes in words the corner they have agreed to. In some cases, one or the other of the parties hires a registered surveyor to measure the selected corner location in reference to existing control monuments and prepare a map and description defining the selected corner. Unfortunately, in far too many cases, some person relatively unskilled in measurement techniques, property law and description writing prepares the description of the corner for their contract.

The author refers to "the surveyor's age-old devotion to monuments." The writer believes it would be more correct to state "the court's decisions that monuments control over distances and directions given in words." The courts have, in the writer's opinion, very wisely determined that the intent of the buyer and the seller, when specified as being a monument on the ground, is clearly the monument and not the measurements which were determined subsequently to the selection of the corner.

The author also states that he is now convinced that the devotion to monuments is the source of most of the disputes about land ownership. The writer's opinion, based on over 20 yr of land surveying experience, is that descriptions written for corners at which no monument was ever placed are the prime

[5] Chmn., Committee on Land Surveying, Surveying and Mapping Div., ASCE, Sun Prairie, Wis.

source of disputes, followed by lost, obliterated, disturbed, poorly placed, or dishonestly placed monuments.

The author makes reference several times in his paper to early surveys having been "poorly" made. It is the writer's experience that there is no more evidence of poor surveying practice by the early surveyors than there is today, or will be in the future. Accuracy of position is a function of the degree of refinement of measurement techniques and knowledge of statistical probability of the accuracy of a measurement. Related to that time in man's history, the early American surveyors did remarkably accurate work. Since man will undoubtedly continue to progress, future generations will find the measurement work done by us to be far less exact than they will need for their purposes. Does that mean that today we are surveying "poorly"? The writer thinks not.

The author gives the example of a new facility constructed from a set of scaled drawings. He rightly stated that the results will not be the exact image of the precise drawing, and yet useful results are obtained. He asks "Why then, can there not be exact coordinate descriptions of land parcels with marks set on the ground to represent, as accurately as may be necessary, the correct points?" The writer's opinion is that there can.

The author states that land surveyors have been saying "The State Plane Coordinate Systems may be fine in theory, but they will never be able to help us solve the problems in our work." That implies that many surveyors have been saying that. The writer must agree that some few surveyors hold that viewpoint. It is the writer's opinion, however, that most knowledgeable surveyors have been promoting the use of the State Plane Coordinate System for more than 15 yr. The parting of the ways between surveyors and the author comes with the proposal for an instant changeover to absolute control of position by coordinates. Ninety-nine percent of the property corners in this country do not now have precise coordinate descriptions. The determination of precise coordinates for these corners is, if the pun will be pardoned, a monumental task.

In proposing steps toward adoption of a coordinate based system, the author suggests that surveyors must join attorneys and land title insurance companies to devise appropriate systems and promote legislative changes required. One of the constructive critics (not "a leading opponent") of the system proposed by the author is Gurdon H. Wattles, who is a title engineer. Men in Wattles' profession, as well as others who are land surveyors, merely caution the cost of this needed change is so great that it must come about by evolution rather than revolution.

The writer agrees with the author that the first step must be legislative change. Many states have taken the first logical step of adopting legislation permiting the use of state plane coordinates as supplementary identification of corners. To have attempted to pass legislation making state plane coordinates mandatory would have been foolhardy, since the scarcity of high order precision control monuments make compliance prohibitively costly in large areas of the country. The next necessary step after adoption of legislation permitting the use of the State Plane Coordinate System in property descriptions is densification of the network of high order precision monumentation. Then, and only then, will it be possible to adopt legislation to require the use of state plane coordinates on every property description.

With regard to the author's conclusion, this writer must express his opinion that accepting a theoretical coordinate description of a point as correct

will not end all confusion and dispute. The basis of the coordinate system is a point on the earth's surface and a direction from that point. The system is then extended by establishing monuments at many other points on the ground and measuring their relationship to the point of origin of the system. Since measurement is a statistical approximation of the exact theoretical distance between points, improvement of measurement techniques in the future will show a better approximation of the distance than is determined today. The numbers (coordinates) that are used today to identify a point will then no longer be valid.

The point will not change—the coordinates will. Therefore, the writer concludes that the "age-old devotion" of property owners, surveyors, title companies and the courts to monuments is well-founded and wise.