

STATE OF MICHIGAN



JOHN ENGLER, Governor

DEPARTMENT OF ENVIRONMENTAL QUALITY

HOLLISTER BUILDING, PO BOX 30473, LANSING MI 48909-7973

RUSSELL J. HARDING, Director

REPLY TO:

LAND & WATER MANAGEMENT DIVISION
PO BOX 30458
LANSING MI 48909-7958

TO WHOM IT MAY CONCERN:

SUBJECT: Evaluation of Critical Dune Areas

Enclosed with this letter you will find a copy of the Evaluation of Critical Dune Areas report completed by Michigan State University, Center for Remote Sensing (MSU), in June 1996. This report was required under Part 353, Sand Dune Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

Please note that this report represents MSU's recommended changes to existing Critical Dune Areas (CDA). The Department of Environmental Quality (the Department) is in the process of evaluating this report. Therefore, it should not be considered a recommendation of the Department. Any changes made to the boundaries of CDAs must be made by the Legislature.

If you have any questions regarding this report, please contact Mr. Steve DeBrabander at 517-373-3895, or you may contact me.

Sincerely,

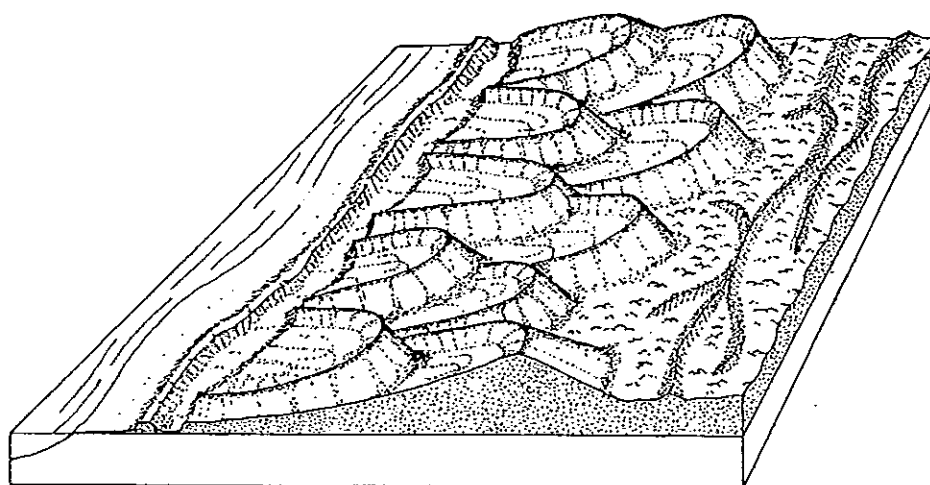
A handwritten signature in cursive script, reading "James G. Ribbens".

James G. Ribbens, In Charge
Coastal Programs Unit
Land and Water Management Division
517-373-8787

Enclosure

FINAL REPORT

**EVALUATION OF CRITICAL DUNE AREAS
Designated Under Part 353
(Sand Dune Protection And Management)
of the
Natural Resources and Environmental
Protection Act
1994 PA 451**



**David P. Lusch, Ph.D.
William D. Hudson, Ph.D.
Linda K. Erickson
Frank Krist
Mark Zweifler**

**Center for Remote Sensing
Michigan State University**

**To
Michigan Department Of Environmental Quality
Land And Water Management Division
Great Lakes Shorelands Section**

June 1996



FINAL REPORT

**Evaluation Of Critical Dune Areas
Designated Under
Part 353 (Sand Dune Protection And Management)
of the
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Statement Of The Problem

According to Buckler (1978):

The sand dunes along the shorezone of Michigan's Great Lakes are among the youngest and largest geomorphic features within the state. Because of favorable conditions, nowhere are they better developed than on the eastern and southern shores of Lake Michigan. These dunes are somewhat unique and collectively probably represents the largest accumulation of sand dunes along any fresh water body in the world. They are valued by many for their aesthetically pleasing backdrop to the lakeshore, for the ecological communities which they support and for the recreational potential they provide. Because the environmental (climatic and geomorphic) conditions under which they formed no longer exists, once destroyed, they are not likely to regain their present significant size and extent.



In an effort to preserve the quality of the state's dunal topography, the Michigan Legislature passed the Sand Dune Protection and Management Act (1976 PA 222). This act gave authority to the Michigan Department of Natural Resources (MDNR) to undertake specific steps to ensure the wise use and protection of Michigan's sand dunes within two miles of the ordinary high water mark along all of its Great Lakes shorelines.

Act 222 was amended in 1989 by PA 146 and 147, to include the regulation of all vegetation removal, earthmoving, and construction activities within designated Critical Dune Areas (CDAs) which were recognized as a "unique, irreplaceable and fragile resource that provides significant recreational, economic, scientific, geological, scenic, botanical, educational, agricultural and ecological benefits to the people of this state and to people from other states and countries who visit this resource." These Critical Dune Areas were mapped by staff from the Land and Water Management Division, MDNR to define areas which were subject to regulation under PA 222, as amended by PA 146 and 147, and were published in the *Atlas of Critical Dunes* (MDNR, 1989). These CDAs were based on an analysis of the delineated barrier dune formations, a review of soil surveys and U.S.G.S. topographic maps, and maps of exemplary dune-associated plant species provided by the Natural Features Inventory.

Further amendments to the Sand Dune Protection and Management Act occurred in 1994 (1994 PA 135). The first portion of Section 23a of PA 135 (1994) stipulated:

Within 1 year of the effective date of this section, the department shall appoint a team of qualified ecologists who may be employed by the department or may be persons with whom the department enters into contracts who shall review "the atlas of critical dune areas" dated February 1989. The review team shall evaluate the accuracy of the designations of critical dune areas within the atlas and shall recommend to the legislature any changes to the atlas or underlying criteria revisions to the atlas that would provide more precise protection to the targeted resource.

In January, 1995, all environmental protection acts were codified and repealed and became parts of the Natural Resources and Environmental Protection Act (1994, PA 451). The Sand Dune Protection and Management Act as amended became Part 353 of Act 451.

In April 1995, the Center For Remote Sensing at Michigan State University responded to a Request For Proposal issued by the Office of Purchasing, State of Michigan, Department of Management and Budget (Invitation To Bid Number: 071I5001458) on behalf of the Great Lakes Shorelands Section, Land and Water Management Division, MDNR (now the MDEQ, Michigan Department of Environmental Quality).



Criteria for Identifying and Mapping Critical Dune Areas

Section II-C-1 of the RFP (Work Statement - Tasks - Evaluation of Atlas of Critical Dune Areas) states:

- A. Detailed evaluation of the accuracy of designated CDAs dated February 17, 1989, utilizing remote sensing, U.S.G.S. topographic maps, soil surveys, on-site inspections, vegetation determinations, geomorphologic interpretation and other methods determined useful. The purpose of this review is to determine if the current CDA designations accurately represent the CDAs of this state.
- B. Detailed evaluation of sand dune areas which were not designated as CDAs to determine if they meet the definition of CDAs utilizing the methods listed in Item 1 above. The purpose of this review is to determine if all sand dunes which exhibit CDA qualities have been included in the designation.

The Sand Dune Protection and Management Part (353) of the Natural Resources and Environmental Protection Act (1994 PA 451) stipulated that the MDNR was to make or cause to have made several types of comprehensive studies and inventories relating to the dunes and their values for environmental, recreational and industrial purposes. The "Dune Type Inventory and Barrier Dune Classification Study of Michigan's Lake Michigan Shore" (Buckler, 1978; 1979) [hereafter referred to as the Buckler Study] was authorized under the old Act 222 (1974) and contracted by the Geological Survey Division, MDNR. The Remote Sensing Project [the precursor to the Center For Remote Sensing] at Michigan State University was the contractor. The Buckler Study created the Dune Morphology Classification of the Lake Michigan Shore (Figure 1) which greatly aided the present reevaluation project.

The Buckler Study was conducted within seven high priority areas consisting of nine shoreline segments along Michigan's Lake Michigan shoreline. The boundaries of the segments were predetermined by the MDNR for the Series I Designated Sand Dune Areas (MDNR, 1978). In subsequent contracts, Buckler continued the inventory and classification of dunes types and the delineation of the barrier dune within the confines of Series II and Series III Designated Sand Dune Areas. All of these studies by Buckler resulted in the creation of a set of map folders, one for each 7.5-minute quadrangle (many 7.5-minute quadrangles were photographically created from 15-minute quads for these studies), which contained stable-base overlays registered to the USGS maps. The overlays depicted the dune classification of the area, delimited the barrier dune, and portrayed other miscellaneous delineations (Figure 2).

As stated earlier, in response to the 1989 amendments to Act 222 of 1976 [now Part 353, 1994 PA 451] the Critical Dune Areas (CDAs) were mapped by the MDNR in order to define which areas were subject to regulation. These were documented in the *Atlas of Critical Dunes* dated February 17, 1989. In the review of background materials germane to this project, the specific criteria used by the MDNR to map CDAs were made available and are listed in Table 1.



Dune Form	Relative Relief of Dune Form	Orientation of Dune Form with Respect to Present Shoreline	Arrangement of Dune Form	Underlying and/or Associated Landforms
Parabolic dune	high moderate low	parallel normal arcuate irregular	singular repetitive	n/a
linear dune Ridge	high moderate low	parallel normal arcuate irregular	singular repetitive	n/a
dune Terrace	high moderate low	parallel normal arcuate irregular	singular repetitive	n/a
dune Platform	high moderate low	parallel normal arcuate irregular	singular repetitive	n/a
Domal dune	high moderate low		singular repetitive	n/a
Complex dune field	high moderate low	n/a	n/a	n/a
dune Flat	n/a	n/a	n/a	n/a
marginal sand Apron	high moderate low	n/a	n/a	lacustrine plain outwash plain alluvial plain moraine till plain
inter-dune Lowland	n/a	n/a	n/a	as above

On the maps, polygons are identified by concatenating selected letters (shown as bold capitals above) from the categories listed under the criteria Form, Relief, Orientation, Arrangement, and Associated Landforms. For example, the capitalized items in line one above (Parabolic, High, Parallel, Repetitive) would be shown as "**Phpr**" on the map. **Pmpr** is a related dune assemblage, but exhibiting a moderate amount of local relief. **Cl** refers to a Complex dune field of low relief. A low relief, marginal sand apron formed on an outwash plain is shown as "**Alo**".

Figure 1. Dune morphology classification of the Lake Michigan shore (Buckler, 1978; 1979).



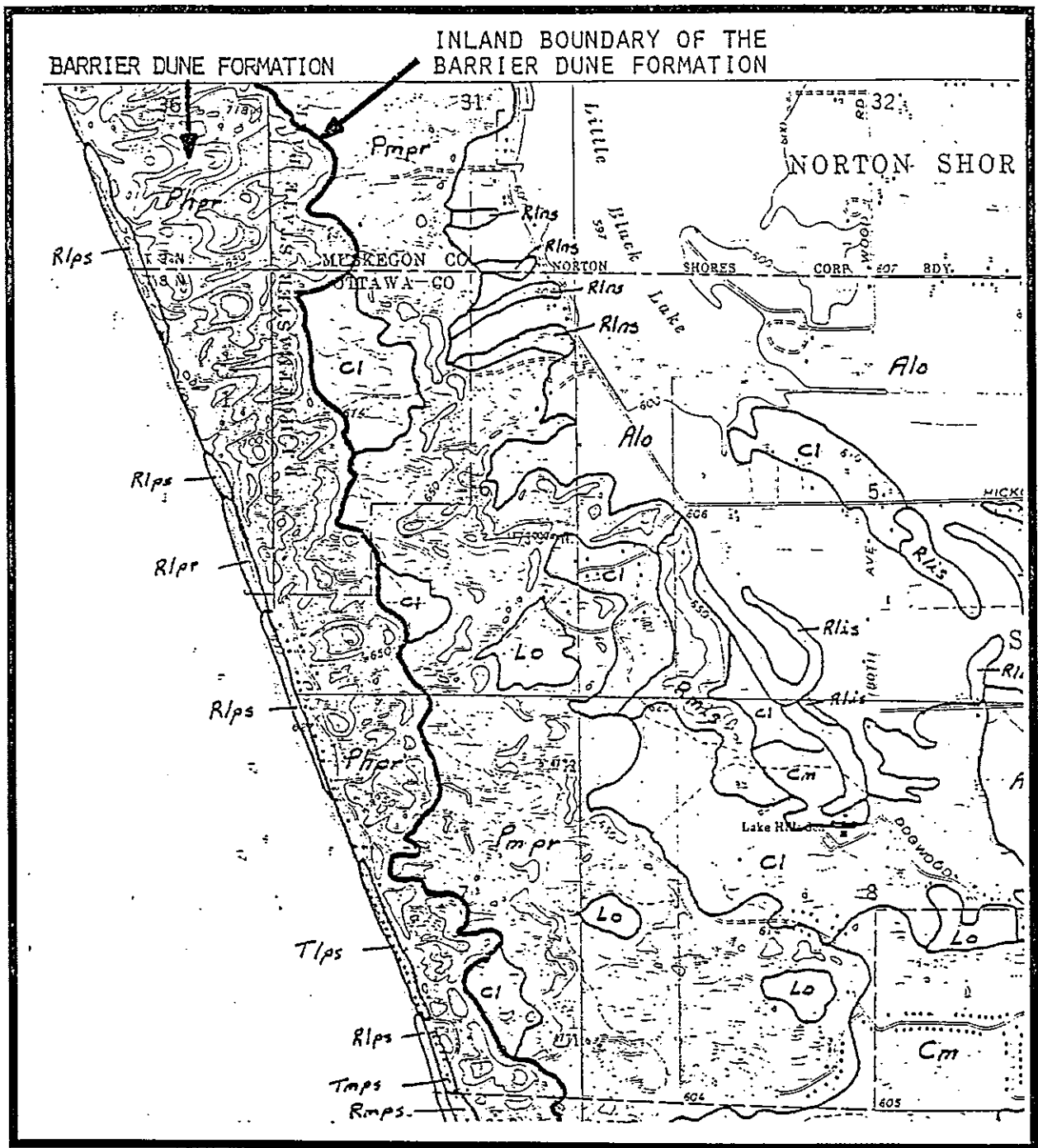


Figure 2. Example of the topographic map overlay created by Buckler displaying both the outlines of the various dune assemblages and the landward boundary of the Barrier Dune Formation. See Figure 1 for an explanation of the codes used to identify the various dune types.



Table 1. 1989 Criteria for Identifying Critical Dune Areas, Land and Water Management Division, Michigan Department of Natural Resources

Critical Dune Areas include the following:

- 1. Barrier dune formations designated pursuant to 1976 PA 222.**
- 2. Areas outside the barrier dune formations which meet all three of the following criteria:**
 - a. Areas composed primarily of dune sand, as identified on soil surveys.**
 - b. Areas containing dunes at least 20 feet in height. Isolated occurrences of single dunes meeting height criteria were not included.**
 - c. Areas exhibiting a minimum length (measured more or less parallel to the shoreline) of 1.5 miles.**
- 3. Additional areas were included if they met the following criterion:**

Areas supporting exemplary dune associated plant communities as identified by MNFI, within the boundaries of a designated sand dune area.

plant communities:

interdunal wetlands
coastal plain marsh
dune and swale complex
open dunes
mesic southern forest
dry mesic southern forest
mesic northern forest



During the initial phase of the work, all available background and source materials were reviewed by the team. Each team member became familiar with all phases of the interpretation project including the MDEQ mapping criteria (see Table 1), definitions, and standards. Following this familiarization phase, the team analyzed a pilot area as a means of evaluating the MDEQ criteria. All project participants (project manager, senior analyst, and the photo interpreters) worked together to study an arbitrarily selected stretch of shoreline to review existing and potential Critical Dune Areas. A series of questions resulted from this initial method review. On October 4, 1995, the MSU team met with the following staff from the Great Lakes Shorelands Section, Land and Water Management Division to resolve these issues: Steve Debrabander, James Ribbens, and Christy Fox. The following decisions were made at this meeting:

1. *Is there a spatial contiguity requirement for CDAs? That is, do otherwise acceptable dune polygons which are physically separated from the shore-bound CDA polygon get included?*

No, there is no contiguity requirement, detached polygons within the two mile shore buffer are acceptable.

2. *How irregular may the boundary of a CDA polygon be? Is there a minimum width for protrusions of CDA or intrusions of non-CDA lands?*

Be as accurate as possible in delineating the CDA boundary. There is no prescribed width criteria to peninsulas or reentrants.

3. *What unit area of analysis should be used to evaluate the local relief (e.g., 40 ac, 10 ac, 2.5 ac)?*

No decision was taken on this issue. It was determined that a strict unit area of analysis had not been employed by MDEQ staff during their mapping of CDAs. There was consensus among MDEQ staff and the MSU team that the unit area should be somewhere in the range of 10 to 40 acres. The MSU team committed to a mini-study to evaluate this issue. Upon conclusion of the mini-study, MDEQ staff will review the recommendations of the MSU team and finalize the relief criteria method.

4. *How was the 1.5 mile shore length criteria actually employed? Does it refer to the actual length of the polygon measured along its longest axis or to the length of the shoreline subtended by rays projected from the ends of the CDA polygon at right angles to the shoreline?*

This criteria was not rigorously employed in a quantitative manner. Rather, the polygon was visually evaluated to estimate whether a trend line quasi-parallel to the shore and passing through the polygon was about 1.5 miles in length.



5. *Is there a minimum area threshold for individual CDA polygons?*

After some discussion, and referring back to the previous dialog about shore length, a consensus rule was developed that CDA polygons must be ≥ 40 acres in size. The rationale was that a 40 ac. or larger CDA polygon (considering only the portion within the 2 mile shore buffer) might not have a projected shore length of 1.5 miles but would nevertheless be recognized as a Critical Dune Area by most observers. Conversely, it was decided that if any of the very abrupt, longitudinal dunes which might be 1.5 miles or greater in length were not 40 acres or more in size they would be too small to include in the regulated class of CDA. In order for a polygon to be less than 40 acres in size and be 1.5 miles in length, its width must be less than 220 feet. At the mapping scale of 1:24,000 (1":2,000'), this ground distance appears as a width of only 0.11 inches.

6. *Which soil textures should be used for "dune sand"?*

Consensus was reached that the upper horizons (A, E, or B) could be loamy sand or sand, but that the C horizon must be sand (but not stratified sand and gravel).

7. *Regarding the two-mile inland limit of the study, if a CDA polygon extends beyond the two-mile limit does it get truncated at the limit line or mapped inland to its natural border?*

This should not happen since the two-mile limit was created in part to handle this problem. If some rare circumstance does occur, the CDA must be truncated along the two-mile inland limit.

On October 18, 1995, the MSU team met with MDEQ staff (Steve Debrabander and James Ribbons) to review the results of the local relief mini-study (see question 3 above). Several new questions were discussed and resolved:

Regarding map generalization, should two or more CDA polygons be merged into one larger polygon when they occur close to one another? If so, what is the maximum gap size? Also, what is the minimum size of an area to be excluded from within a CDA polygon when it fails the local relief criteria.

The aim of the project is to capture as little non-CDA terrain as possible within any CDA polygon. Therefore, do not merge proximal CDAs, show them as distinct areal units. In an attempt to be as precise as possible, necks and blanks of non-CDA terrain within and around a CDA polygon must be wider than 0.1 inches to be shown at the scale of 1 inch: 2,000 feet (i.e., they must be approximately 200 feet or more wide to be mapped).



After a thorough review of the mapping results of the various criteria trials over the same test area (i.e., local relief assessed in unit areas of 10 ac., 40 ac., and 160 ac. using local-relief thresholds of 20 ft., 40 ft, and 60 ft.) the MSU team recommended and the MDEQ staff concurred that the standard for mapping Critical Dune Areas should be:

- ☐ The unit area for assessing local relief shall be 10 acres
- ☐ The local relief threshold for inclusion as a CDA shall be ≥ 40 feet
- ☐ CDAs must be 40 acres or larger in size irrespective of their projected shoreline length
- ☐ A CDA must be composed primarily of dune sand (C horizon = sand not stratified sand and gravel)
- ♦ These criteria do not apply to Barrier Dunes as designated pursuant to 1976 P.A. 222 as amended

The above analysis and discussion was conducted in fulfillment of the directive given in Section 23a of the 1994 amendments to the Sand Dune Protection and Management Act (1994 PA 135) and restated in Section I-A of the Request For Proposal that the contractor was to conduct "... a review of the underlying criteria used to determine critical dune areas that would provide more precise protection to the targeted resource." *Several changes in the criteria to be used for mapping CDAs were recommended and adopted by the Land and Water Management Division, MDEQ. These changes are:*

1. Employ a 10-acre unit area within which to evaluate local relief. This makes the relief criterion much more spatially precise. The previous MDNR criteria did not include this parameter.
2. Use a minimum local relief threshold of 40 feet. The implemented procedure required four 10-ft. contour lines to be within the sand dune feature (i.e., the interpreters did not interpolate between contour lines in order to "get" 40 ft. of local relief). The previous MDNR criterion used a threshold of 20 feet. This change ensured that the targeted resource that was mapped would be very obvious in the field and on maps and airphotos.
3. Employ a 40-acre minimum polygon size for CDAs. This criterion was much easier to implement than the previous MDNR criterion of 1.5 miles of projected shore length. Once again, this change was agreed upon in order to ensure that the CDAs that were mapped would be very obvious in the field as well as on maps and airphotos.



Barrier Dunes and their Relationship to Critical Dune Areas

The following discussion is extracted from the original Barrier Dune report (Buckler, 1978):

The Sand Dune Protection and Management Act (Michigan Legislature, 1976) defines a barrier dune as "the first landward sand dune formation along the shoreline of a Great Lake or a sand dune formation designated by the department" (Michigan Department of Natural Resources, 1978). This definition is somewhat ambiguous, and it is most difficult, if not impossible, to clearly designate a barrier dune from a morphological point of view, given the types, arrangements, ages and evolutionary processes of the lakeshore dunes.

The delineation of the "barrier dune", therefore, is not included in the scheme of the Dune Morphology Classification of the Lake Michigan Shore. It must be defined as a separate entity. Dune types vary along the shoreline and so must the morphologic and geometric characteristics of the barrier dune.

...

In the spirit of P.A. 222 the barrier dune seems to refer to a dune assemblage which separates the present-day shorezone and the interior environments. It is the landward edge of the recreationally oriented, "aesthetically pleasing" shoreland and the lakeward edge of inland oriented activities. It is a sand formation whose relief and location impede interaction between the two areas. In essence, the barrier dune is a buffer zone, but a buffer zone which seems more important, and unique, to the littoral rather than the terrestrial environment. ...

To realistically delimit the barrier dune formation the following prerequisites were assumed:

1. Logical criteria should be established so that it can be defined as objectively as possible.
2. Its definition must allow for variation in its morphologic and geometric characteristics.
3. Its boundaries, and especially its landward limit, should be relatively easily recognized and delineated on stereo-paired aerial imagery at a scale of 1:20,000 and larger.
4. It should be a relatively permanent formation.

...

As a practical definition, this study has identified the BARRIER SAND DUNE FORMATION as that first* dune assemblage whose forms display the greatest relative relief within the officially designated "sand dune areas" (Michigan Department of Natural Resources, 1978); its inland boundary is at the base of the assemblage's landward limit. ...

* In cases where two different dune assemblages within the sand dune area have similar relative relief, the most lakeward assemblage would normally be the recognized barrier sand dune formation.



As Buckler clearly pointed out, the barrier dune is not a morphologically defined landform. It is defined solely on the basis of its position relative to the shoreline. Critical Dune Areas, on the other hand, are defined on the basis of morphology, primarily their local relief. As discussed above, one of the original MDNR criteria that was **not** changed was that all barrier dunes designated pursuant to 1976 P.A. 222 were automatically members of the Critical Dune Areas. It should be noted, however, that because they are delineated using different criteria, *numerous portions of the designated Barrier Dunes do not meet the relief criteria established for Critical Dunes Areas.*

In keeping with the terms of this contract, the MSU team did not alter the delineation of any of the previously mapped barrier dunes except in two cases. First, where obvious digitizing errors had occurred (i.e., the map in the Atlas of Critical Dunes did not match the original Barrier Dune delineation - the so-called Buckler maps) the correct line position is shown on the evaluation maps. The second case involves correcting mapping errors in the original Series I, II or III Barrier Dune Mapping Projects conducted for the Geological Survey Division, MDNR. This is necessary, because at the time the Barrier Dune Mapping Projects were conducted, numerous areas along the Lake Michigan shore, in west and northwest Lower Michigan in particular, were mapped by the USGS only at the 15-minute quadrangle level of detail (1:62,500 scale, usually with a 20 ft. contour interval). In comparison, the largest-scale topographic map now available for these areas is the 7.5-minute, 1:24,000 quadrangle which typically has a 10 ft. contour interval. In the original Barrier Dune Mapping Projects, all maps were compiled at the 1:24,000 scale, but those areas lacking a 7.5-minute map were completed by photo-enlarging the 15-minute (1:62,500) quadrangle by a factor of 2.604. In such cases, the basemap becomes a 1:24,000-scale product, but its inherent spatial accuracy in both the horizontal and the vertical domains remains those associated with the original 1:62,500 scale.

The horizontal National Map Accuracy Standard (NMAS) for both the 1:24,000 and the 1:62,500 quadrangles is *90% correct +/- 1/50 inch at scale*. For the 7.5-minute quadrangle that measures +/- 40 feet; for the 15-minute quadrangle it measures +/- 104 feet. The vertical NMAS for both maps is *90% correct +/- one-half a contour interval*. For maps with a 10 ft. contour interval that means +/- 5 feet; for those with a 20 ft. contour interval (e.g. many of the 15-minute quads) it measures +/- 10 feet. It should be expected that some "errors" exist in the original Barrier Dune Maps, induced solely as result of the scale differences of the topographic maps.

Examples of Problem or Change Areas

Figure 3 illustrates the application of the 40 ft. local relief criterion regarding the delineation Critical Dune Areas. Polygons "A" and "B" are examples of the type of terrain which were added as new CDAs. The sand ridge noted at "C", however, does not exhibit 40 feet of relief and therefore is not a qualified CDA. Also shown on Figure 3, at "D", are two portions of a designated Barrier Dune which do not meet the relief criterion for CDA. Areas such as this



exist in many places within the Designated Sand Dunes Areas of Michigan. As discussed above, this project was not authorized to, and did not, edit any of the Designated Barrier Dune polygons due to low relief. Digitizing errors were, however, corrected. In Figure 4, the area shown at "1" illustrates the correction of such an error. The sand ridge at "2" is typical of a dune area that is too small in size to qualify as a CDA. Finally, the dune at "3" is an example of a newly added CDA. In this case, the addition itself is less than 40 acres in size but it is acceptable due to its contiguity with an adjoining dune assemblage (a designated Barrier Dune).

T. 7 R. 16 W.

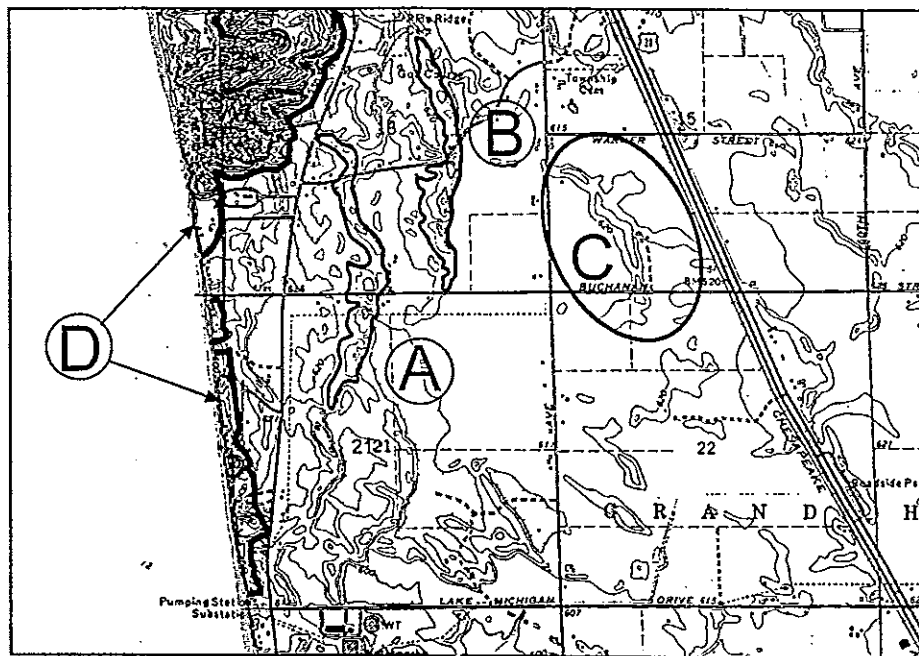


Figure 3. Examples of CDA mapping problems.



T. 4 N. R. 16 W.

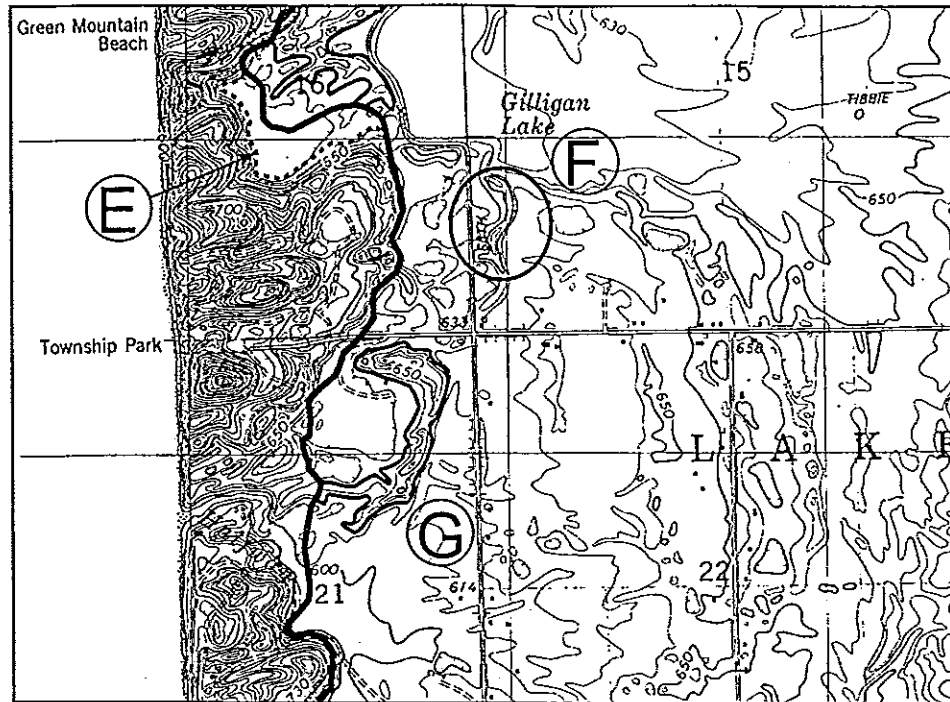


Figure 4. Examples of change areas from the reevaluation of the *Atlas of Critical Dunes*.

Reevaluation of the Atlas Critical Dunes

Appendix A presents the details of the quadrangle folders, their relationship to the pages of the *Atlas of Critical Dunes*, the names of the USGS quadrangles (both current and previous) involved, the relationship of the folder number to the Series I, II, or III Sand Dune Area designations used by the Geological Survey Division, the status of the soil surveys in the various areas, and the status of the revision mapping conducted by this project. Of the 72 pages in the *Atlas of Critical Dunes*, changes are recommended on 60 of them (as shown in the extreme right hand column of Appendix A).

The actual changes (additions, deletions, or linework alterations) are graphically depicted on the various registered overlays presented in Appendix B. Where changes to the *Atlas* were suggested or suspected by MDEQ staff (as shown by circled question areas), the page from the *Atlas* is reproduced and annotated regarding the review recommendations. Following the page from the *Atlas*, the one or more overlays to the 7.5-minute quadrangles are presented. These graphics are plotted at the scale of 1:24,000 and serve as registered overlays to the USGS 7.5-minute quads to which they refer. Registration is achieved via the section-corner tic marks. These maps are presented in Folder number sequence with respect to the USGS quadrangle format. The folder number generally increments northward along the west shore of the Lower Peninsula. In the Upper Peninsula, the folder numbers increment westward along the north shore of Lake Michigan and again westward along the Lake Superior shoreline from Chippewa County to Keeweenaw County.



References

- Buckler, William R. 1978. Dune Type Inventory and Barrier Dune Classification Study of Michigan's Lake Michigan Shore. Contract report from the Remote Sensing Project, Michigan State University submitted to the Geological Survey Division, Michigan Department of Natural Resources. 71 p.
- Buckler, William R. 1979. Dune Type Inventory and Barrier Dune Classification Study of Michigan's Lake Michigan Shore. Report of Investigation 23. Lansing, Michigan: Geological Survey Division, Michigan Department of Natural Resources. 31 p.
- MDNR. 1978. Proposed designated dune areas: Series I. Lansing, Michigan: Geological Survey Division, Michigan Department of Natural Resources. 18 p.
- MDNR. 1989. Atlas of Critical Dunes. Lansing, Michigan: Land and Water Management Division, MDNR. February 17, 1989 (reprinted February, 1993). 74 p.



Appendix A



Appendix A

Index information				Topography			Source Information				Revision Mapping		
Atlas		Dune Maps		Soil Survey		Soil Survey		Map		Change?			
Page #	Folder #	New Quad(s)	Date of new quads	Scale of new quads	Old Quad(s) Buckler Names	Series	Digitizing and dune atlas status of Buckler maps	County	Soil Survey	Soil Survey date	Folder #	done by	
1 c	1	New Buffalo W.	1970	1:24000	New Buffalo W		CDA digitized but work not done by Buckler	Berrien	Current	1980	1	L c	
2 nc	2	New Buffalo E.	1970	1:24000	New Buffalo W		CDA digitized but work not done by Buckler	Berrien	Current	1980	2	M nc	
2 nc	2	New Buffalo E.	1970	1:24000	New Buffalo E	1	Buckler Dunes digitized	Berrien	Current	1980	2	M nc	
2 c	3	Bridgeman	1970	1:24000	Bridgeman	1	Buckler Dunes digitized	Berrien	Current	1980	3	M c	
2 nc	4	3 Oaks	1970	1:24000	3 Oaks	1	No Dunes in 3 Oaks. Too far east	Berrien	Current	1980	4	F nc	
3 c	3	Bridgeman	1970	1:24000	Bridgeman	1	A small Dune segment east of I-94 not digitized	Berrien	Current	1980	3	M c	
4 c	3	Bridgeman	1970	1:24000	Bridgeman	1	Buckler Dunes digitized	Berrien	Current	1980	3	M c	
4 nc	5	Stevensville	1970	1:24000	Stevensville	1	Buckler Dunes digitized	Berrien	Current	1980	5	L nc	
5 c	6	Benton Heights	1970	1:24000	Benton Heights	1	Buckler Dunes digitized	Berrien	Current	1980	6	M c	
5 c	7	Coloma	1970	1:24000	Coloma	1	Buckler Dunes digitized	Berrien	Current	1980	7	M c	
6 c	7	Coloma	1970	1:24000	Coloma	1	Buckler Dunes digitized	Van Buren	Current	1986	7	M c	
6 c	8	Covert	1981	1:24000	South Haven SE	1	Buckler Dunes digitized	Van Buren	Current	1986	8	L c	
7 c	8	Covert	1981	1:24000	South Haven SE	1	Buckler Dunes digitized	Van Buren	Current	1986	8	L c	
7 nc	9	South Haven	1981	1:24000	South Haven SE	1	No Dunes in that area	Van Buren	Current	1986	9	F nc	
8 nc	10	Glenn	1981	1:24000	Fenville	2	No Dunes in that area	Allegan	Current	1987	10	F nc	
8 c	11	Saugatuck	1981	1:24000	Fenville	2	Buckler Dunes digitized	Allegan	Current	1987	11	L c	
9 c	11	Saugatuck	1981	1:24000	Fenville	2	Buckler Dunes digitized	Allegan	Current	1987	11	L c	
9 c	12	Holland W.	1972	1:24000	Holland W.	2	Buckler Dunes digitized	Allegan	Current	1987	12	F c	
10 c	12	Holland W.	1972	1:24000	Holland W.	2	Buckler Dunes digitized	Ottawa	Current	1972	12	F c	
11 c	12	Holland W.	1972	1:24000	Holland W.	2	Buckler Dunes digitized	Ottawa	Current	1972	12	F c	
11 c	13	Port Sheldon	1980	1:24000	Port Sheldon	1	Buckler Dunes digitized	Ottawa	Current	1972	13	L c	
12 c	13	Port Sheldon	1980	1:24000	Port Sheldon	1	Buckler Dunes digitized	Ottawa	Current	1972	13	L c	
12 c	14	Grand Haven	1980	1:24000	Grand Haven	1	Buckler Dunes digitized	Ottawa	Current	1972	14	L c	
13 c	14	Grand Haven	1980	1:24000	Grand Haven	1	Buckler Dunes digitized	Ottawa	Current	1972	14	L c	
14 c	14	Grand Haven	1980	1:24000	Grand Haven	1	Buckler Dunes digitized	Muskegon	Current	1968	14	L c	
14 nc	16	Muskegon E.	1980	1:24000	Muskegon E.	1	No adds in that area. Too far inland	Muskegon	Current	1968	16	F nc	
14 c	15	Muskegon W.	1980	1:24000	Muskegon W.	1	Buckler Dunes digitized	Muskegon	Current	1968	15	L c	
15 c	15	Muskegon W.	1980	1:24000	Muskegon W.	1	Buckler Dunes digitized	Muskegon	Current	1968	15	L c	
15	17,18	Dalton,	1983	1:25000	Montague S.*	1	Barrier dune partially digitized	Muskegon	Current	1968	17,18	F,L nc,nc	
16 nc	18	Michilinda	1983	1:25000	Montague S.*	1	Barrier dune Not digitized	Muskegon	Current	1968	18	L nc	
17 nc	19	Flower Creek	1983	1:25000			Not done by Buckler. Fox?	Muskegon	Current	1968	19	L nc	
17 nc	19	Flower Creek	1983	1:25000			Not done by Buckler. Fox?	Muskegon	Current	1968	19	L nc	
18	20,21	Town Corners, Bigsble Lake	1983	1:25000	Hart SW*	1	Polygons digitized but no notation	Oceana	(Prov. 1972)	1995	20,21	F,F c,c	
19	21,22	Bigsble Lake, Little Point Sable	1983	1:25000	Hart SW*, Hart NW*	1	Polygons digitized, some notation missing	Oceana	(Prov. 1972)	1995	21,22	F,F c,nc	
20	22,23	Little Point Sable, Mears	1983	1:25000	Hart NW*	1	Buckler Dunes digitized	Oceana	(Prov. 1972)	1995	22,23	F,F nc,c	

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Appendix A

Index information				Topography			Source Information			Revision Mapping			
Atlas	Page #	Folder #	New Quad(s)	Date of new quads	Scale of new quads	Old Quad(s) Buckler Names	Series	Digitizing and dune atlas status of Buckler maps	County	Soil Survey	Soil Survey date	Folder #	Map done by
21	c,c	23,24	Mears, Pentwater	1983	1:25000	Ludington SW*	1	Buckler Dunes NOT digitized	Oceana	Interim (Prov. 1972)	1995	23,24	F.L
22	c	24	Pentwater	1983	1:25000	Ludington SW*	1	Buckler Dunes NOT digitized	Mason	Interim	1995	24	L
22	c	24	Pentwater	1983	1:25000	Ludington SW*	1	No Dunes in that area	Mason	Interim	1995	24	L
23	nc	25	Ludington	1983	1:25000	Ludington NW*	1	Buckler Dunes digitized	Mason	Interim	1995	25	L
24	nc	25,26	Ludington	1983	1:25000	Ludington NW*	1	Buckler Dunes digitized	Mason	Interim	1995	25,26	L,F
24	c	26	Hamlin Lake	1982	1:25000	Manistee S.*	1	Buckler Dunes NOT digitized	Mason	Interim	1995	26	F
25	c	26	Hamlin Lake	1982	1:25000	Manistee S.*	1	Buckler Dunes NOT digitized	Mason	Interim	1995	26	F
25	c	26	Hamlin Lake	1982	1:25000	Manistee N.*	1	Buckler Dunes digitized	Mason	Interim	1995	26	L
26	c	27	Manistee NW	1982	1:25000	Manistee N.*	1	Buckler Dunes digitized	Mason	Interim	1995	27	L
27	c	27	Manistee NW	1982	1:25000	Manistee N.*	1	Buckler Dunes digitized (No Dunes in area)	Manistee	Old		27	L
27	nc	27,28	Manistee NW	1982	1:25000	Bar Lake*	2	No Dunes in area	Manistee	Old		27,28	L,F
28	c	29	Parkdale	1983	1:25000	Bar Lake*	2	Buckler Dunes digitized	Manistee	Old		29	M
29	c	29,30	Parkdale	1983	1:25000	Bar Lake*	2	Buckler Dunes digitized	Manistee	Old		29,30	
29	c	31	Onekama	1982	1:25000	Onekama NW*	2	Buckler Dunes digitized	Manistee	Old		31	F
30	c	32	Bear Lake	1983	1:25000	Onekama NW*	2	Buckler Dunes digitized	Manistee	Old		32	F
31	c	32	Elberta	1983	1:25000	Frankfort SW*	2	Buckler Dunes digitized	Benzie	No		32	F
32	c	32,33	Frankfort	1983	1:25000	Frankfort SW*	2	Buckler Dunes digitized	Benzie	No		32,33	F,L
33	c	33	Frankfort	1983	1:25000	Frankfort NW*	2	Buckler Dunes digitized	Benzie	No		33	L
33	c	33,34	Frankfort, Beulah,	1983	1:25000	Frankfort NW*	2	Buckler Dunes digitized	Benzie	No		33,34	L,L
33	c	33,34	Frankfort, Beulah,	1983	1:25000	Frankfort NW*	2	Buckler Dunes digitized	Benzie	No		33,34	L,L
33	c	33,34	Frankfort, Beulah,	1983	1:25000	Frankfort NW*	2	Buckler Dunes digitized	Benzie	No		33,34	L,L
34	c	35	Empire	1983	1:25000	Empire SE*	2	Buckler Dunes digitized	Benzie	No		35	L,L
34	c	35	Empire	1983	1:25000	Frankfort NE*	2	Buckler Dunes digitized	Benzie	No		35	L,L
34	c	35	Empire	1983	1:25000	Frankfort NE*	2	Buckler Dunes digitized	Benzie	No		35	L,L
34	c	35	Empire	1983	1:25000	Empire NE*	2	Buckler Dunes digitized	Benzie	No		35	L,L
35	c,c,c	35,36,37	Glen Haven, Glen Arbor	1983	1:25000	Empire NE*	2	Buckler Dunes NOT digitized	Leelanau	Current	1973	35,36,37	L,M,M
35	c,c	36,37	Glen Haven	1983	1:25000	Maple City NW*	2	Buckler Dunes NOT digitized	Leelanau	Current	1973	36,37	M,M
35	c,c	36,37	Glen Haven	1983	1:25000	Maple City NW*	2	Buckler Dunes NOT digitized	Leelanau	Current	1973	36,37	M,M
36	c	37	Glen Arbor	1983	1:25000	Maple City NW*	2	Buckler Dunes digitized	Leelanau	Current	1973	37	M
37	c	37	Glen Arbor	1983	1:25000	Maple City NW*	2	Buckler Dunes digitized	Leelanau	Current	1973	37	M
37	nc	38	Good Harbor Bay	1983	1:25000	Maple City NE*	2	Buckler Dunes digitized	Leelanau	Current	1973	38	M
38	nc	38	Good Harbor Bay	1983	1:25000	Maple City NE*	2	Buckler Dunes digitized	Leelanau	Current	1973	38	M
39	nc	38	Good Harbor Bay	1983	1:25000	Maple City NE*	2	Buckler Dunes digitized	Leelanau	Current	1973	38	M

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Appendix A

Index information				Topography				Source Information				Revision Mapping			
								Dune Maps		Soil Survey					
Atlas Page #	Folder #	New Quad(s)	Date of new quads	Scale of new quads	Old Quad(s) Buckler Names	Series	Digitizing and dune atlas status of Buckler maps	County	Soil Survey	Soil Survey date	Folder #	Map done by	Change?		
39	nc	Leland	1983	1:25000	Northport NW*	2	Buckler Dunes digitized	Leelanau	Current	1973	39	L	nc		
40	c	Gillis Pier	1983	1:25000	Northport NW*	2	(No dunes)	Leelanau	Current	1973	40	M	c		
41	c	Gillis Pier	1983	1:25000	Northport NW*	2	Buckler Dunes digitized	Leelanau	Current	1973	40	M	c		
42	nc,c	Northport NW, Northport	1983	1:25000	Northport NW*	2	Buckler Dunes digitized	Leelanau	Current	1973	41,42	M, M	nc, c		
43	c	Northport	1983	1:25000	Northport NE*	2	Buckler Dunes digitized	Leelanau	Current	1973	42	M	c		
44	c	S. Manitou I.	1983	1:25000	N. Manitou SW*	2	Dune sheet missing from folder	Leelanau	Current	1973	43	L	c		
45	c	N. Manitou I.	1983	1:25000	N. Manitou SE*	2	Dune sheet missing from folder	Leelanau	Current	1973	44	M	c		
46	c	N. Manitou I.	1983	1:25000	N. Manitou SE*	2	Dune sheet missing from folder	Leelanau	Current	1973	44	M	c		
47	c	S. Fox I.	1986	1:24000	S. Fox I.*	3	Folder missing	Leelanau	Current	1973	45	M	c		
48	c	S. Fox I.	1986	1:24000	S. Fox I.*	3	Folder missing	Leelanau	Current	1973	45	M	c		
49	c	Alden	1983	1:25000	Elk Rapids NE*	2	Small sliver of Dune see p.48	Antrim	Current	1978	46	M	nc		
50	c	Elk Rapids	1983	1:25000	Elk Rapids NE*	2	Buckler classes as BD but NOT classed BD in Atlas	Antrim	Current	1978	47	M	c		
51	nc	Central Lake	1983	1:25000	Central Lake SE*	2	Dune sheet partially digitized.	Antrim	Current	1978	48	L	nc		
52	nc	Atwood, Charlevoix	1983	1:25000	Charlevoix*	2	Buckler BD but Not classed as BD in Atlas	Charlevoix	Current	1974	49	F	nc		
53	c	Charlevoix	1983	1:25000	Charlevoix*	2	Buckler Dunes NOT digitized.	Charlevoix	Current	1974	50	M	c		
54	c	Charlevoix	1983	1:25000	Charlevoix*	2	Partially Buckler BD but Not classed BD in Atlas	Charlevoix	Current	1974	50	M	c		
55	c	Ironton	1983	1:25000	Bayshore SW*	2	Buckler Dunes NOT digitized	Charlevoix	Current	1974	51	M	c		
56	nc	High I.	1986	1:24000	Beaver I.*	3	Folder missing	Charlevoix	Current	1974	52	M	nc		
57	c	Beaver I. S	1986	1:24000	Beaver I.*	3	Folder missing	Charlevoix	Current	1974	53	L	c		
58	c	Beaver I. N	1986	1:24000	Beaver I.*	3	Folder missing	Charlevoix	Current	1974	53	L	c		
59	c	Garden I. W	1986	1:24000	Beaver I.*	3	Folder missing	Charlevoix	Current	1974	53	L	c		
60	nc	Harbor Springs	1983	1:25000	Petoskey NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	54	L	nc		
61	c	Cross Village	1982	1:25000	Cross Village NE*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	55	L	c		
62	c	Cross Village	1982	1:25000	Pellston NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	55	L	c		
63	c	Bliss	1982	1:25000	Pellston NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	56	L	c		
64	c	Bliss	1982	1:25000	Pellston NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	56	L	c		
65	c	Bliss	1982	1:25000	Pellston NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	56	L	c		
66	c	Bliss	1982	1:25000	Pellston NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	56	L	c		
67	c	Bliss	1982	1:25000	Pellston NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	56	L	c		
68	c	Big Stone Bay	1975,	1:25000	Pellston NW*	2	Buckler Dunes NOT digitized	Emmet	Current	1973	56	L	c		
69	c	Levering	1982	1:25000	Big Stone Bay	2	No Dunes in Big Stone Bay	Emmet	Current	1973	57,58	L, M	nc,c		
70	c	Levering	1982	1:25000	Pellston NE*	2	Buckler Dunes digitized	Emmet	Current	1973	58	M	c		

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Appendix A

Index information				Topography				Source Information				Revision Mapping			
				Dune Maps				Soil Survey							
Atlas Page #	Folder #	New Quad(s)	Date of new quads	Scale of new quads	Old Quad(s) Buckler Names	Series	Digitizing and dune atlas status of Buckler maps	County	Soil Survey	Soil Survey date	Folder #	Map done by	Change?		
59	c 59	McGulpin Pt.	1984	1:24000	McGulpin Pt.	2	Bucker Dunes POORLY digitized	Emmet	Current	1973	59	M	c		
60	nc 60	Moran	1976	1:24000	Pointe Aux Chenes	1	Dunes too far inland	Mackinac	Interim	1995	60	F	nc		
60	c 61	Pointe Aux Chenes	1984	1:24000	Pointe Aux Chenes	1	Buckler Dunes digitized	Mackinac	Interim	1995	61	F	c		
61	c 62	Kenneth	1984	1:24000	Kenneth	1	Buckler Dunes digitized	Mackinac	Interim	1995	62	F	c		
61	c 63	Brevort	1975	1:24000	Brevort	1	Buckler Dunes digitized	Mackinac	Interim	1995	63	F	c		
62	c 64	Seul Choix Point	1972	1:24000	Seul Choix Point	3	Folder missing	Schoolcraft	Old		64	F	c		
63	c 65	Gulliver	1972	1:24000	Gulliver	3	Folder missing	Schoolcraft	Old		65	F	c		
64	c 66	Dollar Settlement	1951	1:24000	Dollar Settlement	3	Folder missing	Chippewa	Current	1992	66	F	c		
65	c 67	Betsy Lake N.	1968	1:24000	Betsy Lake N.	3	Bucker Dunes NOT digitized	Luce	Old		67	F	c		
66	c 68	Betsy Lake NW	1968	1:24000	Betsy Lake NW	3	Bucker Dunes NOT digitized	Luce	Old		68	F	c		
67	c 68	Betsy Lake NW, Lake Muskallonge - Lake East	1968	1:24000	Betsy Lake NW, Lake Muskallonge - Lake East	3	Bucker Dunes NOT digitized	Luce	Old		68	F	c		
67	c 69	Muskallonge - Lake West	1968	1:24000	Muskallonge Lake West	3	Bucker Dunes NOT digitized	Luce	Old		69	F	c		
68	c 70	Grand Marais NE	1968	1:24000	Grand Marais NE	3	Bucker Dunes NOT digitized	Luce	Old		70	F	c		
68	c 71	Grand Marais NE, Grand Marais	1968	1:24000	Grand Marais NE	3	Bucker Dunes NOT digitized	Luce	Old		71	F	c		
69	c 71, 72	Grand Marais	1968	1:24000	Grand Marais	3	Bucker Dunes NOT digitized	Alger	Old		71, 72	F, F	c, c		
70	c 72, 73	Grand Sable Lake	1966	1:24000	Grand Sable L.	3	Bucker Dunes NOT digitized	Alger	Old		72, 73	F, F	c, c		
71	c 78	Eagle Harbor	1975	1:24000	Eagle Harbor	3	Bucker Dunes NOT digitized	Keweenaw	No		78	F, F	c		
71	c 78	Eagle Harbor	1975	1:24000	Phoenix	3	Bucker Dunes NOT digitized	Keweenaw	No		78	F, F	c		
72	c, nc 78, 77	Phoenix	1975	1:24000	Phoenix	3	Bucker Dunes NOT digitized	Keweenaw	No		78, 77	F, F	c, nc		
Not in Atlas but mapped by Buckler															
Pictured rocks area:															
74		Au Sable Pt.	1966	1:24000	Au Sable Pt.	3	No critical dunes	Alger	Old		74	F	nc		
75		Au Sable Pt. SW	1966	1:24000	Au Sable Pt. SW	3	No critical dunes	Alger	Old		75	F	nc		
76		Trappers Lake	1983	1:25000	Grand Portal Pt.*	3	Adds made	Alger	Old		76	M	c		
Torch Lake area:															
47		Elk Rapids NE		1:24000	Elk Rapids NE	2	See above				47	M	c		
West of Kenneth:															
		Epouette		1:24000		3	No dunes in area								

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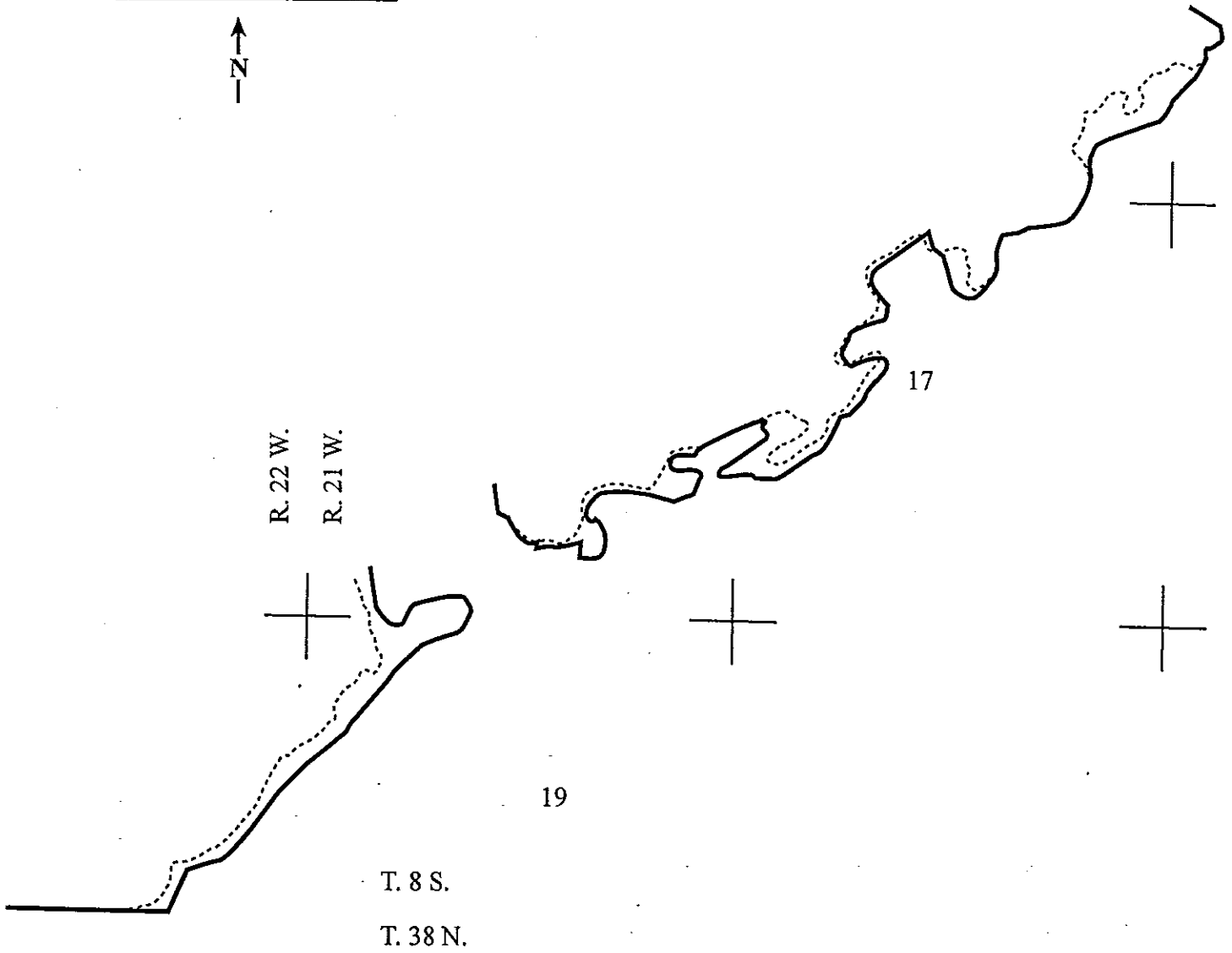
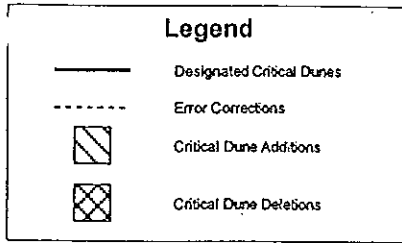
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F = Frank Krist
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Appendix B

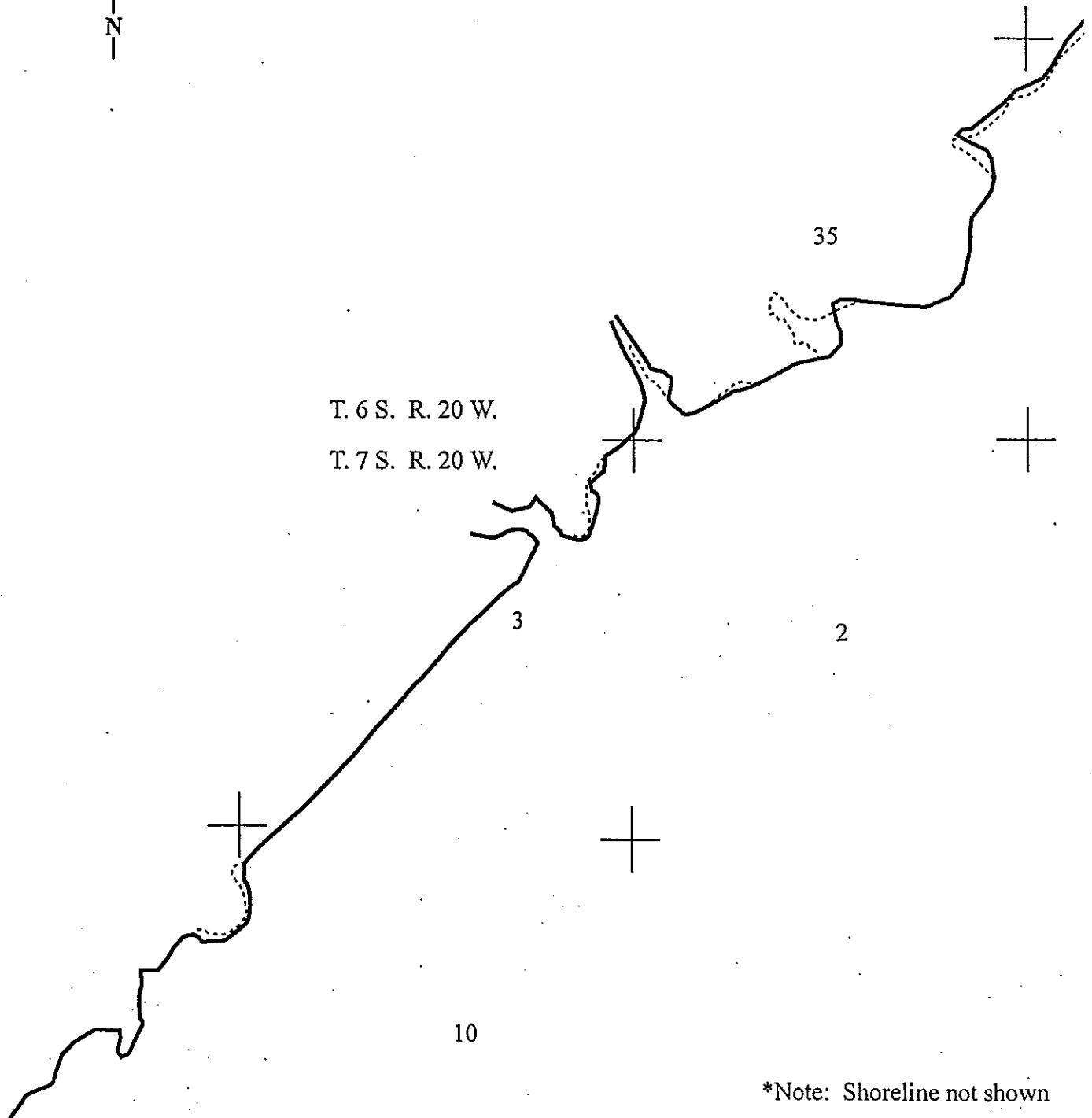
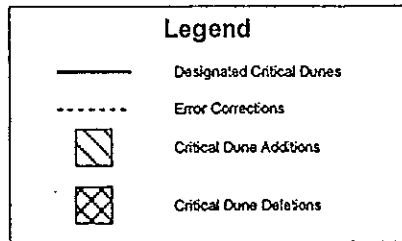


Folder 1: New Buffalo West



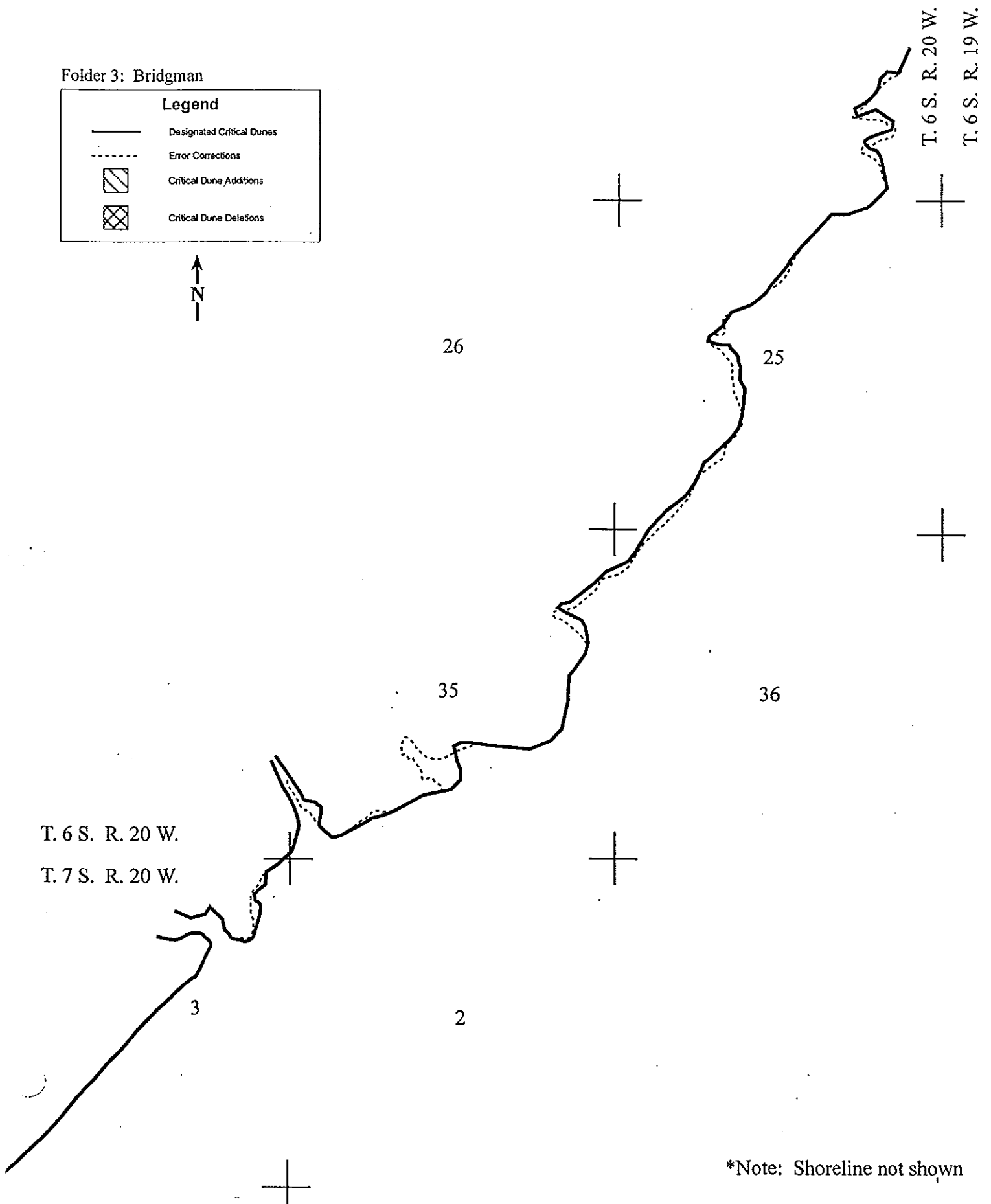
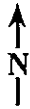
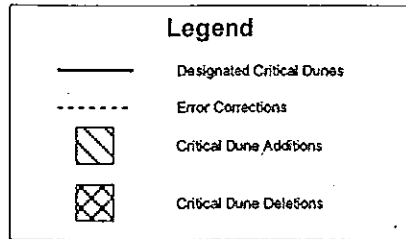
*Note: Shoreline not shown

Folder 3: Bridgman

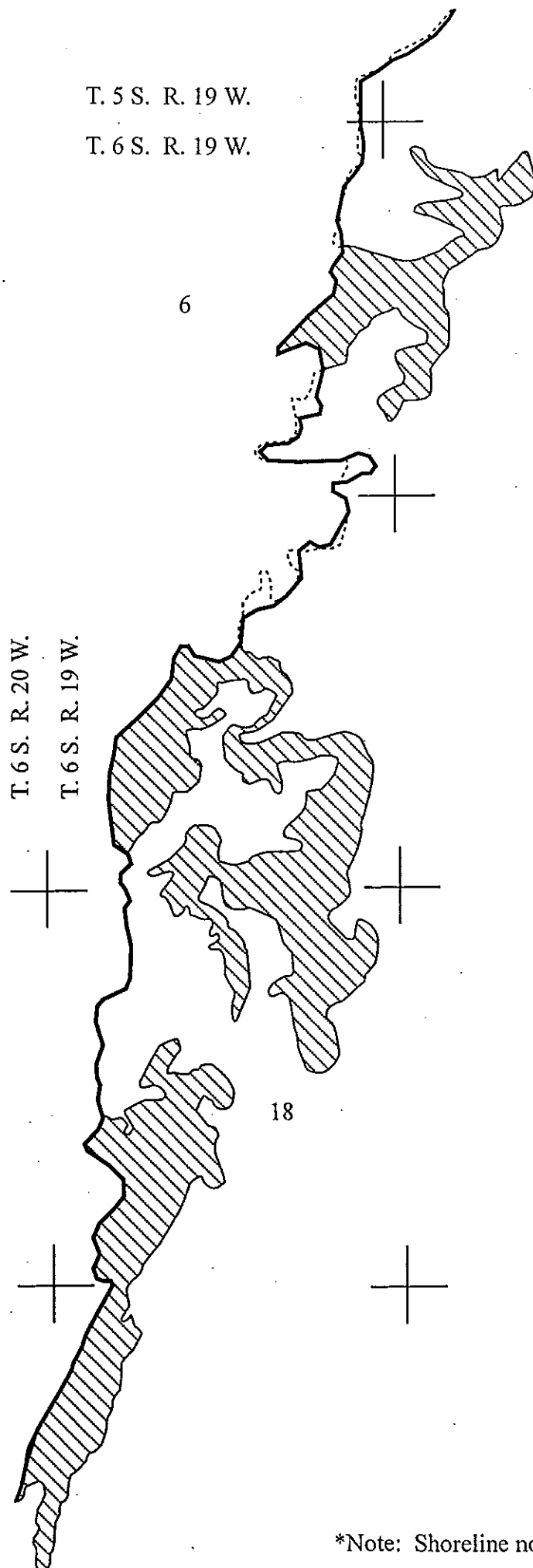
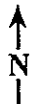
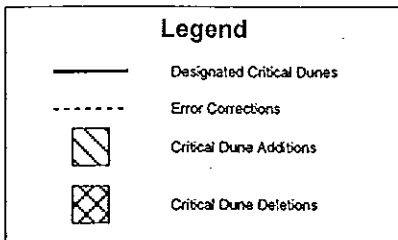


*Note: Shoreline not shown

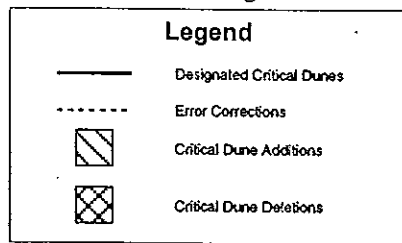
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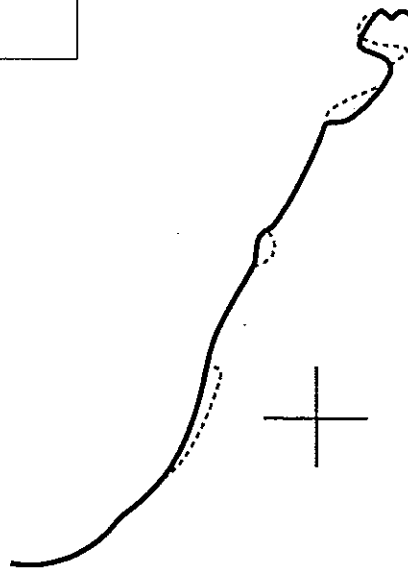
Folder 3: Bridgman



Folder 6: Benton Heights



T. 3 S. R. 18 W.

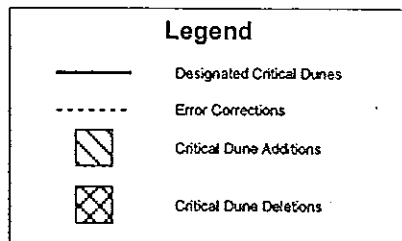


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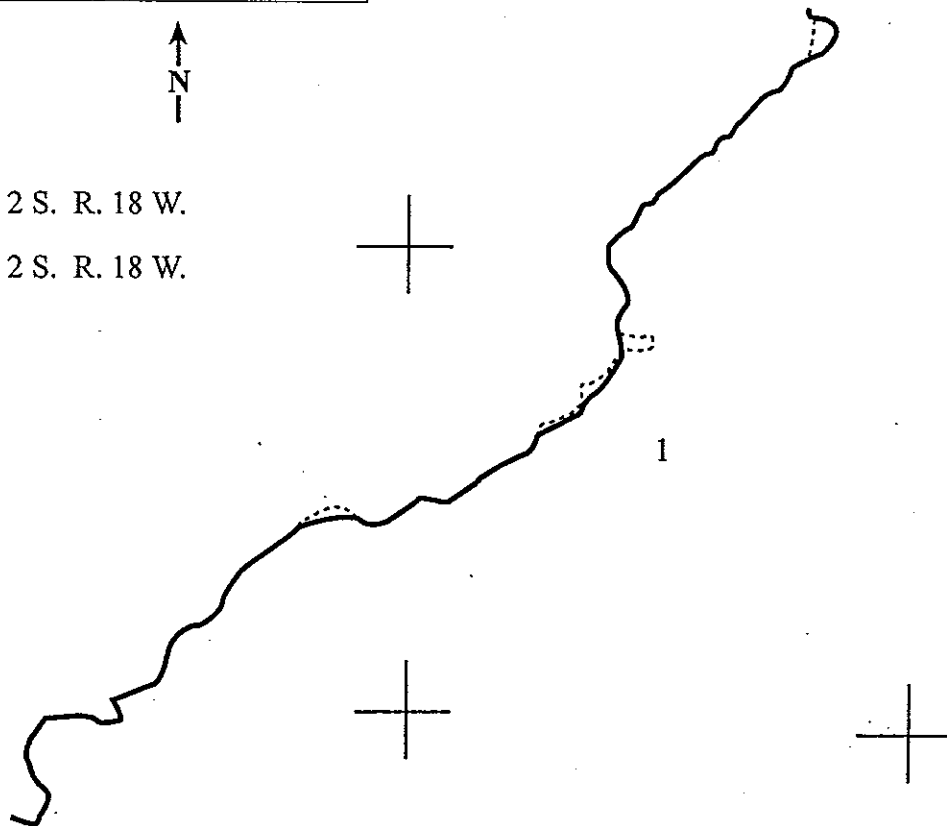
*Note: Shoreline not shown

Folder 7: Coloma



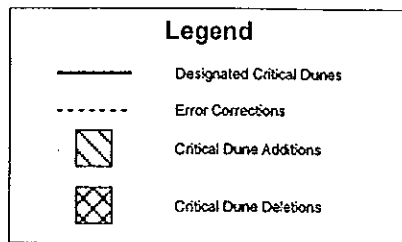
T. 2 S. R. 18 W.

T. 2 S. R. 18 W.

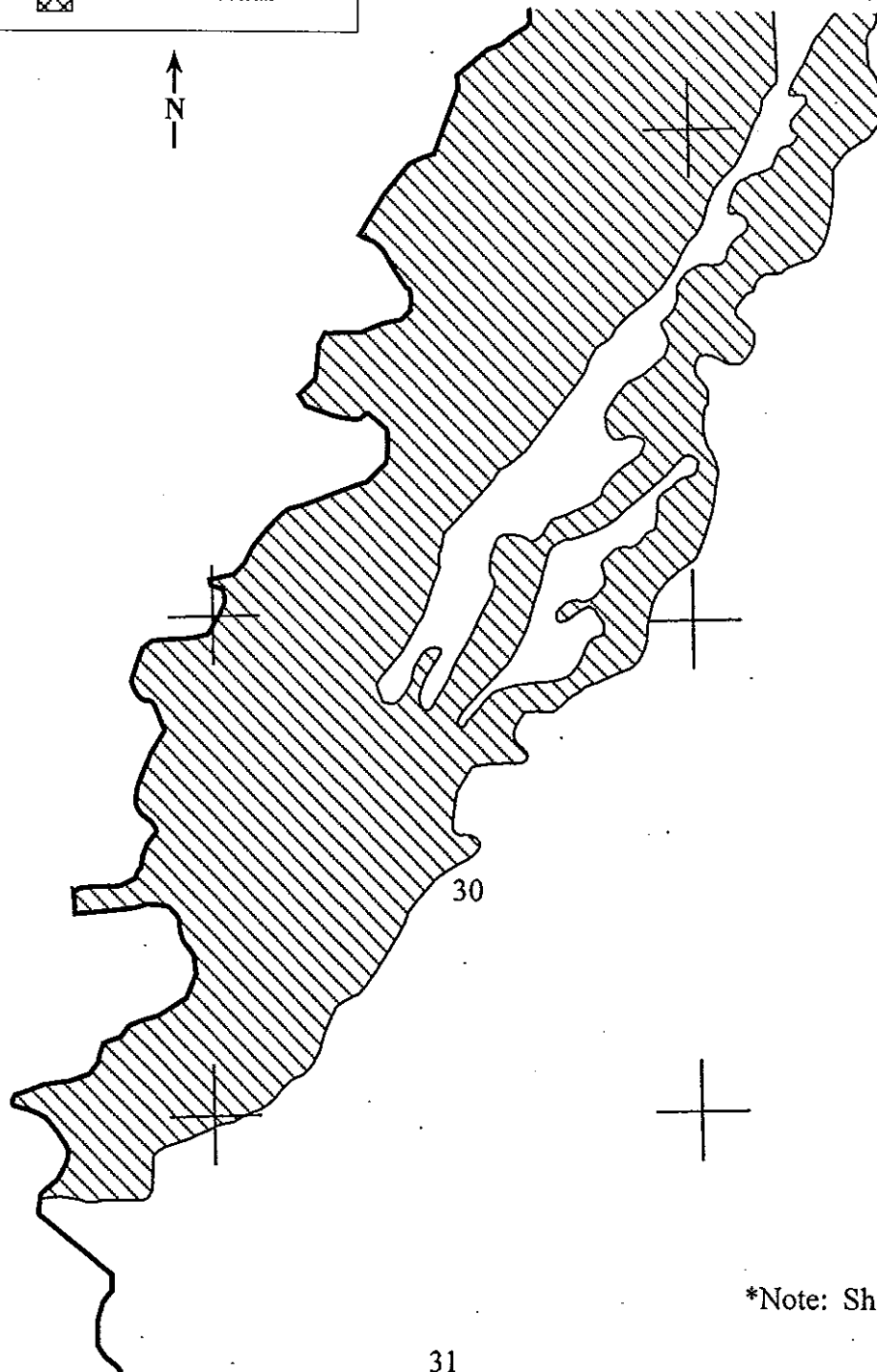


*Note: Shoreline not shown

Folder 8: Covert



T. 2 S. R. 17 W



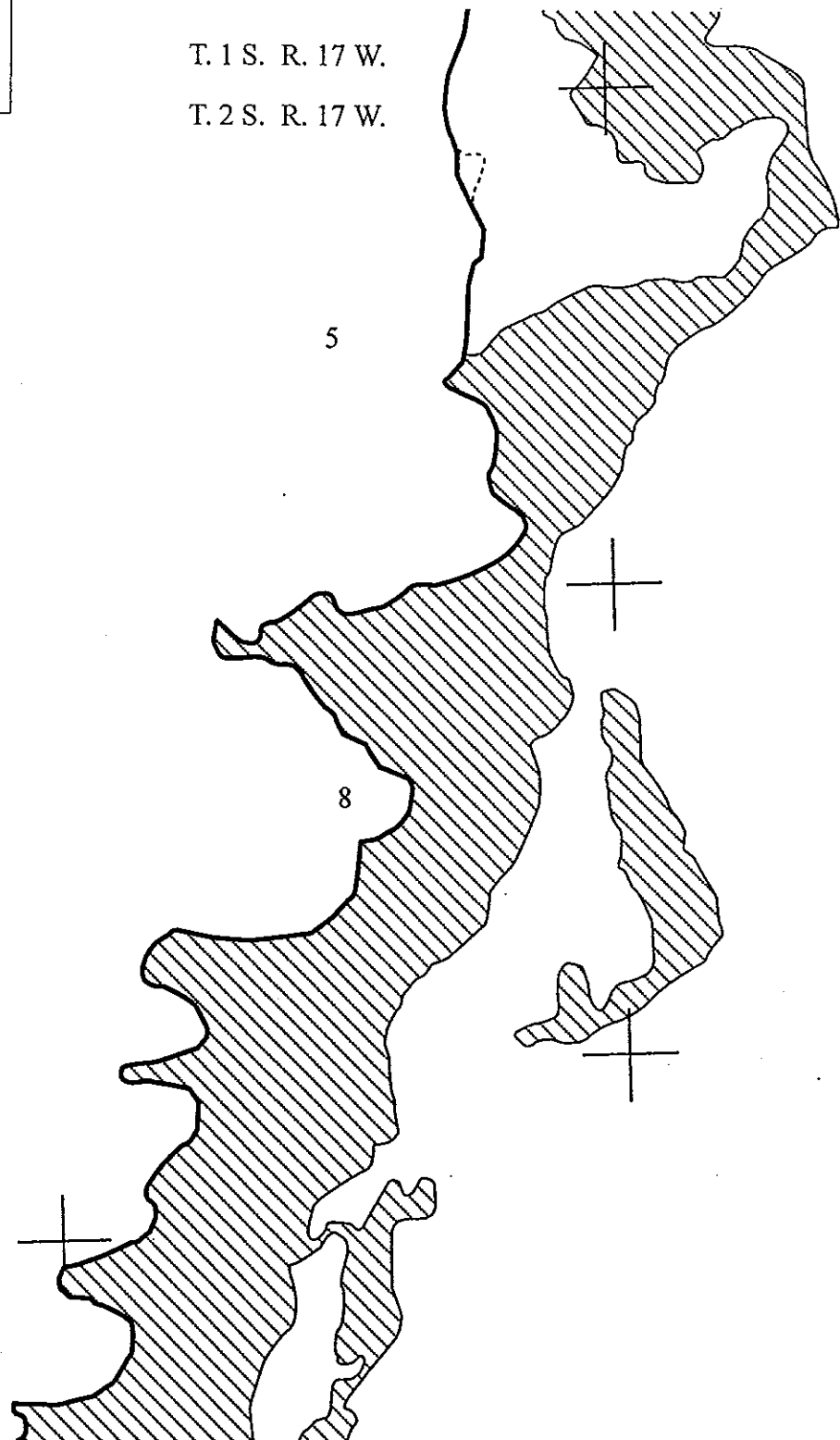
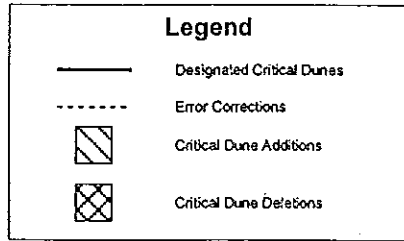
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*Note: Shoreline not shown

31

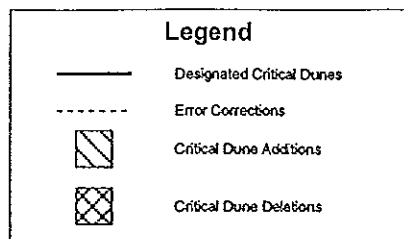
Folder 8: Covert



T. 2 S. R. 17 W

*Note: Shoreline not shown

Folder 8: Covert



T. 1 S. R. 17 W.

T. 2 S. R. 17 W.

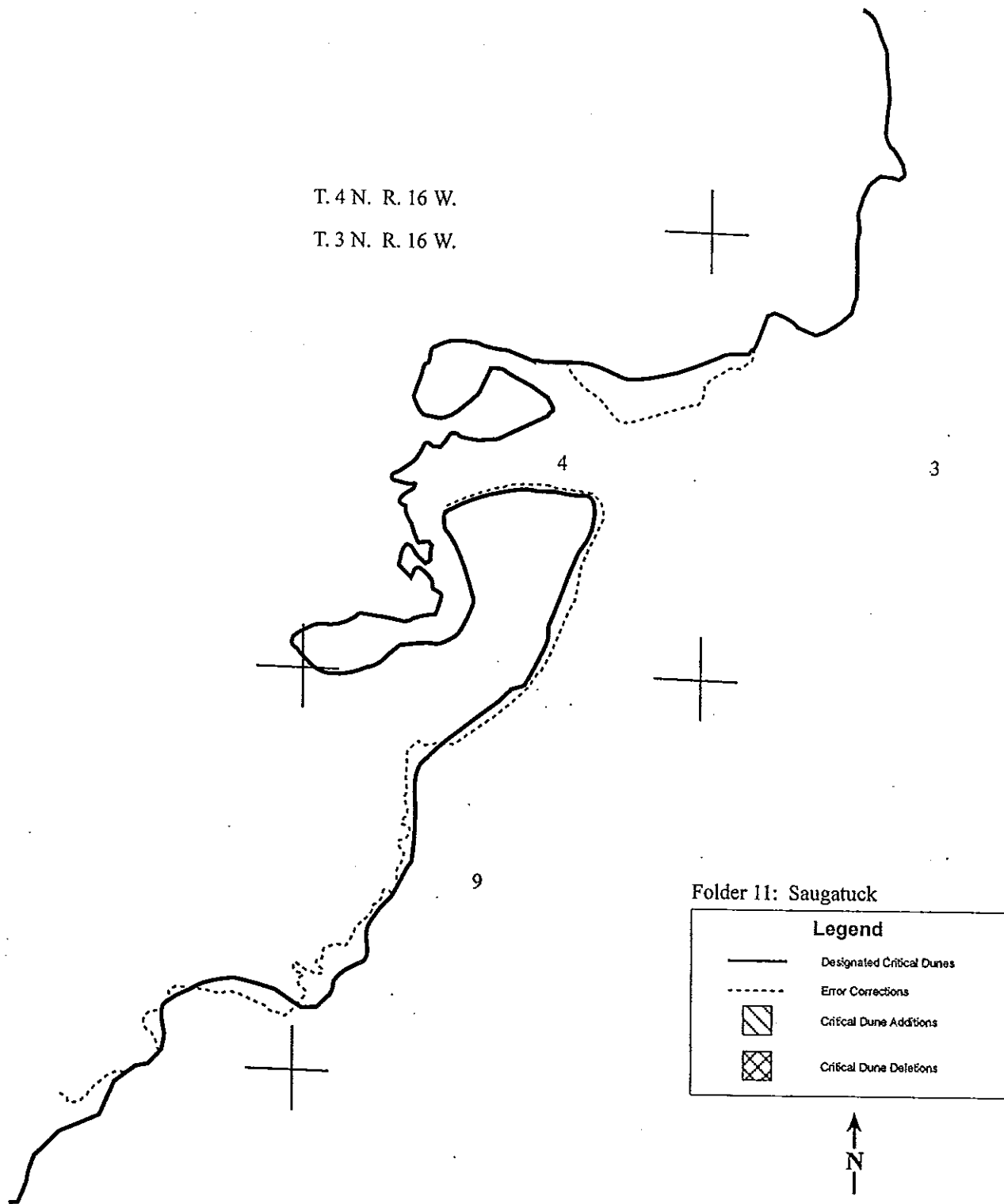
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T. 2 S. R. 17 W

*Note: Shoreline not shown



*Note: Shoreline not shown

T. 4 N. R. 16 W.

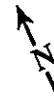
15

Folder 11: Saugatuck

Legend

- Designated Critical Dunes
- - - Error Corrections
- ▨ Critical Dune Additions
- ▩ Critical Dune Deletions

22



*Note: Shoreline not shown



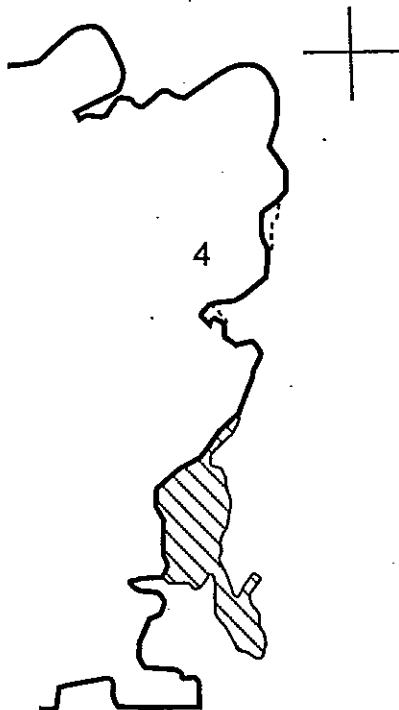
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Folder 12: Holland West

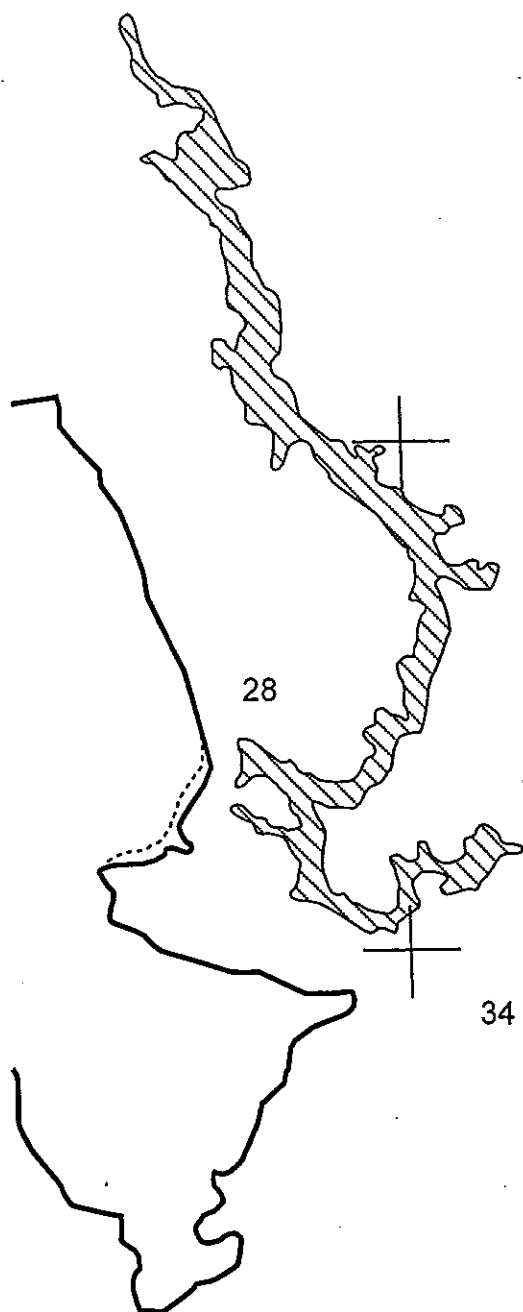
Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



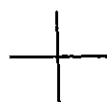
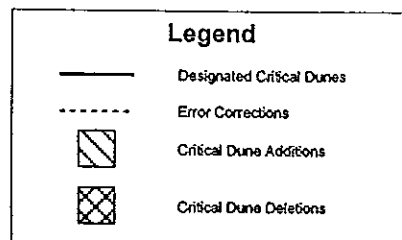
T. 5 N. R. 16 W.

T. 4 N. R. 16 W.

*Note: Shoreline not shown



Folder 12: Holland West



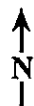
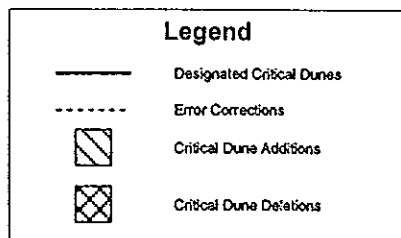
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T. 4 N. R. 16 W.

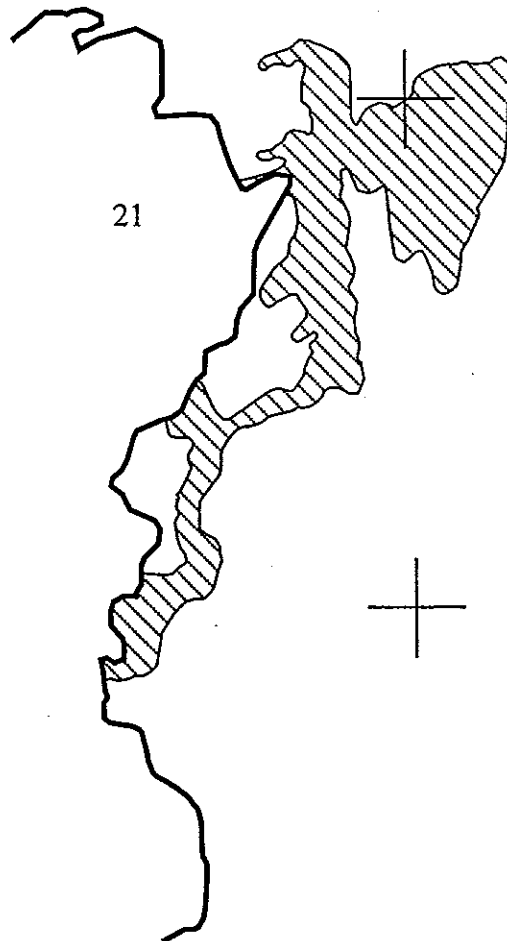
T. 6 N. R. 16 W.



Folder 13: Port Sheldon

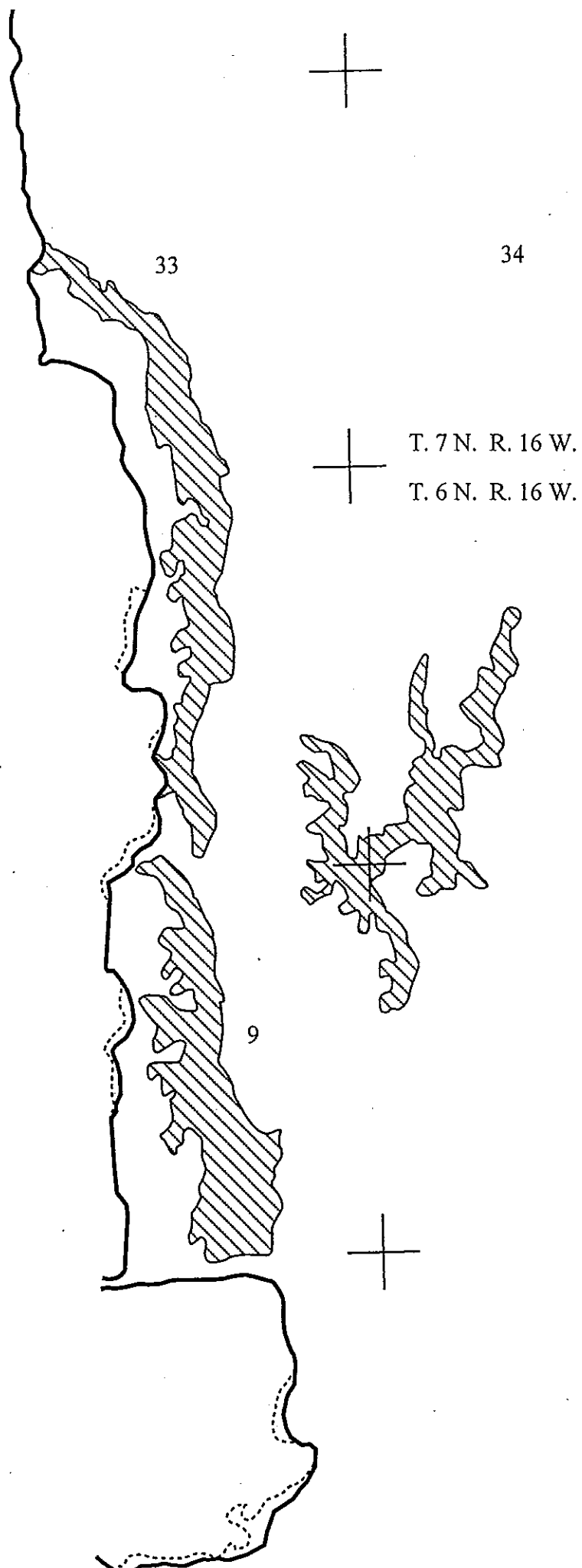
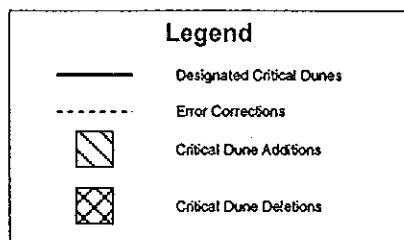


21



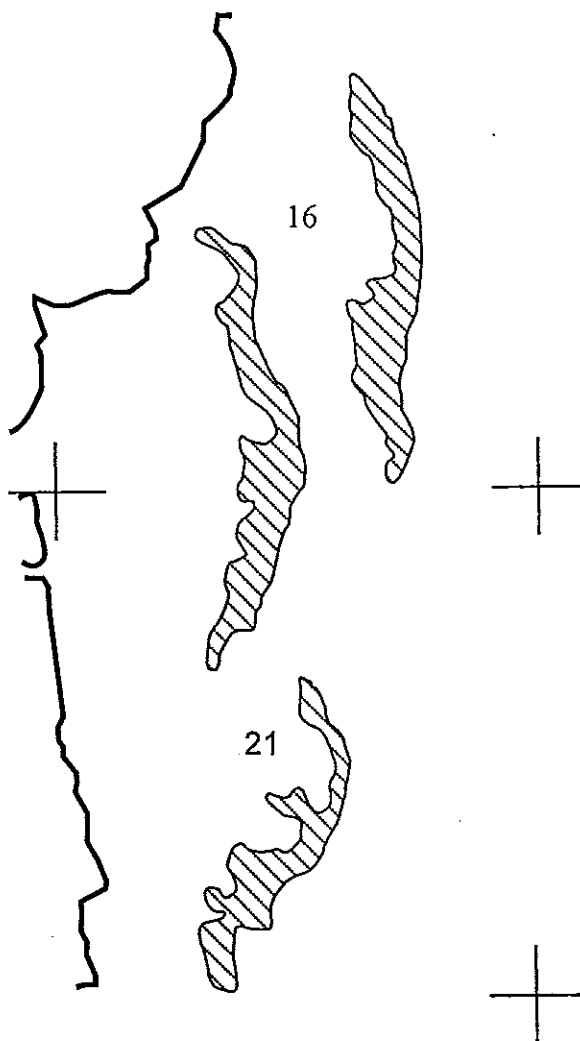
*Note: Shoreline not shown

Folder 13: Port Sheldon

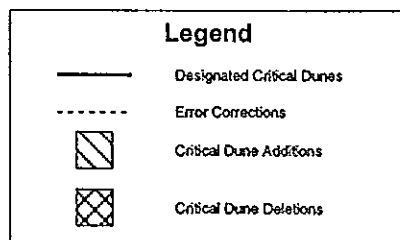


*Note: Shoreline not shown

T. 7 R. 16 W.



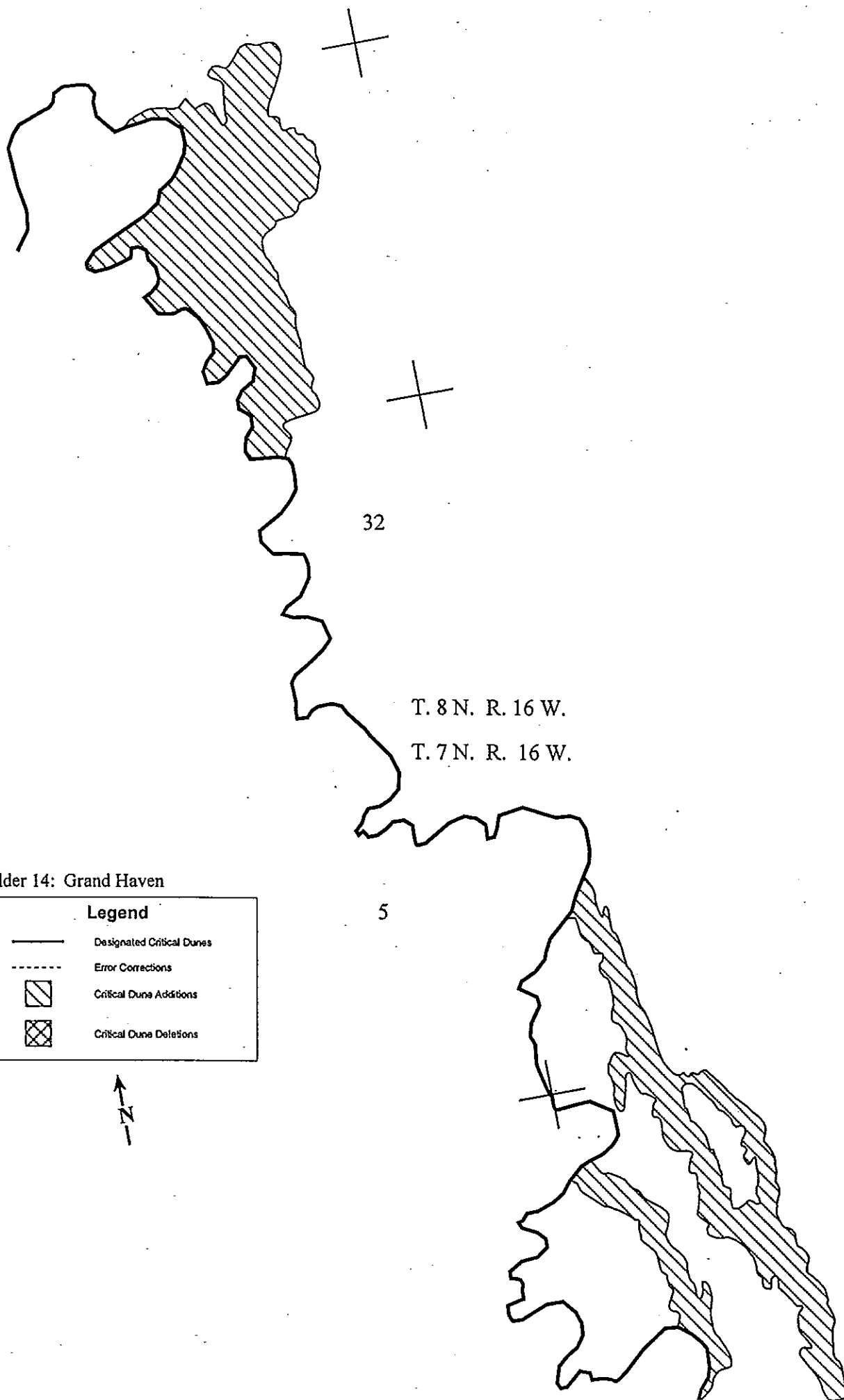
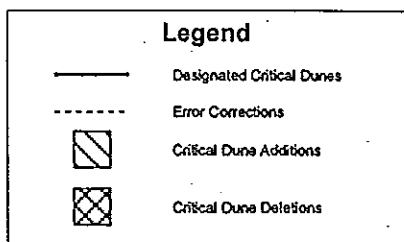
Folder 13: Port Sheldon



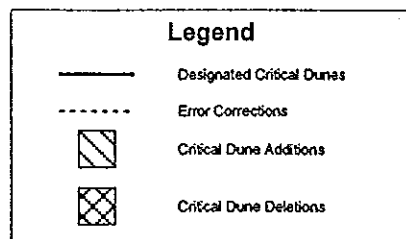
*Note: Shoreline not shown



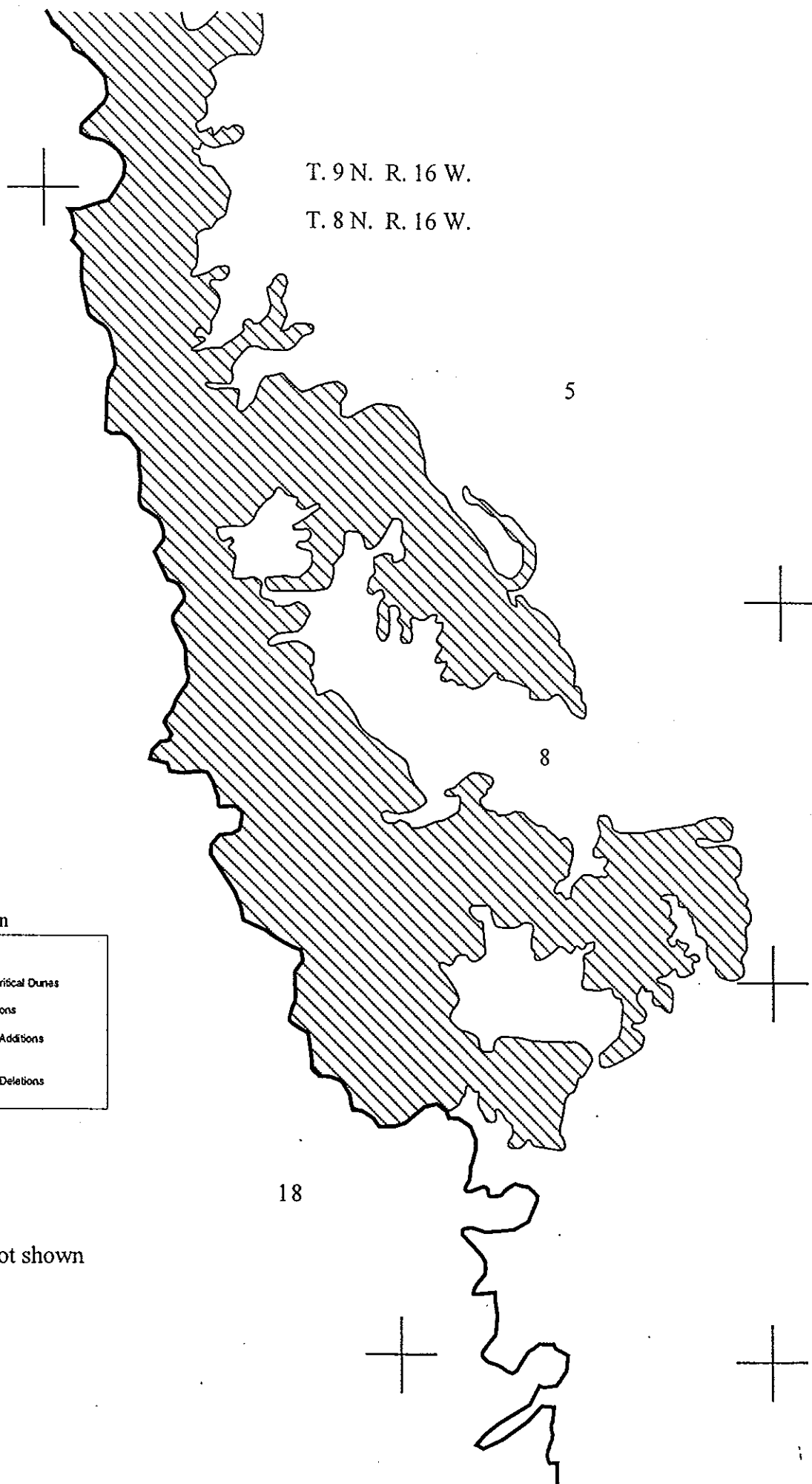
Folder 14: Grand Haven



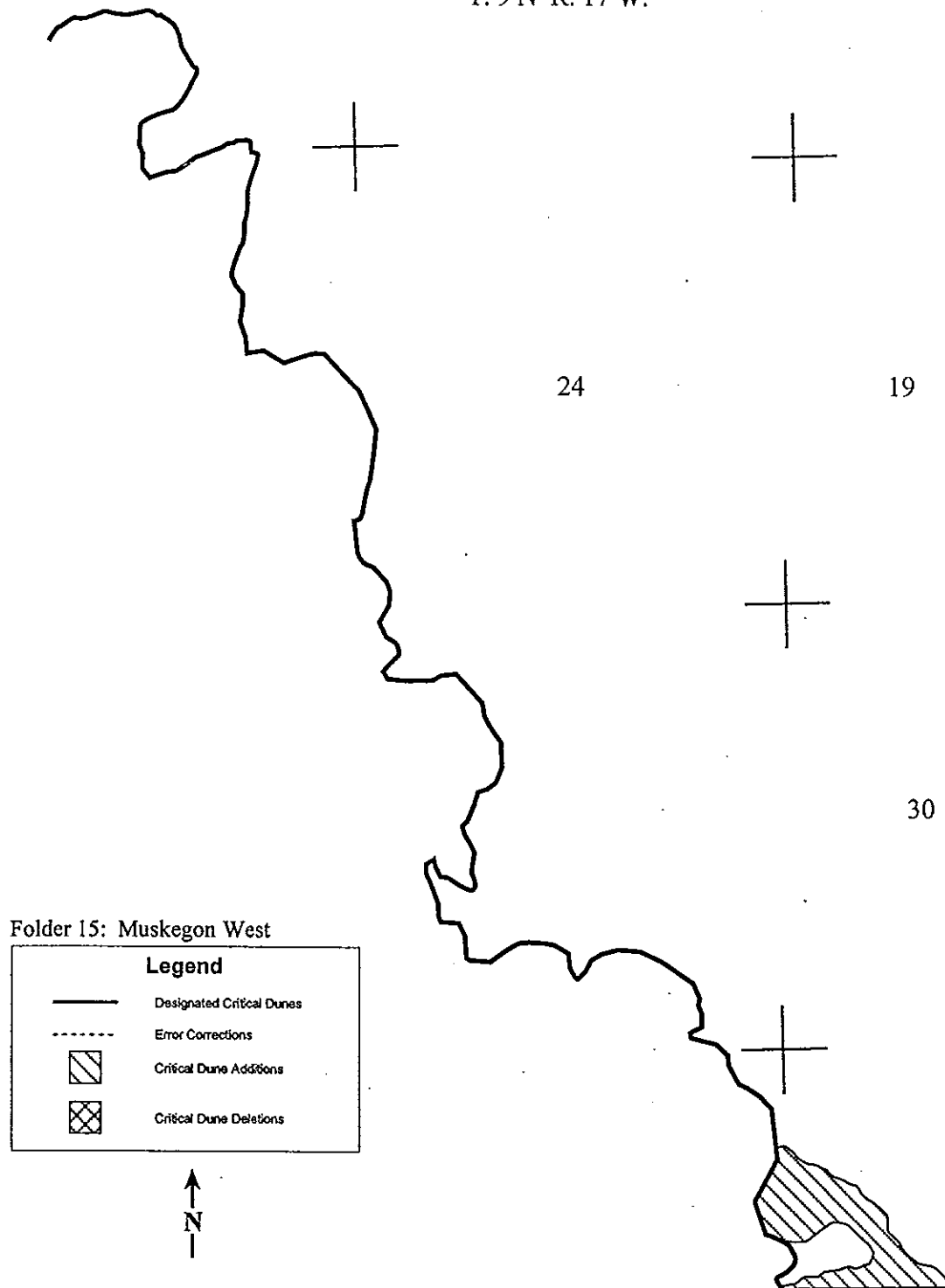
Folder 14: Grand Haven



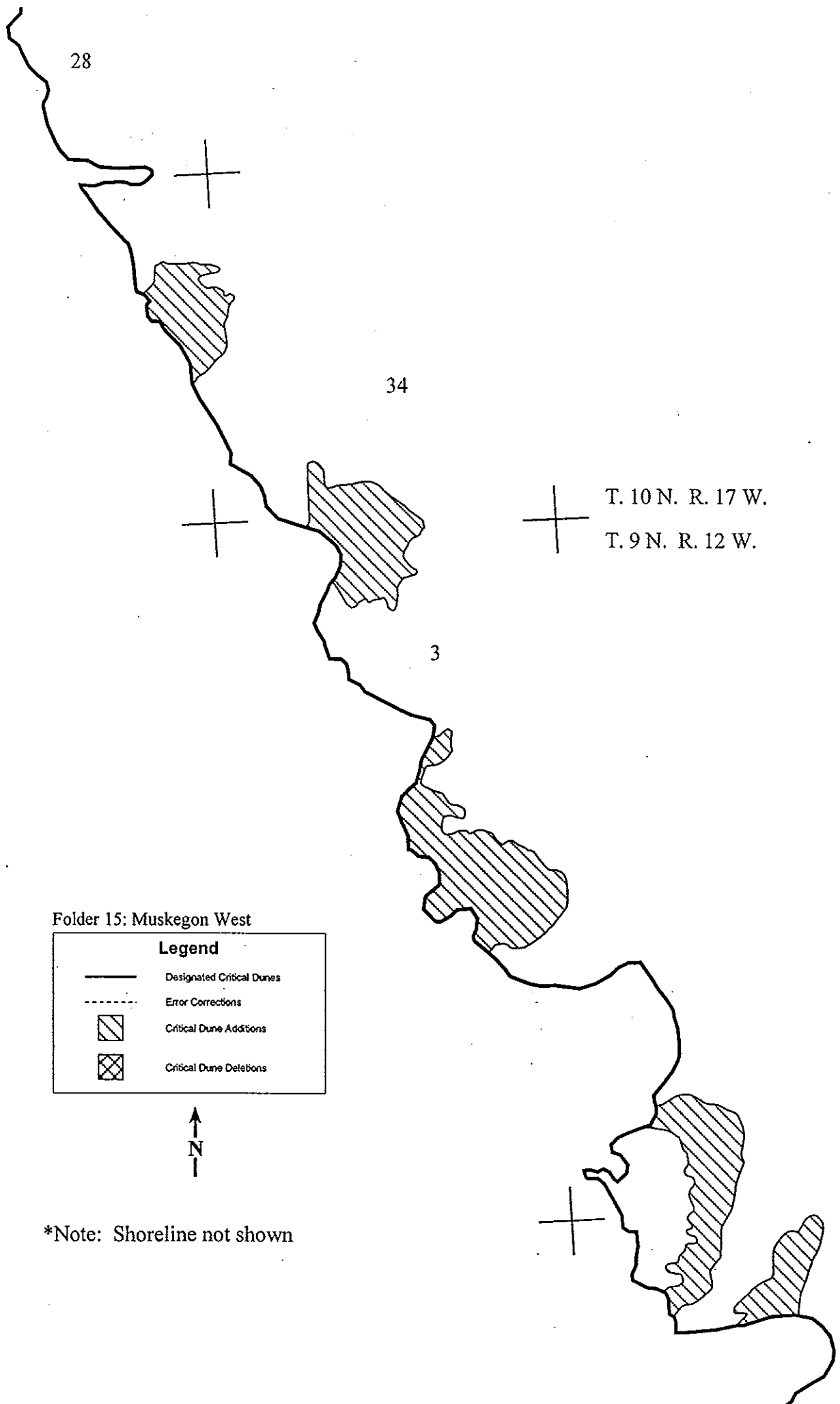
*Note: Shoreline not shown

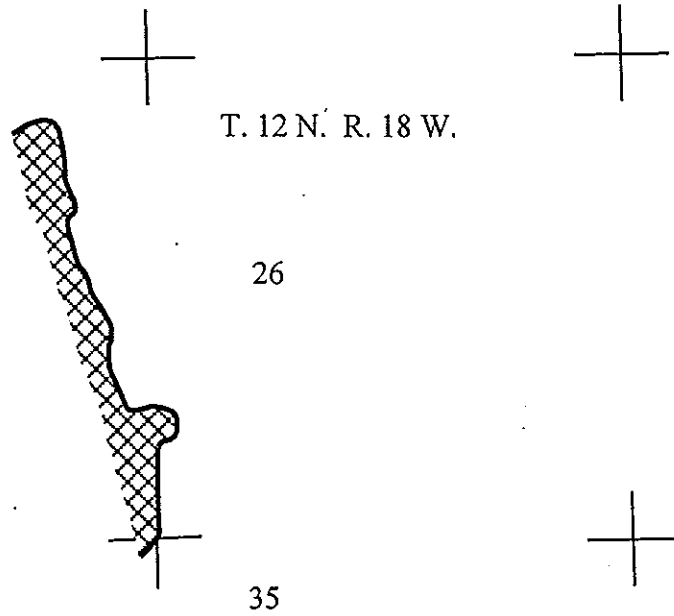


T. 9 N R. 17 W.



*Note: Shoreline not shown



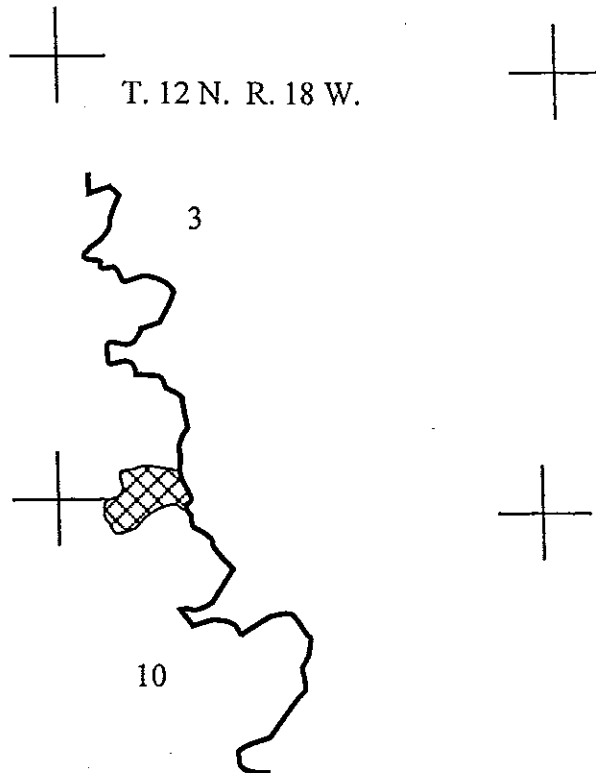


Folder 19: Flower Creek

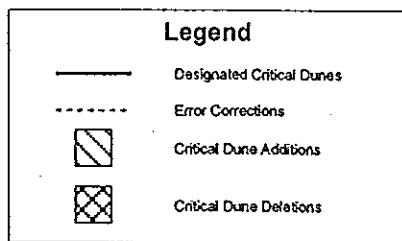
Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



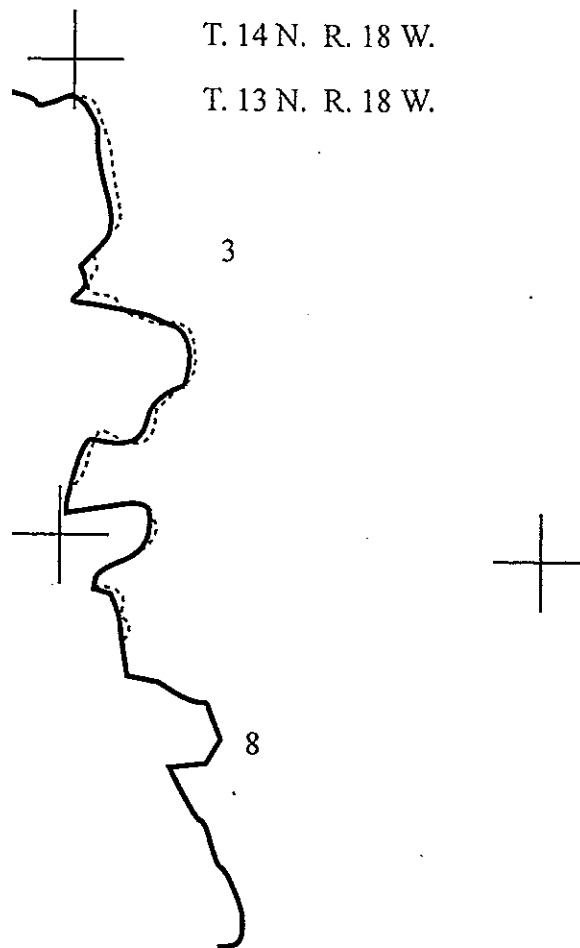
*Note: Shoreline not shown



Folder 19: Flower Creek



*Note: Shoreline not shown



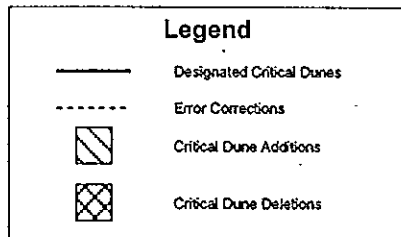
Folder 20: Town Corners

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown

Folder 21: Bigsbie Lake



T. 14 N. R. 19 W.

T. 14 N. R. 18 W.



24

19

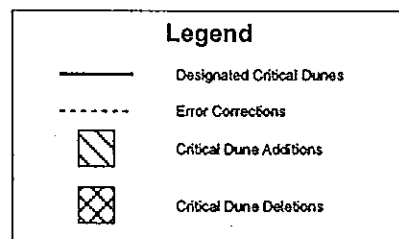
30

*Note: Shoreline not shown

T. 15 N. R. 18 W.

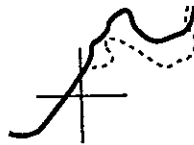


Folder 23: Mears





*Note: Shoreline not shown

T. 16 N. R. 18 W.



Folder 23: Mears

Legend

- Designated Critical Dunes
- - - Error Corrections
-  Critical Dune Additions
-  Critical Dune Deletions



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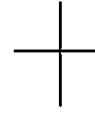


3

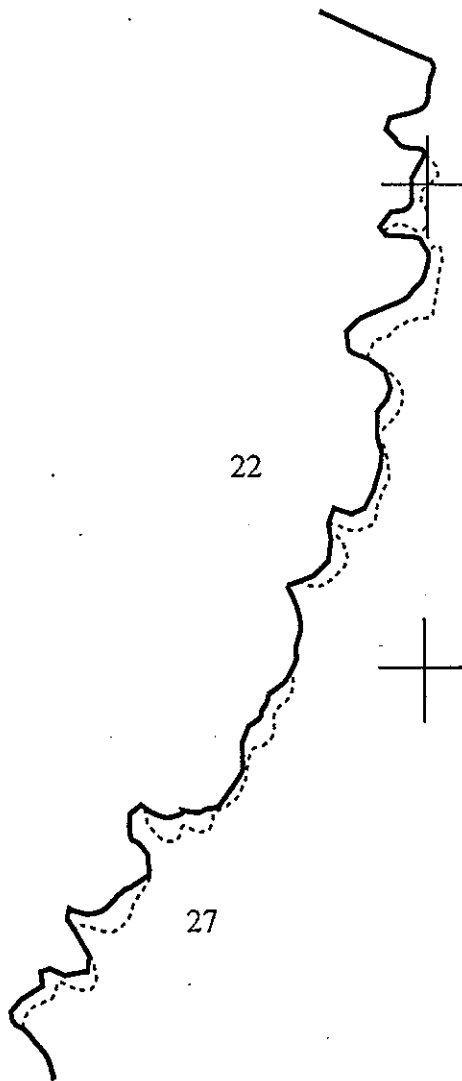
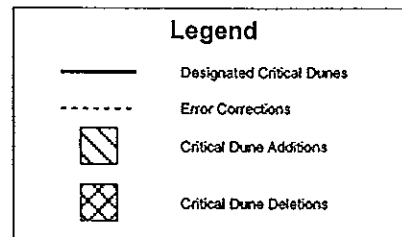


*Note: Shoreline not shown

T. 16 N. R. 18 W.

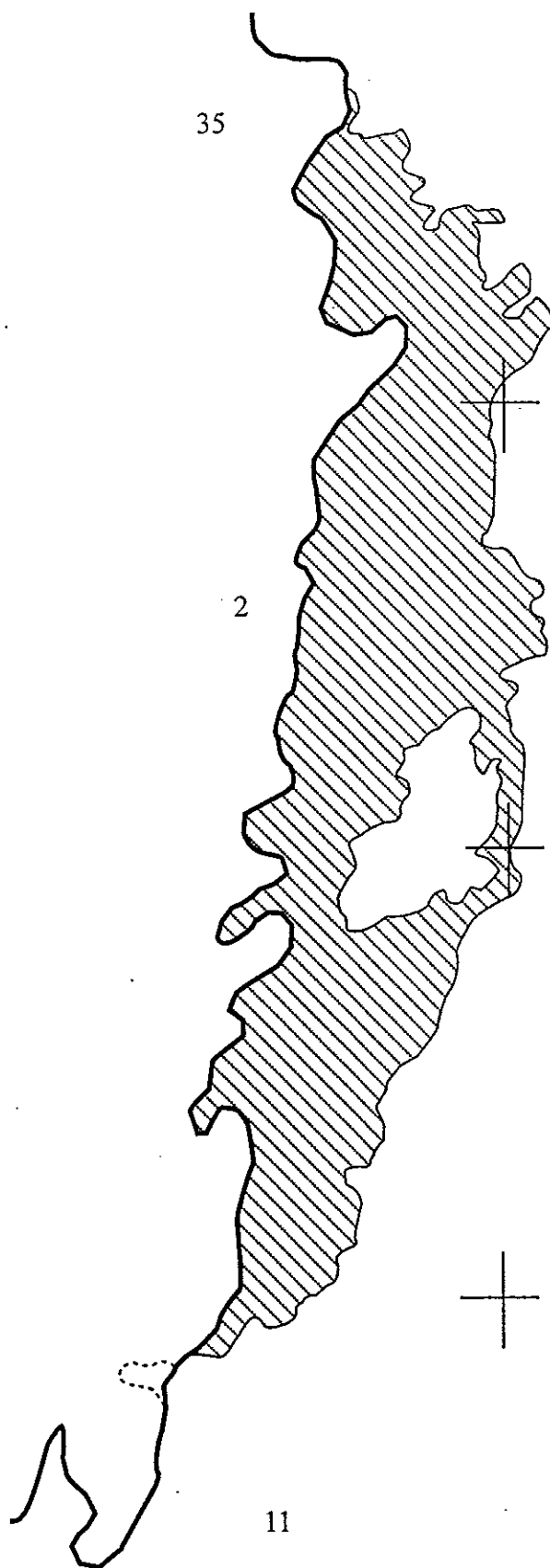
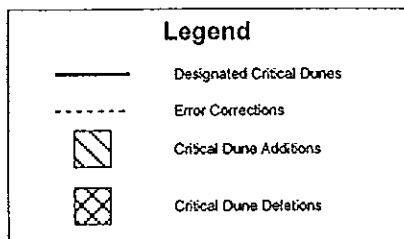


Folder 24: Pentwater



*Note: Shoreline not shown

Folder 24: Pentwater

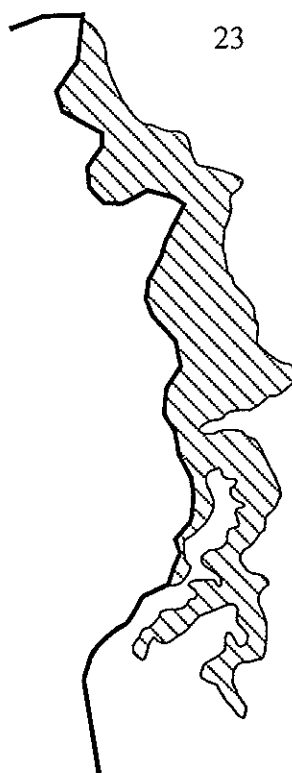
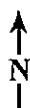
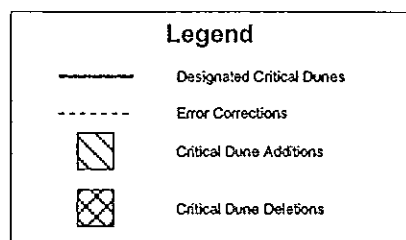


T. 17 N. R. 18 W.

T. 16 N. R. 18 W.

*Note: Shoreline not shown

Folder 24: Pentwater



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T. 17 N. R. 18 W.

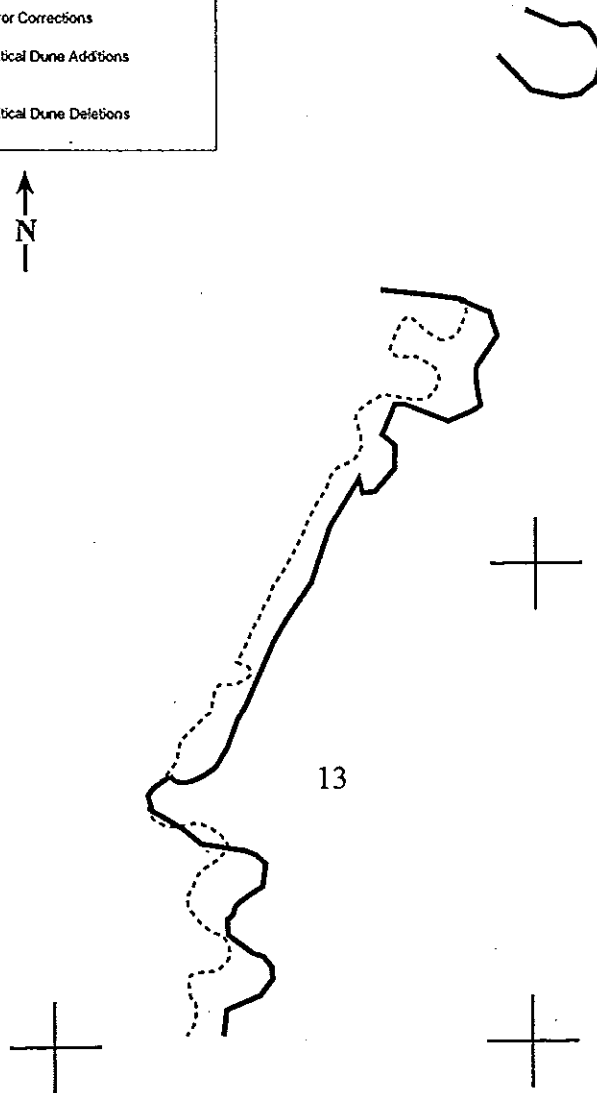
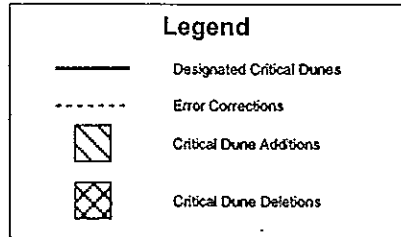
T. 16 N. R. 18 W.

2



*Note: Shoreline not shown

Folder 27: Manistee NW



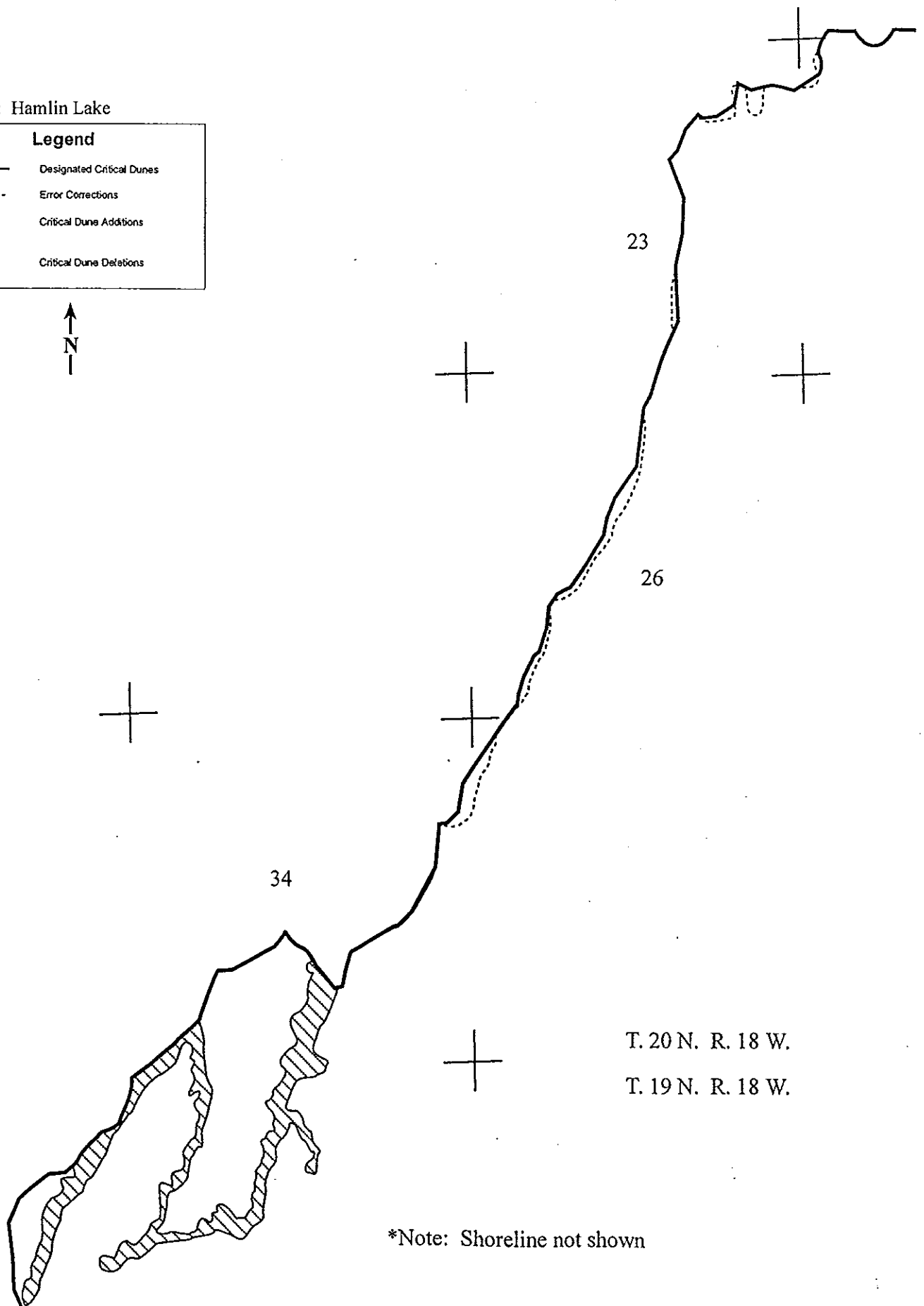
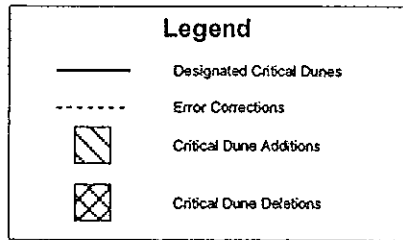
13

*Note: Shoreline not shown

T. 20 N. R. 18 W.

T. 20 N. R. 17 W.

Folder 26: Hamlin Lake



T. 20 N. R. 18 W.

T. 19 N. R. 18 W.

*Note: Shoreline not shown

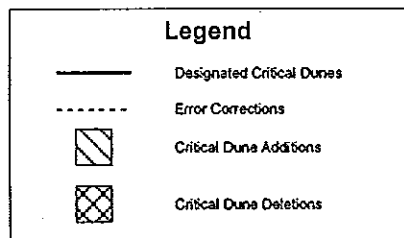
T. 19 N. R. 18 W.

18

19

29

Folder 26: Hamlin Lake

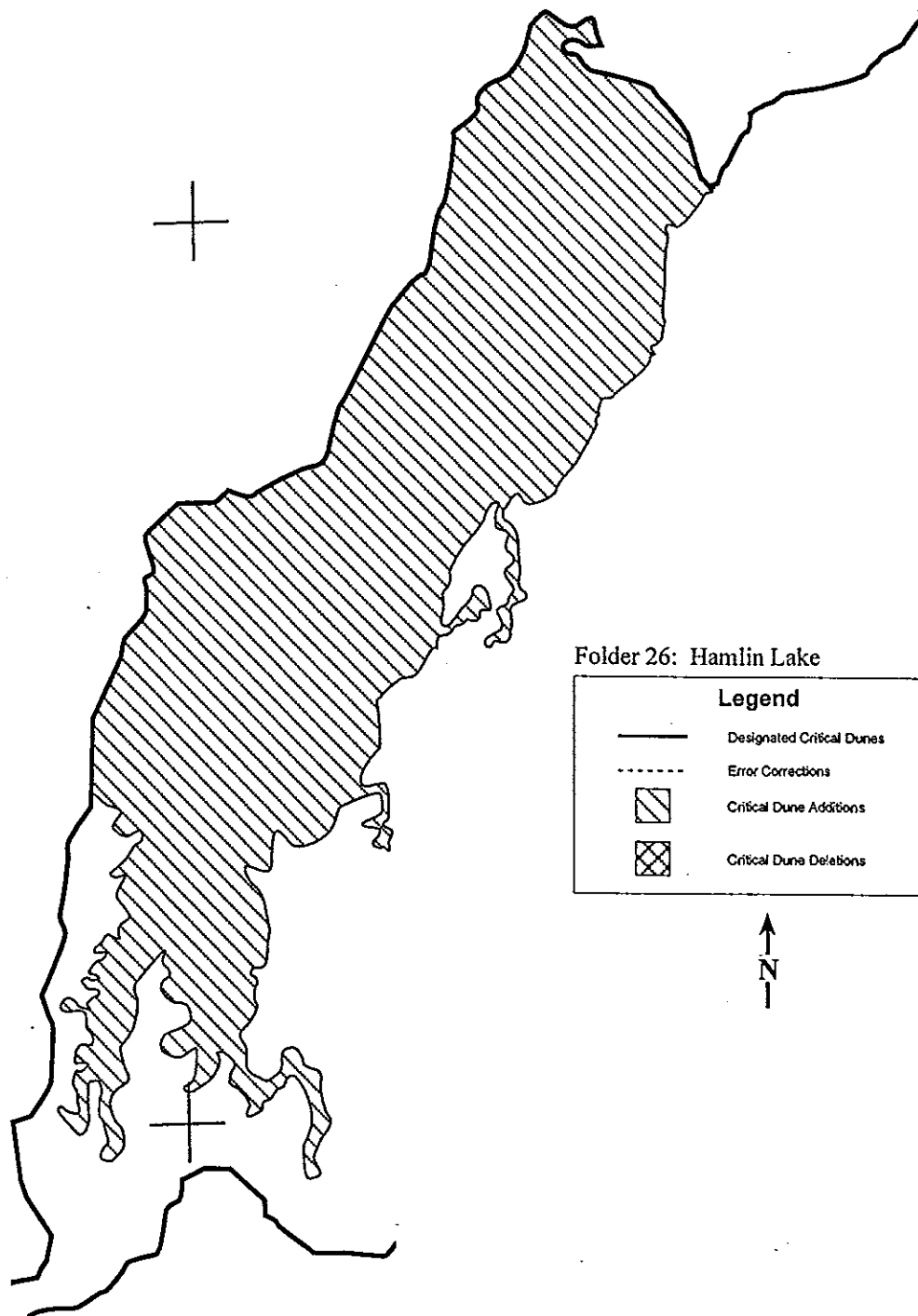


*Note: Shoreline not shown

T. 19 N. R. 18 W.

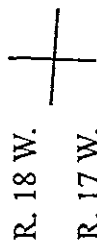
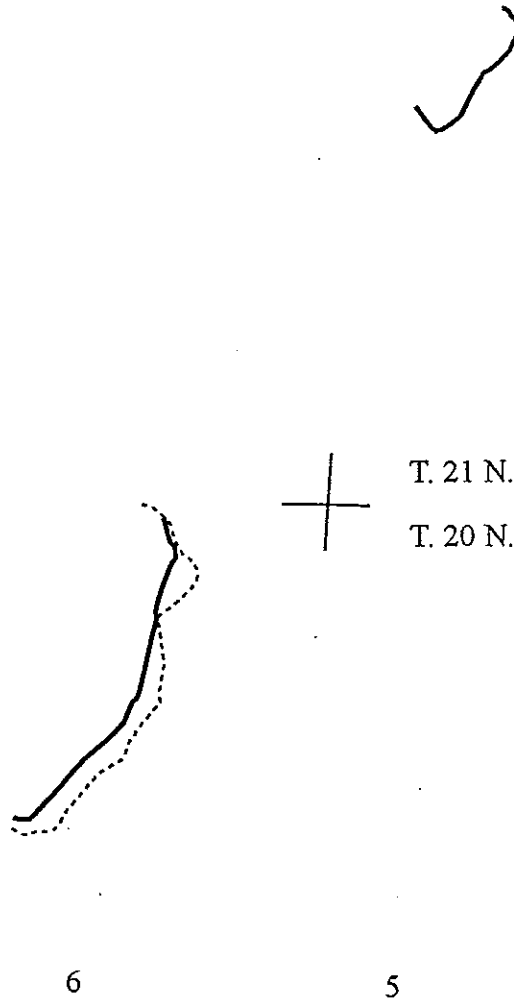
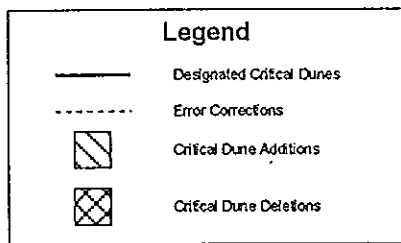
5

18



*Note: Shoreline not shown

Folder 27: Manistee NW

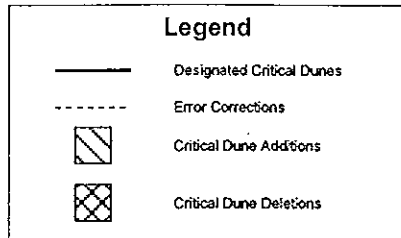


*Note: Shoreline not shown

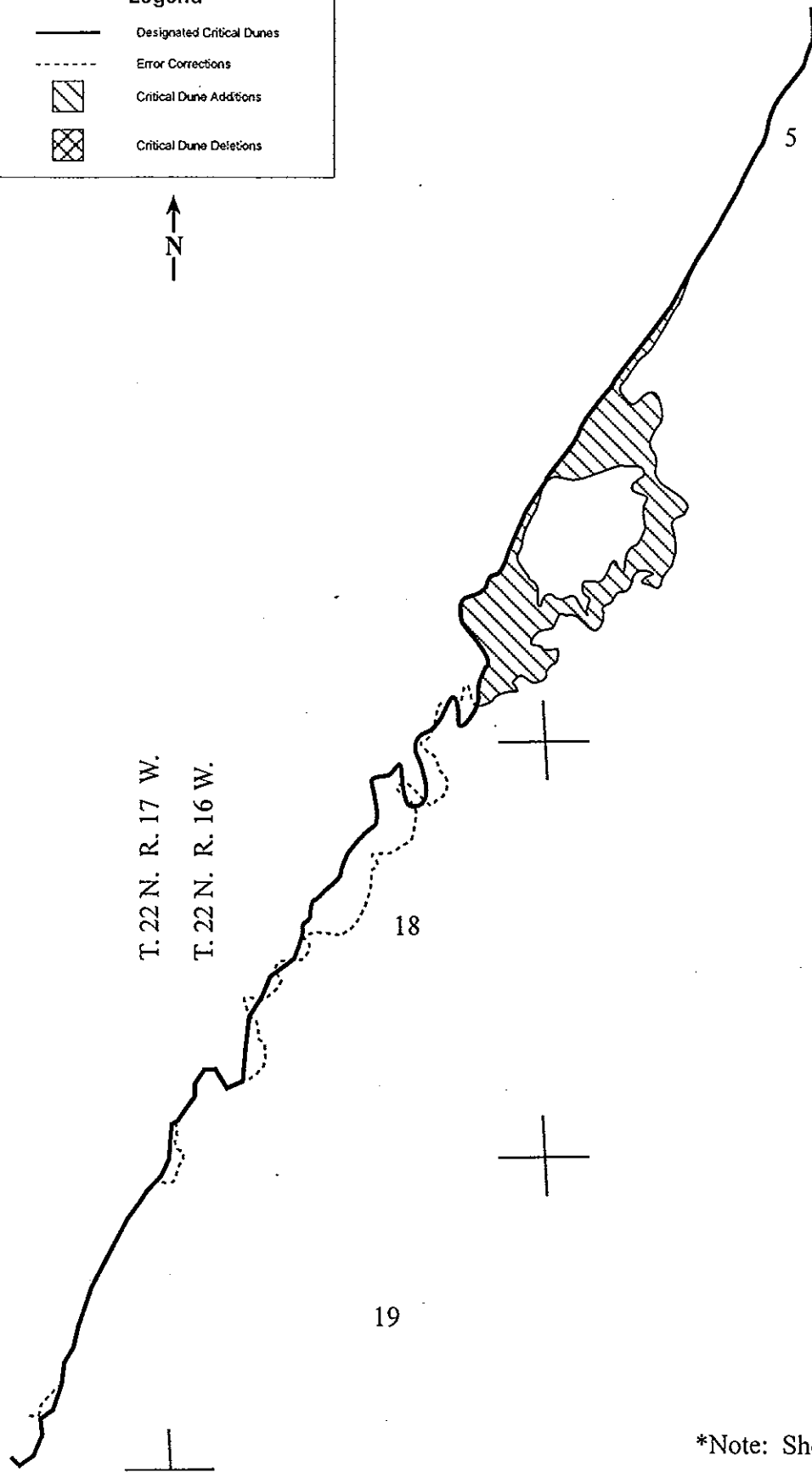
Folder 29: Parkdale

T. 23 N. R. 16 W.

T. 22 N. R. 16 W.

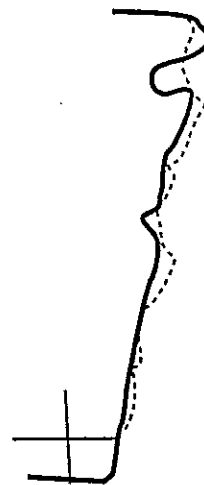
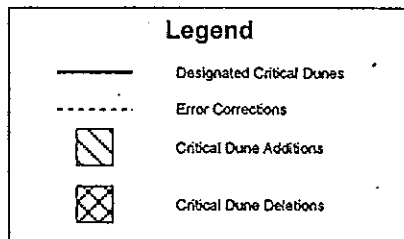


↑
N
↓



*Note: Shoreline not shown

Folder 29: Parkdale



32

33

T. 23 N. R. 16 W.

T. 22 N. R. 16 W.



*Note: Shoreline not shown

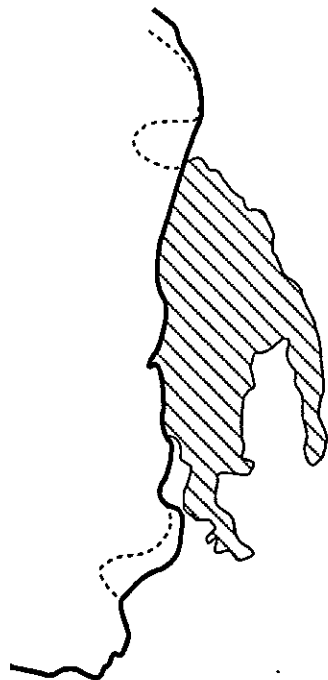


T. 23 N. R. 16 W.

16

15

22



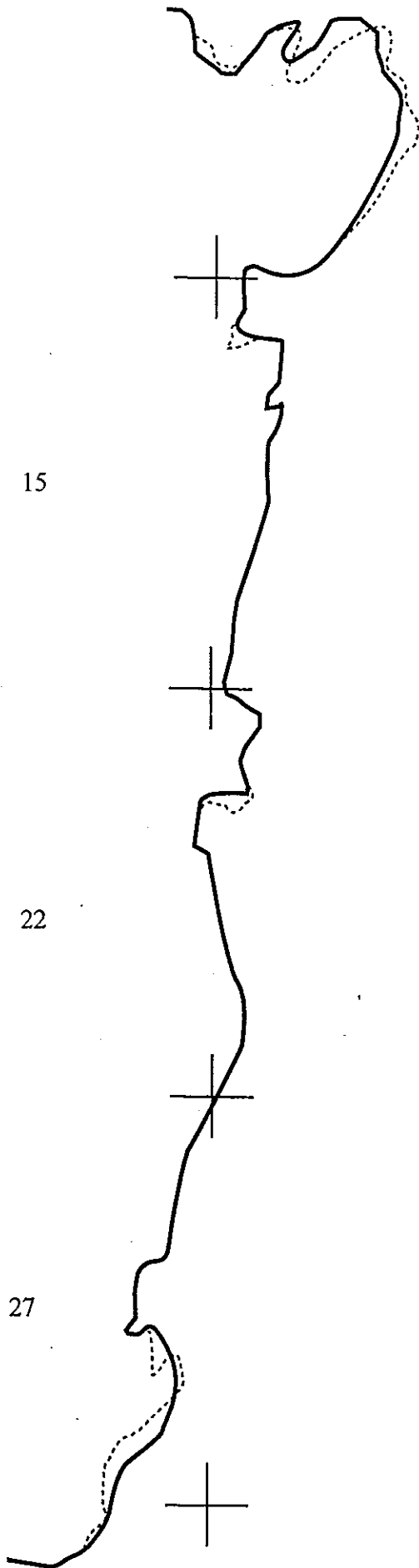
Folder 31: Bear Lake

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions

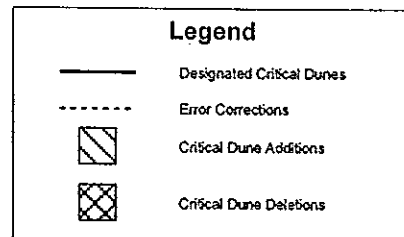


*Note: Shoreline not shown

T. 25 N. R. 16 W.







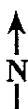
Folder 32: Elberta



*Note: Shoreline not shown

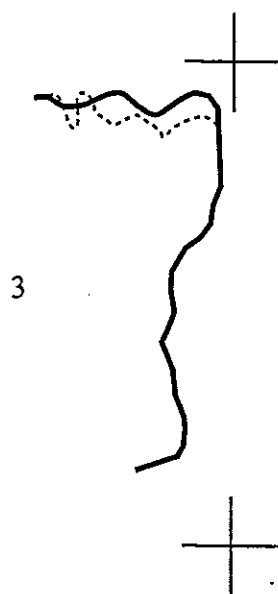
Folder 32: Elberta

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



34

35



3

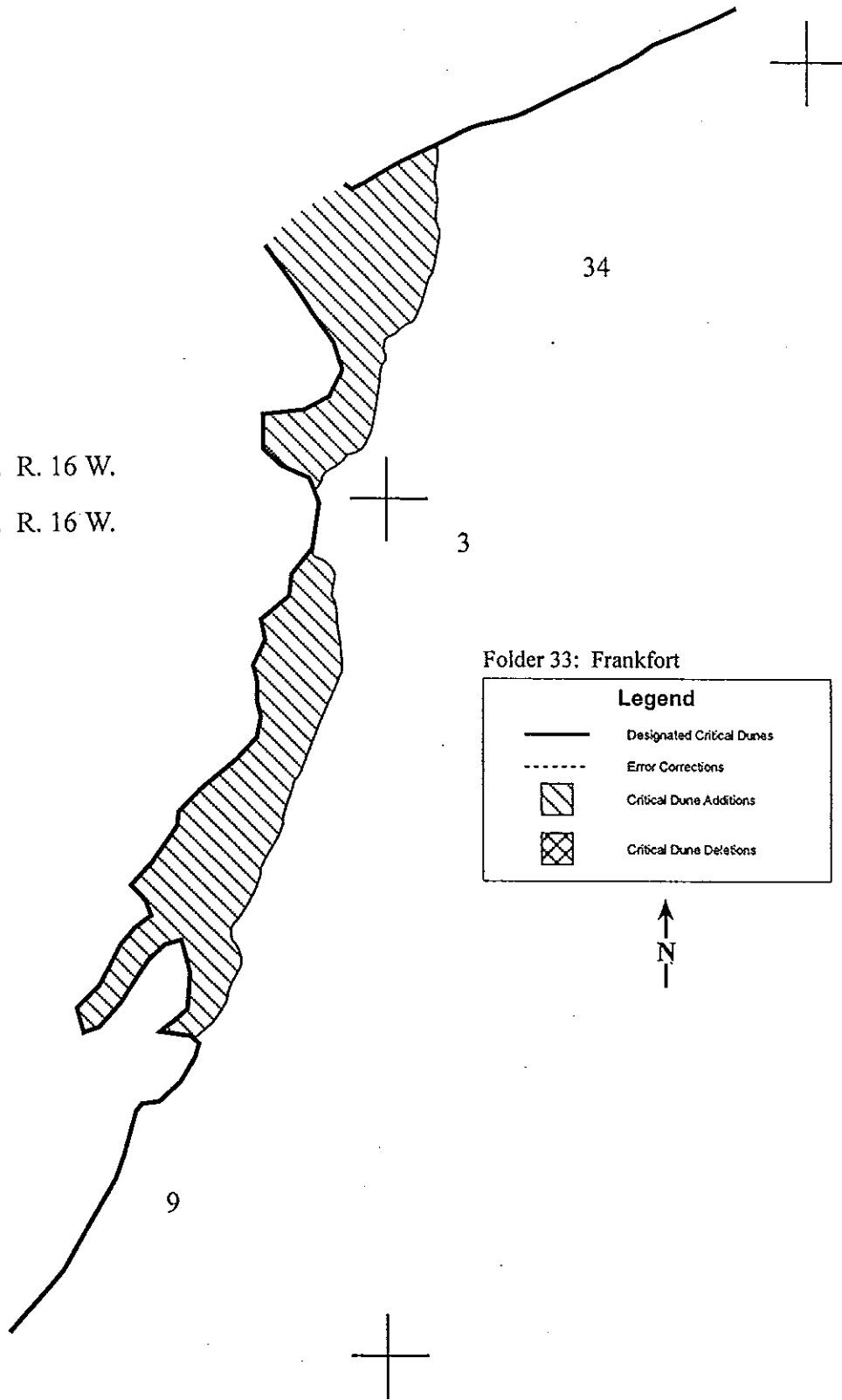
2

T. 26 N. R. 16 W.

T. 25 N. R. 16 W.

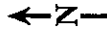
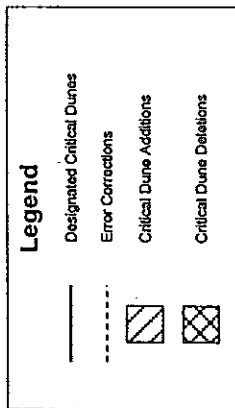
*Note: Shoreline not shown

T. 27 N. R. 16 W.
T. 26 N. R. 16 W.

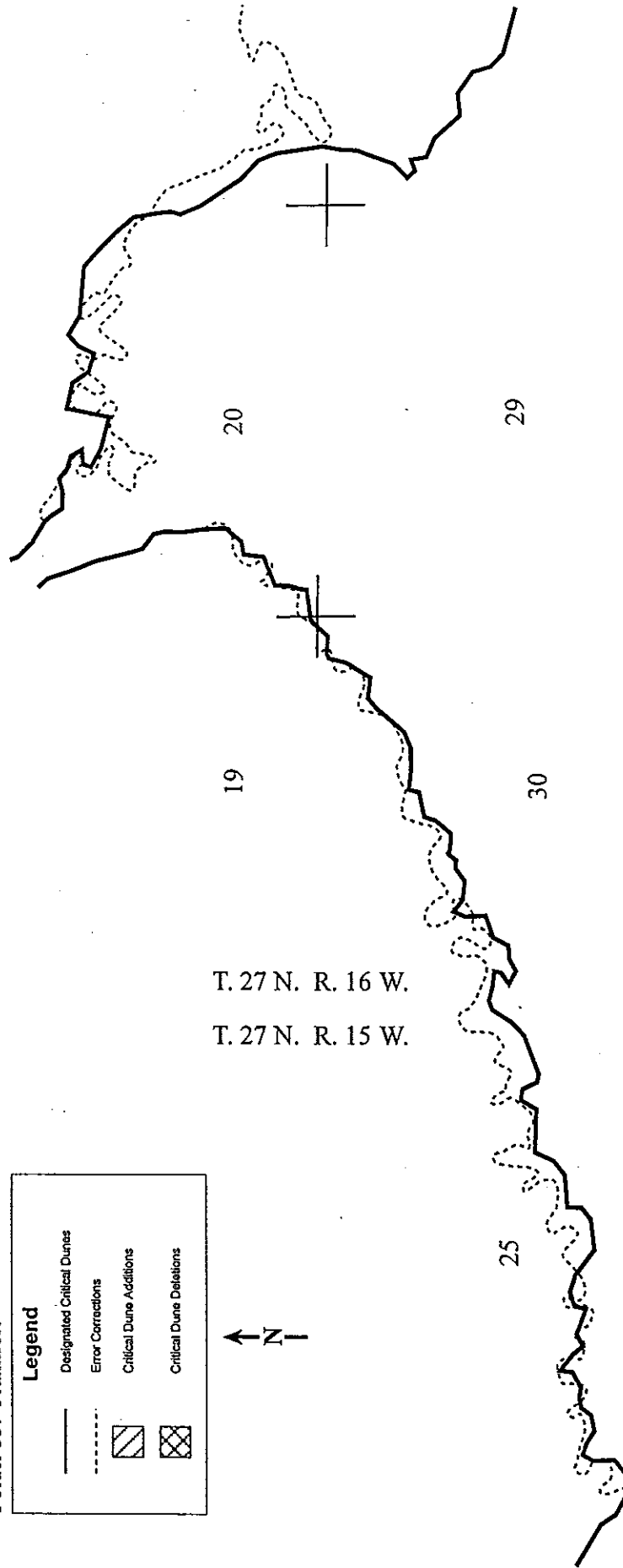


*Note Shoreline not shown

Folder 33: Frankfort

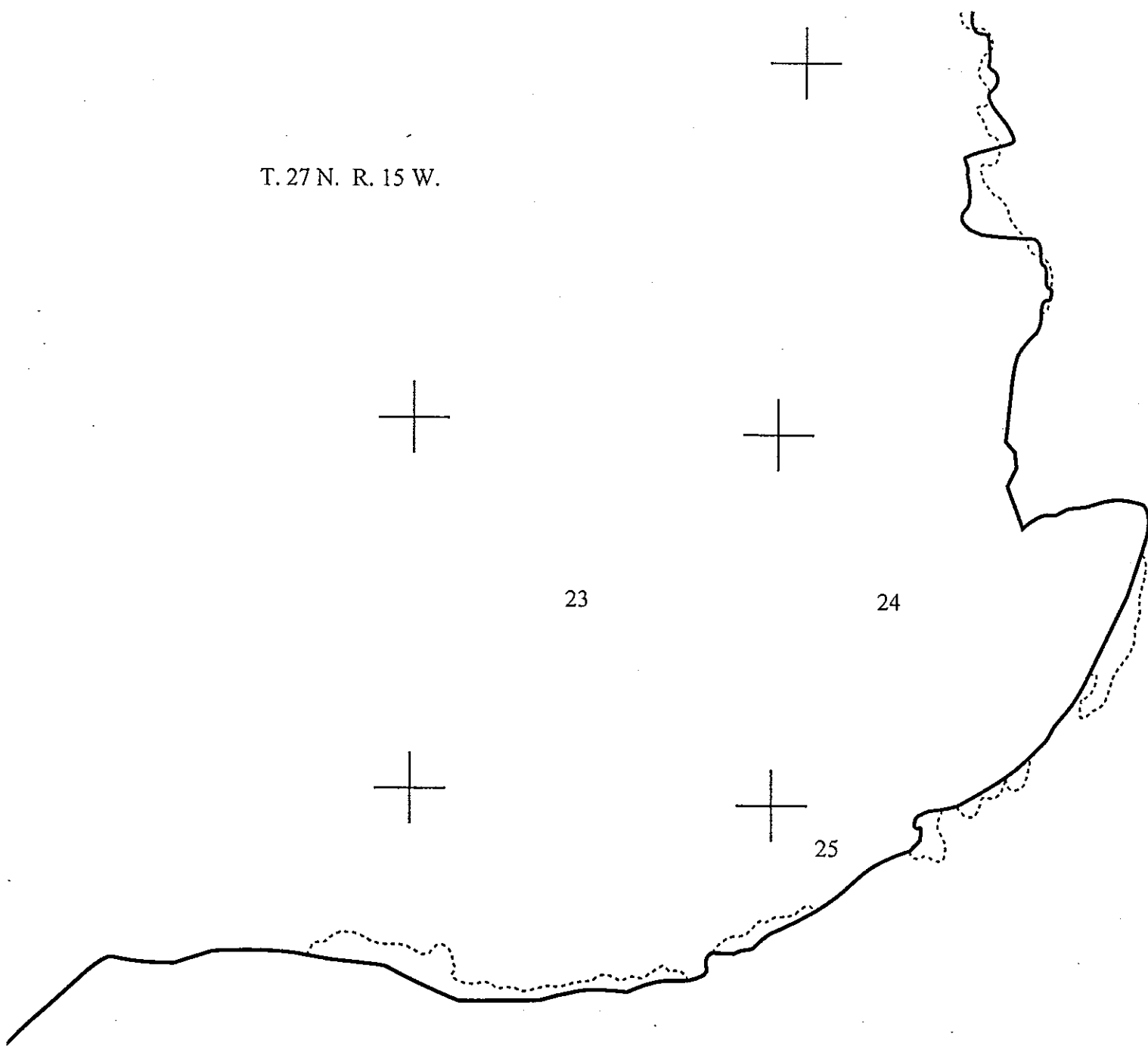


T. 27 N. R. 16 W.
T. 27 N. R. 15 W.

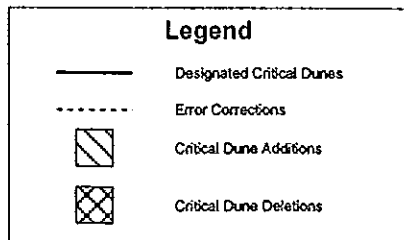


*Note: Shoreline not shown

T. 27 N. R. 15 W.







Folder 34: Beulah

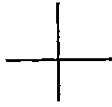


*Note: Shoreline not shown

Folder 35: Empire

Legend

-  Designated Critical Dunes
-  Error Corrections
-  Critical Dune Additions
-  Critical Dune Deletions



R. 15 W.
R. 14 W.







T. 28 N.
T. 27 N.

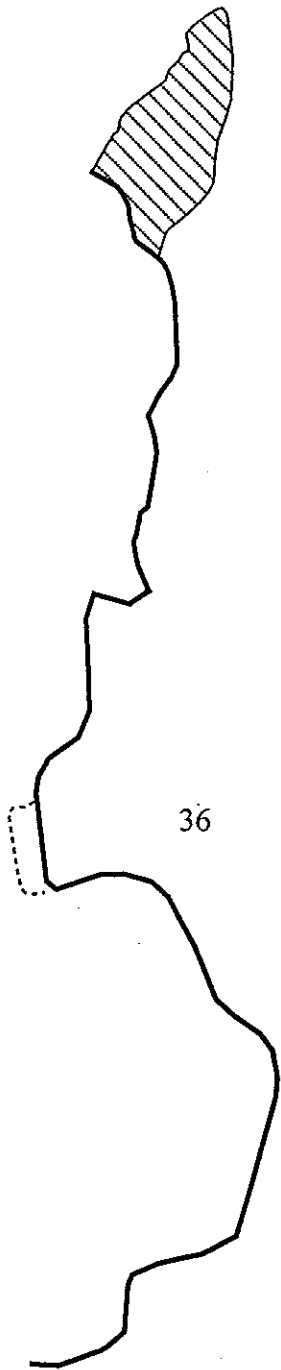
1



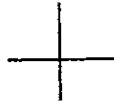
*Note: Shoreline not shown

Folder 35: Empire

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



36



R. 15 W.
R. 14 W.



T. 28 N.

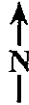
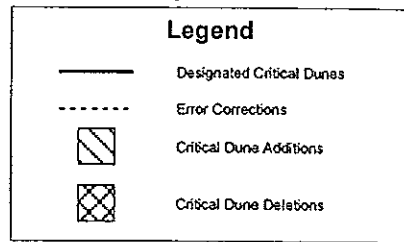
T. 27 N.

1

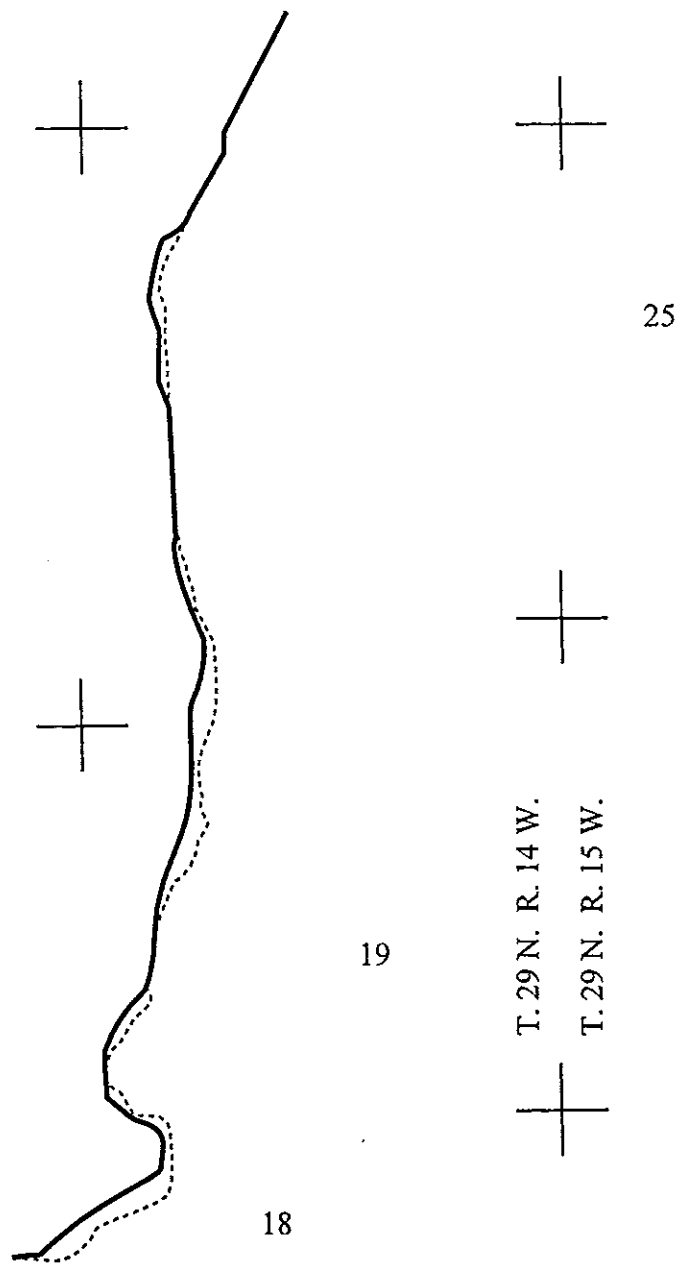


*Note: Shoreline not shown

Folder 35: Empire



*Note: Shoreline not shown



Folder 36: Glen Haven

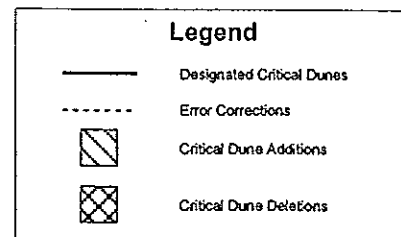
Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown

T. 30 N. R. 14 W.
T. 30 N. R. 13 W.

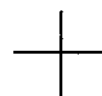
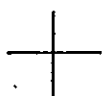
Folder 37: Glen Arbor



36

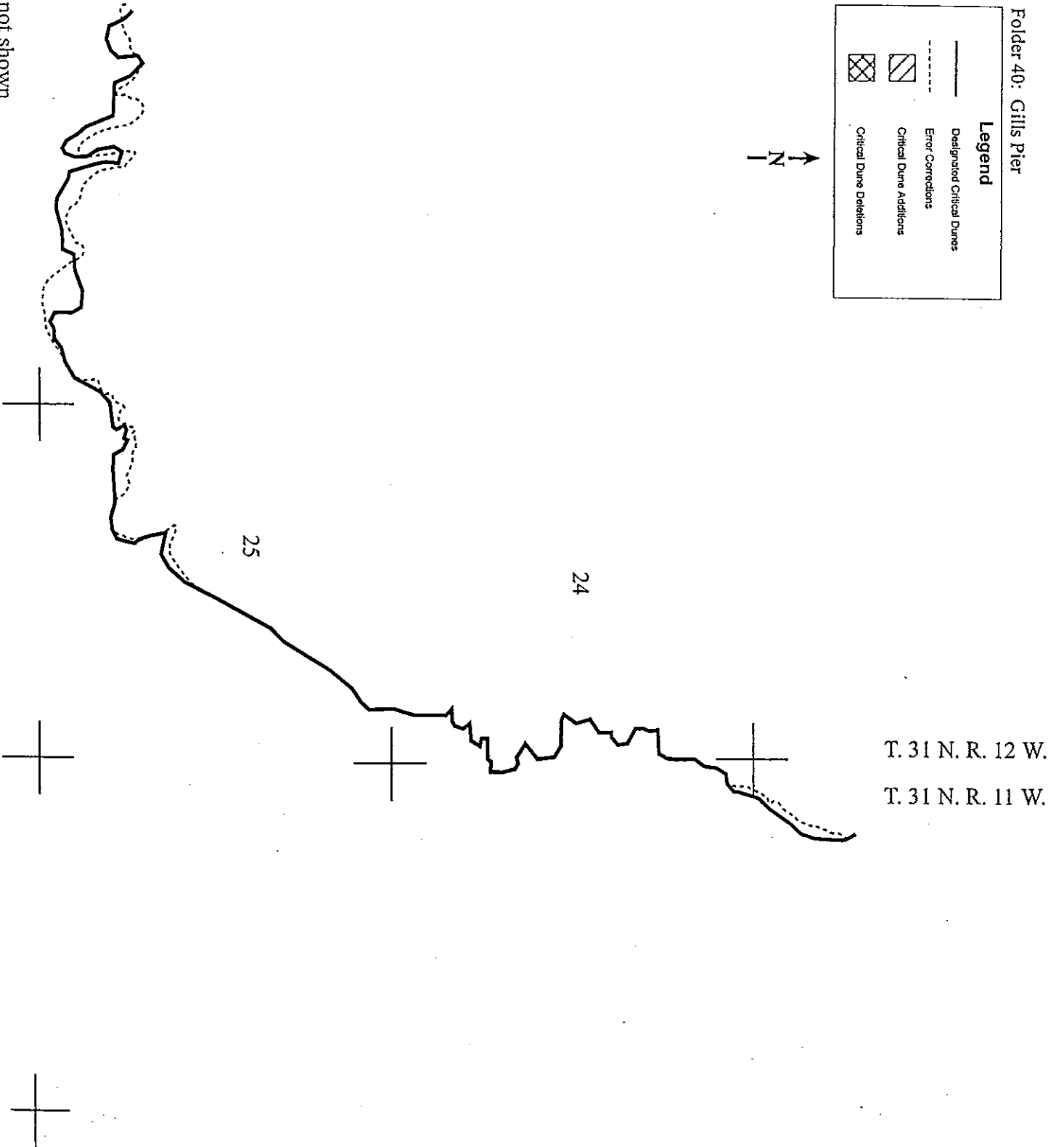
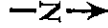
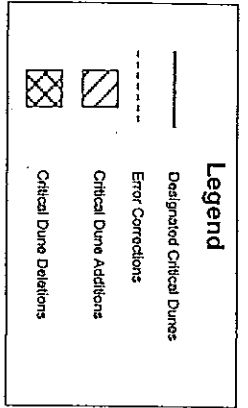
31

32

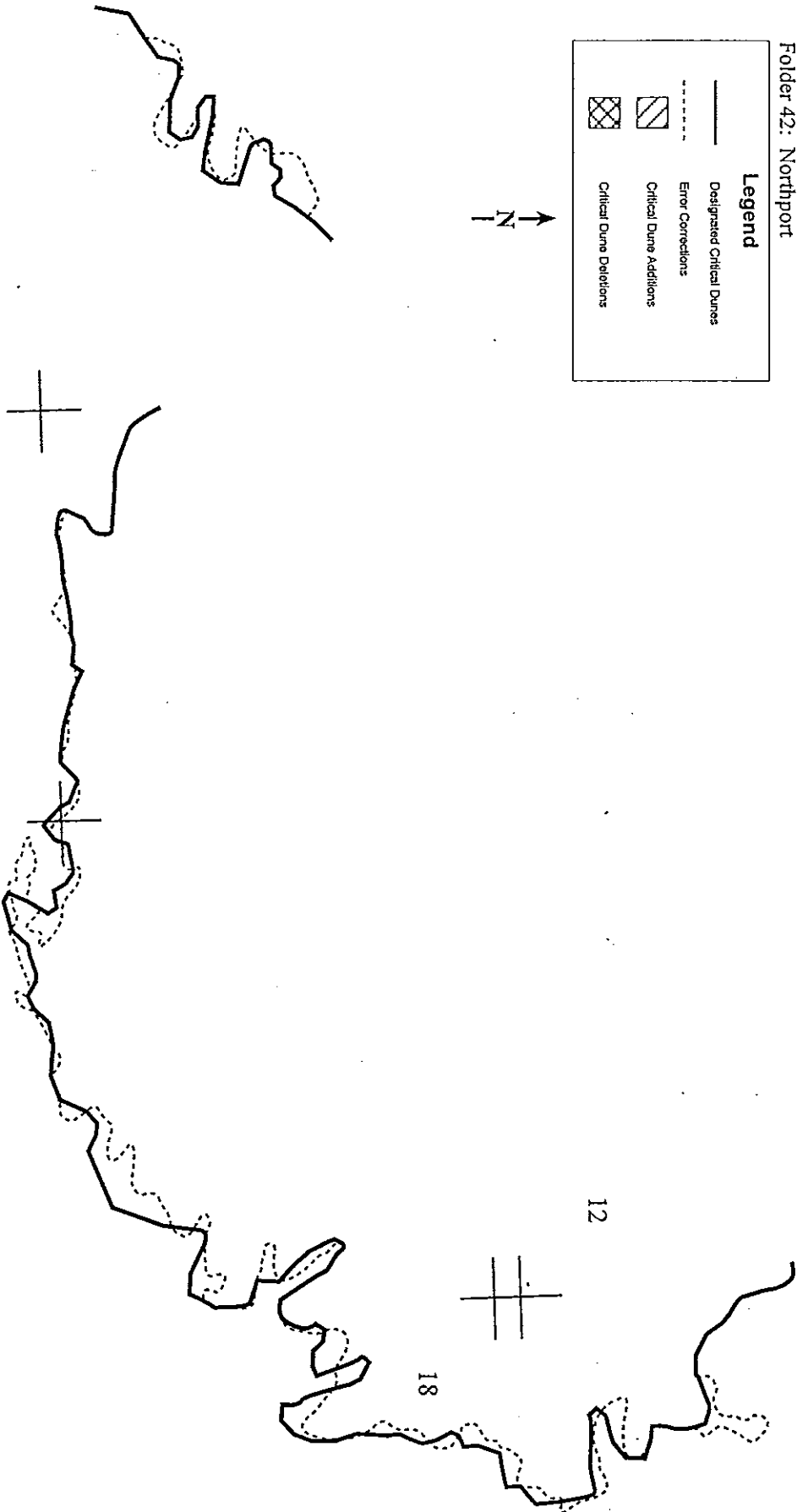
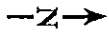
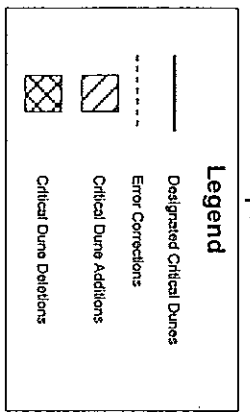


*Note: Shoreline not shown

Folder 40: Gills Pier



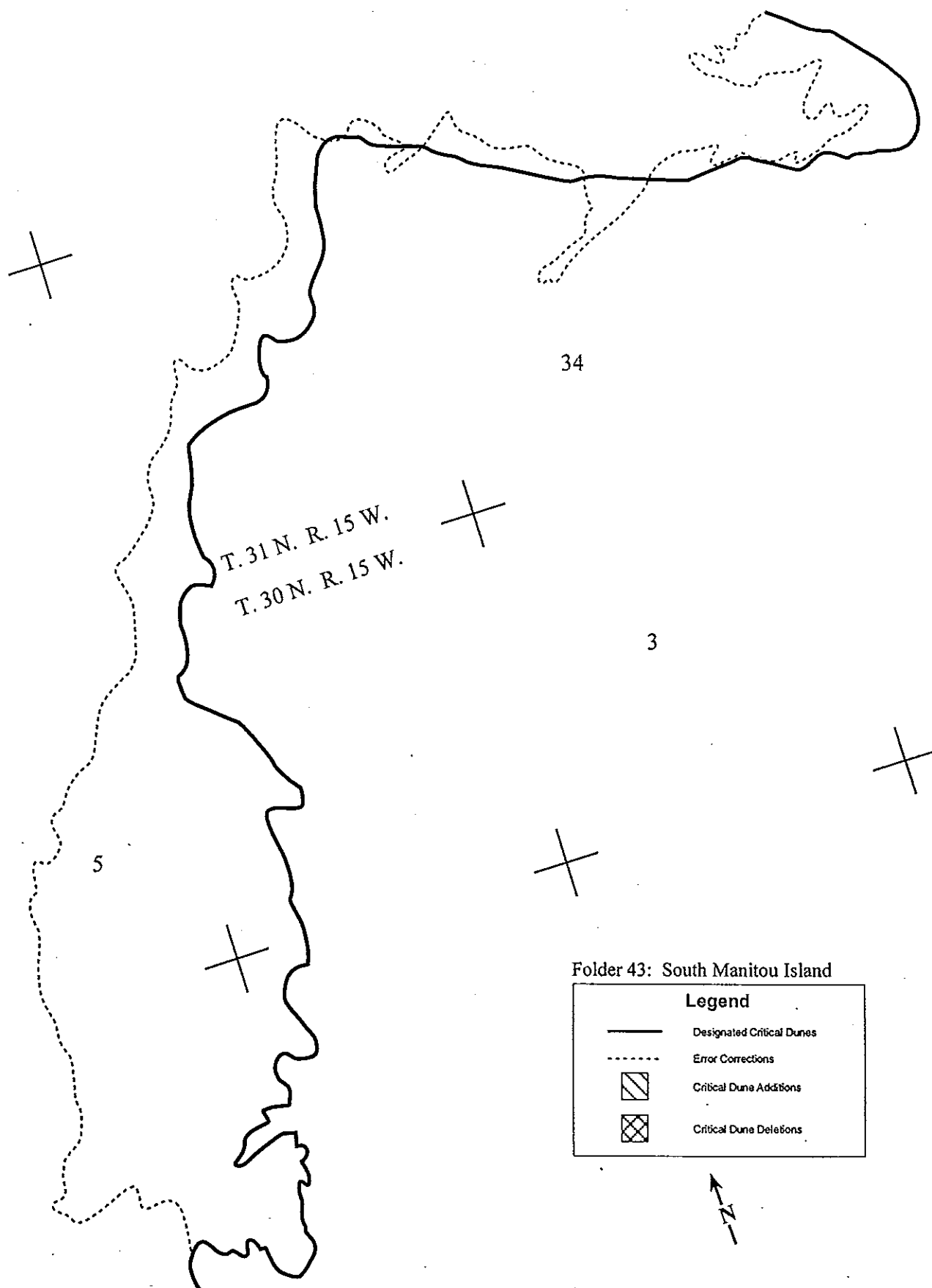
*Note: Preliminary not shown



*Note: Shoreline not shown

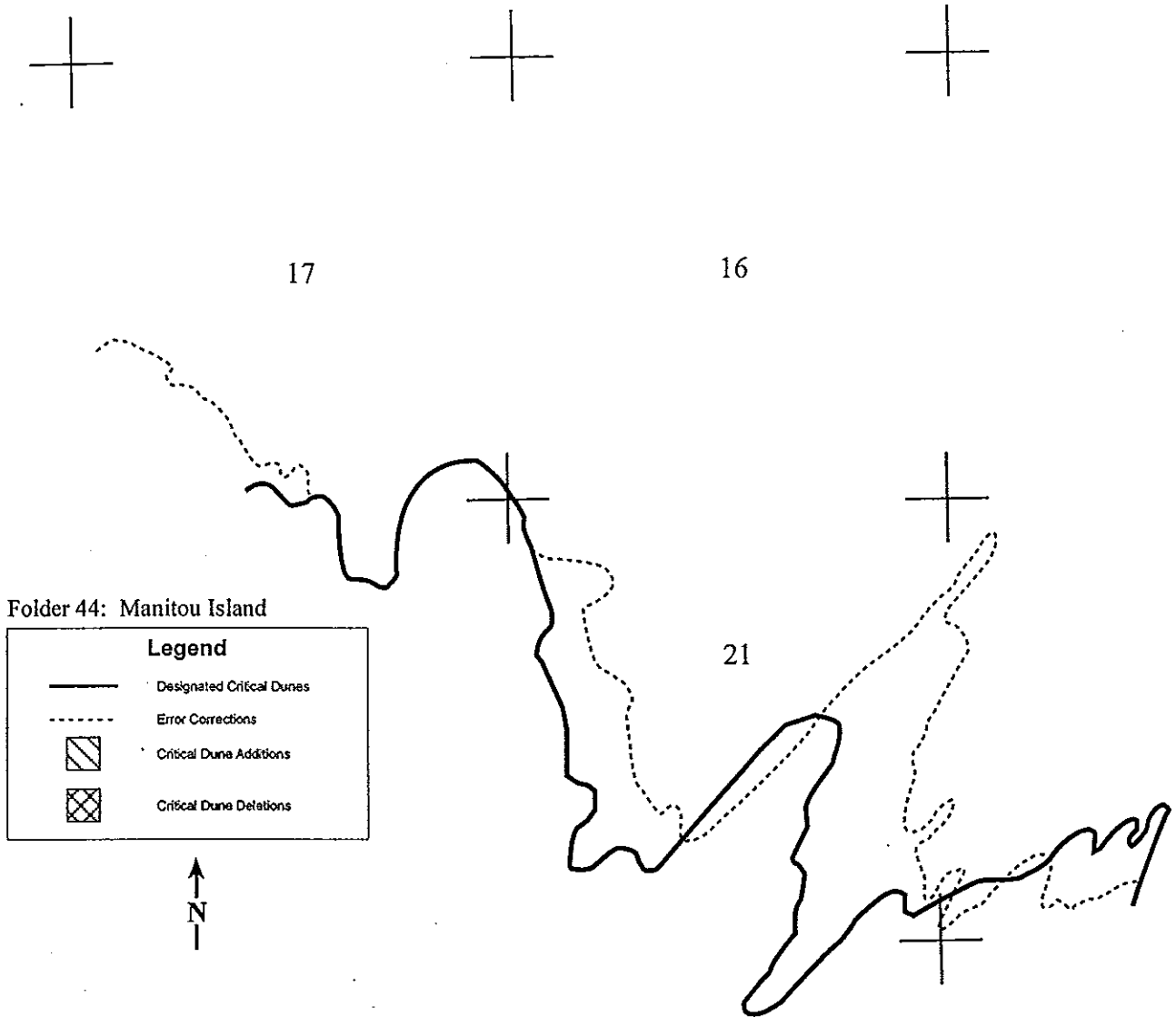
T. 32 N. R. 11 W.

T. 32 N. R. 10 W.



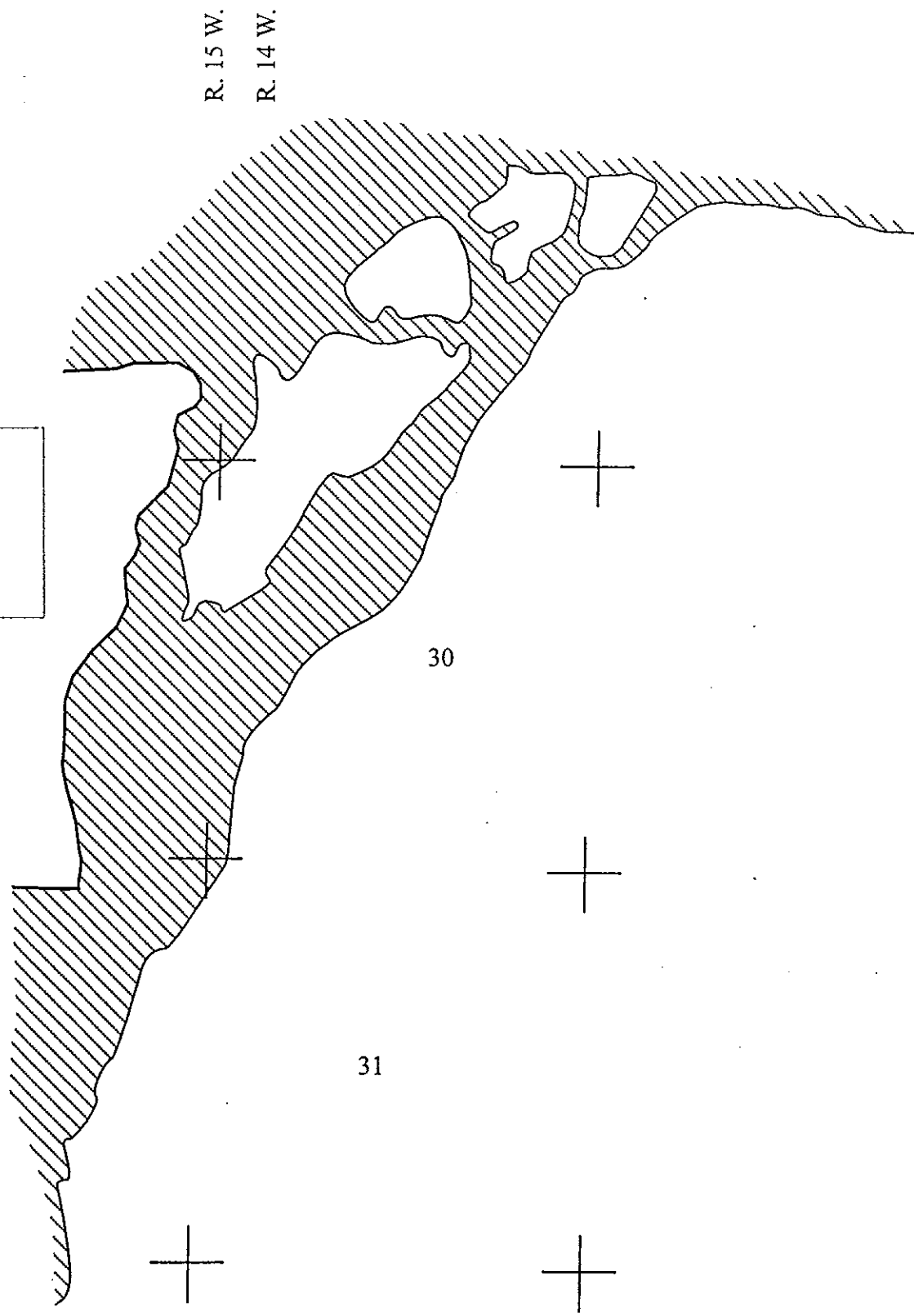
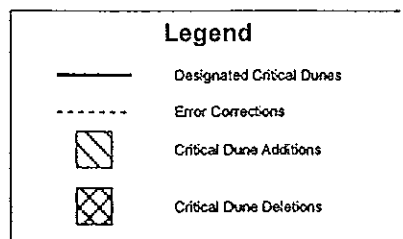
*Note: Shoreline not shown

T. 31 R. 14







*Note: Shoreline not shown

Folder 44: Manitou Island



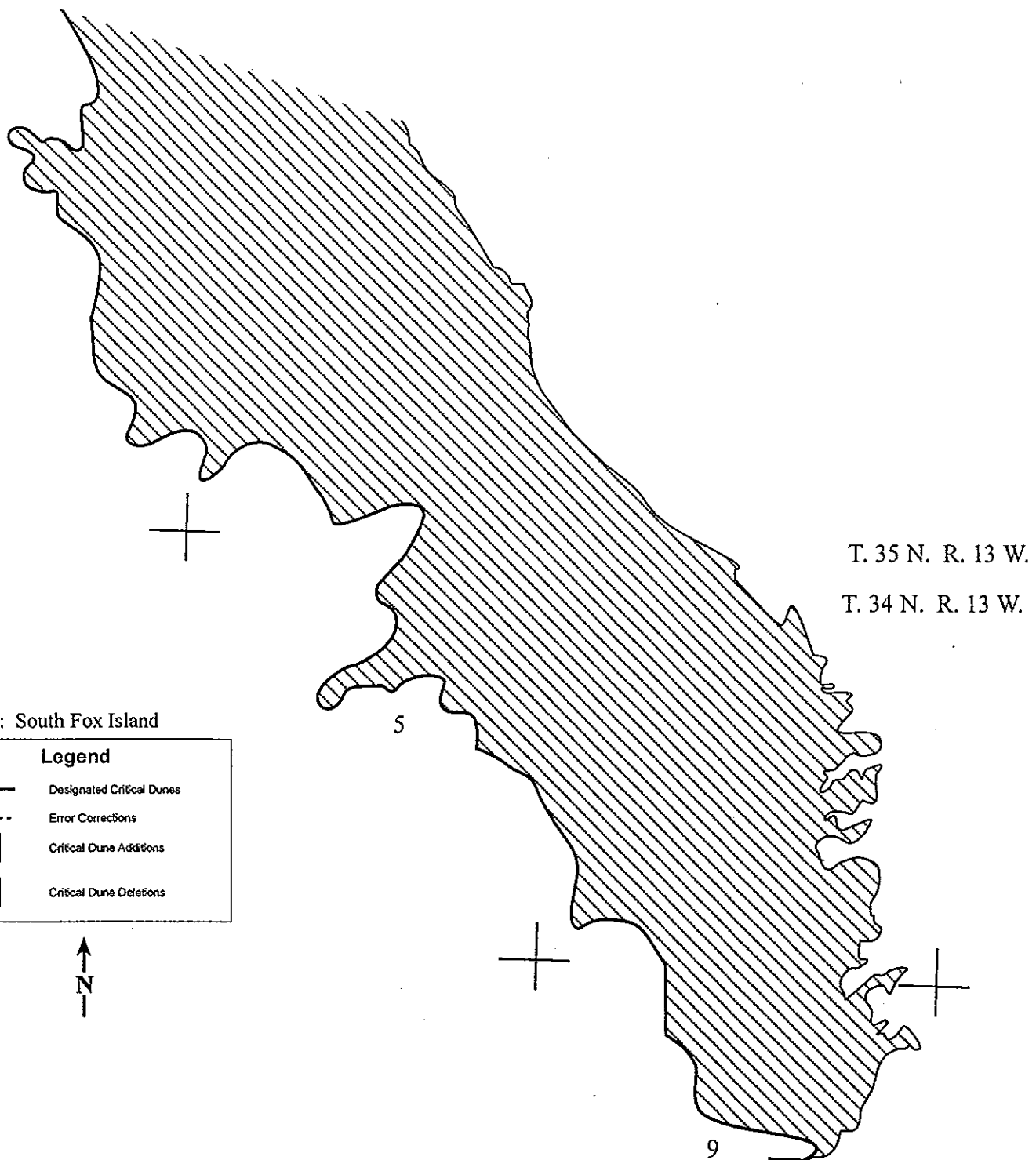
*Note: Shoreline not shown

Folder 45: South Fox Island





Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions

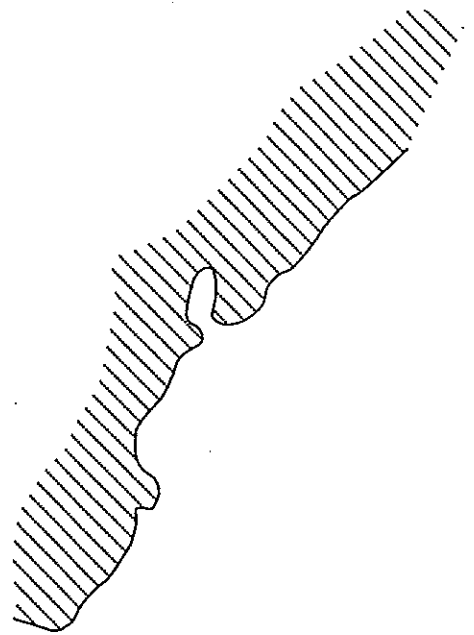


*Note: Shoreline not shown



Folder 47: Elk Rapids

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



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T. 30 N. R. 9 W.

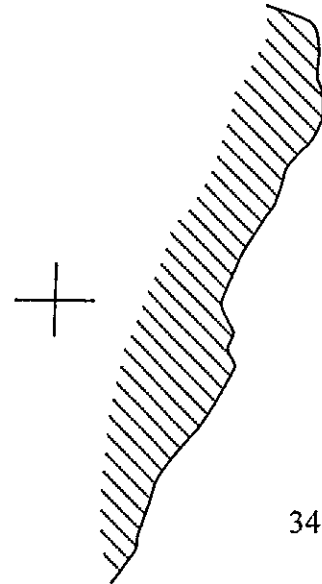
T. 29 N. R. 9 W.

*Note: Shoreline not shown



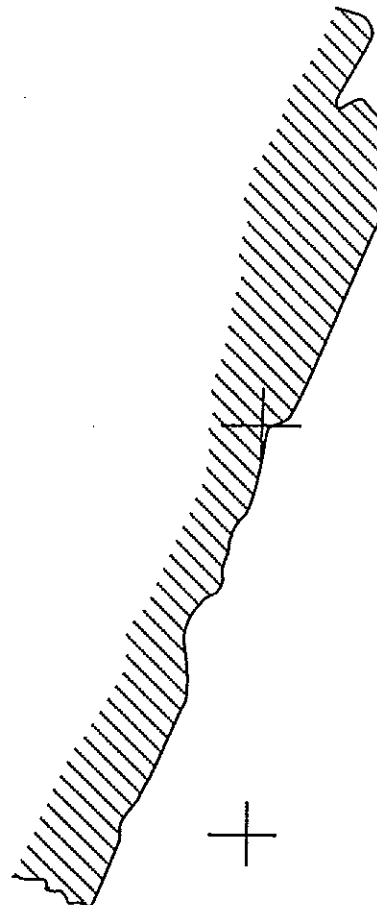
Folder 47: Elk Rapids

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



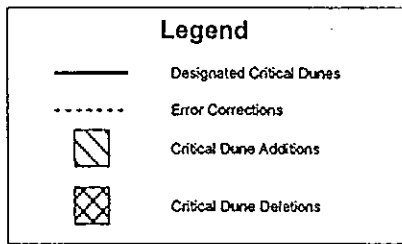
T. 30 N. R. 9 W.

T. 29 N. R. 9 W.



*Note: Shoreline not shown

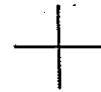
Folder 46 and 48: Alden and Central Lake



T. 30 N. R. 9 W.

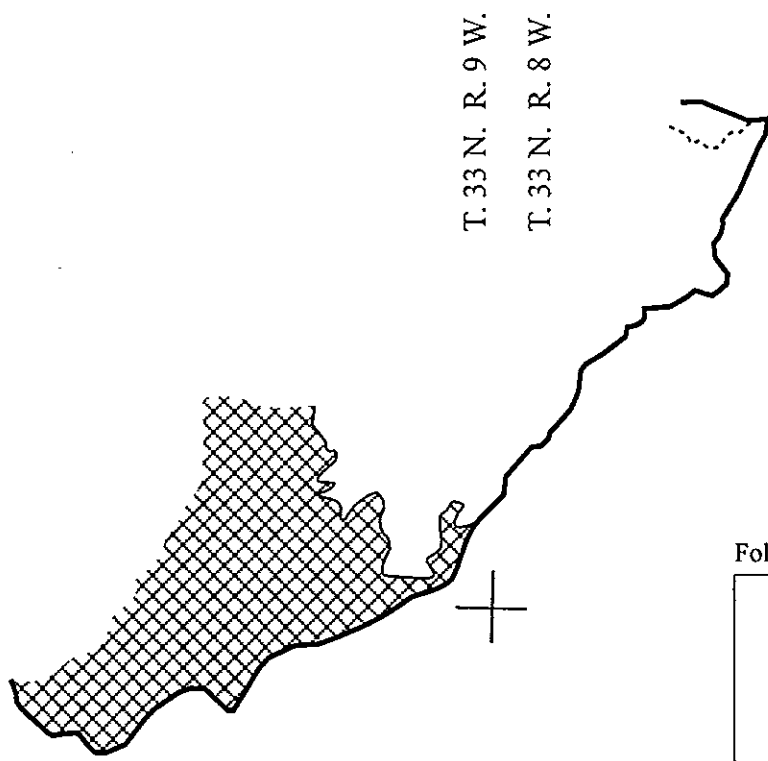


11

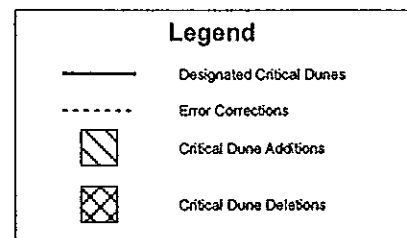


14

*Note: Shoreline not shown

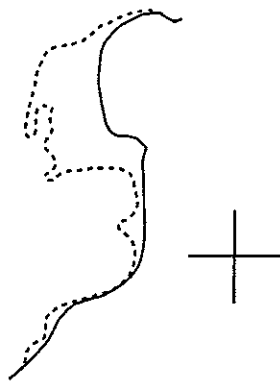


Folder 50: Charlevoix



*Note: Shoreline not shown





T. 34 N. R. 8 W.



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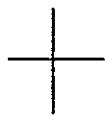
Folder 51: Ironton

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions

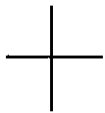
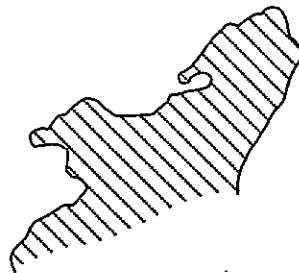


*Note: Shoreline not shown

T.37 N. R. 10 W.



11



Folder 53: Beaver Island South

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown





T. 38 N. R. 10 W.

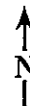


30

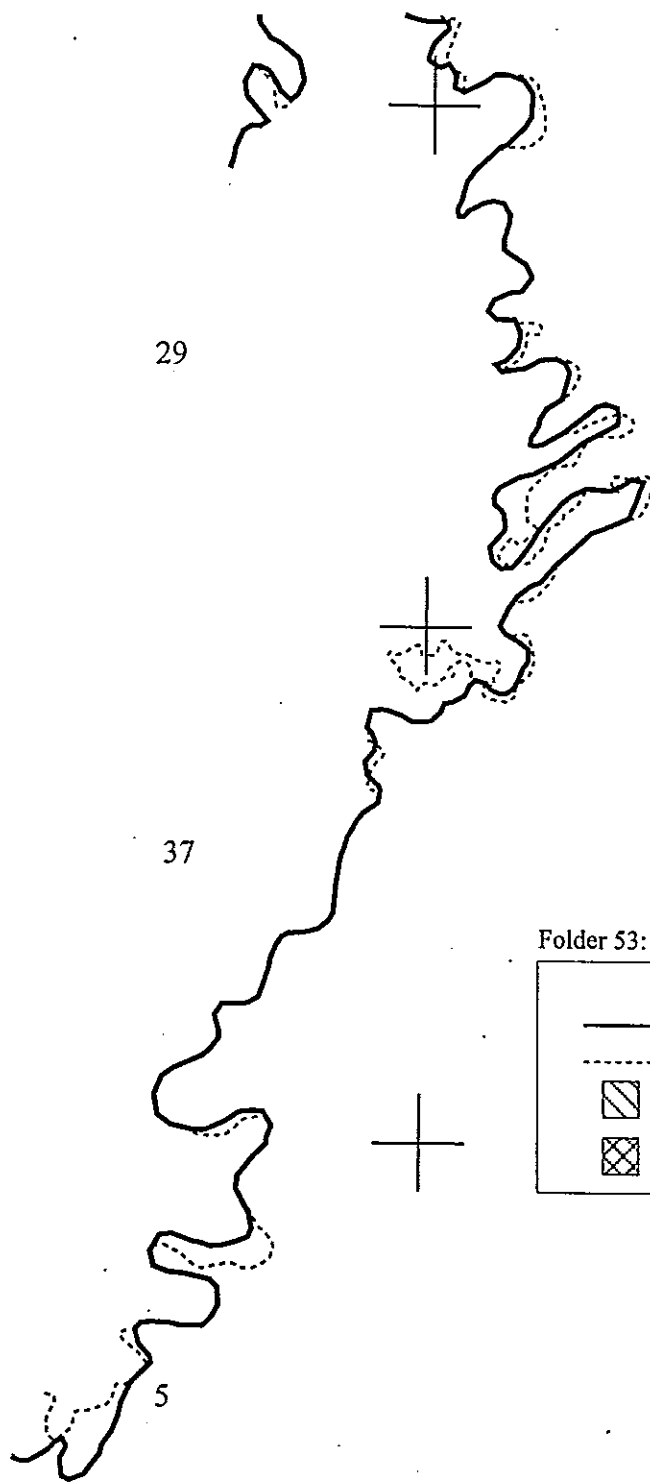


Folder 53: Beaver Island North

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



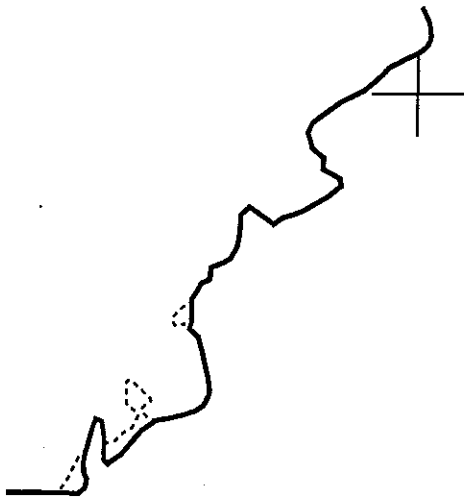
*Note: Shoreline not shown



T. 39 N R. 10 W.

T. 38 N. R. 10 W.

*Note: Shoreline not shown



4



T. 38 N. R. 6 W.

T. 37 N. R. 6 W.





Folder 55: Cross Village

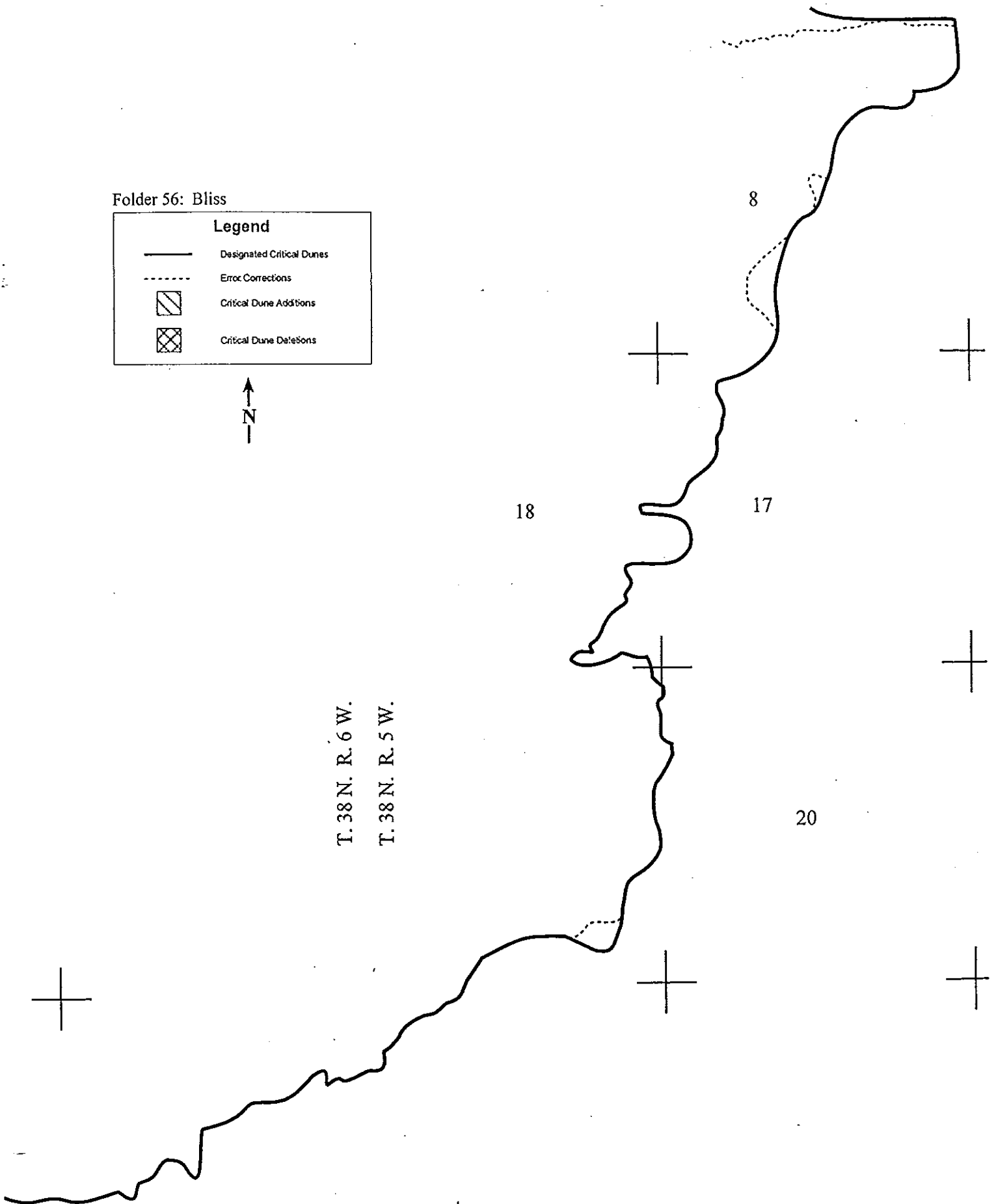
Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown

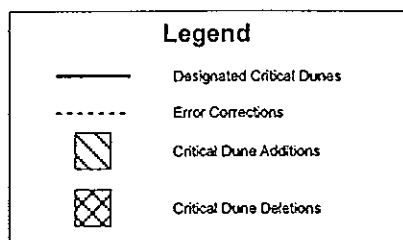
Folder 56: Bliss

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown

Folder 56: Bliss



34

35

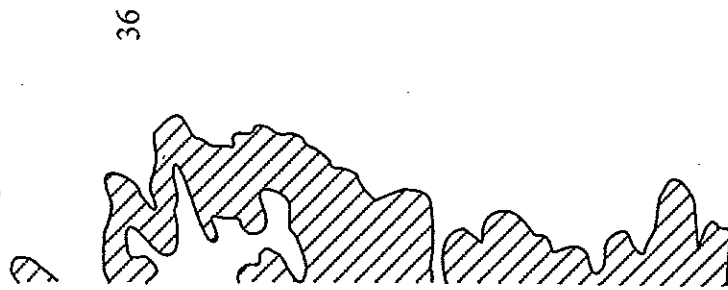


T. 39 N. R. 5 W.

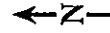
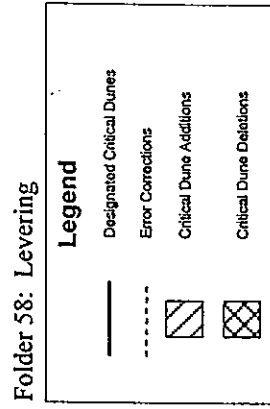
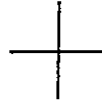
T. 38 N. R. 5 W.

*Note: Shoreline not shown

R. 5 W.
R. 4 W.



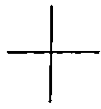
T. 39 N.
T. 38 N.



*Note: Shoreline not shown

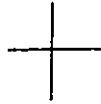
R. 5 W.

R. 4 W.



T. 39 N.
T. 38 N.

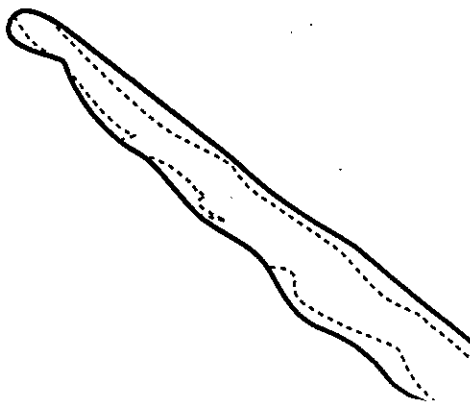
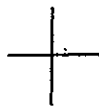
31



32

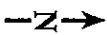


33



Folder 58: Levering





Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown

T. 39 N. R. 4 W.

Folder 59:McGulpin Point

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions

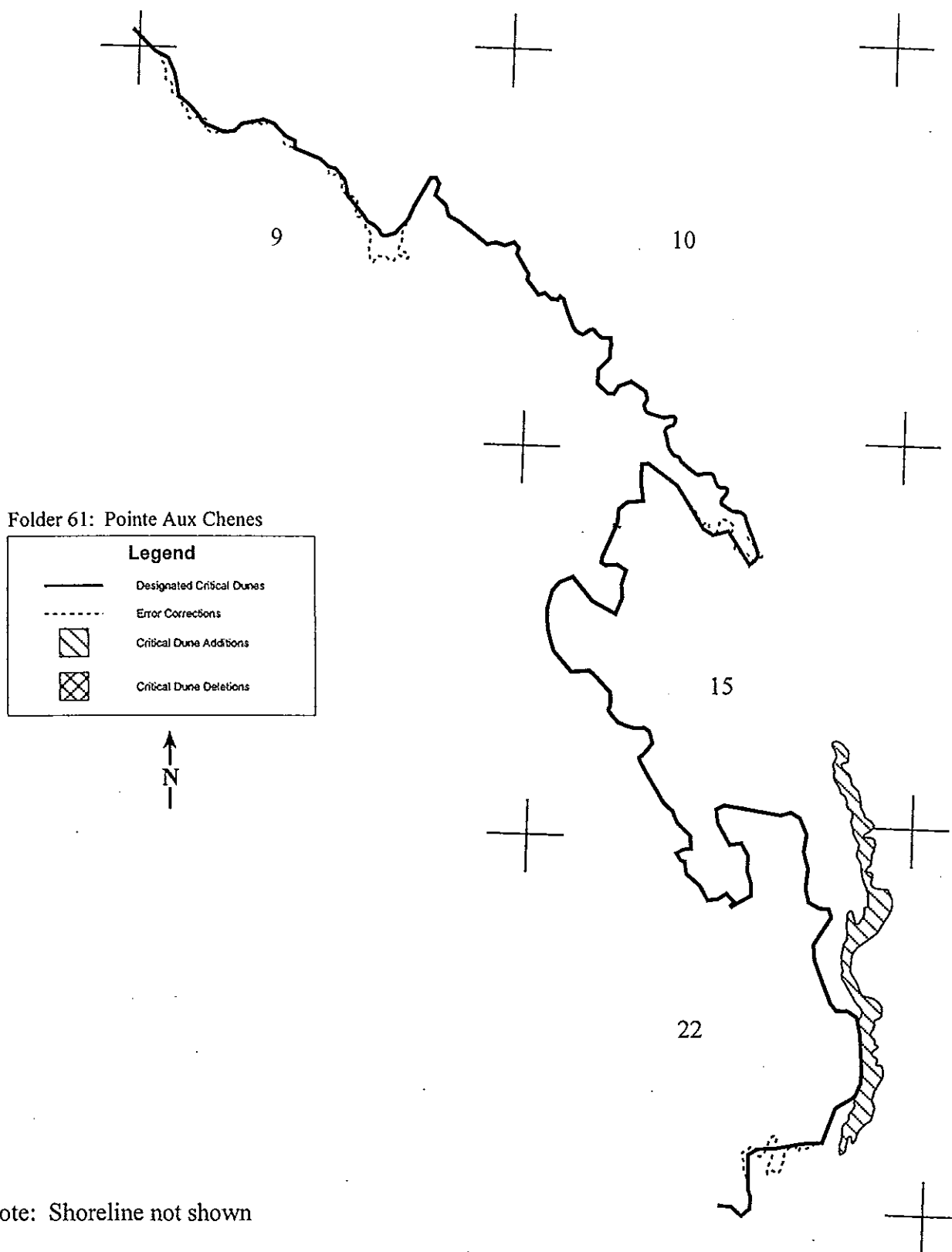


23



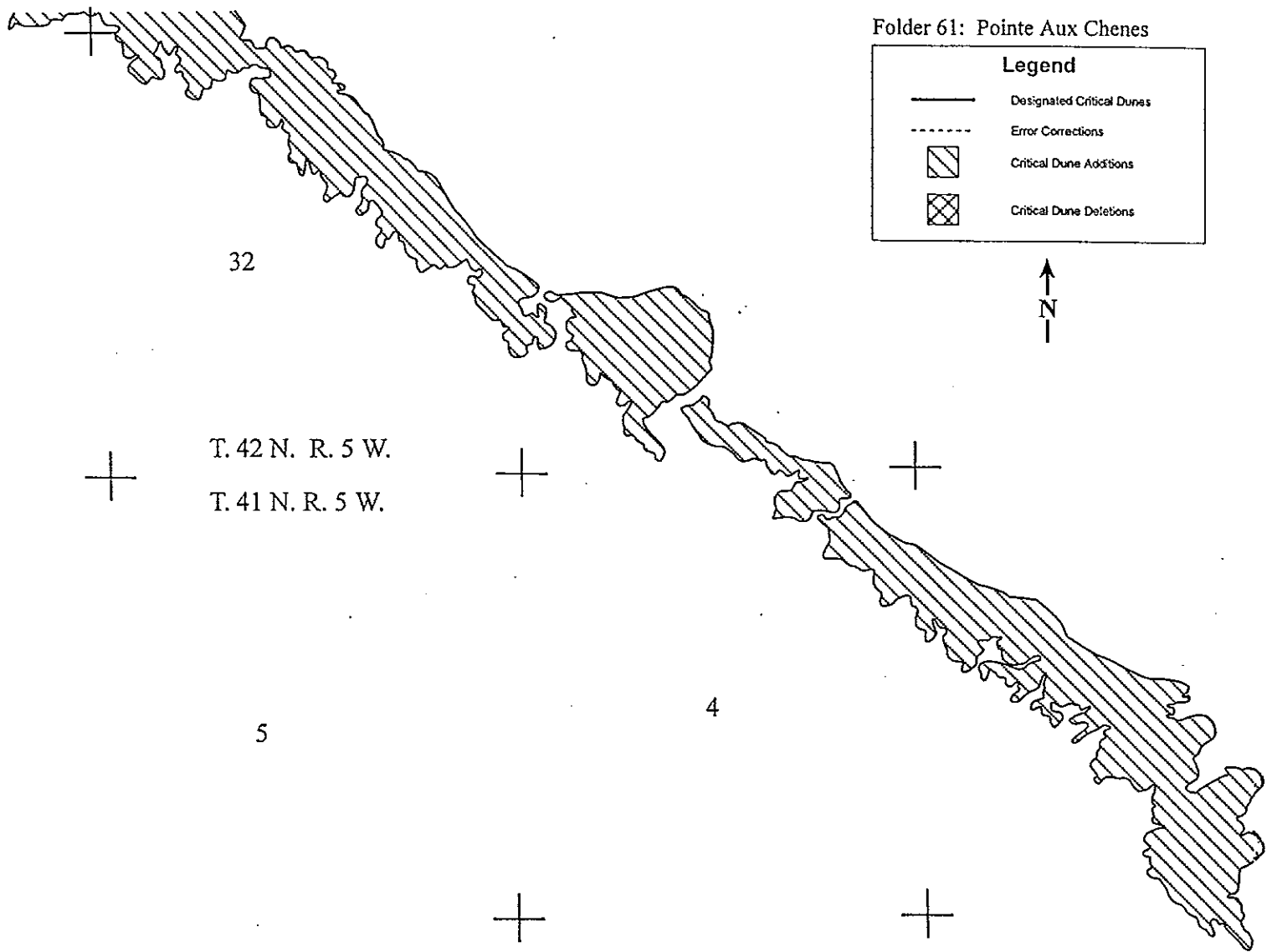
*Note: Shoreline not shown

T. 41 N. R. 5 W.



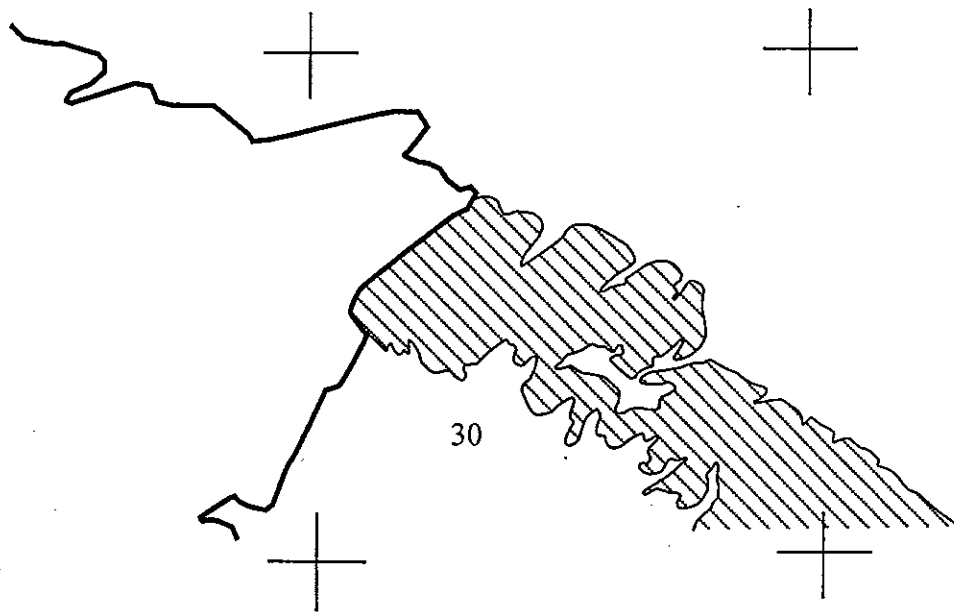
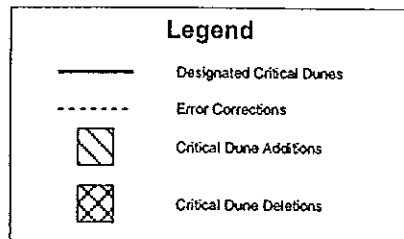
*Note: Shoreline not shown

Folder 61: Pointe Aux Chenes



*Note: Shoreline not shown

Folder 62: Kenneth



T. 42 N. R. 6 W.
T. 42 N. R. 6 W.

*Note: Shoreline not shown

T. 42 N. R. 6 W.







22

23

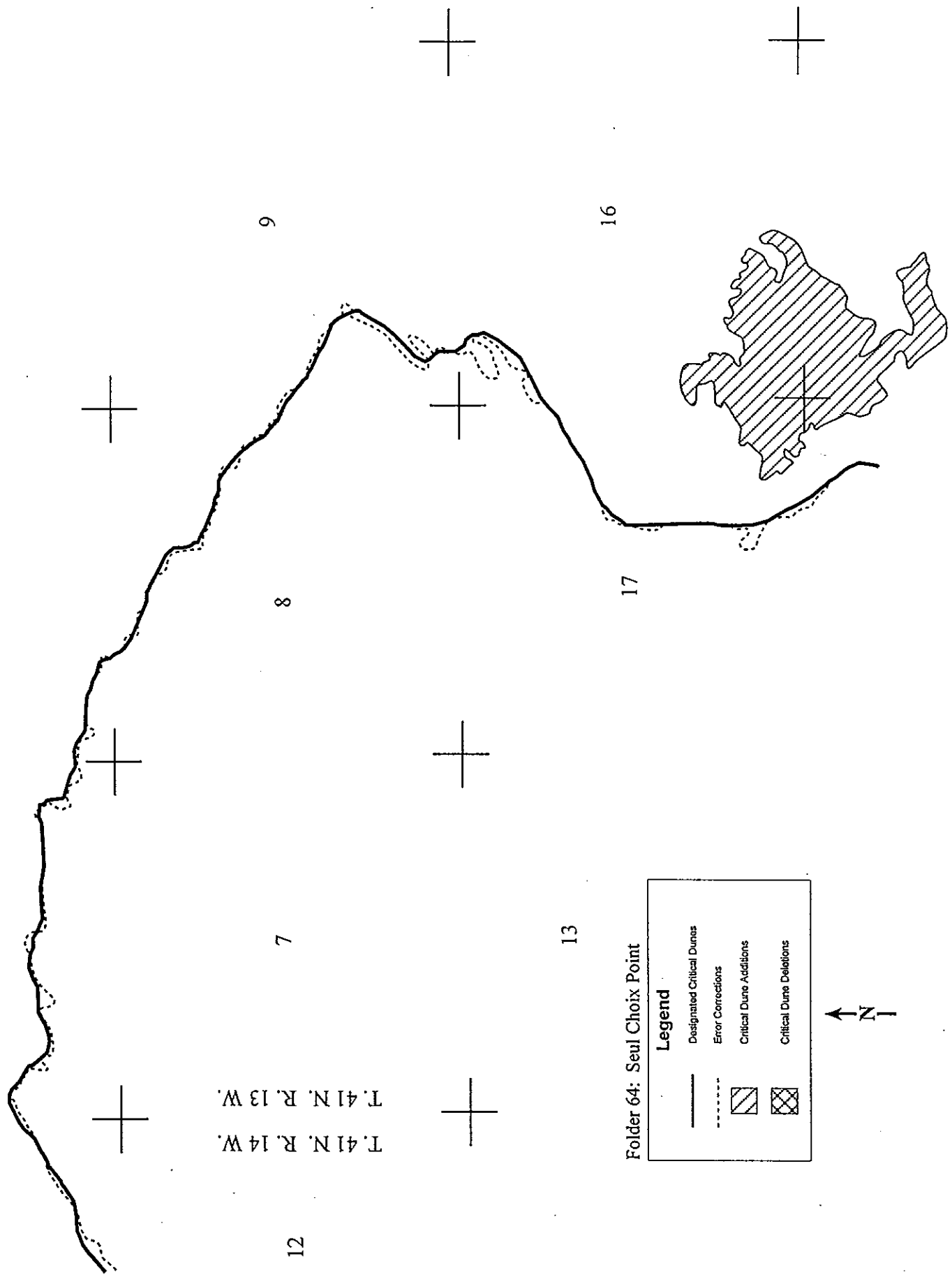


Folder 63: Brevort

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown

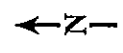


T. 41 N. R. 14 W.
T. 41 N. R. 13 W.

Folder 64: Seul Choix Point

Legend

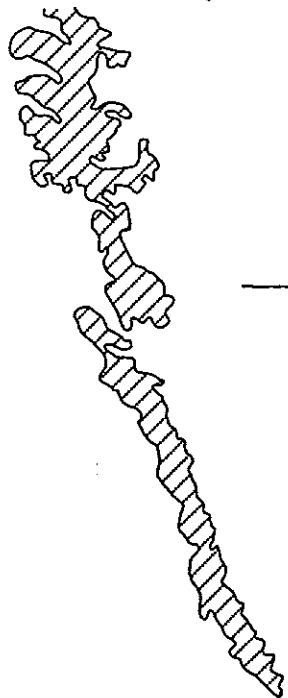
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown

The dune formations on the following sheet are located on the eastern half of the Seul Choix Point USGS quadrangle and meet all criteria for CDA designation. However, under consultation with DEQ officials, it was decided that we restrict our revisions of the CDA atlas to those dunes within USGS quadrangles originally included in the atlas or mapped by Buckler during the GSD series 1-3 investigations. Because these dune formations extend eastward into USGS quadrangles where no prior MDNR/DEQ dune protection surveys have been made, perhaps the dunes displayed on the following sheet will not receive CDA status. There are other dune formations in non-dune protection surveyed areas of Michigan which meet the CDA criteria outlined in this report.





T. 42 N. R. 13 W.

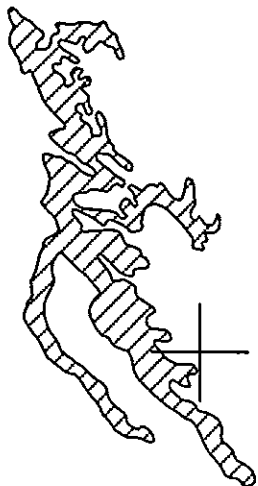
T. 41 N. R. 13 W.



1



2

3



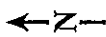
Folder 64: Seul Choix Point

Legend

—	Designated Critical Dunes
- - -	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions

11

10

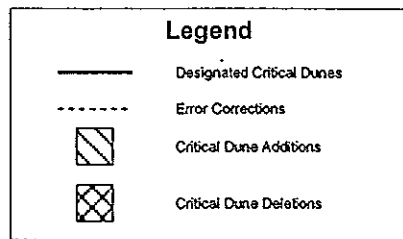


*Note: Shoreline not shown

T. 41 N. R. 15 W.

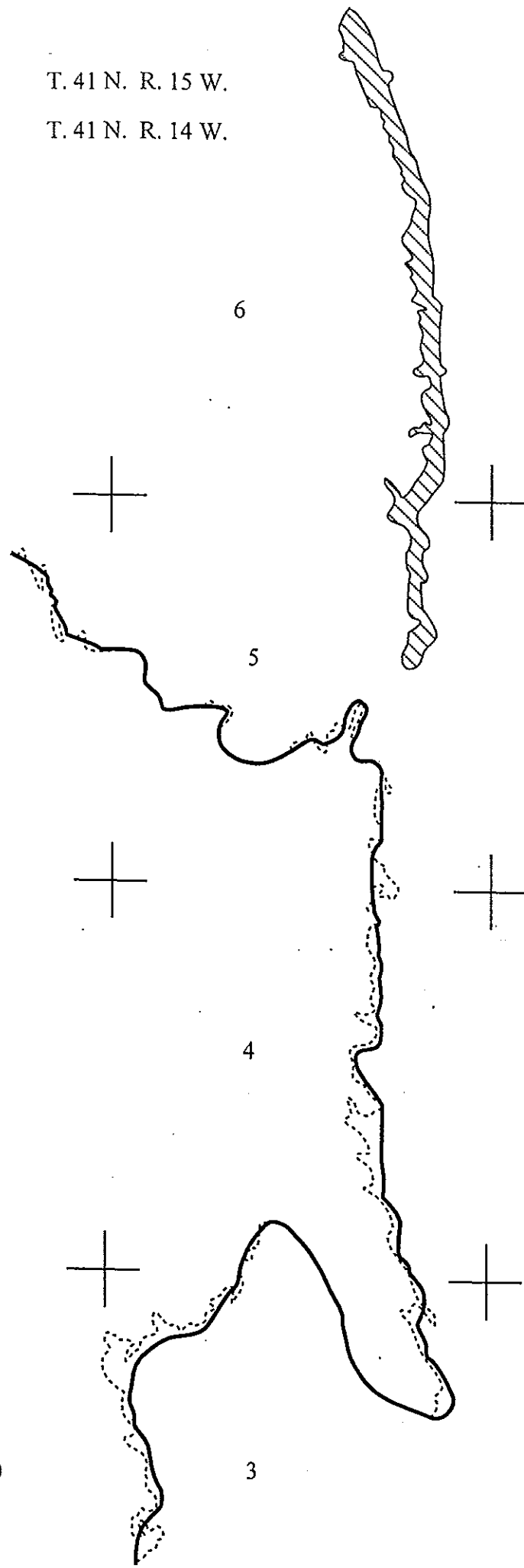
T. 41 N. R. 14 W.

Folder 65: Gulliver

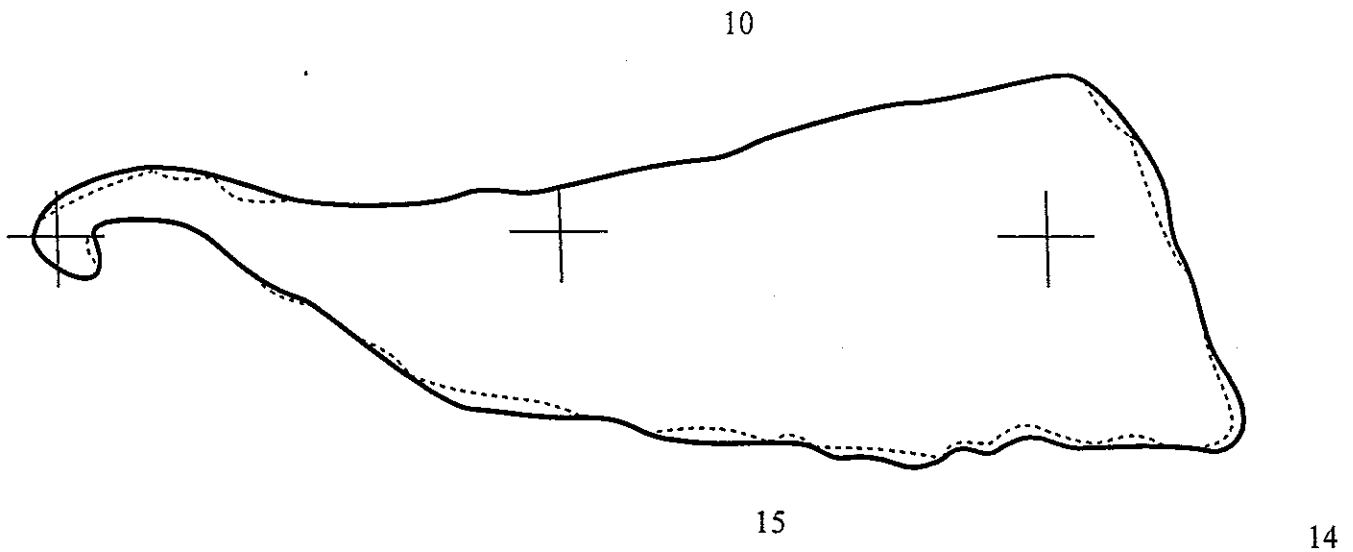


- Z →

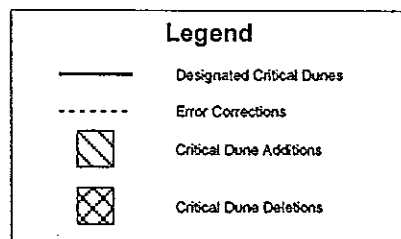
*Note: Shoreline not shown



T. 47 N. R. 3 W.



Folder 66: Dollar Settlement





*Note: Shoreline not shown

T. 50 N. R. 8 W.

Folder 67: Betsy Lake North

Legend

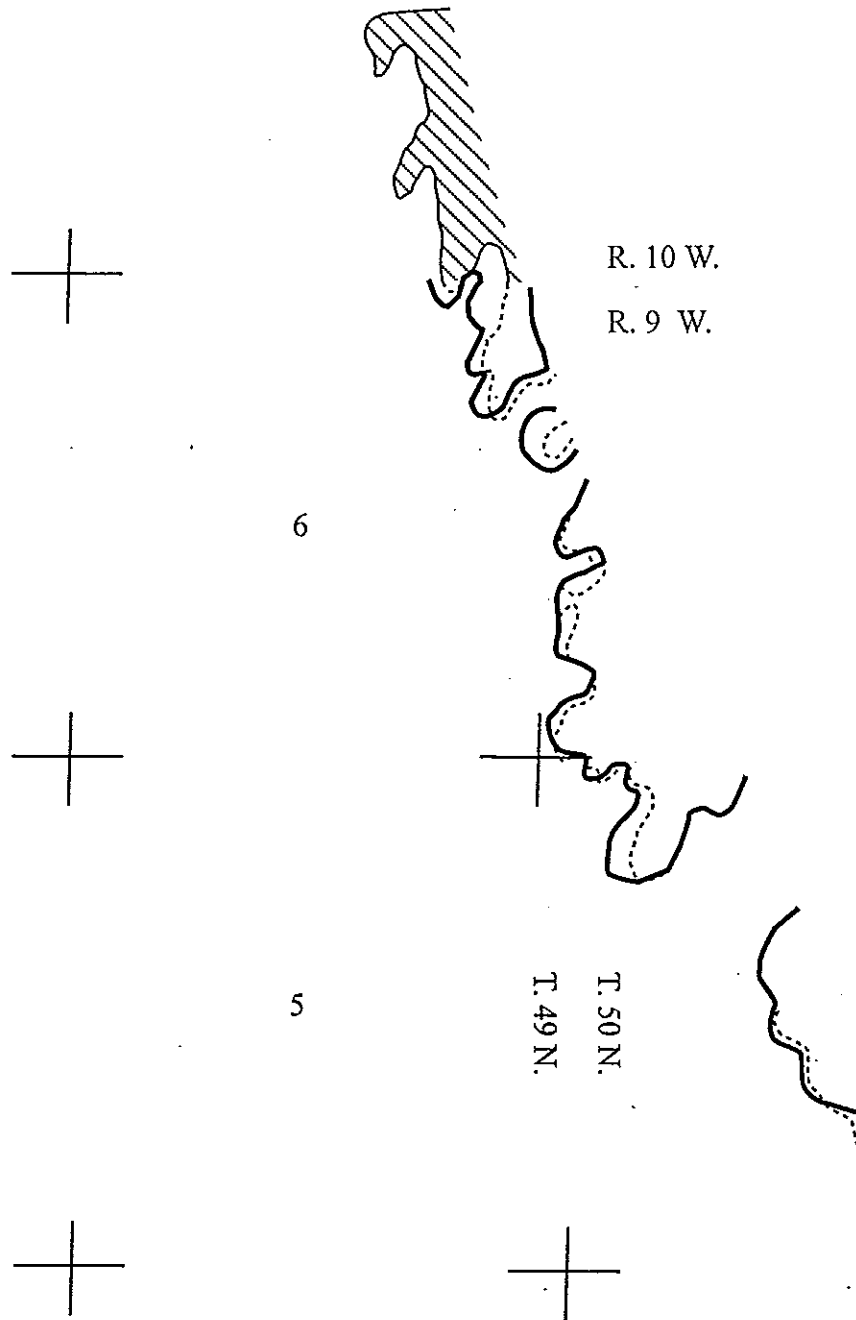
- Designated Critical Dunes
- - - Error Corrections
-  Critical Dune Additions
-  Critical Dune Deletions

- N ➔

16

21

*Note: Shoreline not shown



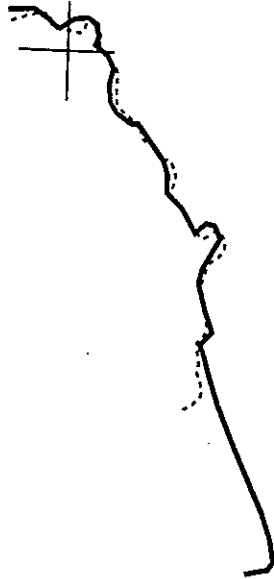
Folder 68: Betsy Lake NW

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions

→Z→

*Note: Shoreline not shown

T. 50 N. R. 9 W.

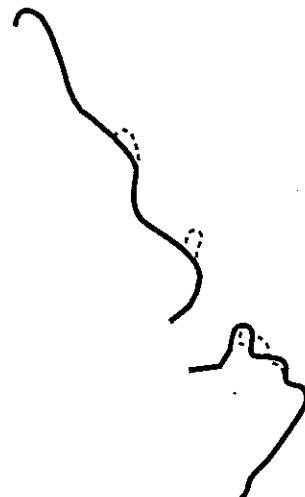
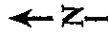
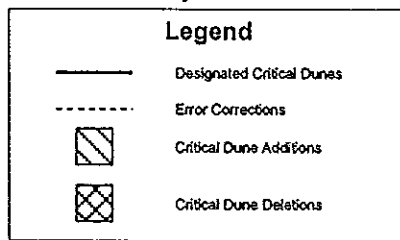


26



Folder 68: Betsy Lake NW

27

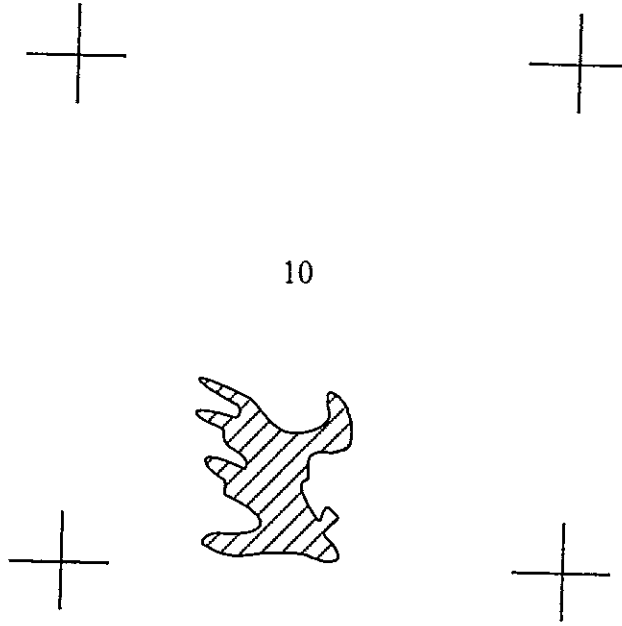


*Note: Shoreline not shown

T. 49 N. R. 10 W.

9

10



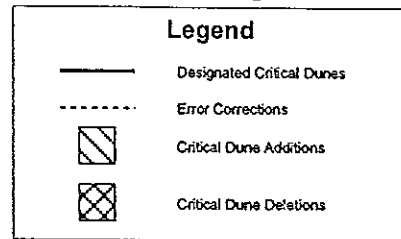
Folder 69: Muskallonge Lake East

Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



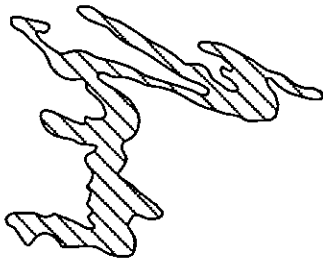
*Note: Shoreline not shown

Folder 70: Muskallonge Lake West

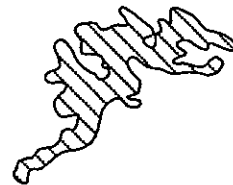


3

T. 49 N. R. 11 W.



9

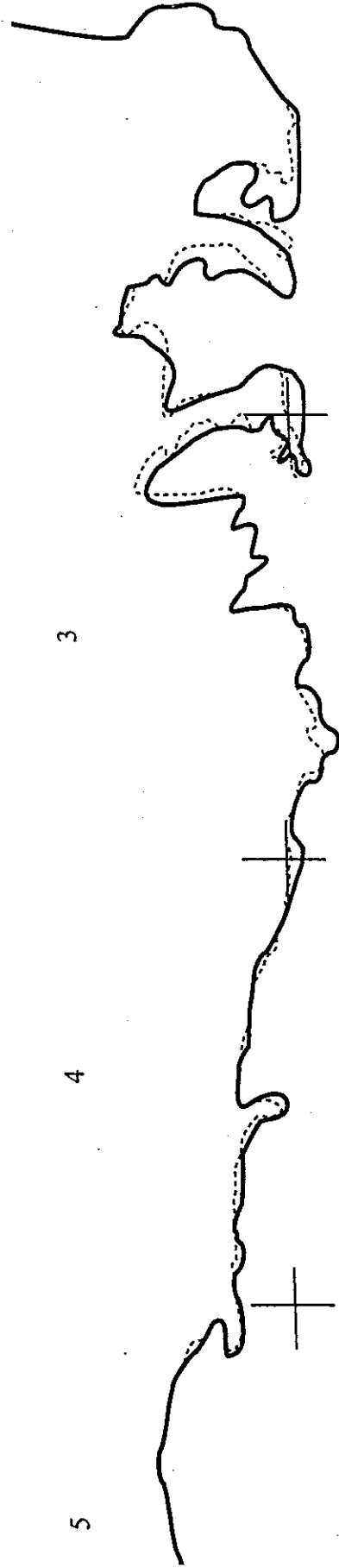


10

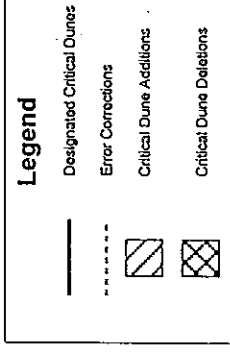


*Note: Shoreline not shown

T. 49 N. R. 12 W.

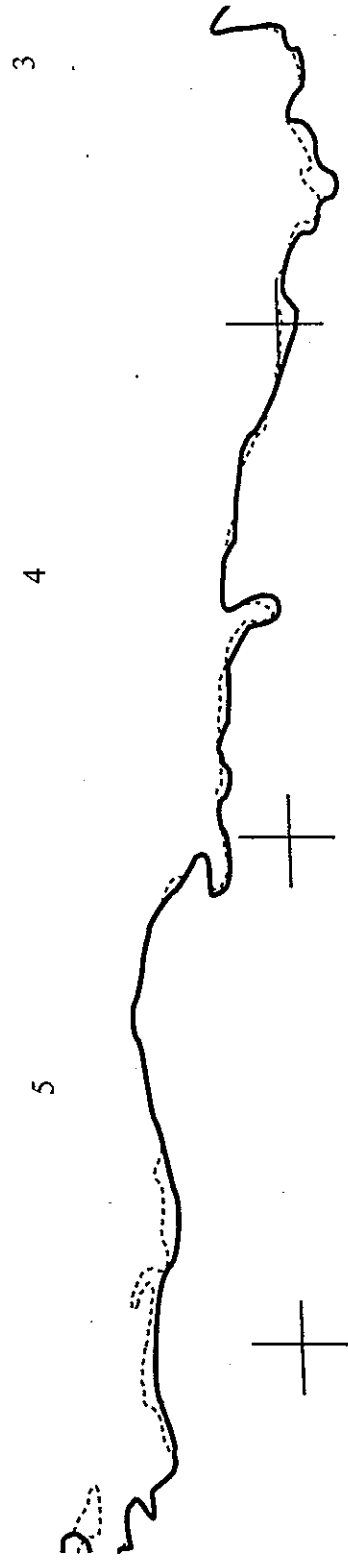


Folder 71: Grand Marais NE

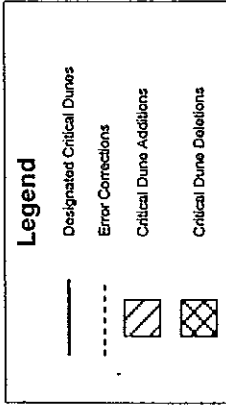


*Note: Shoreline not shown

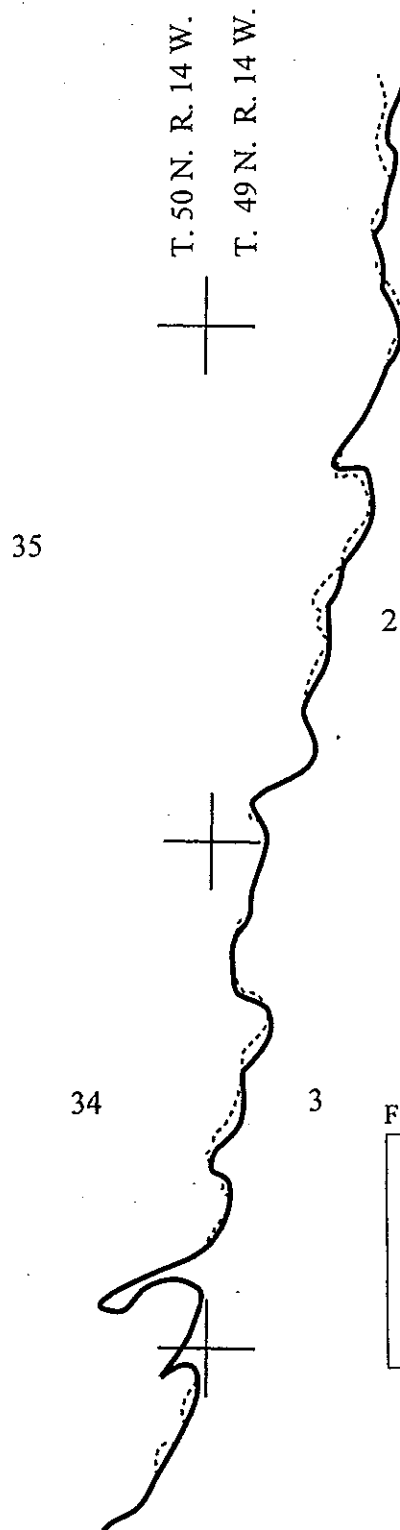
T. 49 N. R. 12 W.



Folder 71: Grand Marais NE



*Note: Shoreline not shown

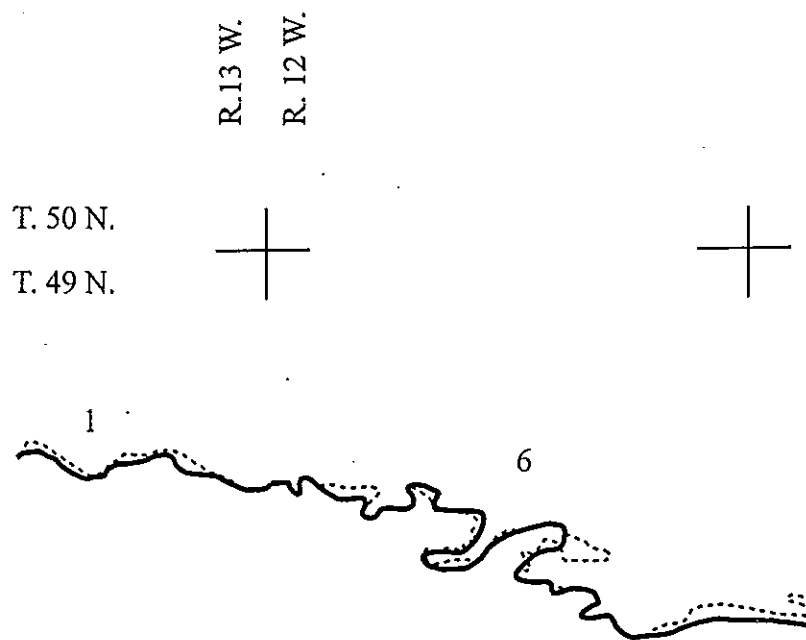


Folder 72: Grand Marais

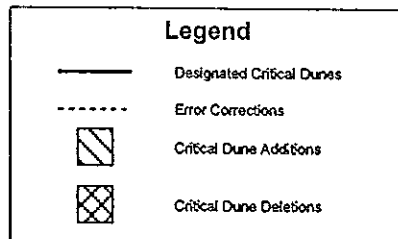
Legend	
	Designated Critical Dunes
	Error Corrections
	Critical Dune Additions
	Critical Dune Deletions



*Note: Shoreline not shown



Folder 71: Grand Marais NE



*Note: Shoreline not shown

T. 49 N. R. 14 W.

10

11

15

14

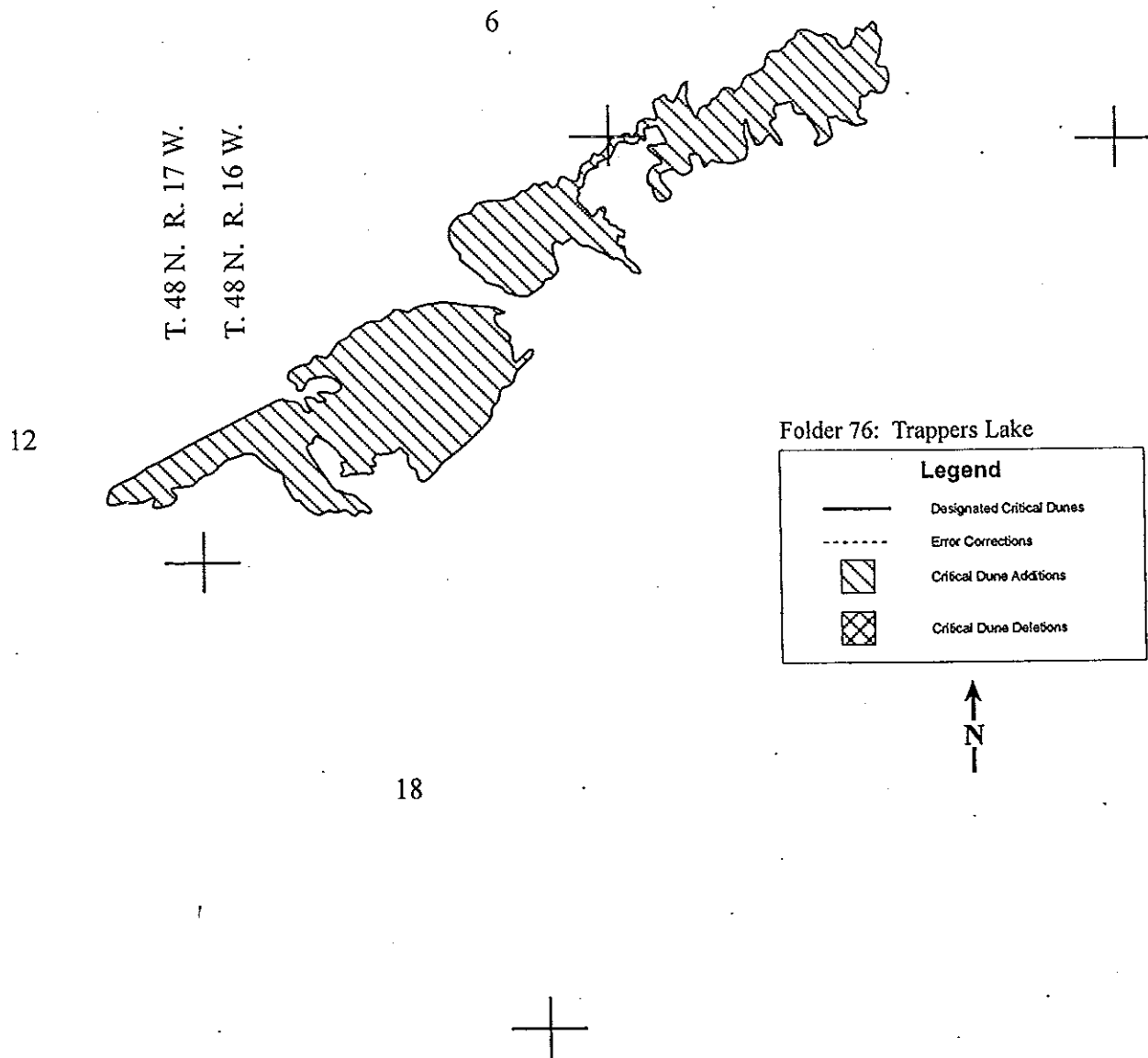
Folder 73: Grand Sable Lake

Legend

- Designated Critical Dunes
- - - Error Corrections
- ▨ Critical Dune Additions
- ▩ Critical Dune Deletions

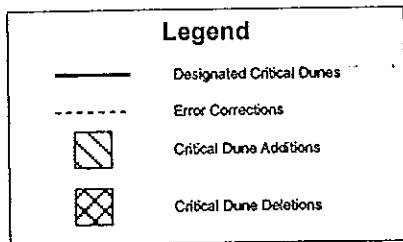
N

*Note: Shoreline not shown

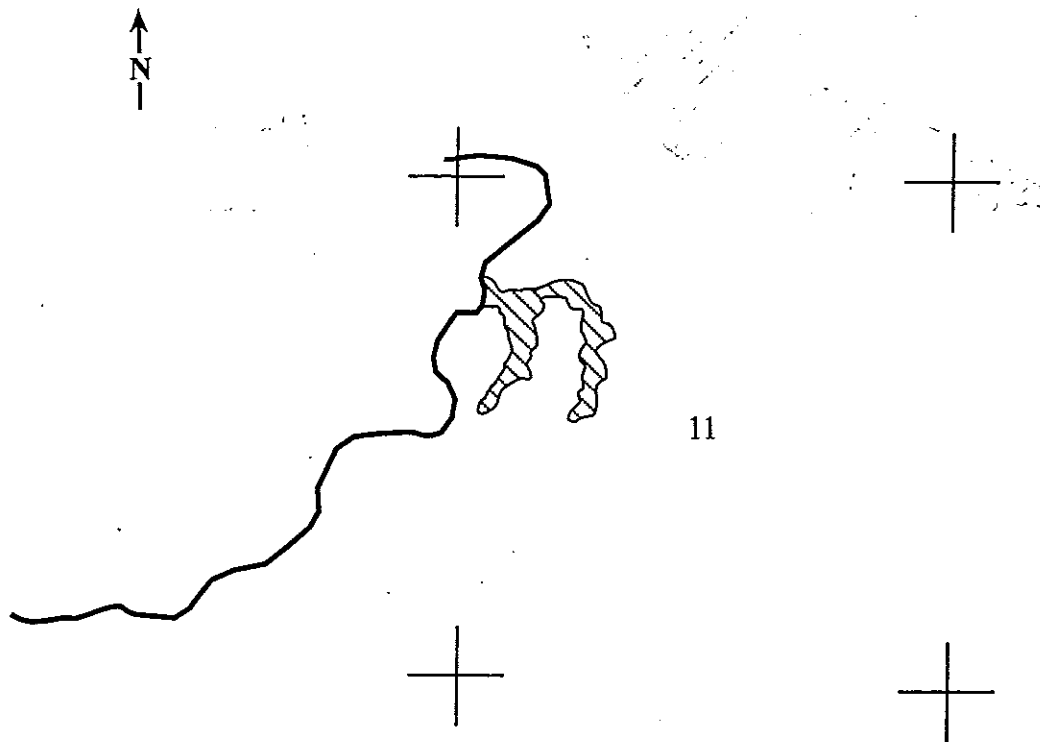


*Note: Shoreline not shown

Folder 78: Eagle Harbor



T. 58 N. R. 31 W.



*Note: Shoreline not shown.