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US Army Corps of Engineers

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TECHNICAL REPORT EL-90-9

PROPOSED 9TH INFANTRY DIVISION FORCE CONVERSION, MANEUVER DAMAGE, EROSION, AND NATURAL RESOURCES ASSE YAKIMA FIRING CENTER, WASHINGTON

Volume II: PLATES

by

L. Jean O'Neil, Michael R. Waring, H. Glenn Hughes, Mary C. Landin

Environmental Laboratory

and

Monte L. Pearson, Patricia A. Morris, Robert J. Larson

Geotechnical Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199



August 1990

Final Report





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Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Engineer District, Seattle
Seattle, Washington 98124-2255
Project No. E87-893153

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Glenn Hughes, Mary C. Landin

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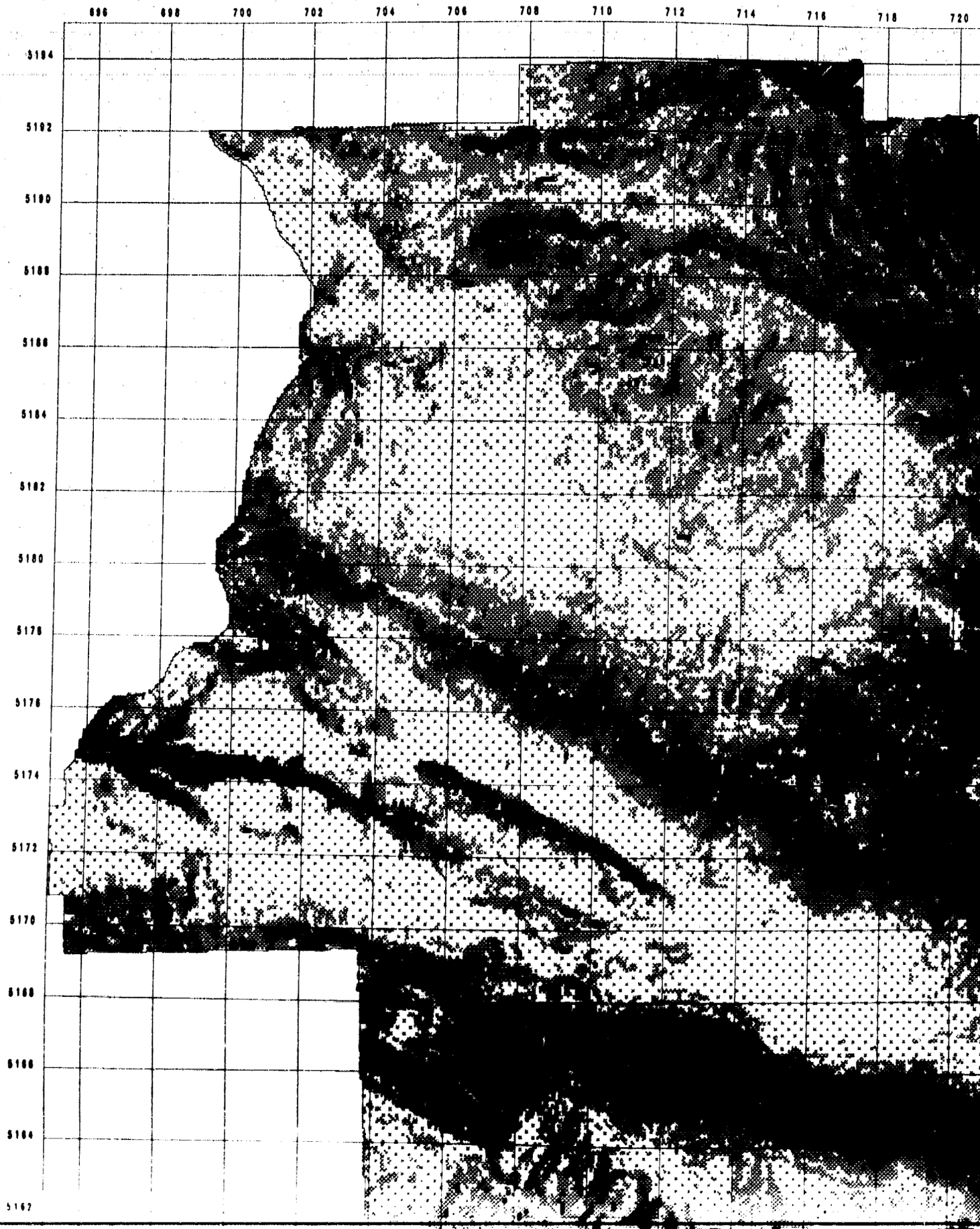
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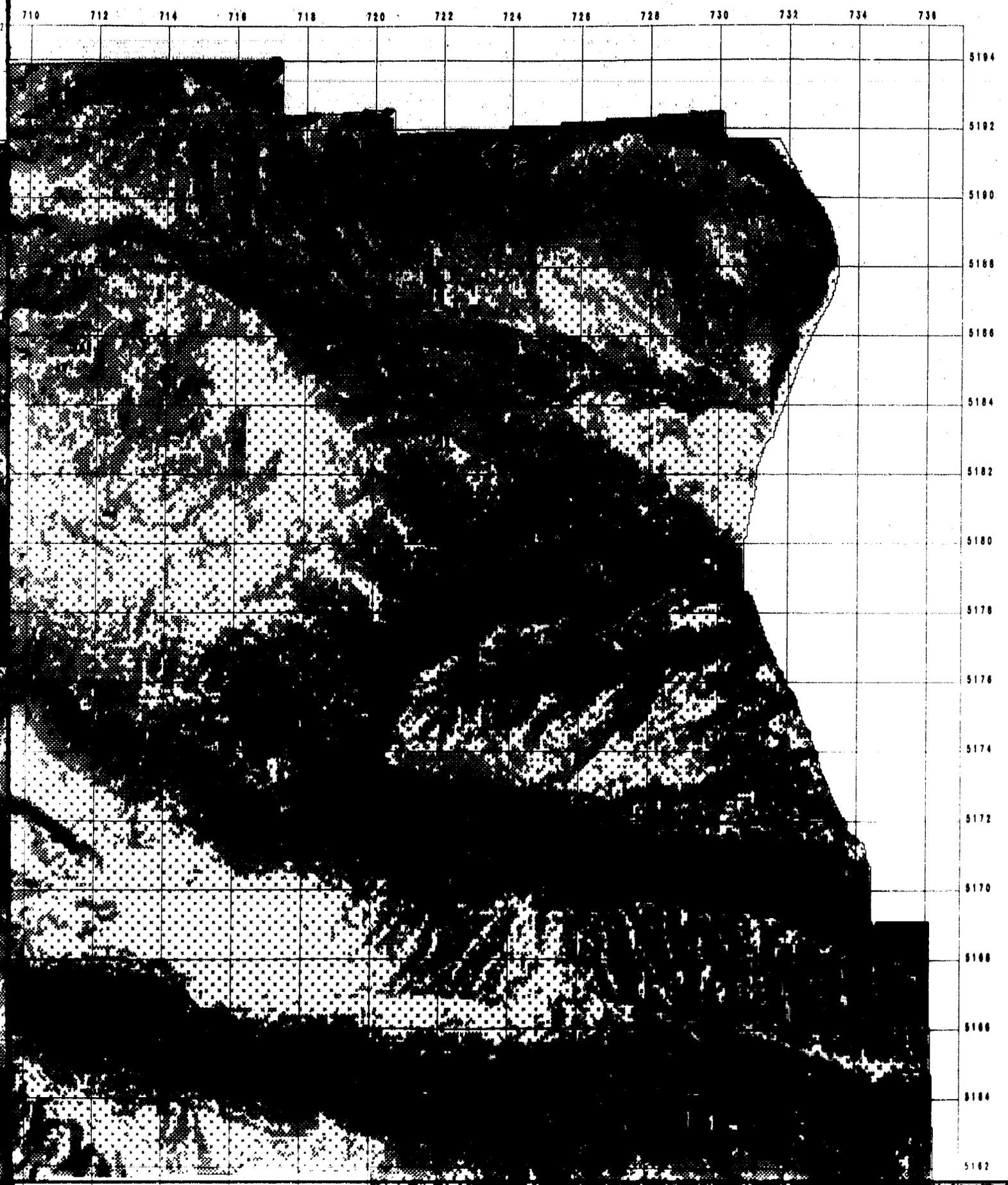
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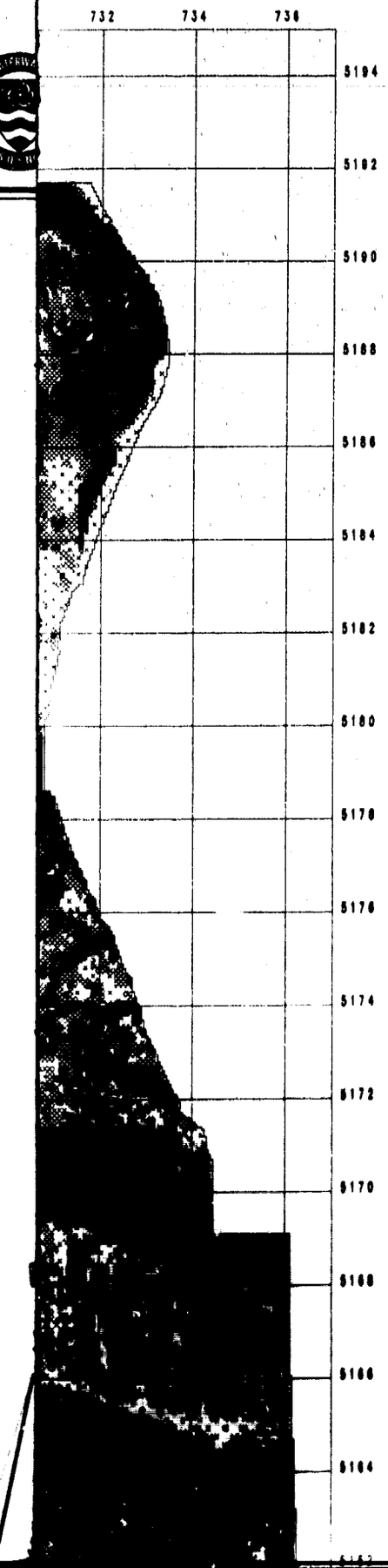
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U. S. Army Corps of Engineers
Waterways
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YAKIMA FIRING CENTER

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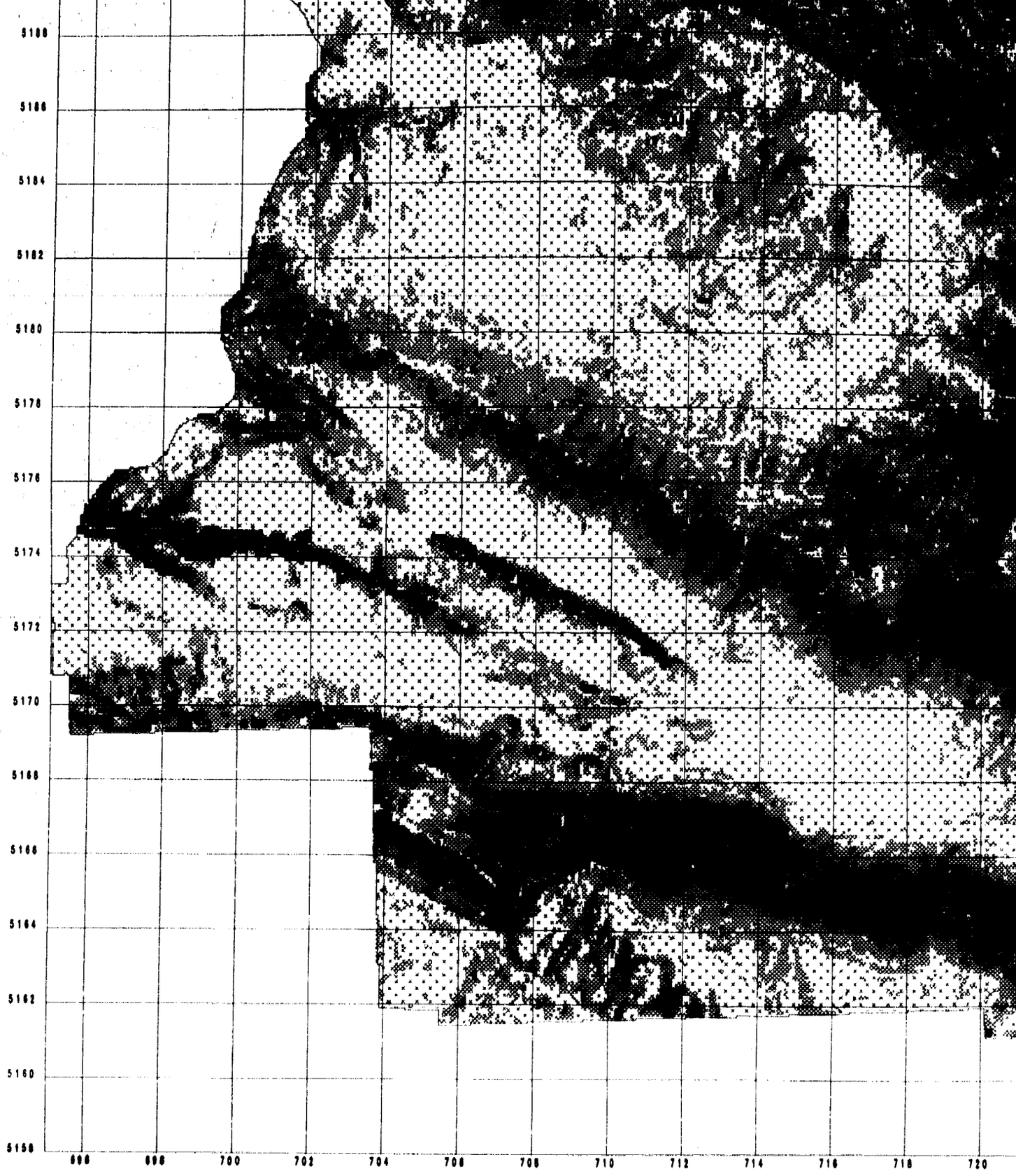


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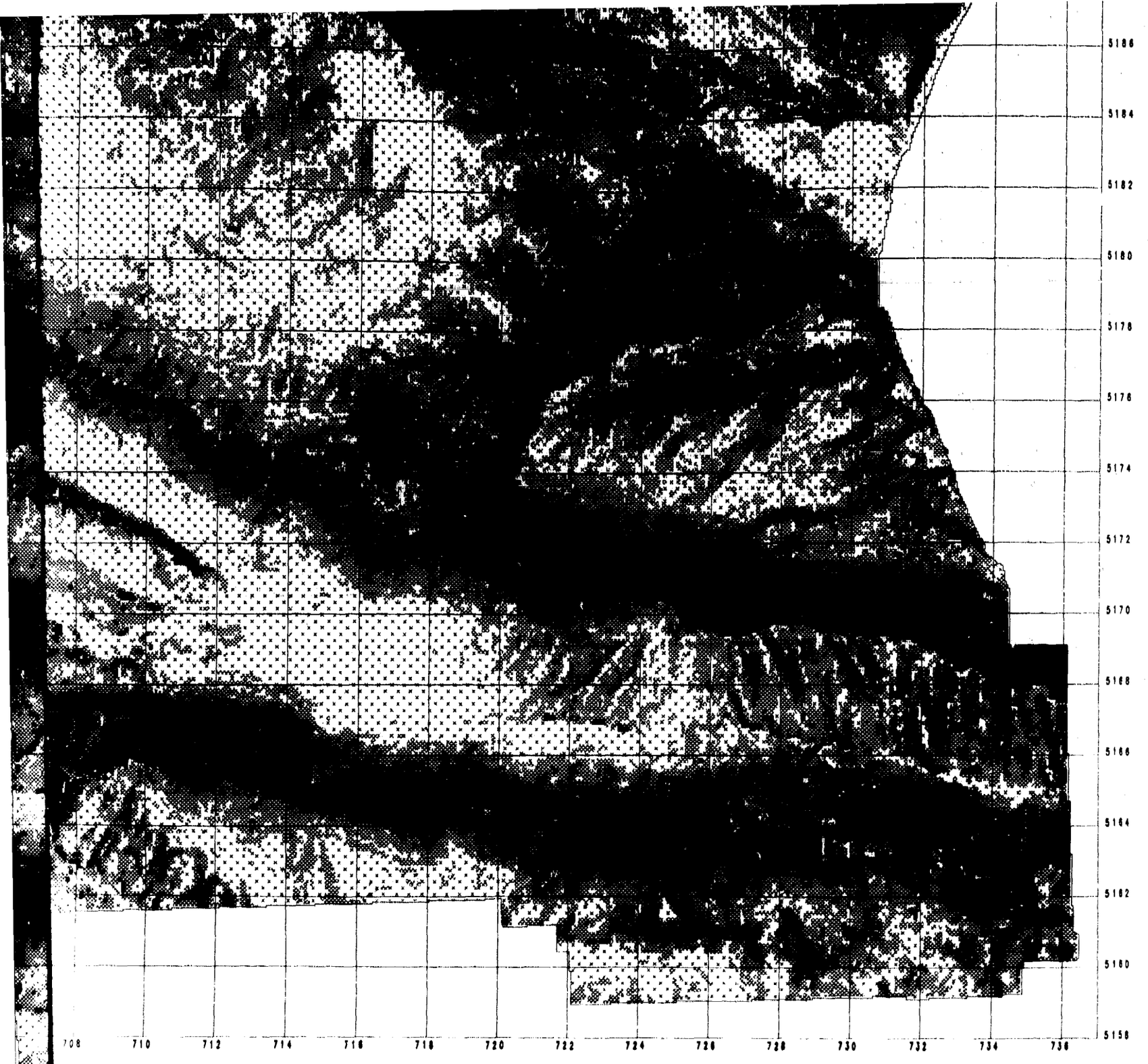
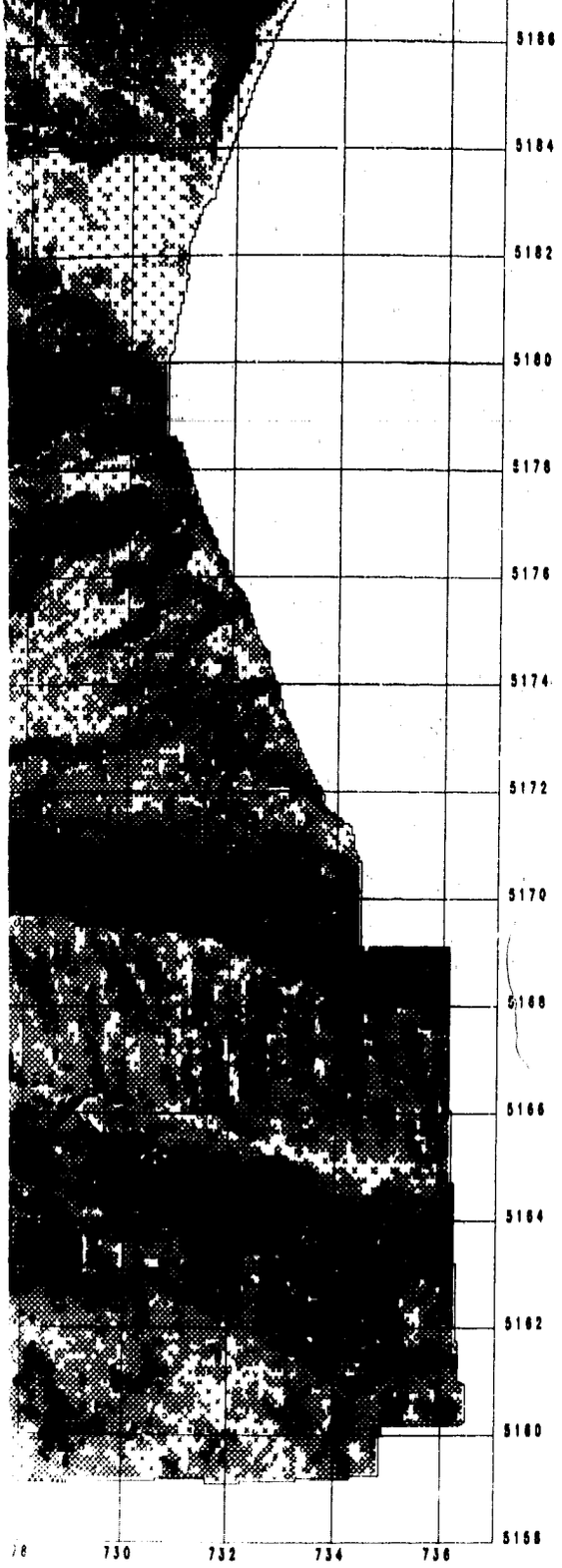


Plate 1. Slope map for Yakima Firing Center study area



study area

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YAKIMA FIRING CENTER

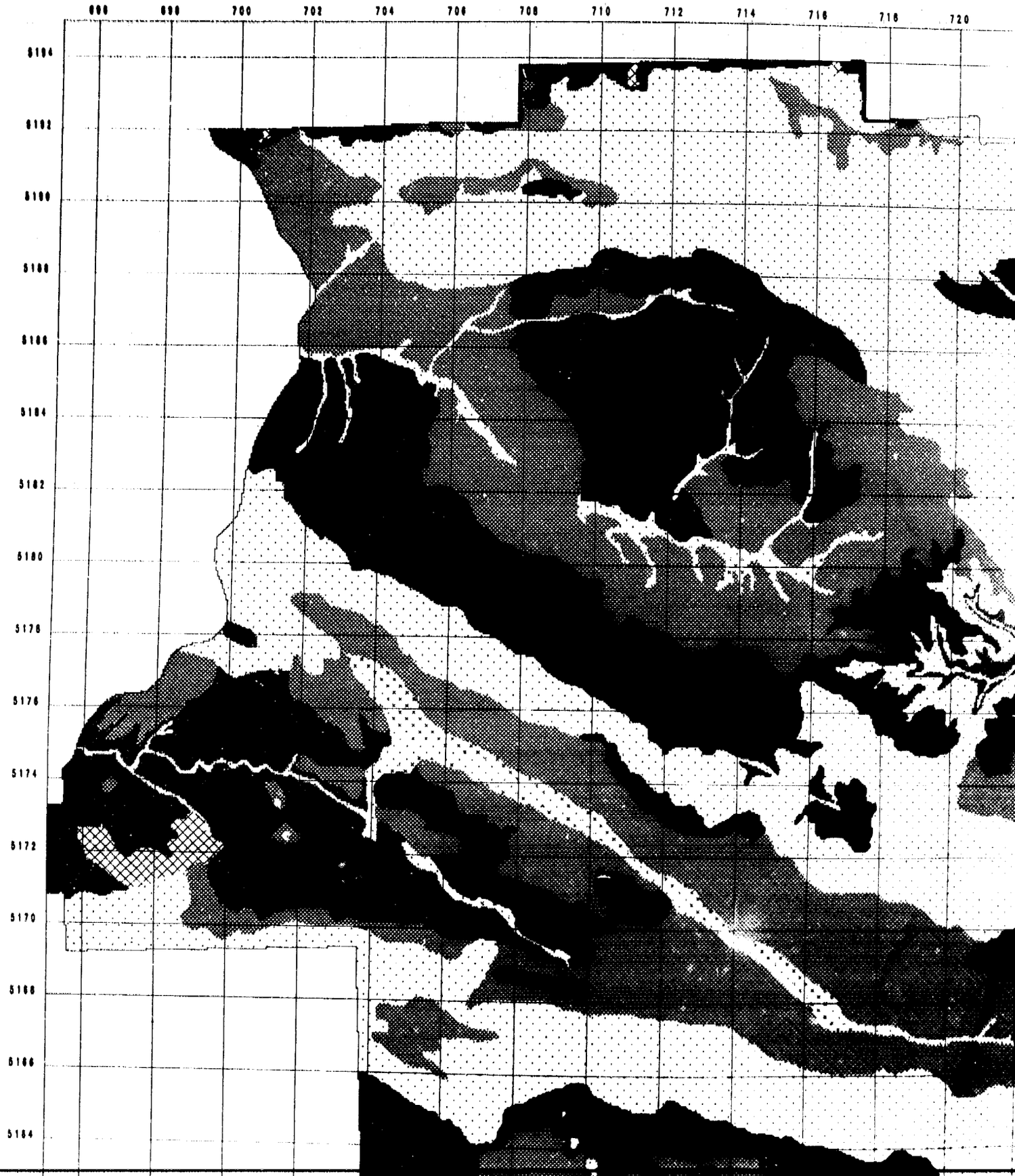
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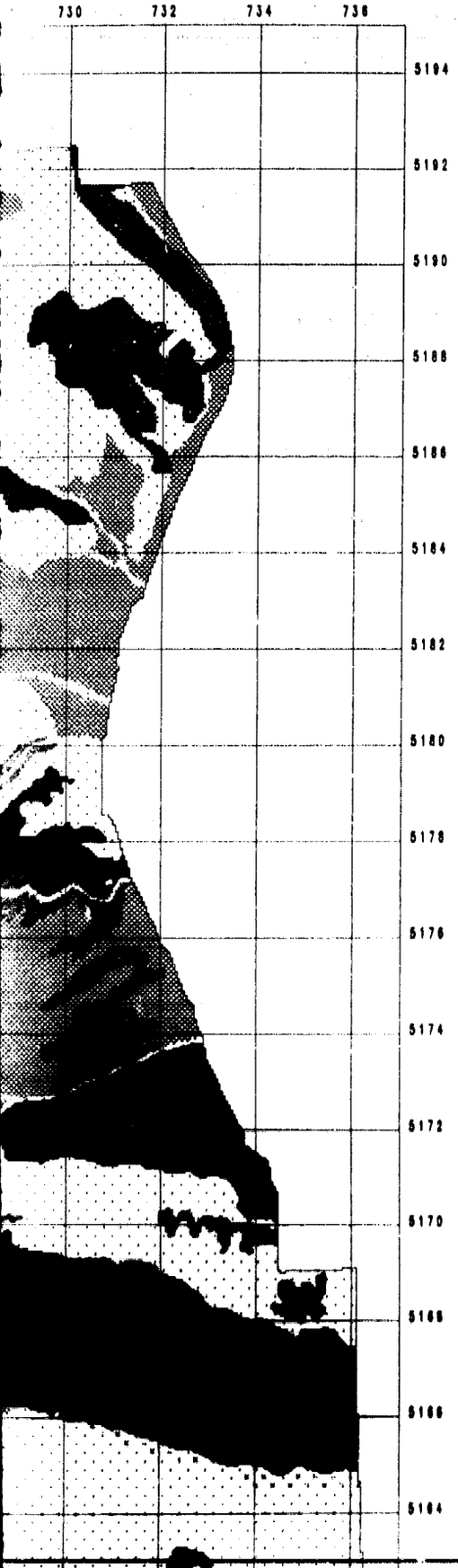
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Waterways
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USCS SOIL TYPE

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CL	GM
ML	GC

YAKIMA FIRING CENTER

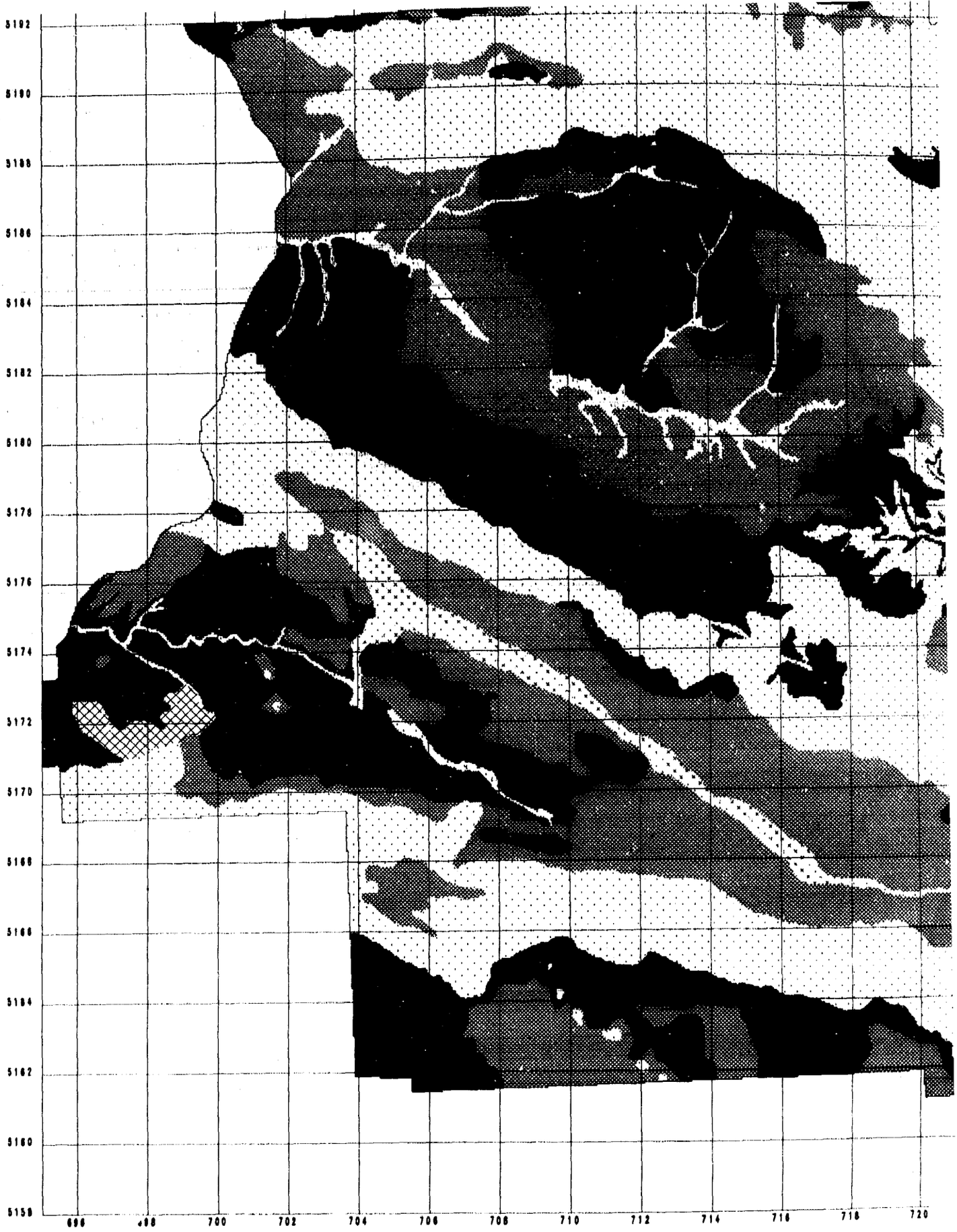


Plate 2. Spatial distributior

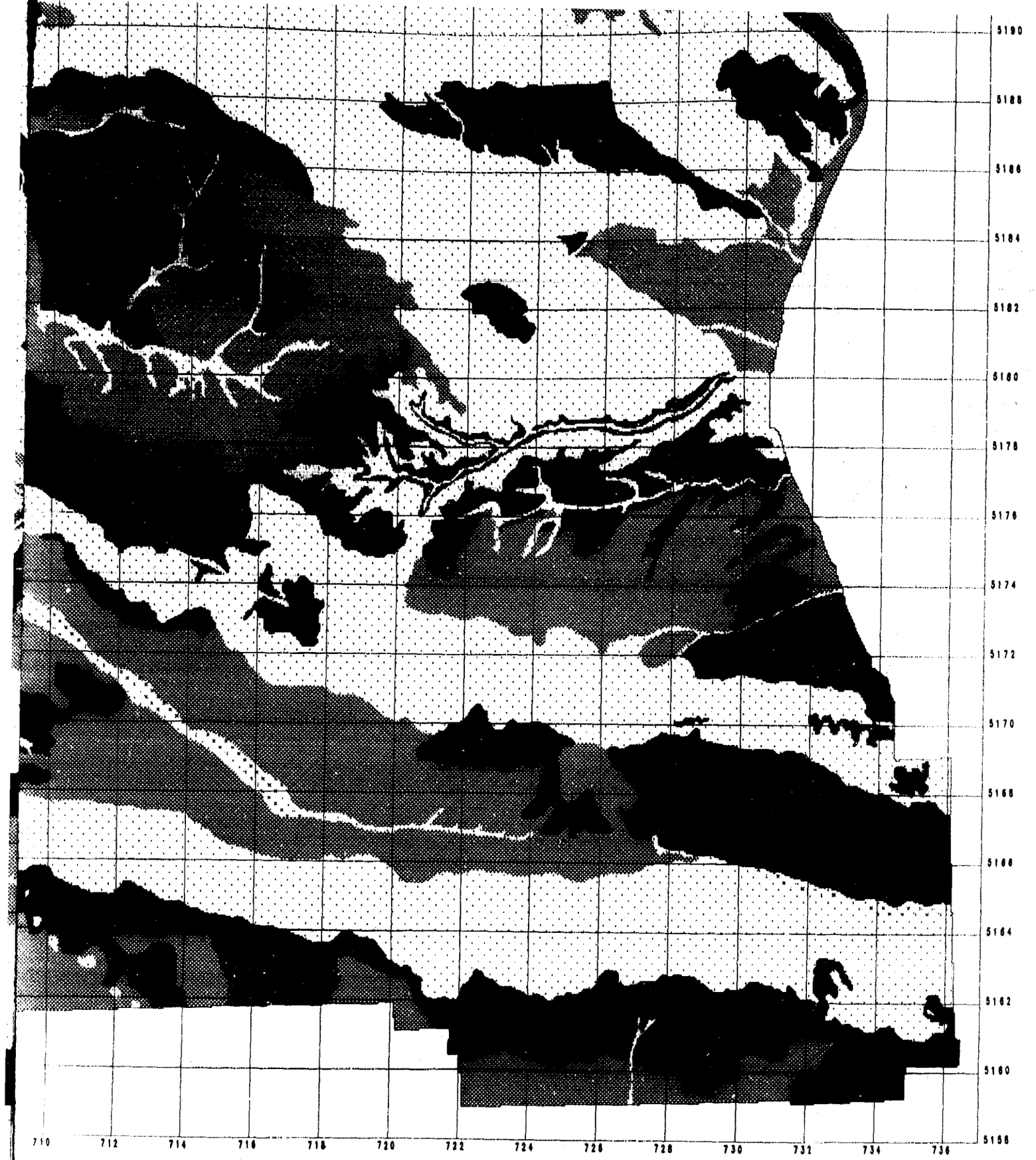
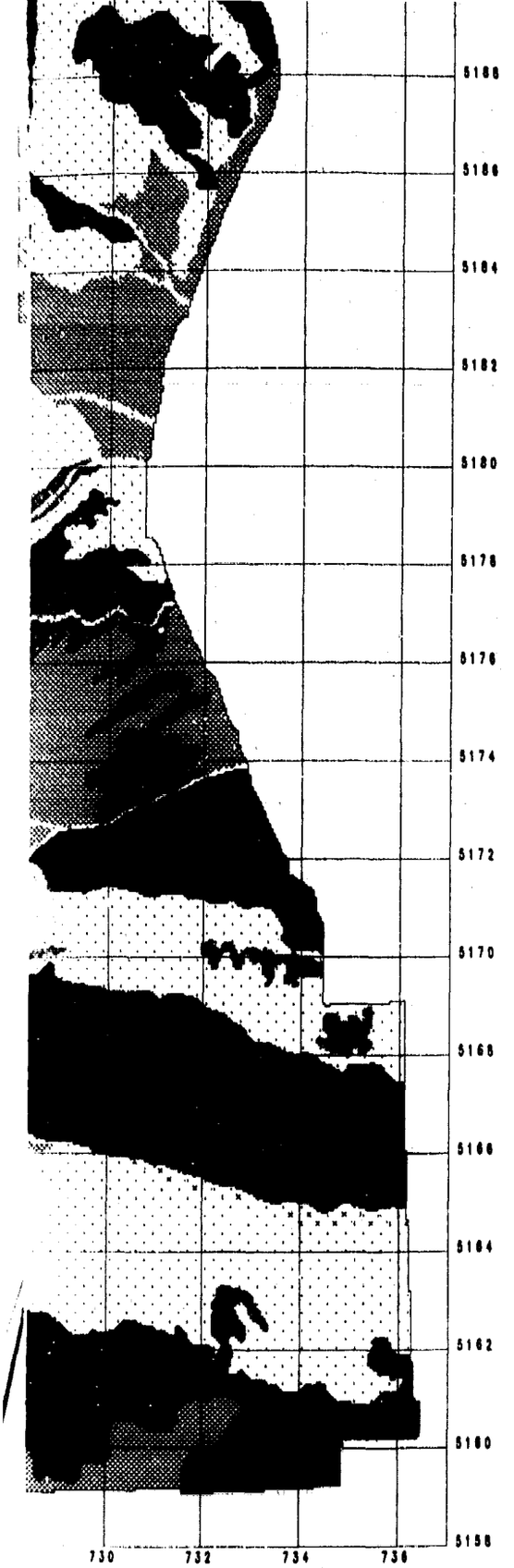


Plate 2. Spatial distribution of soil types for Yakima Firing Center study area



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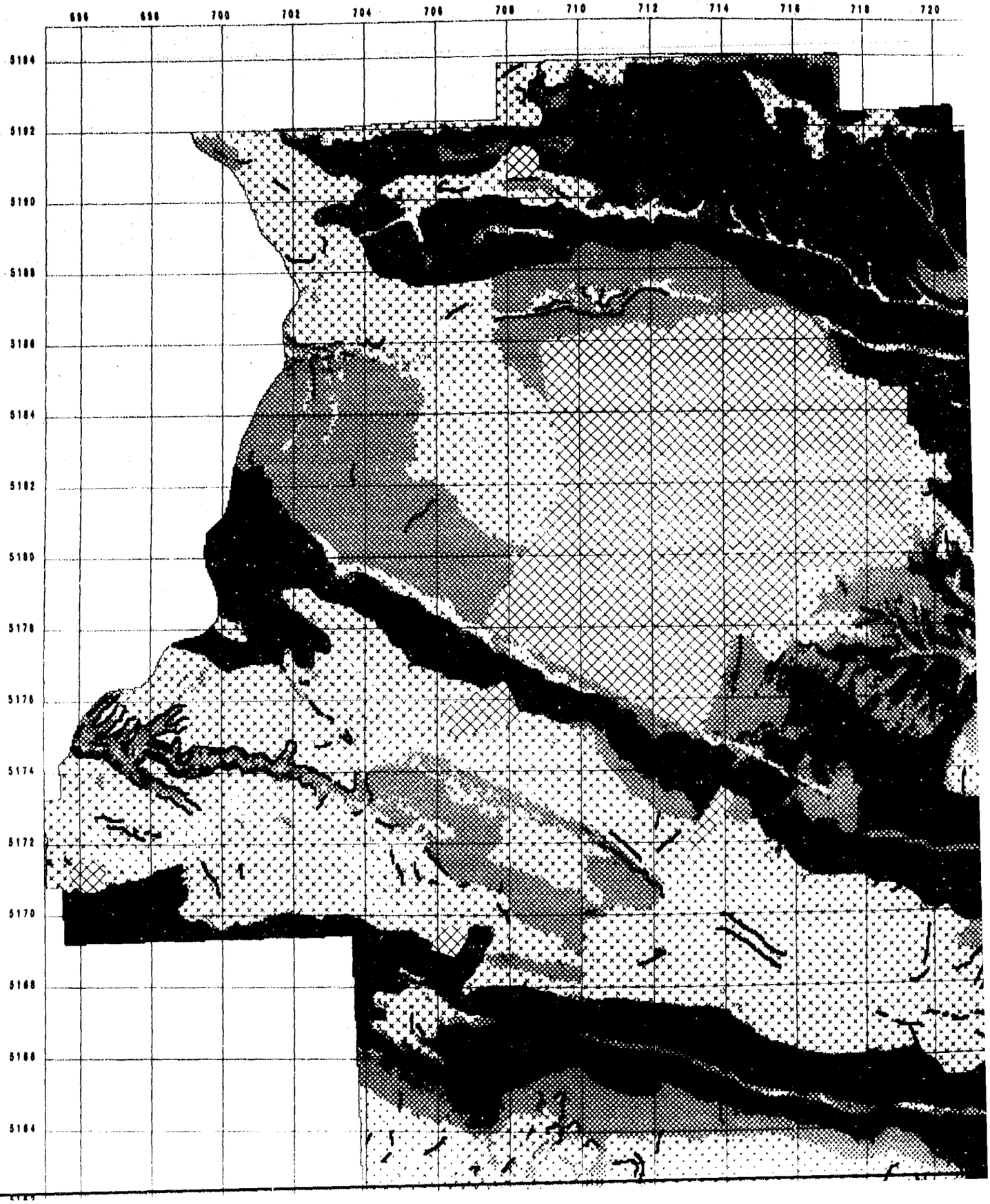
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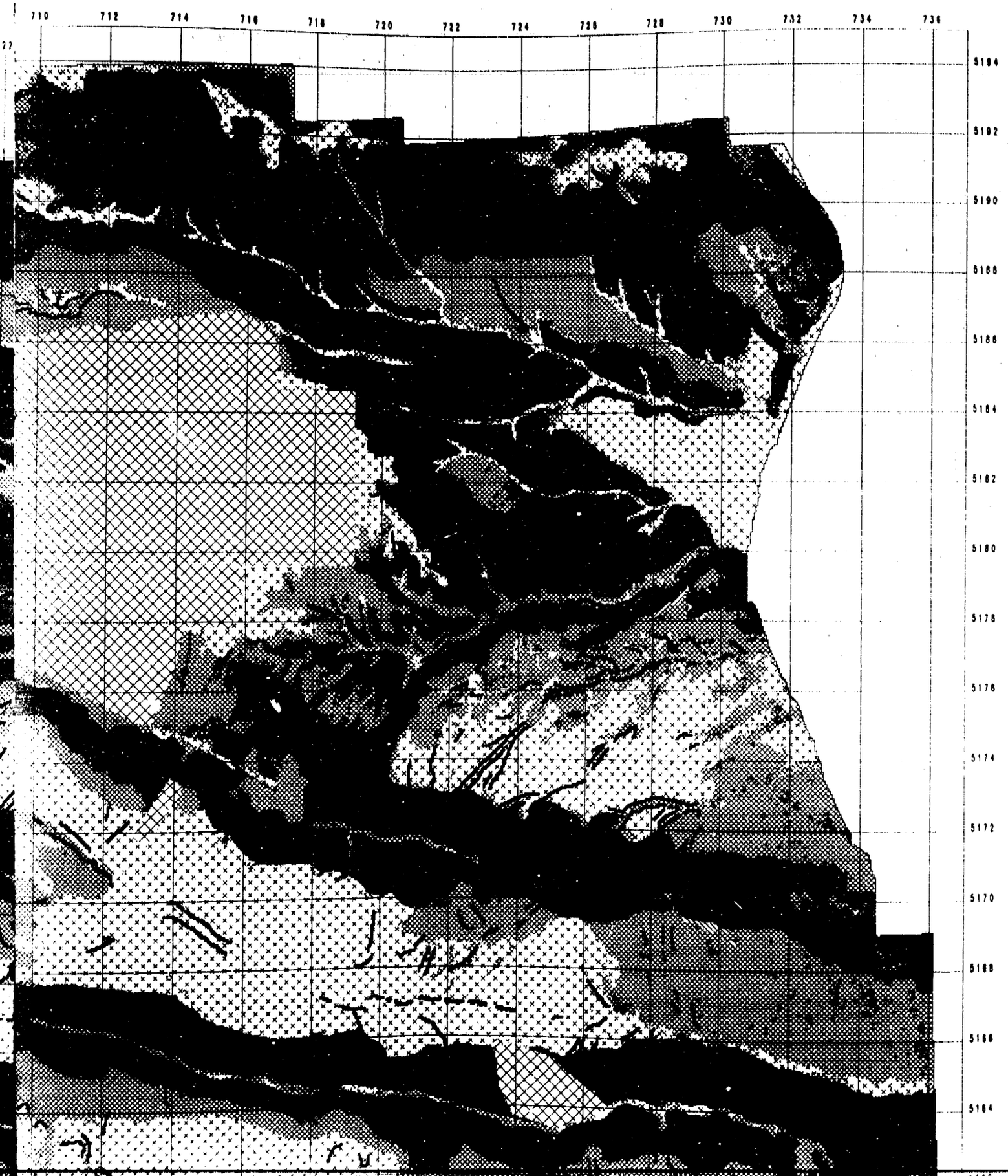
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U.S. Army Corps of Engineers
Waterways
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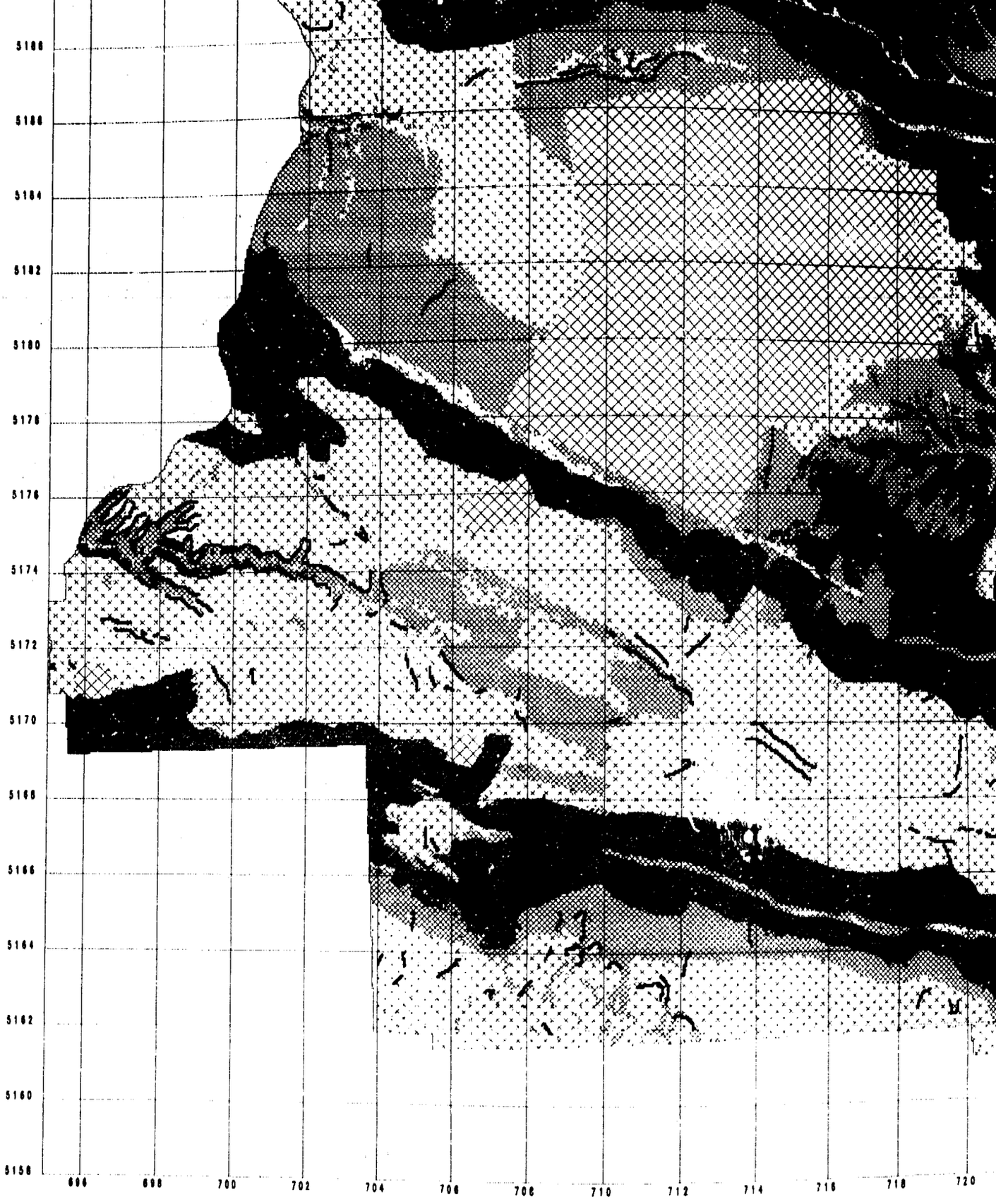


Plate 3. Speed map for M998 (HMM

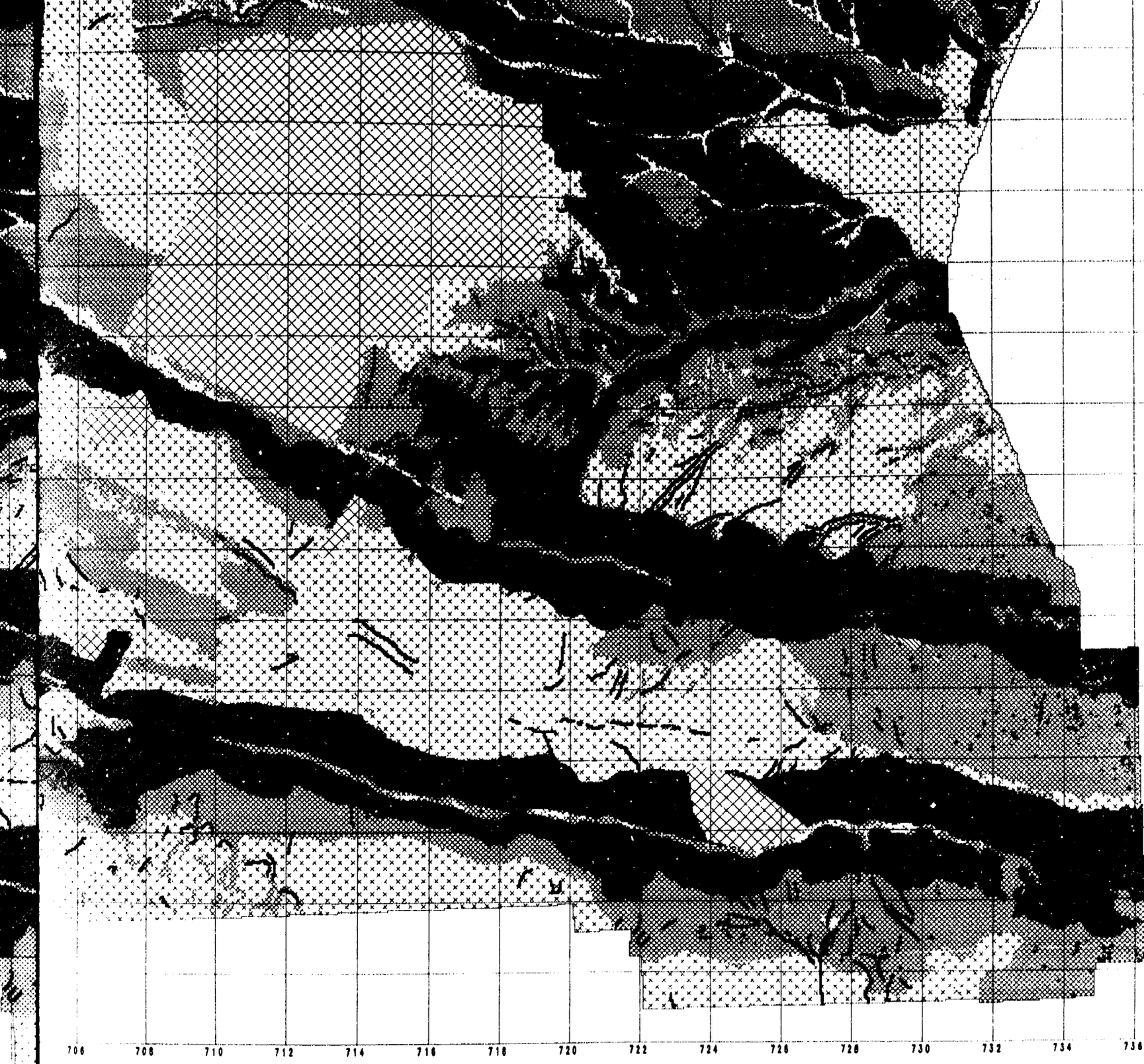
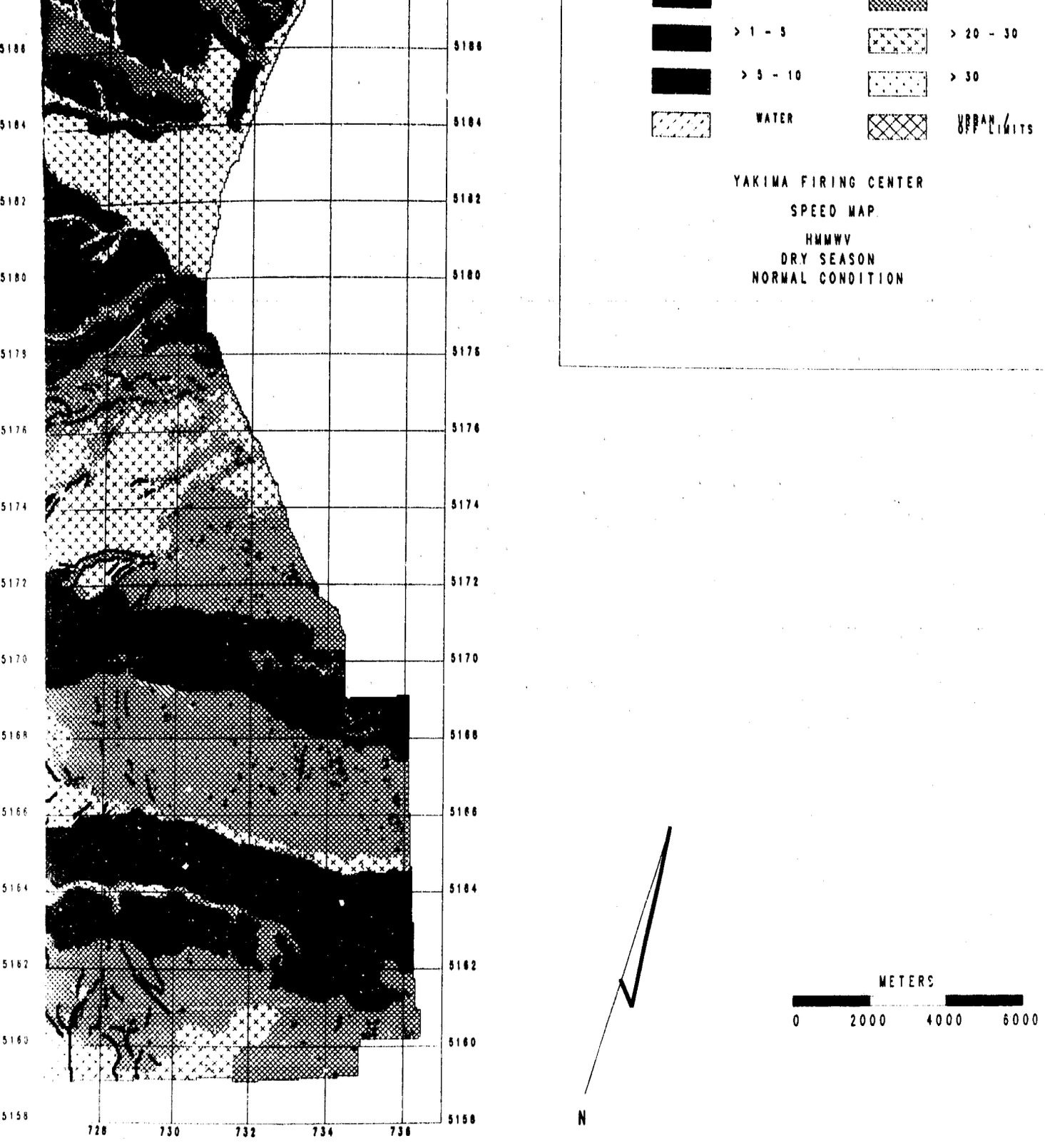
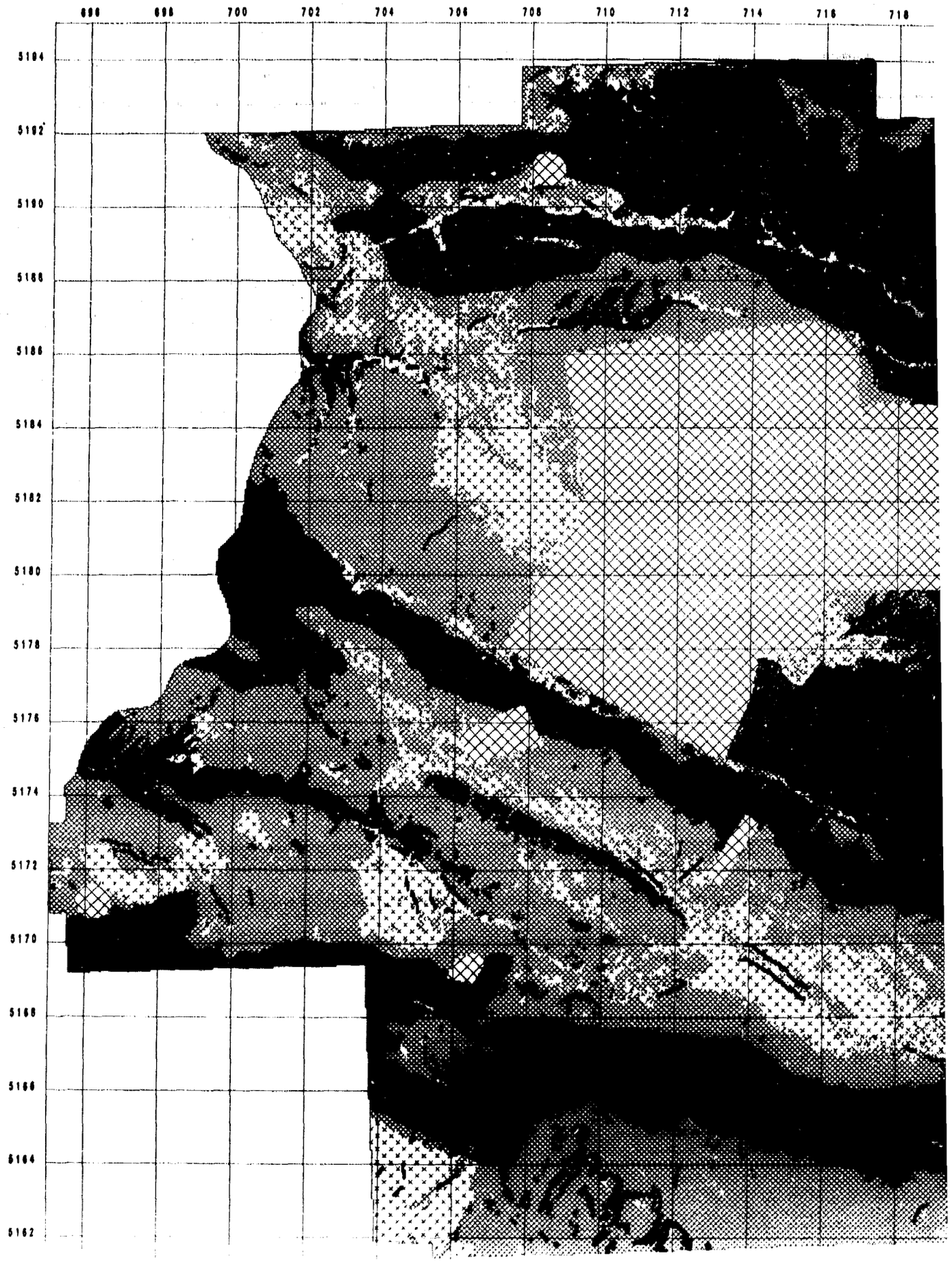
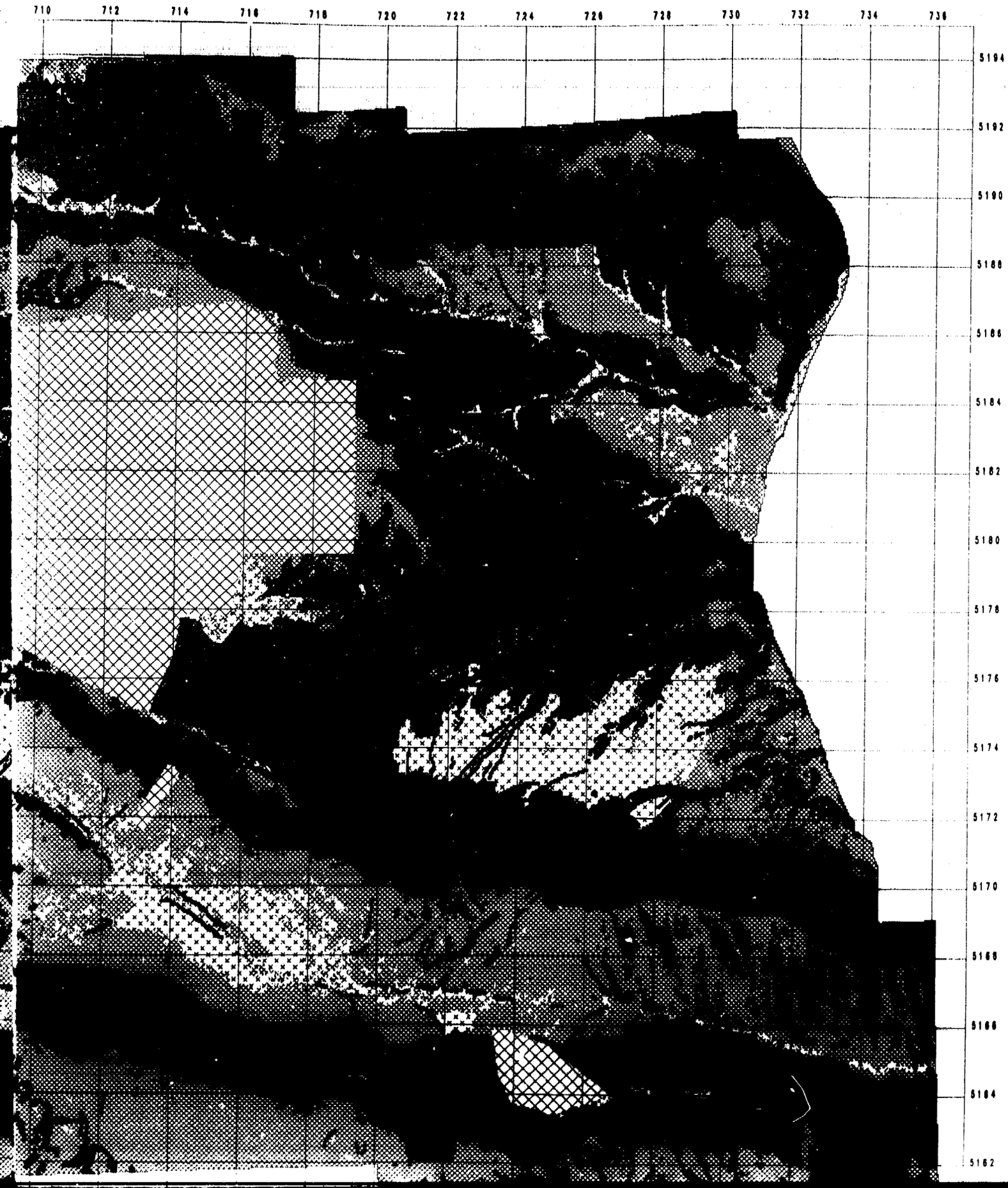


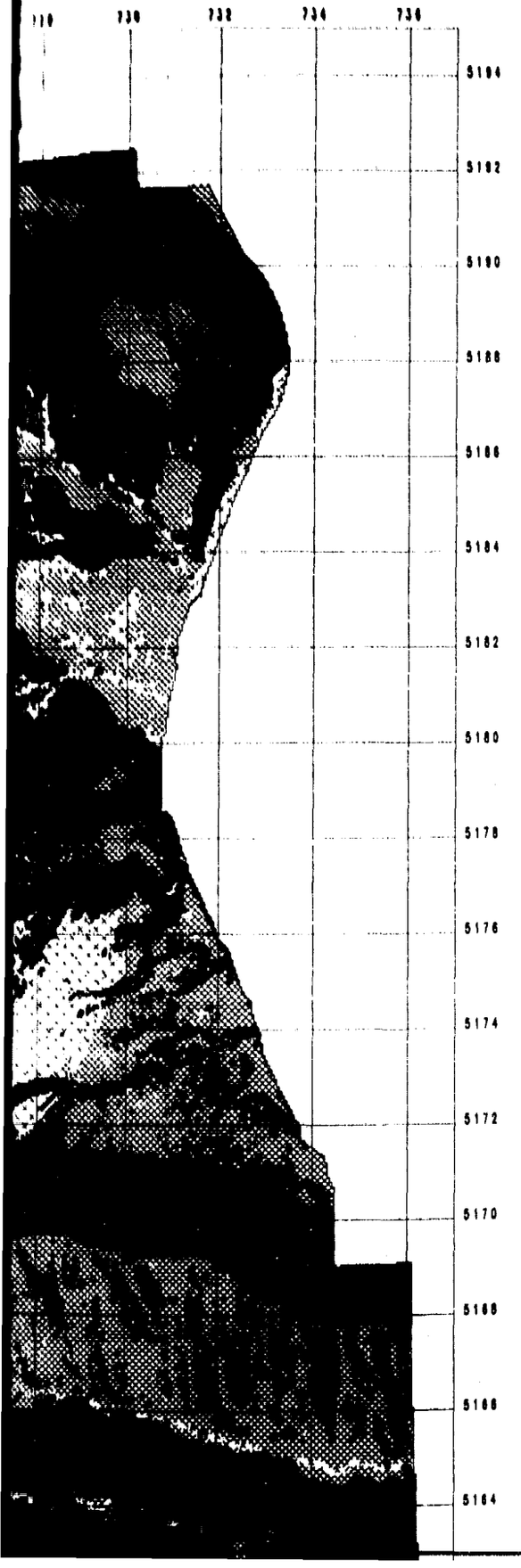
Plate 3. Speed map for M998 (HMMWV) wheeled vehicle in the dry normal surface condition



the dry normal surface condition


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U. S. Army Corps of Engineers
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SPEED (MPH)

SCALE 1:100000

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> 5 - 10	> 30
WATER	URBAN / OFF LIMITS

YAKIMA FIRING CENTER

SPEED MAP

HMMWV
WET-WET SEASON
SLIPPERY CONDITION

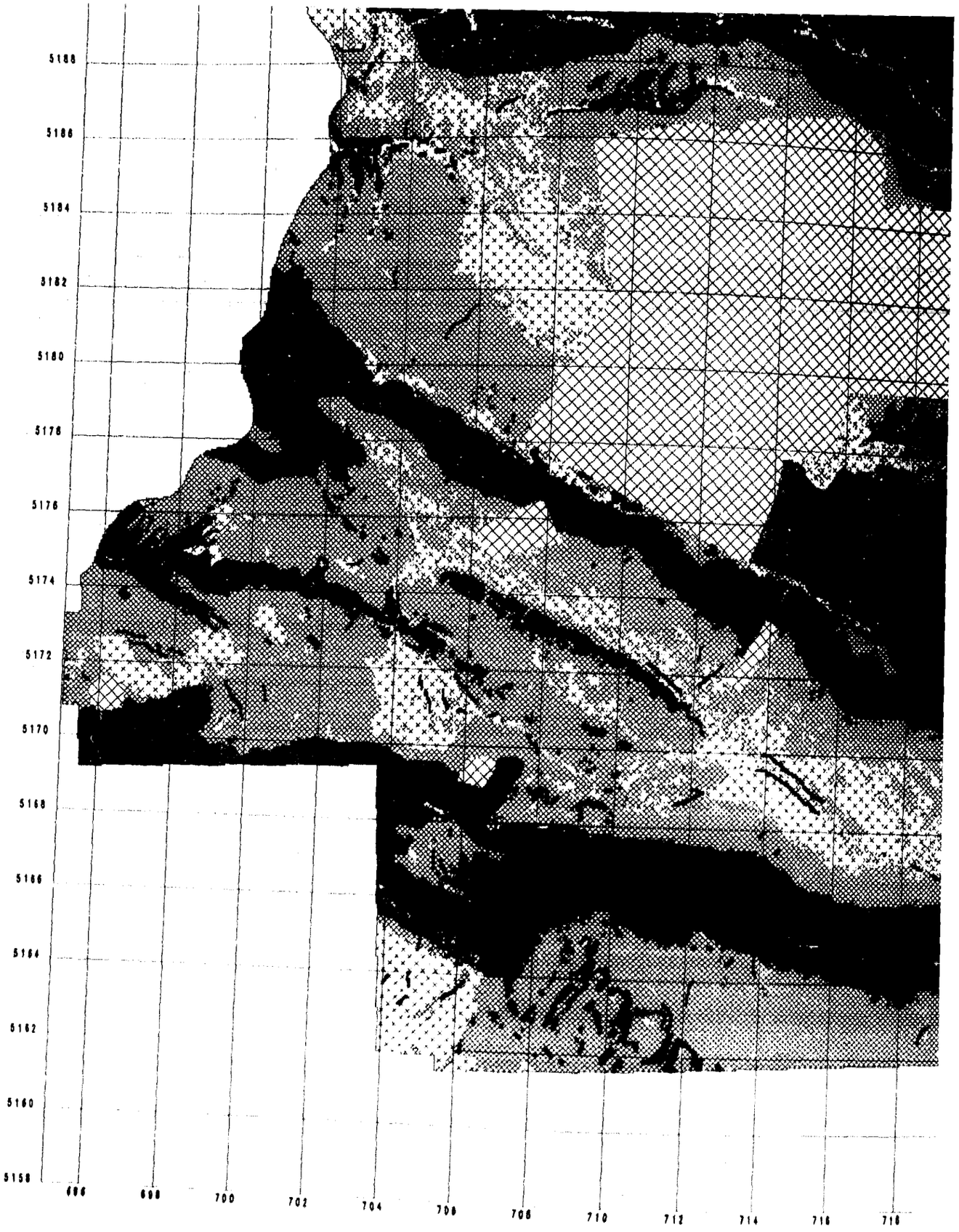


Plate 4. Speed map for M998

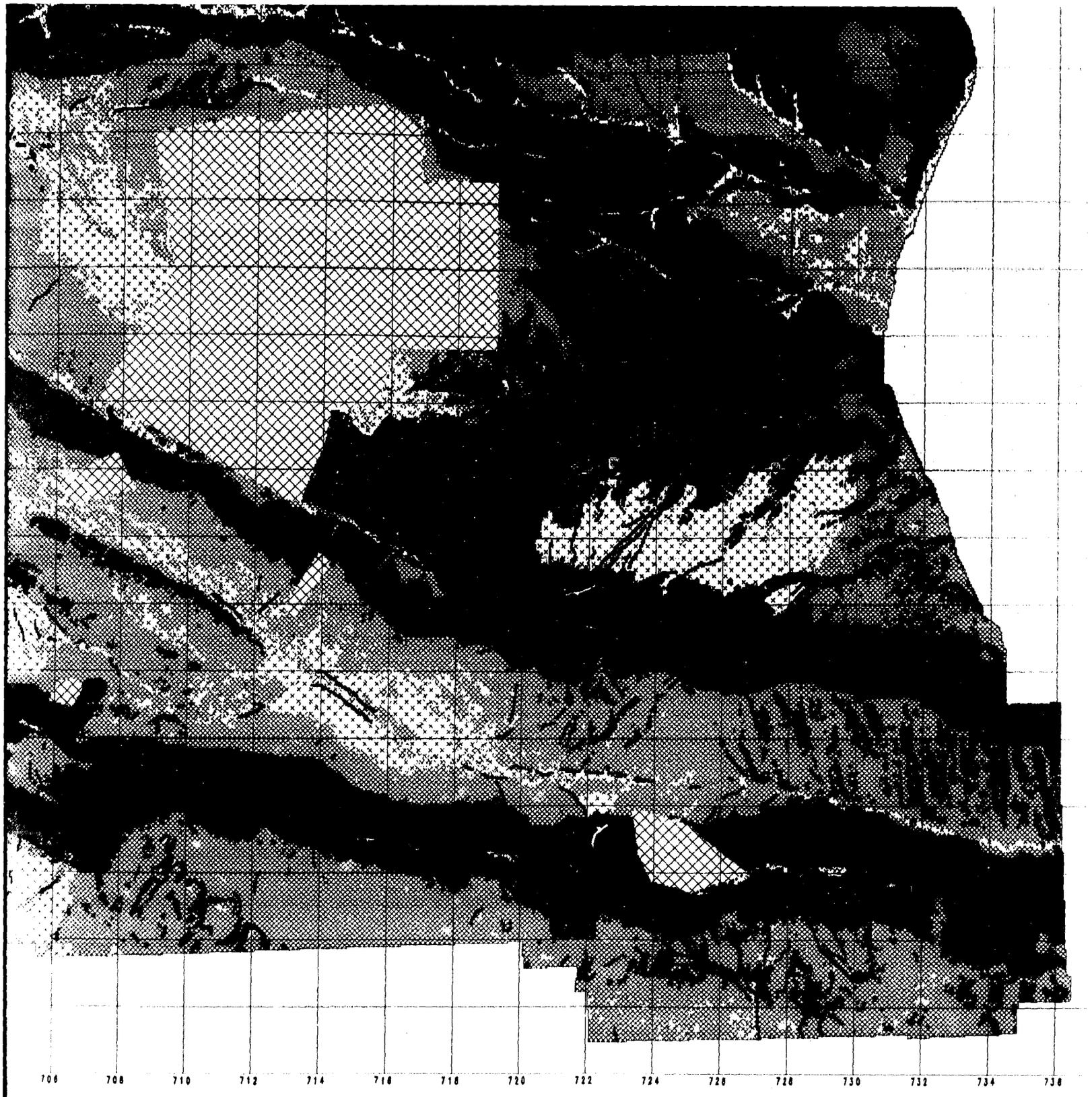
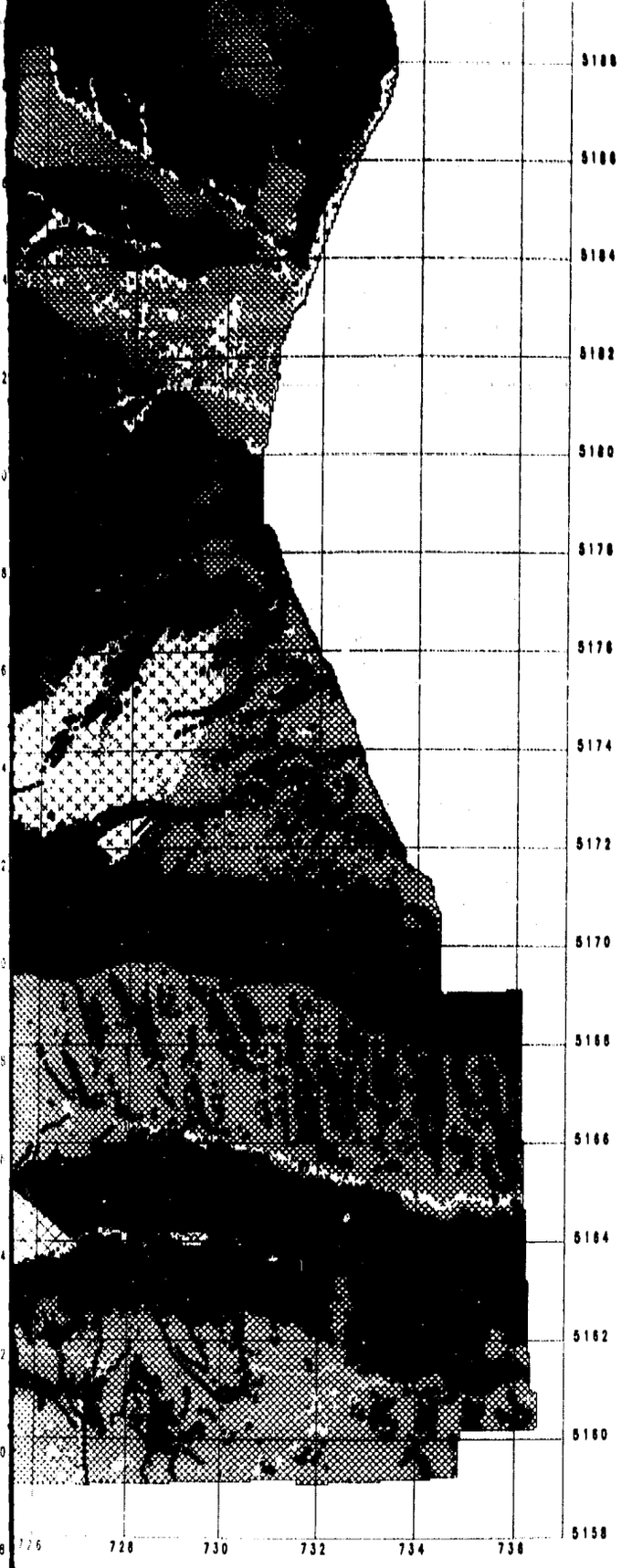


Plate 4. Speed map for M998 (HMMWV) wheeled vehicle in the wet-wet slippery surface condition



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YAKIMA FIRING CENTER

SPEED MAP

HMMWV

WET-WET SEASON

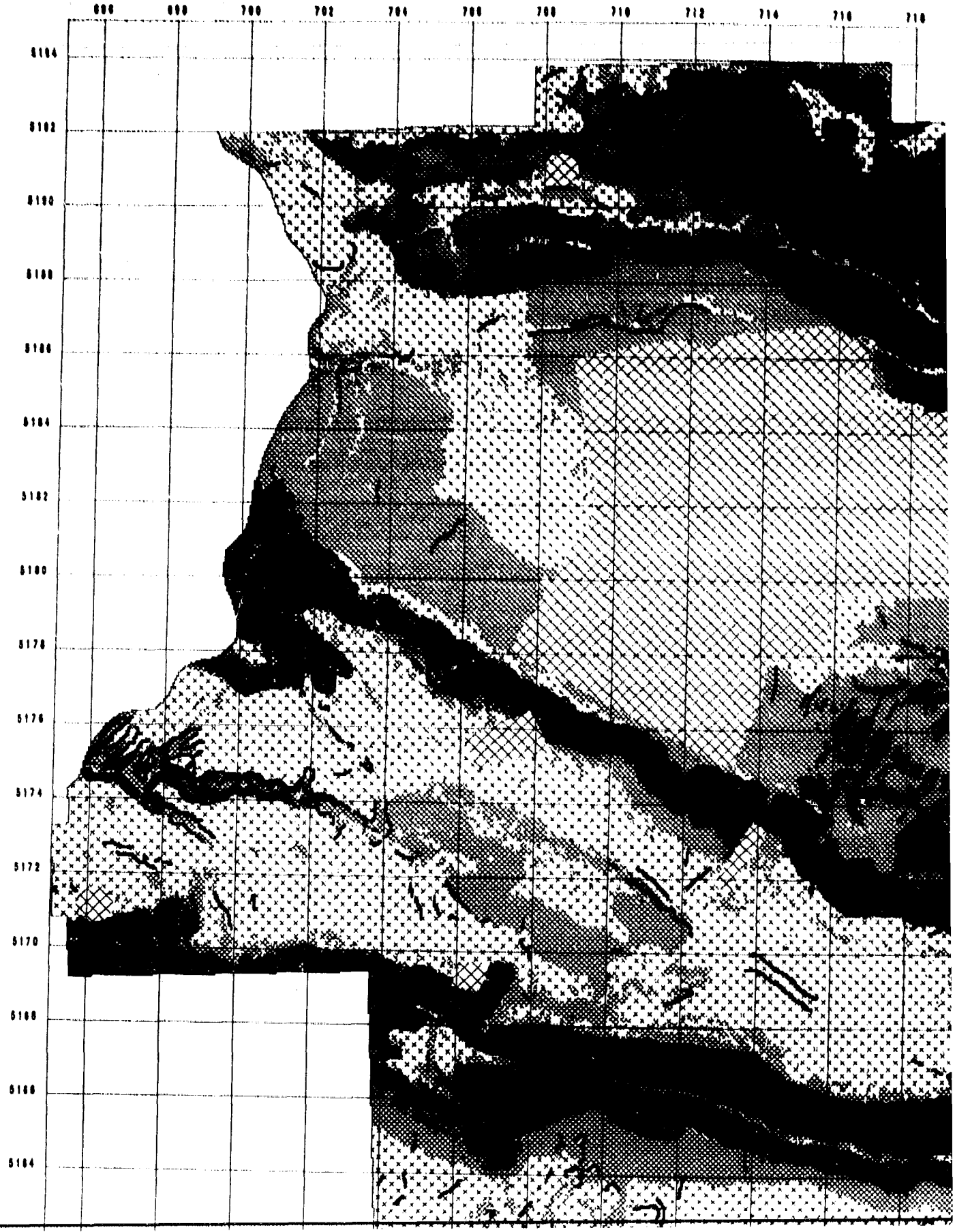
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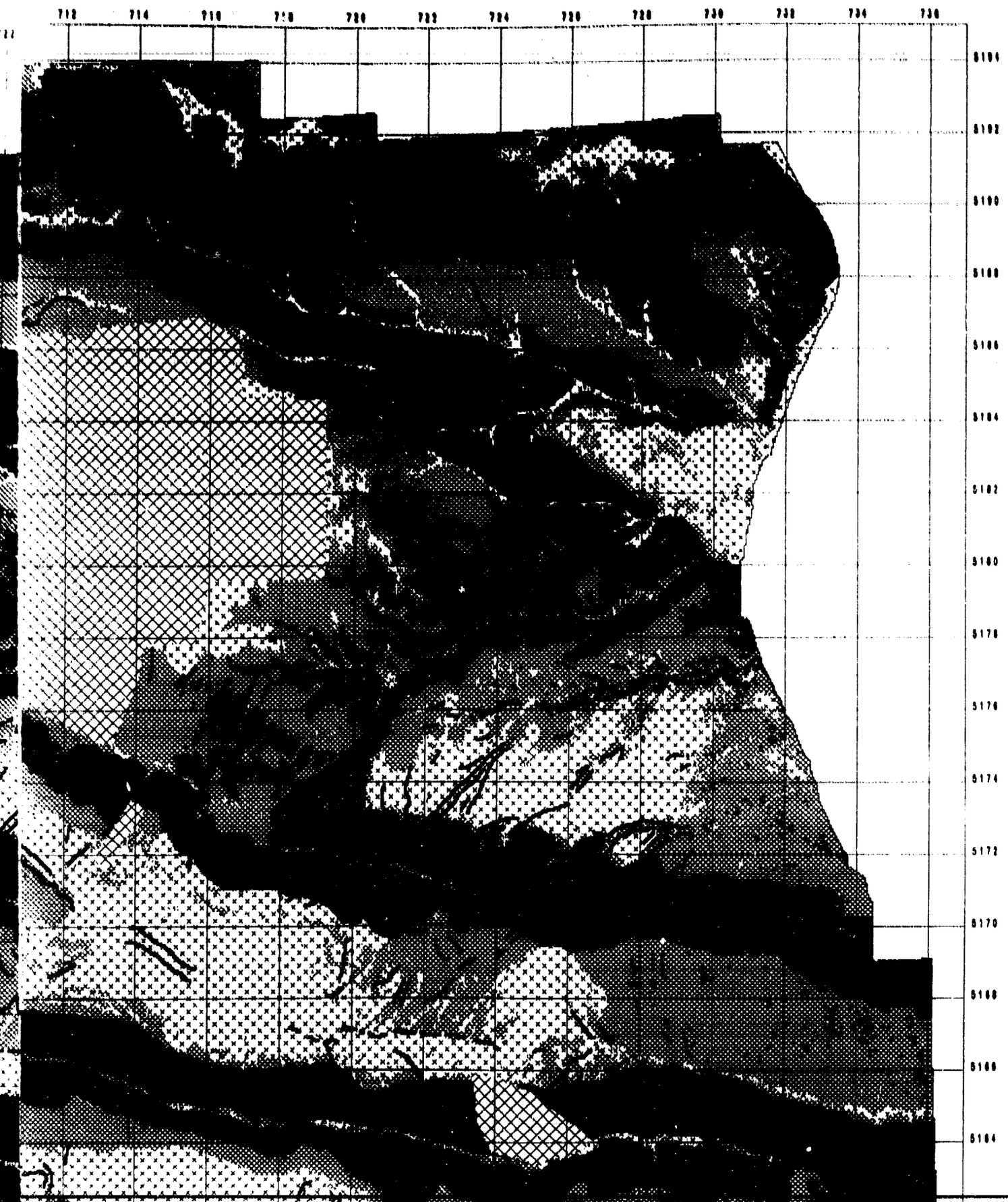
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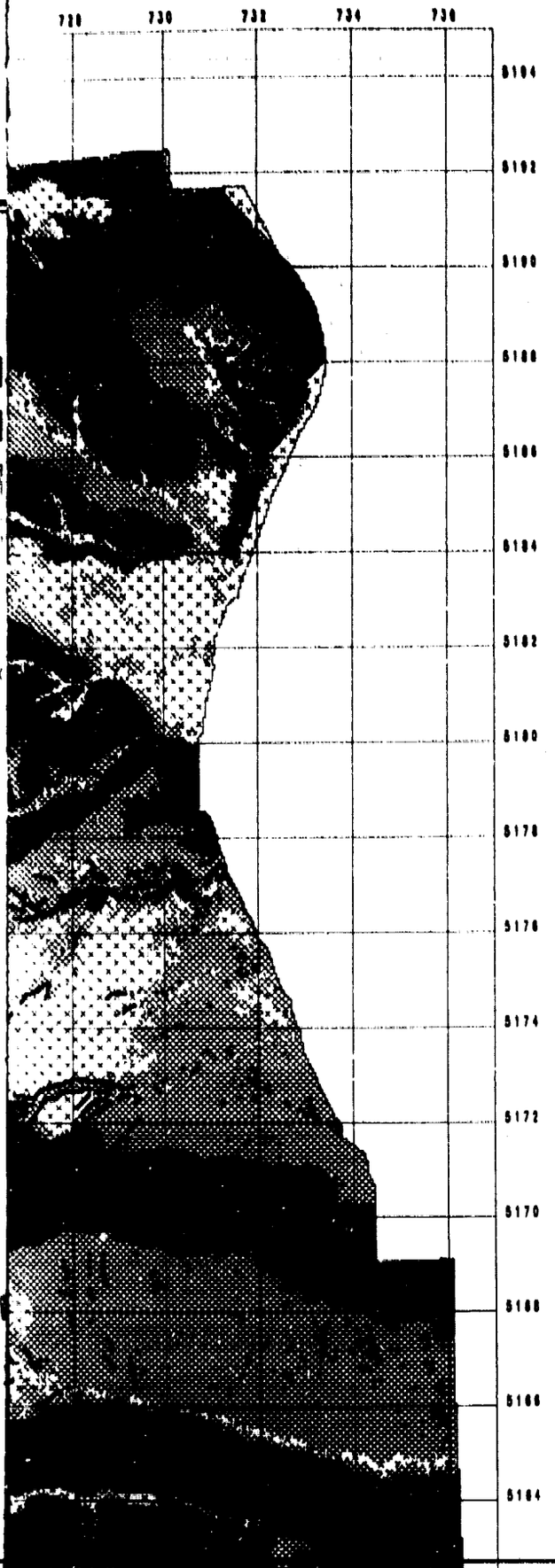
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Station

SPEED (MPH)

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YAKIMA FIRING CENTER

SPEED MAP

8X8 WHEELED COMBAT VEHICLE
DRY SEASON
NORMAL CONDITION

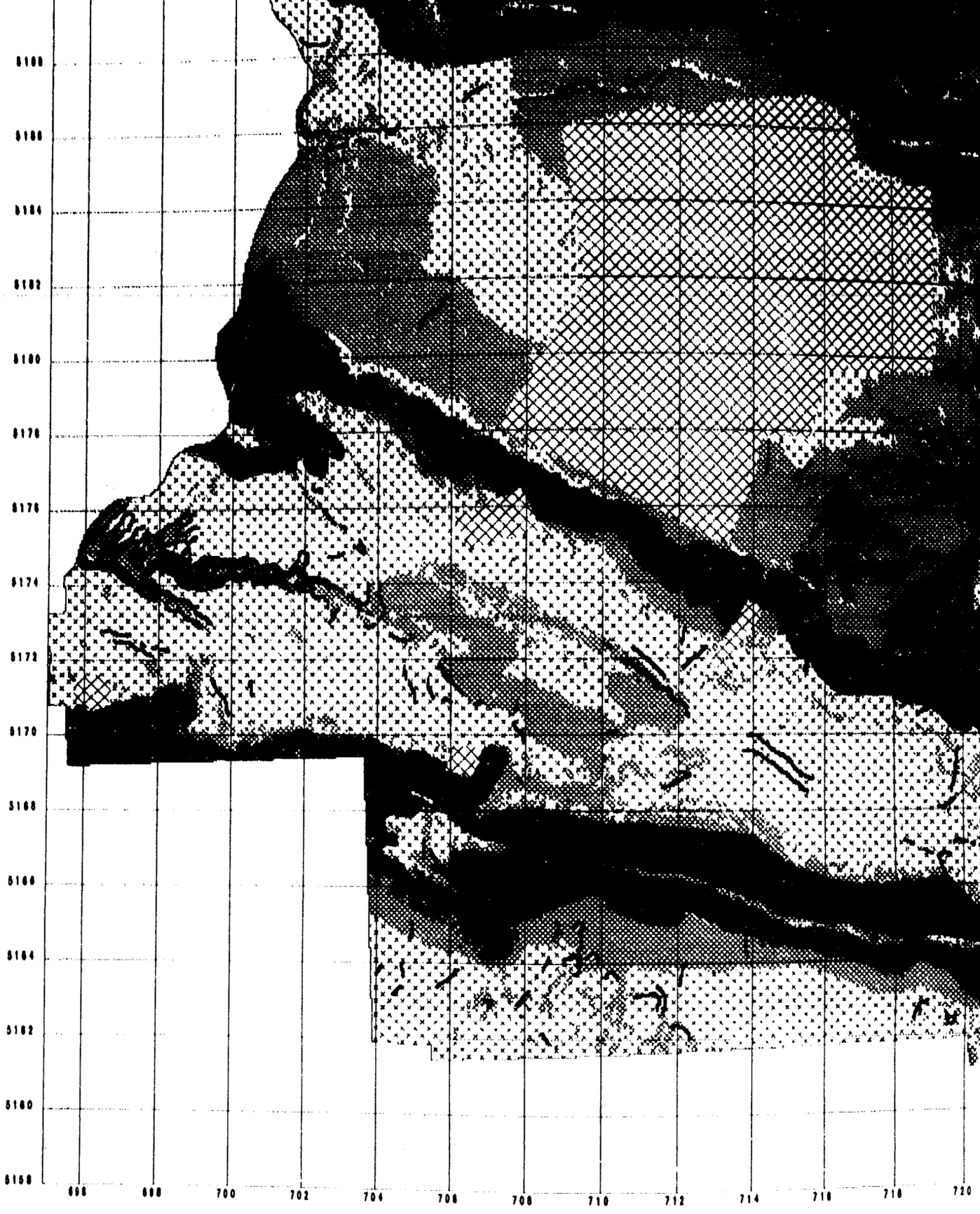


Plate 5. Speed map for 8X8

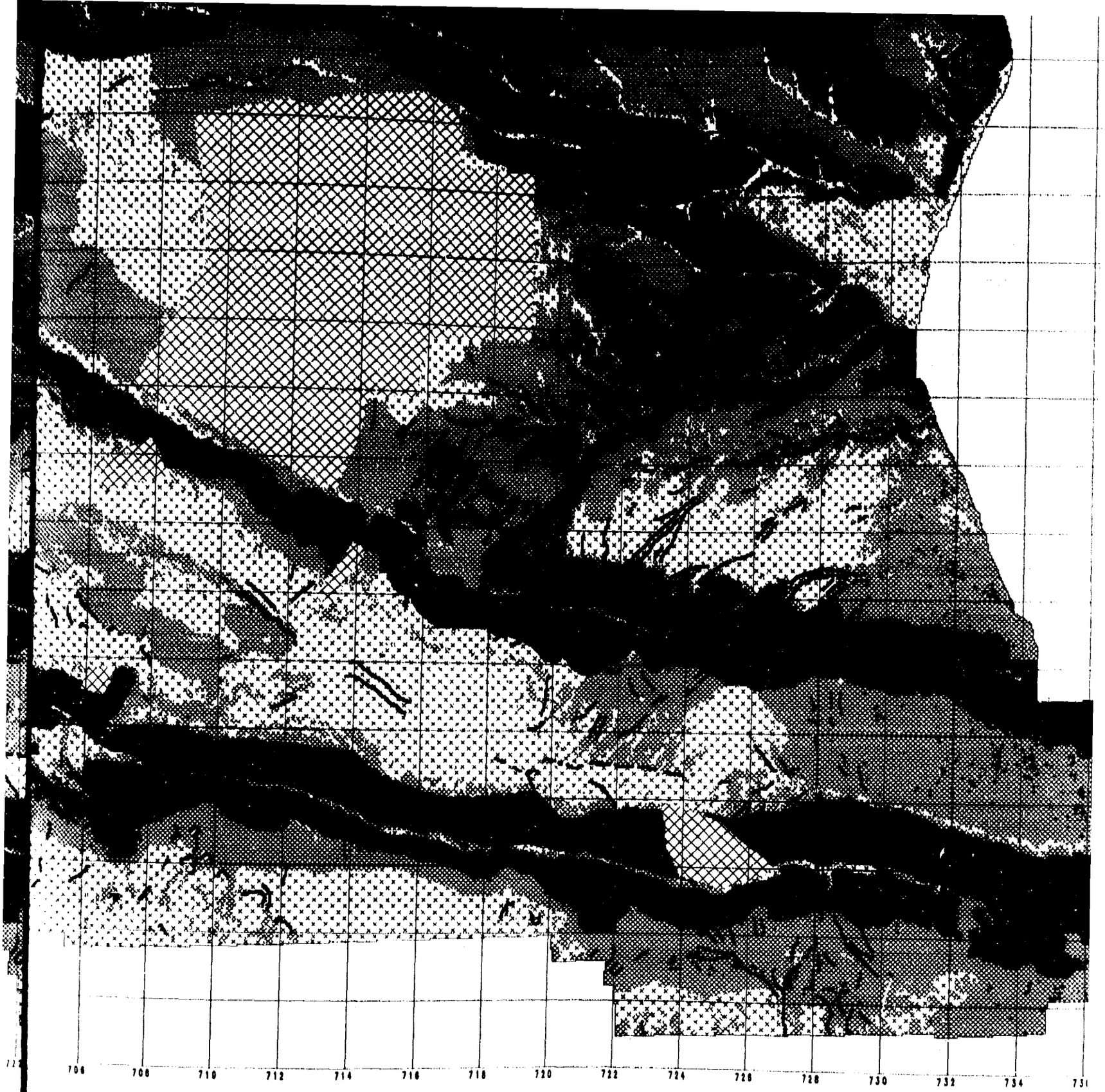
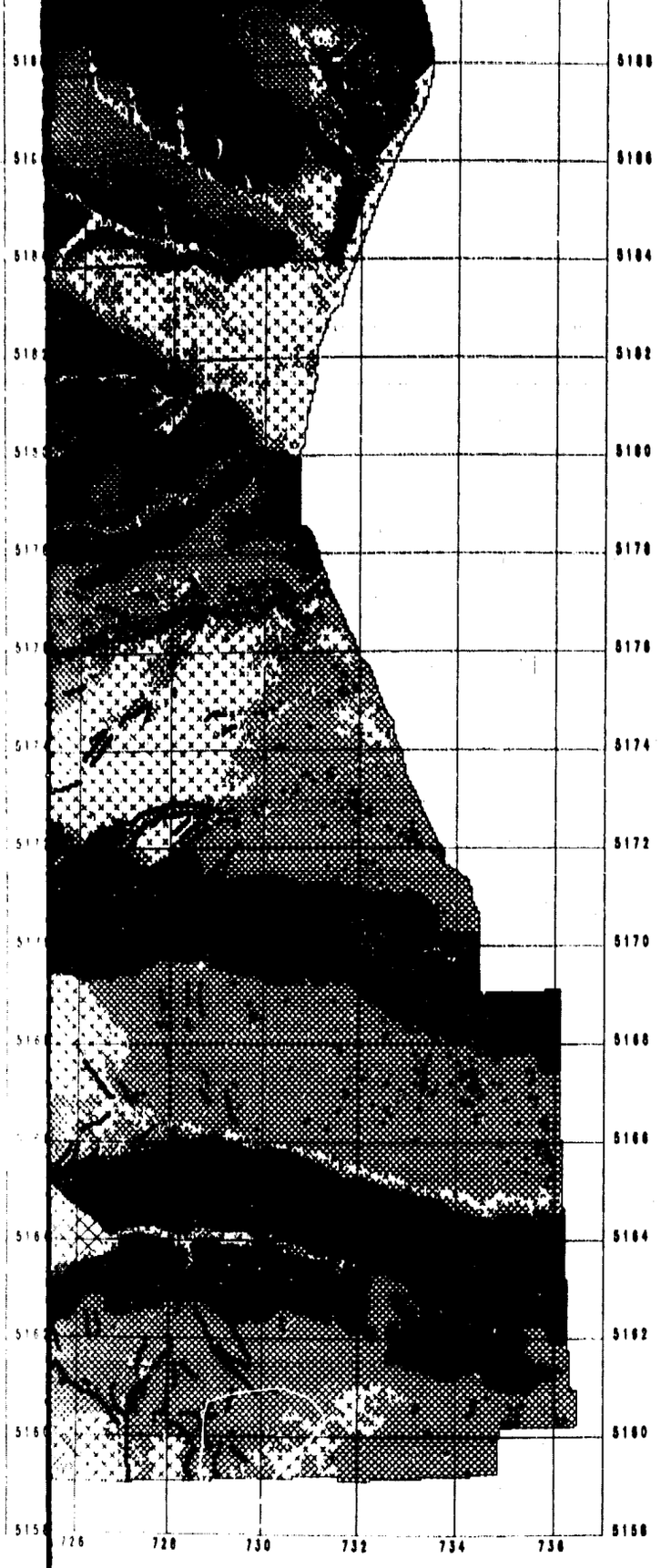


Plate 5. Speed map for 8X8 wheeled combat vehicle in the dry normal surface condition



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WATER	URBAN OFF LIMITS

YAKIMA FIRING CENTER

SPEED MAP

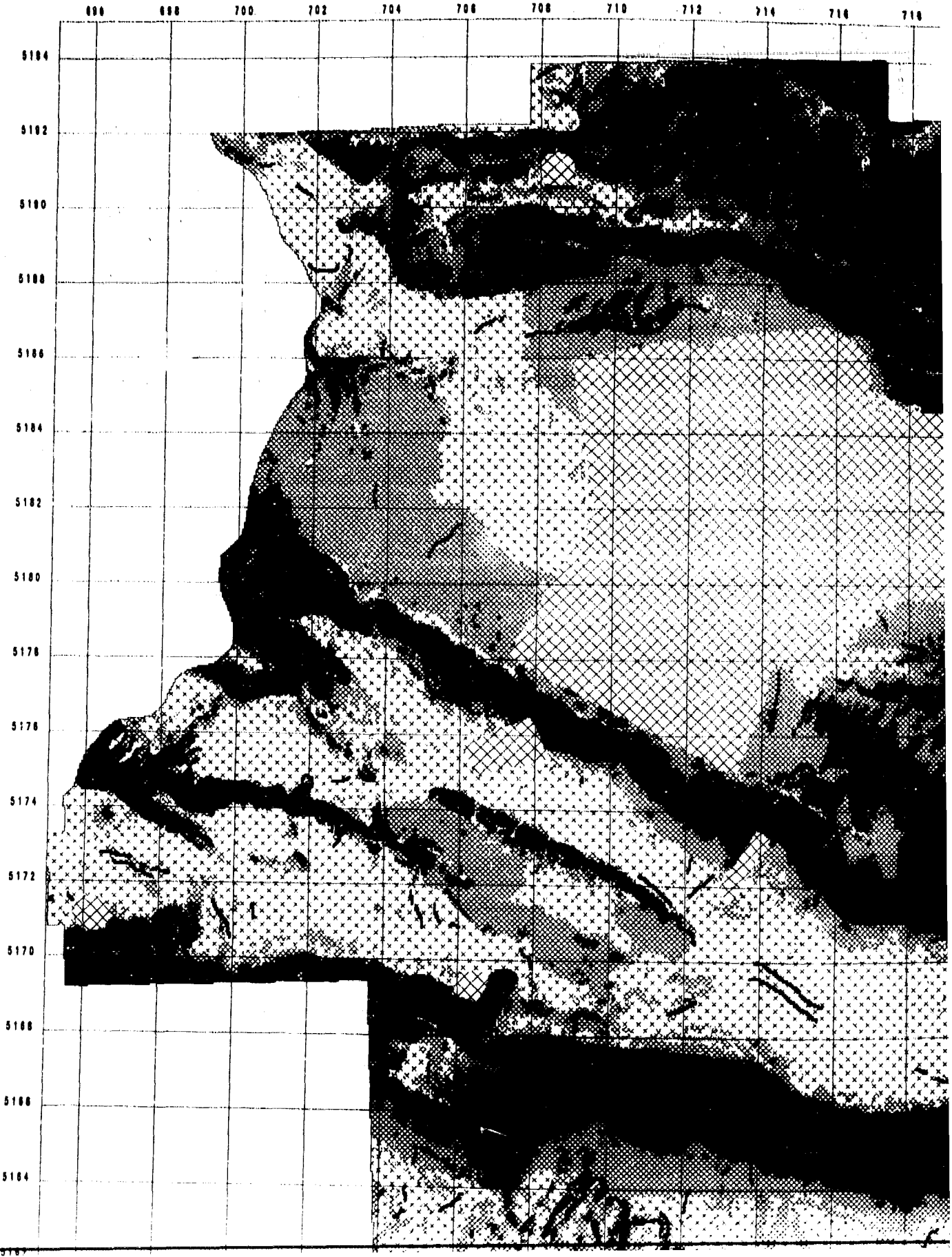
8X8 WHEELED COMBAT VEHICLE
DRY SEASON
NORMAL CONDITION

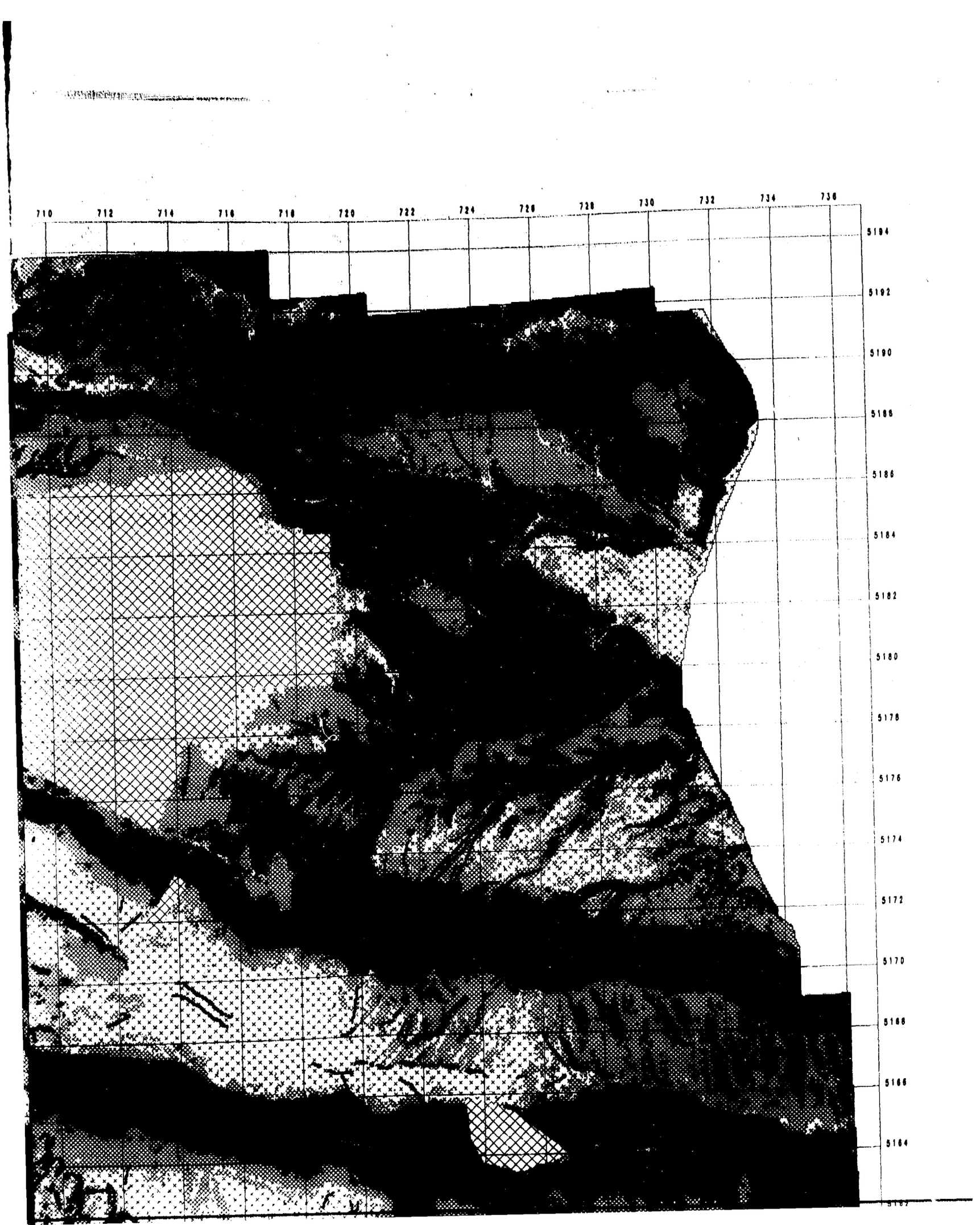
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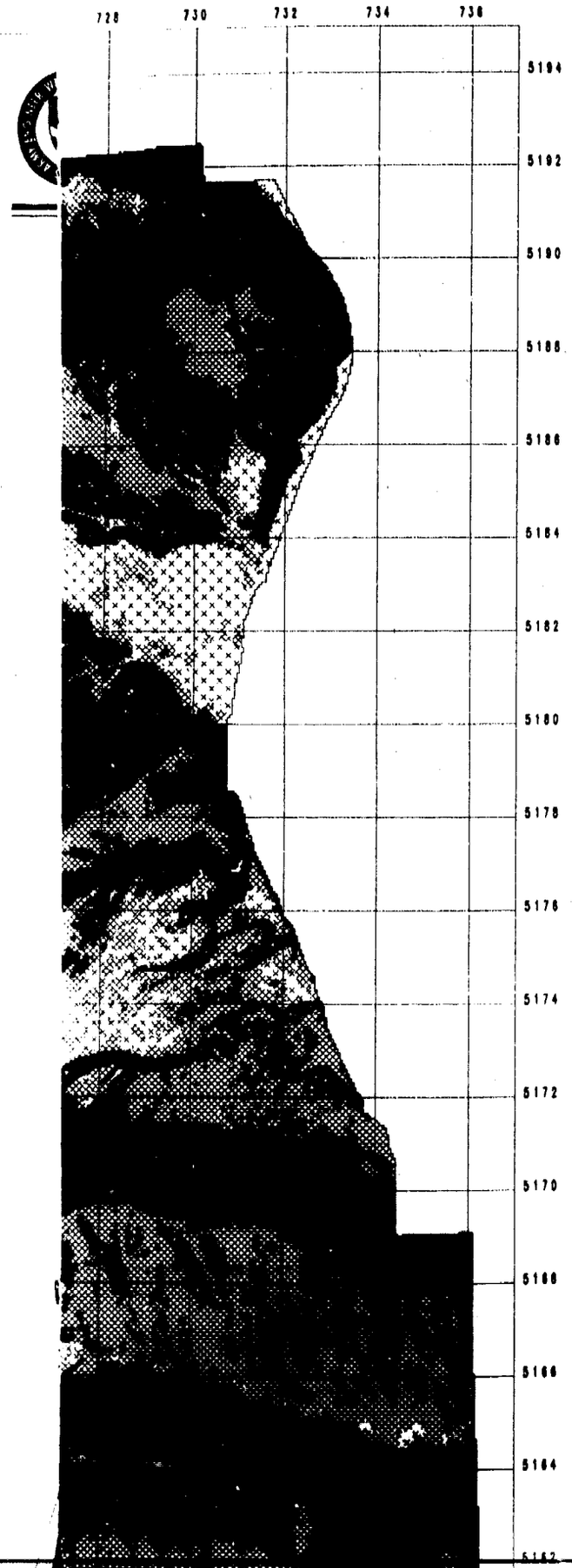
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SPEED (MPH)

SCALE 1:100000

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> 5 - 10	> 30
WATER	URBAN / OFF LIMITS

YAKIMA FIRING CENTER

SPEED MAP

8X8 WHEELED COMBAT VEHICLE
WET-WET SEASON
SLIPPERY CONDITION

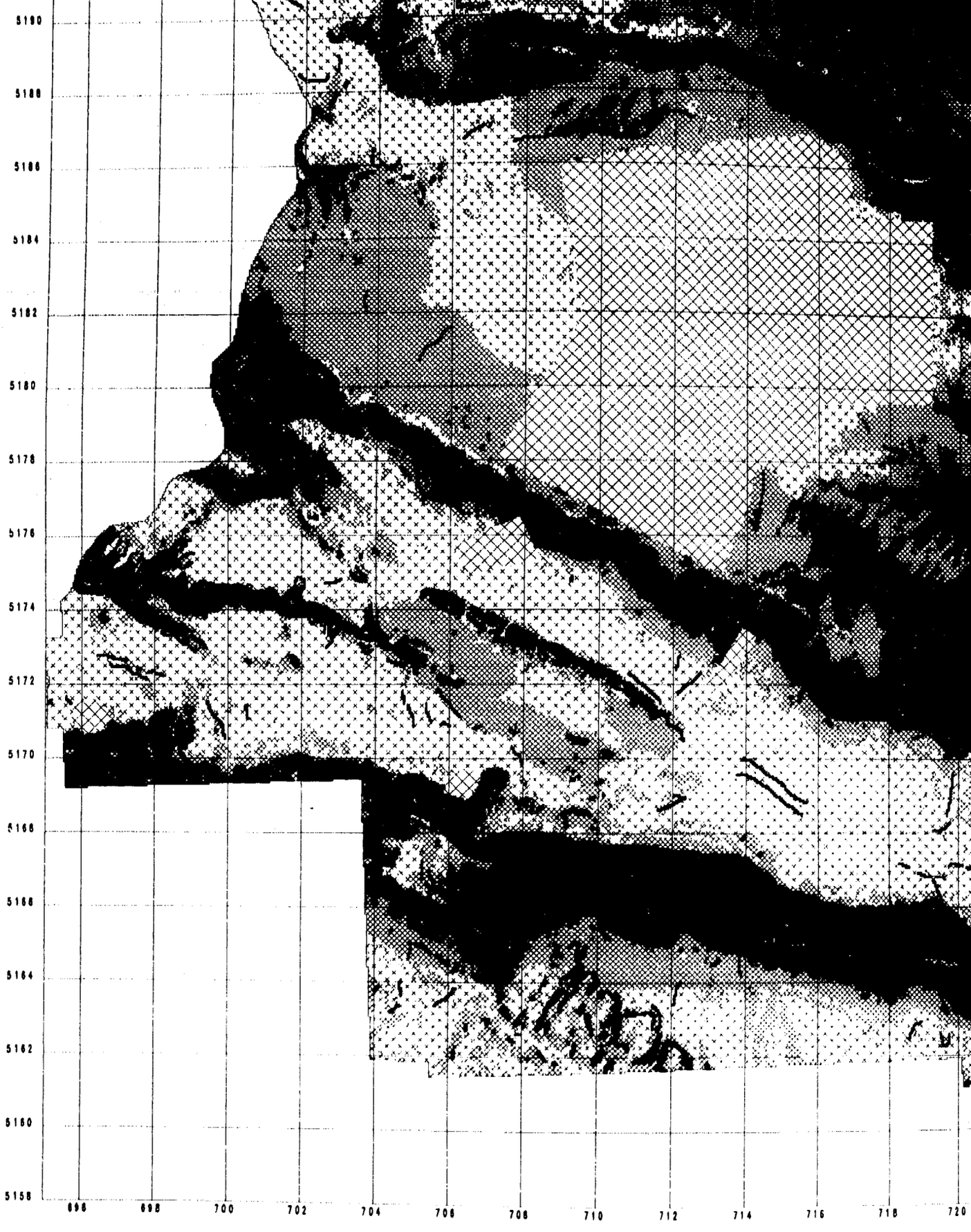


Plate 6. Speed map for 8X8 whee

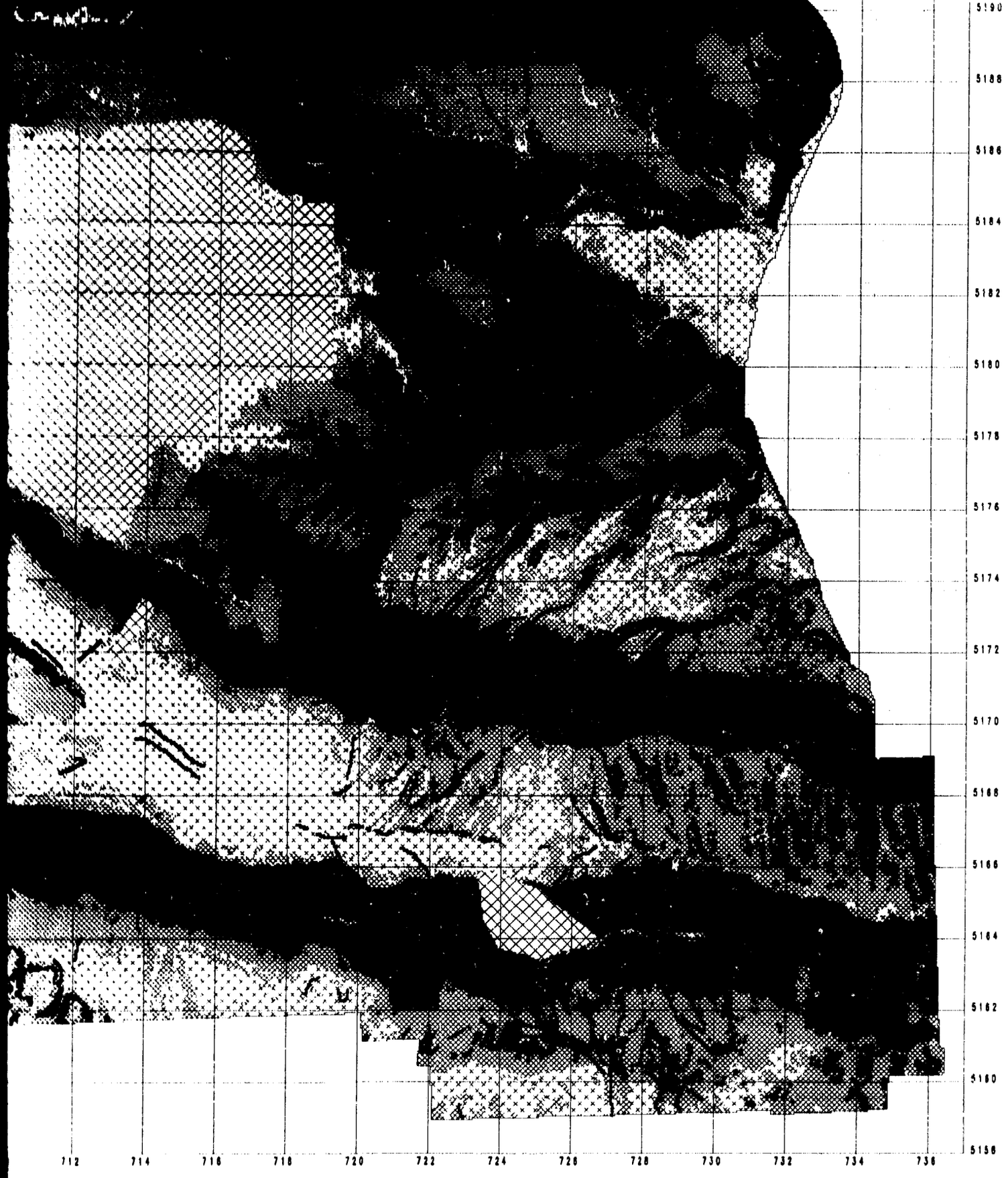
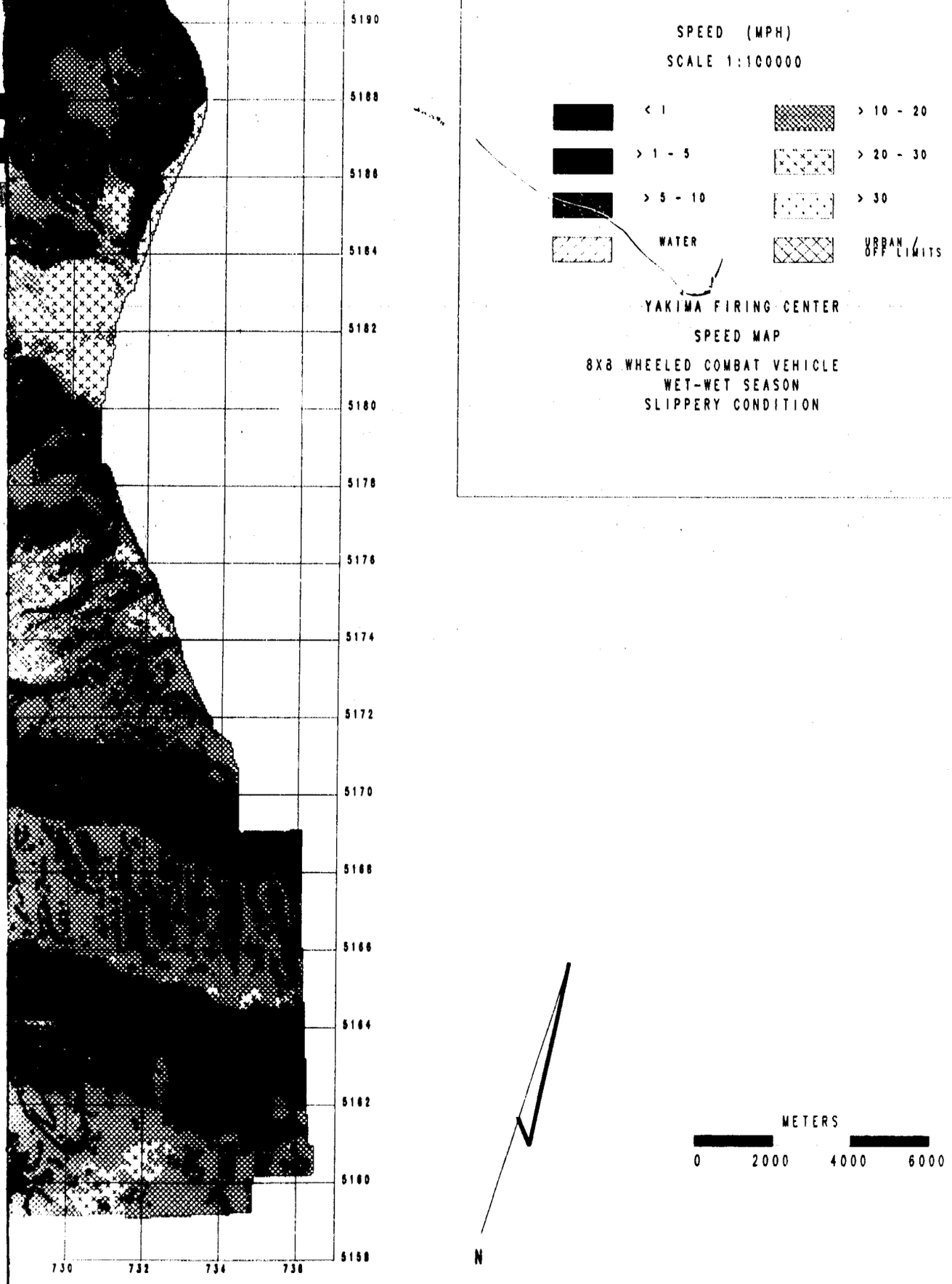
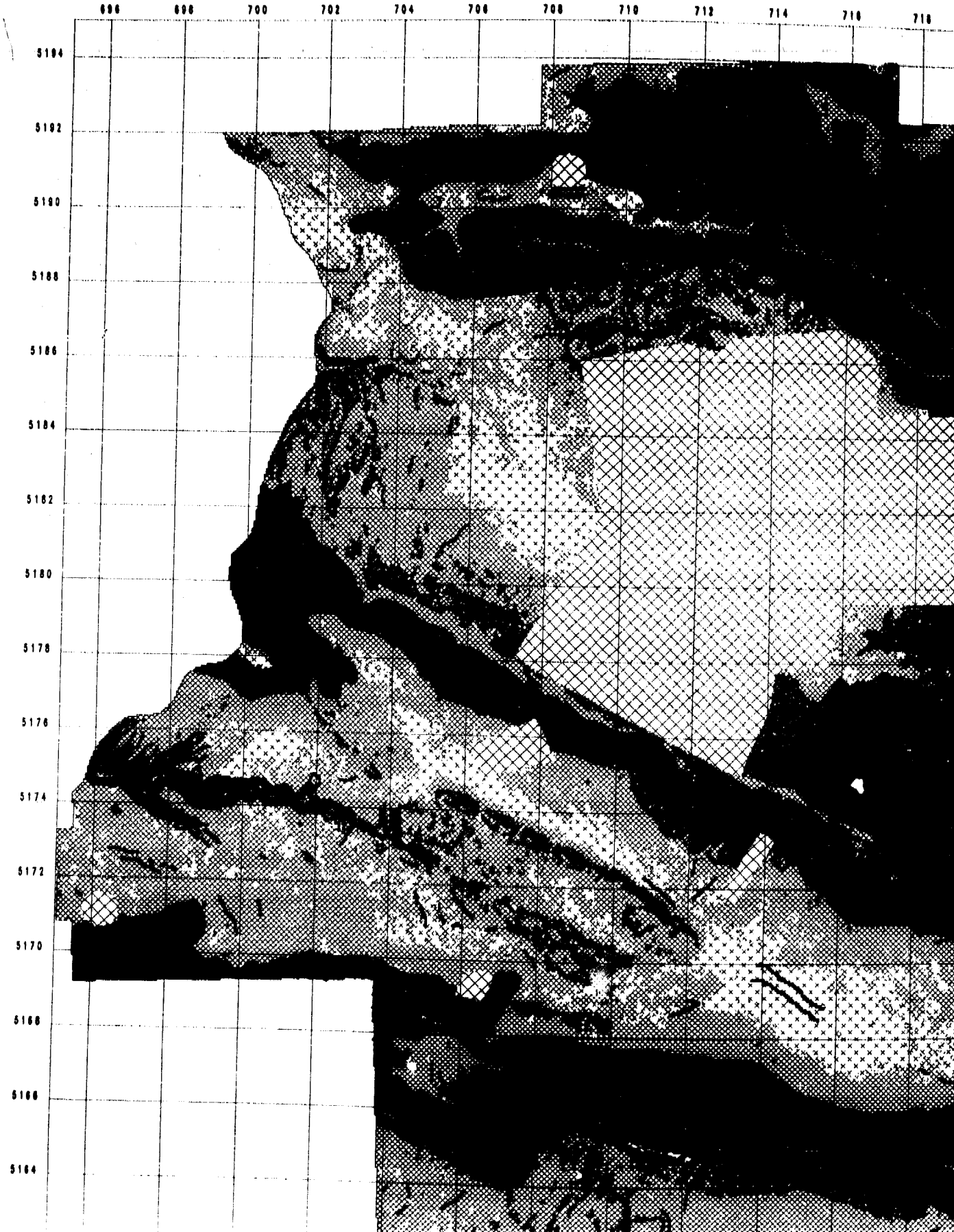
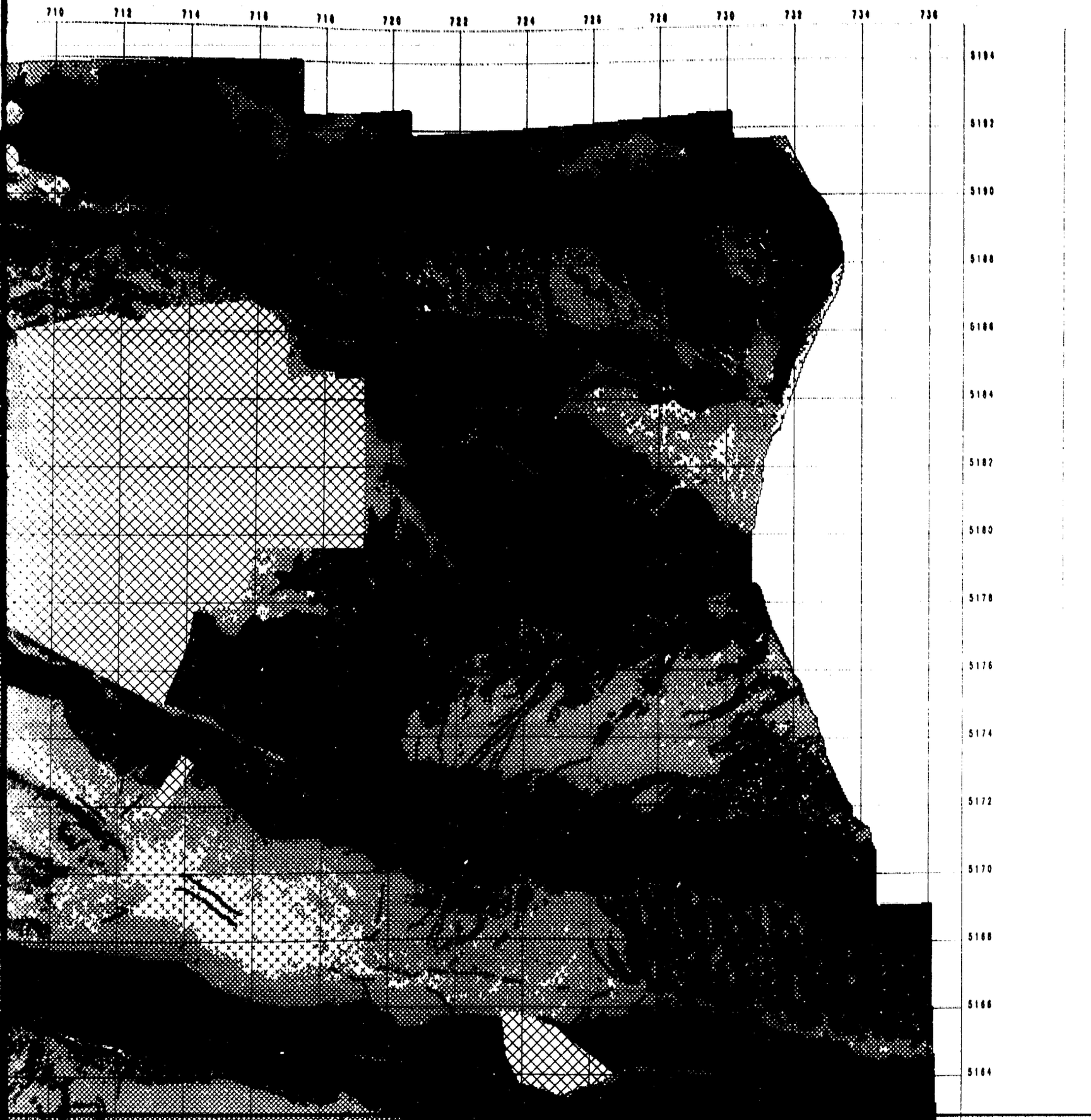


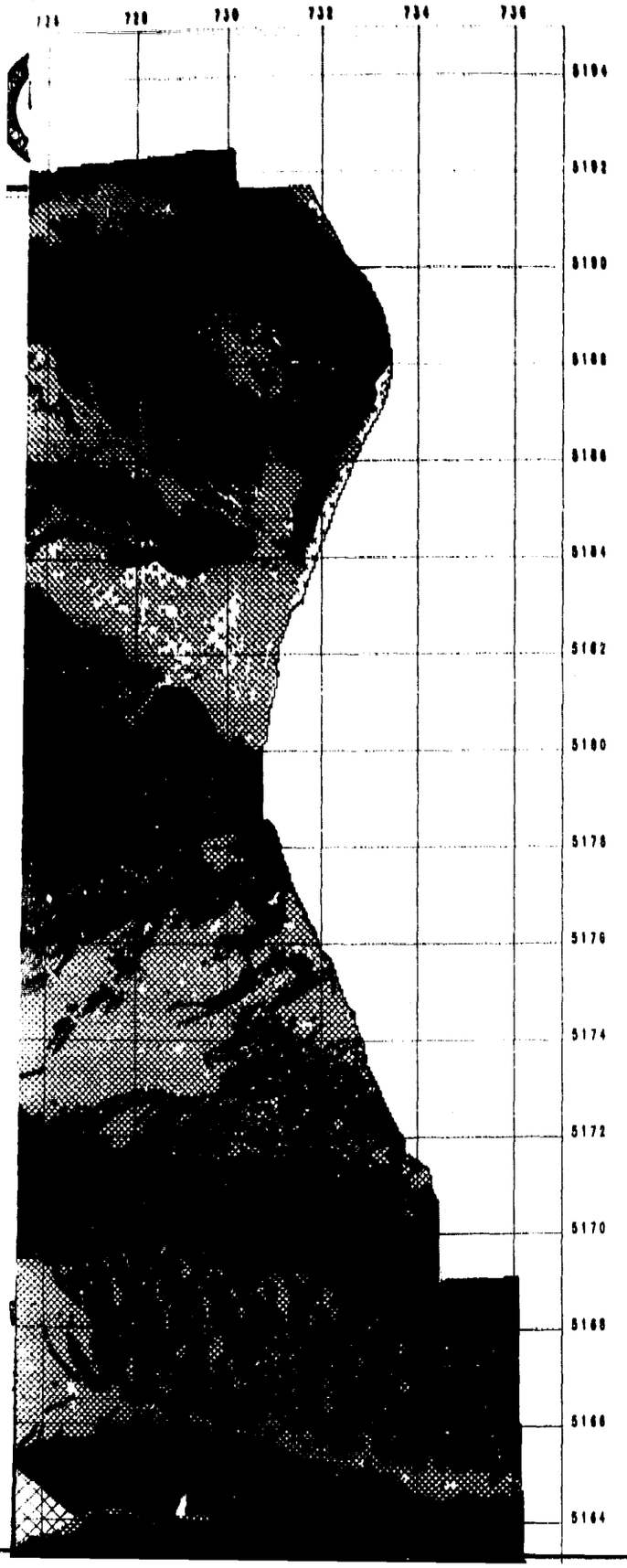
Plate 6. Speed map for 8X8 wheeled combat vehicle in the wet-wet slippery surface condition



t slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED (MPH)

SCALE 1:100000

< 1	> 10 - 20
> 1 - 5	> 20 - 30
> 5 - 10	> 30
WATER	URBAN / OFF LIMITS

YAKIMA FIRING CENTER

SPEED MAP

M60A3
DRY SEASON
NORMAL CONDITION

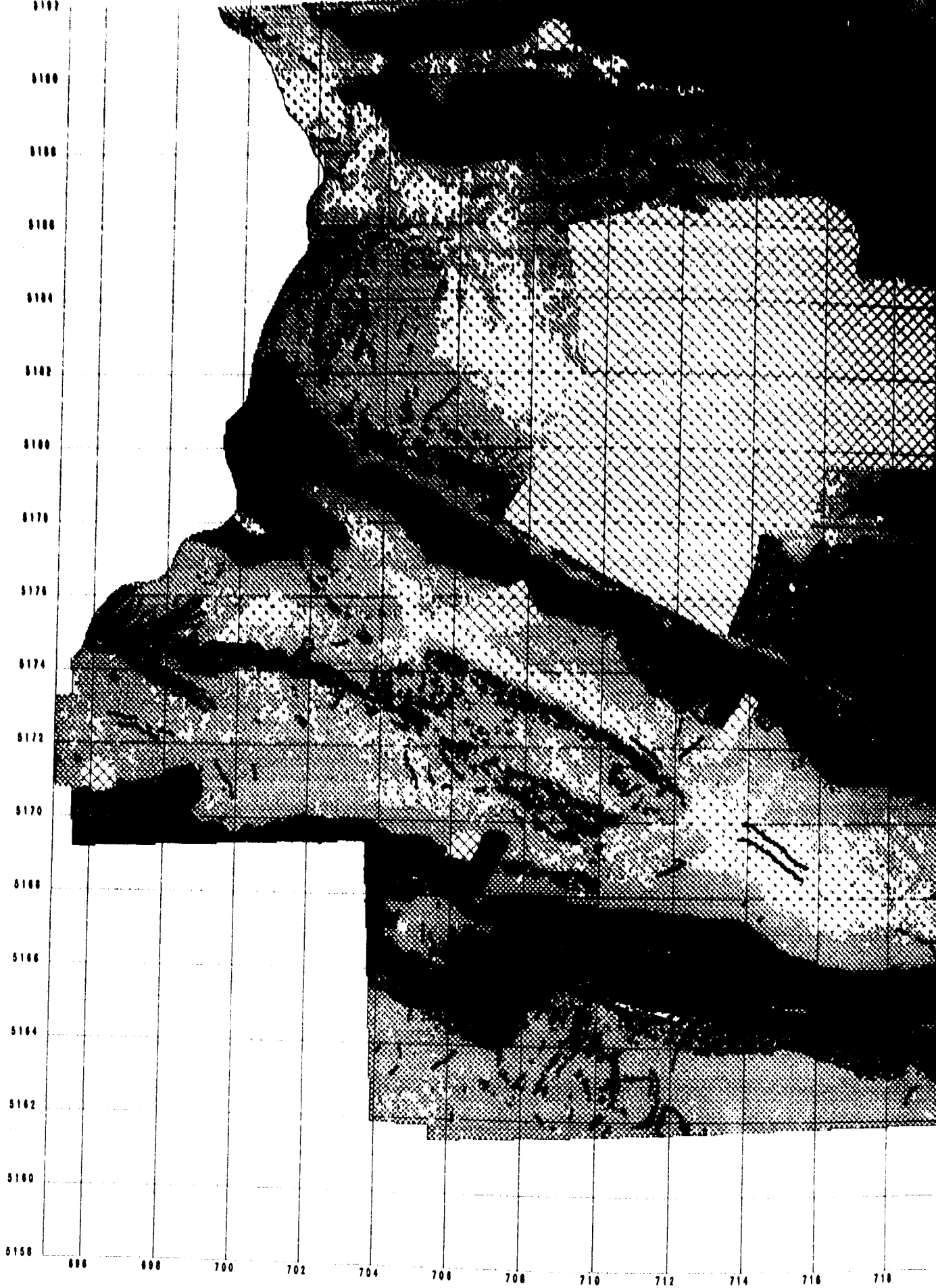


Plate 7. Speed map fo

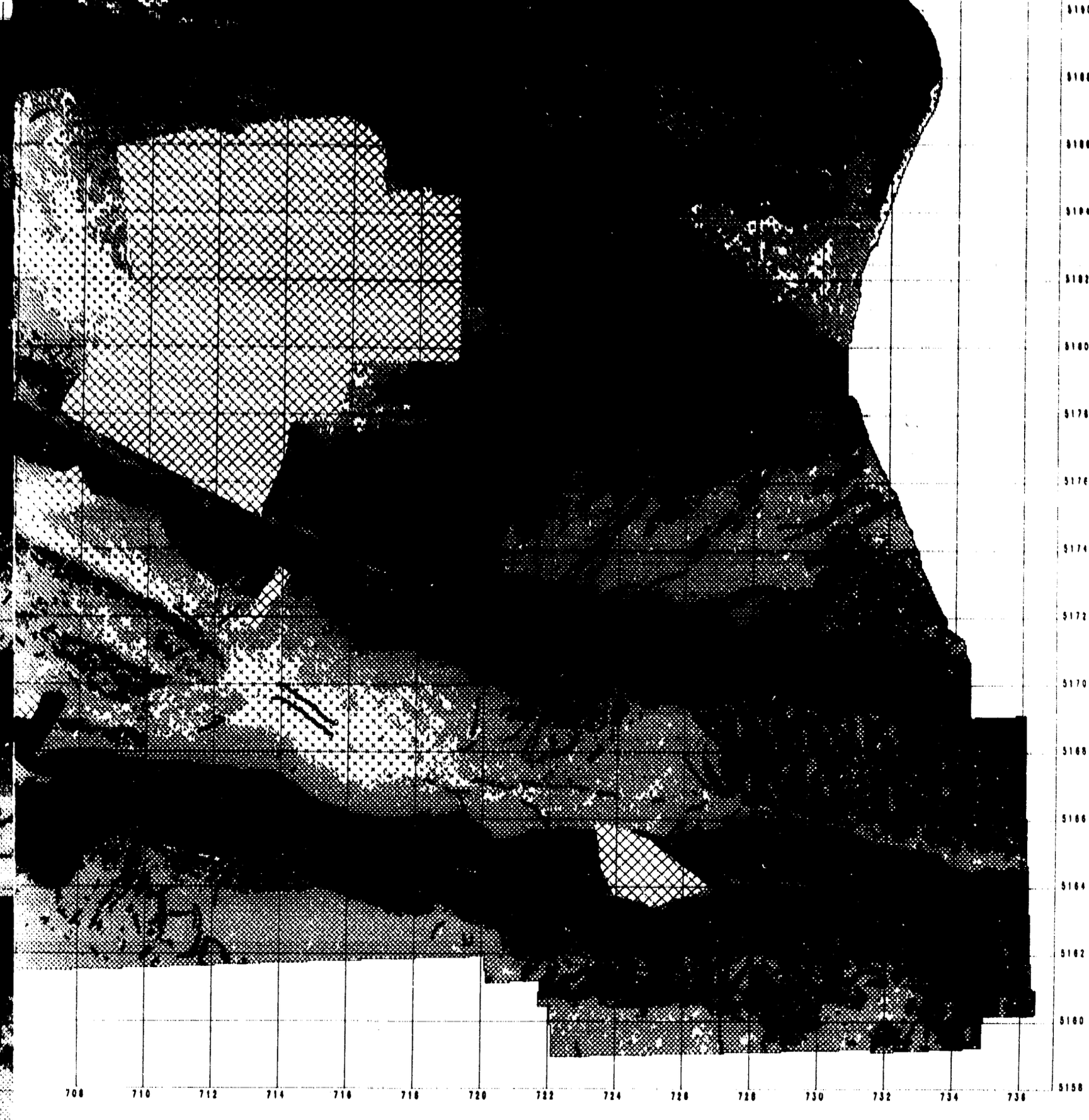
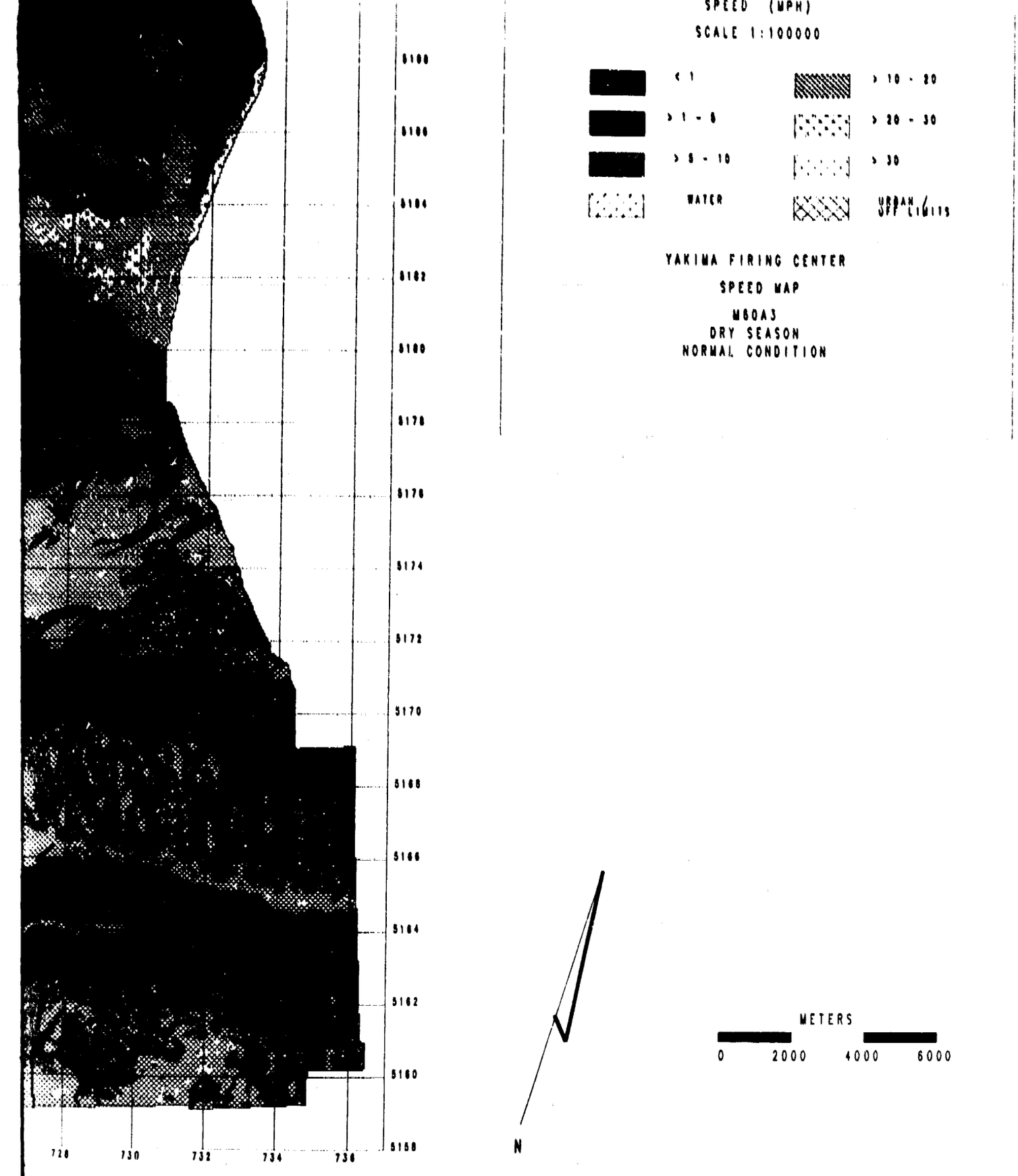
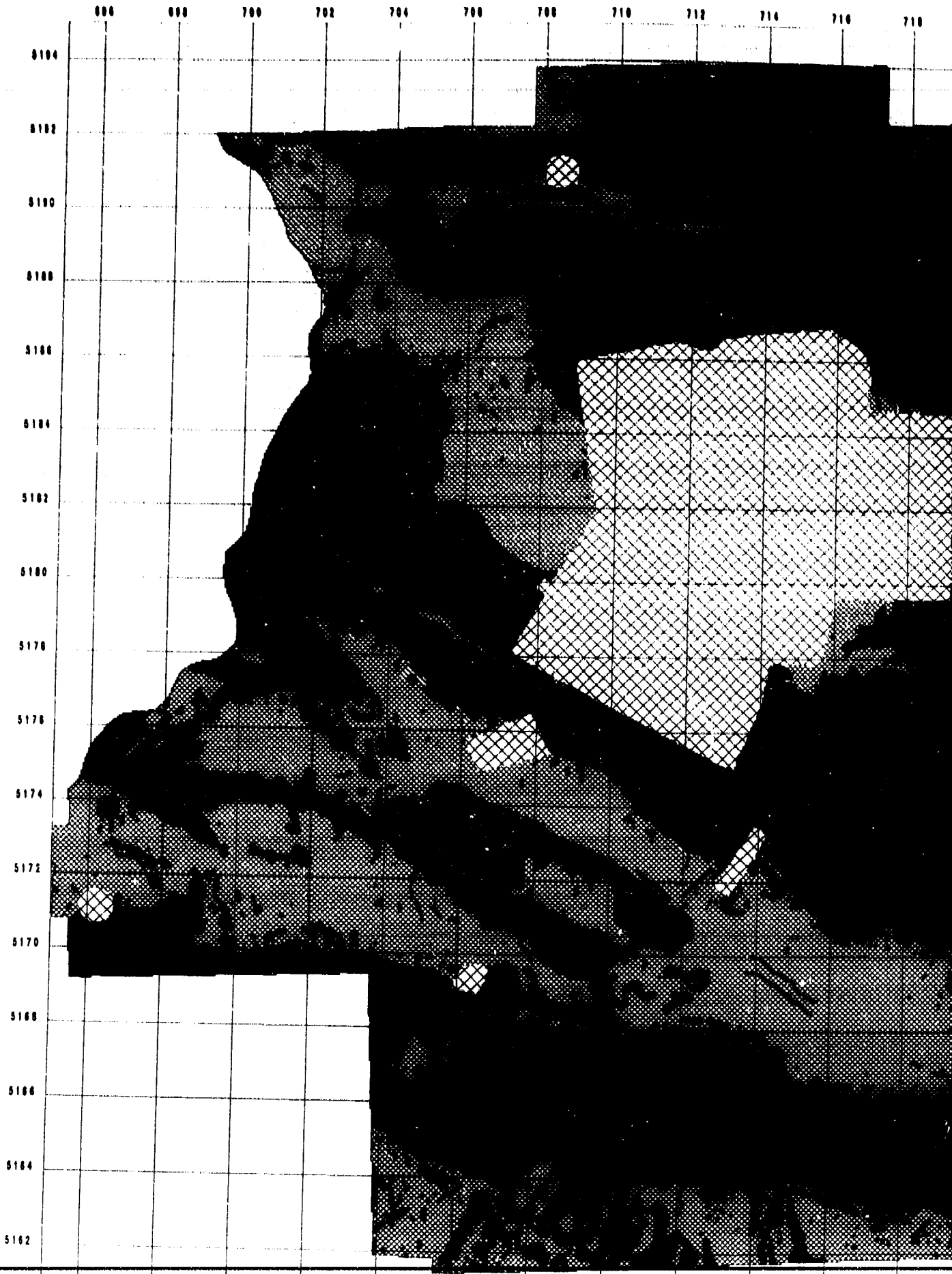


Plate 7. Speed map for M60A3 combat tank in the dry normal surface condition



y normal surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED (MPH)

SCALE 1:100000

< 1	> 10 - 20
> 1 - 5	> 20 - 30
> 5 - 10	> 30
WATER	URBAN / OFF LIMITS

YAKIMA FIRING CENTER

SPEED MAP

M60A3
WET-WET SEASON
SLIPPERY CONDITION

METERS

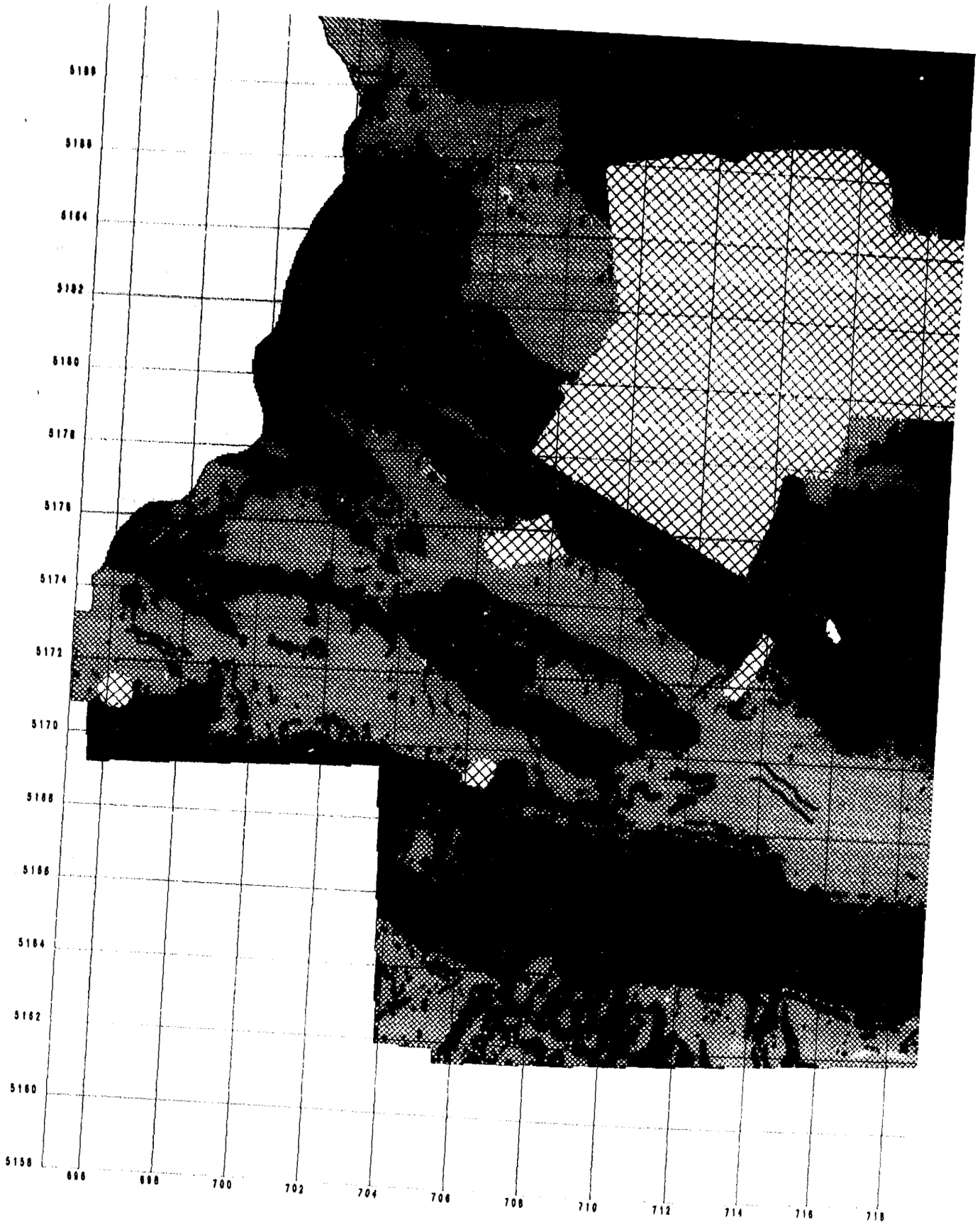


Plate 8. Speed map fo

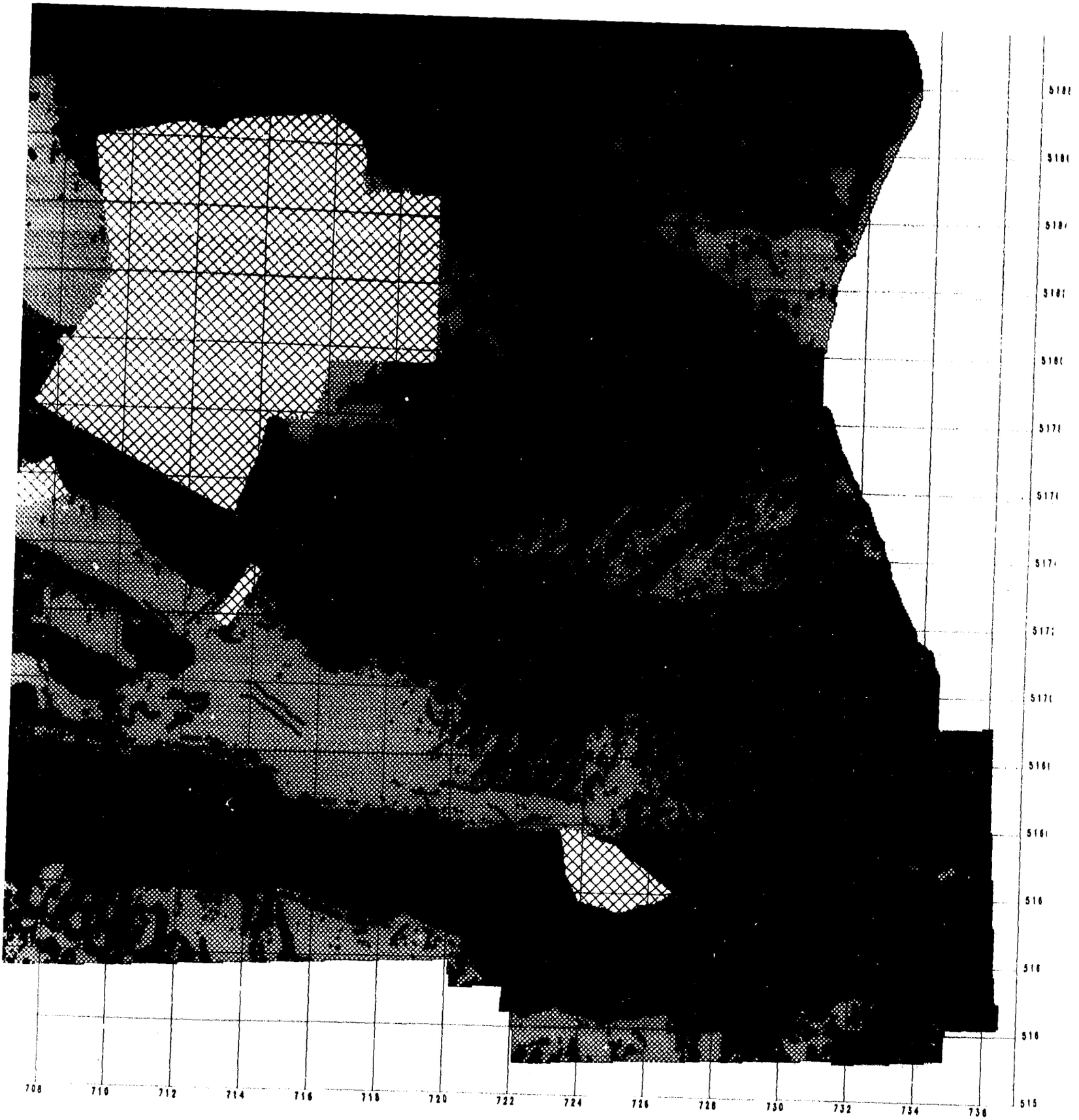
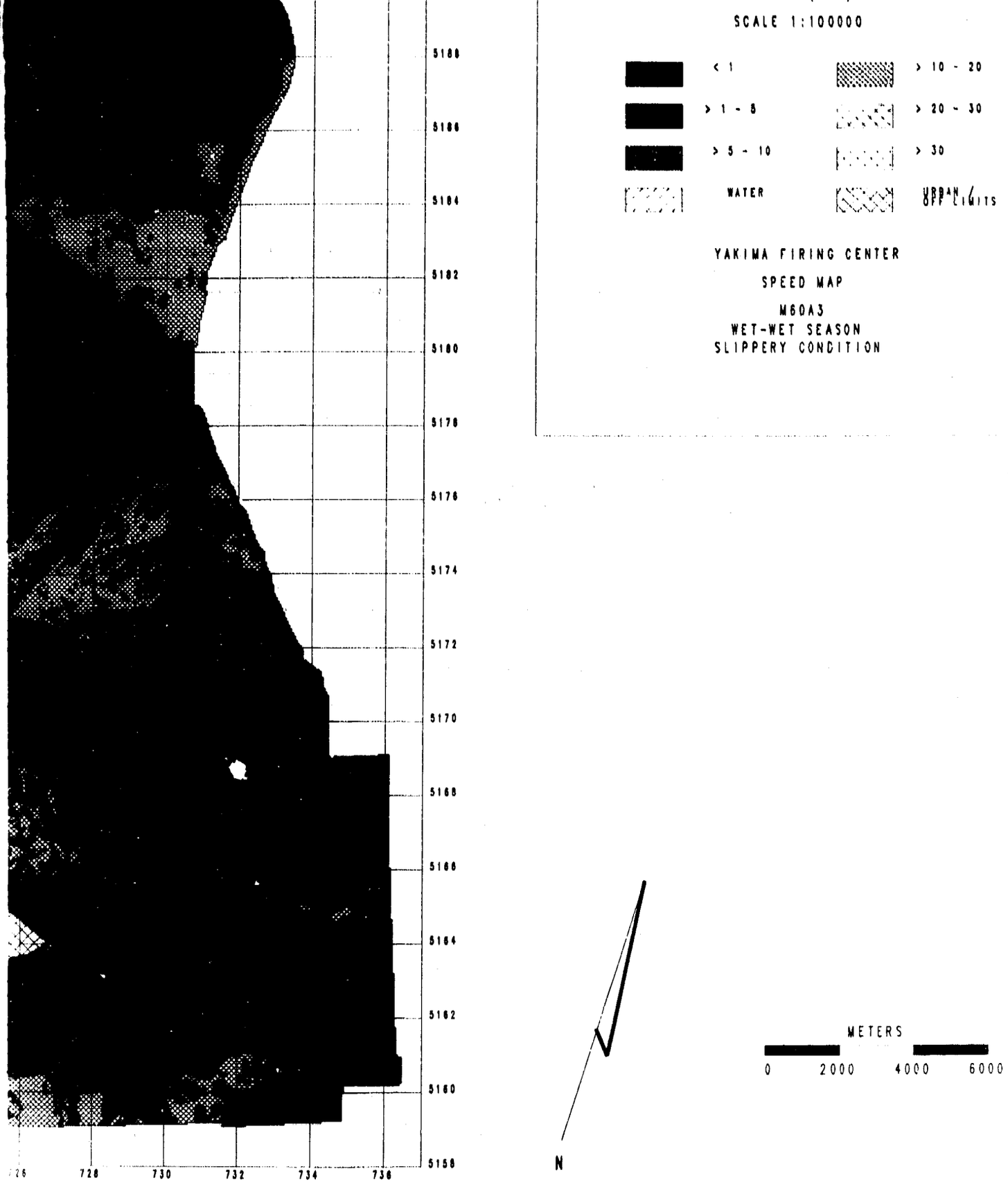
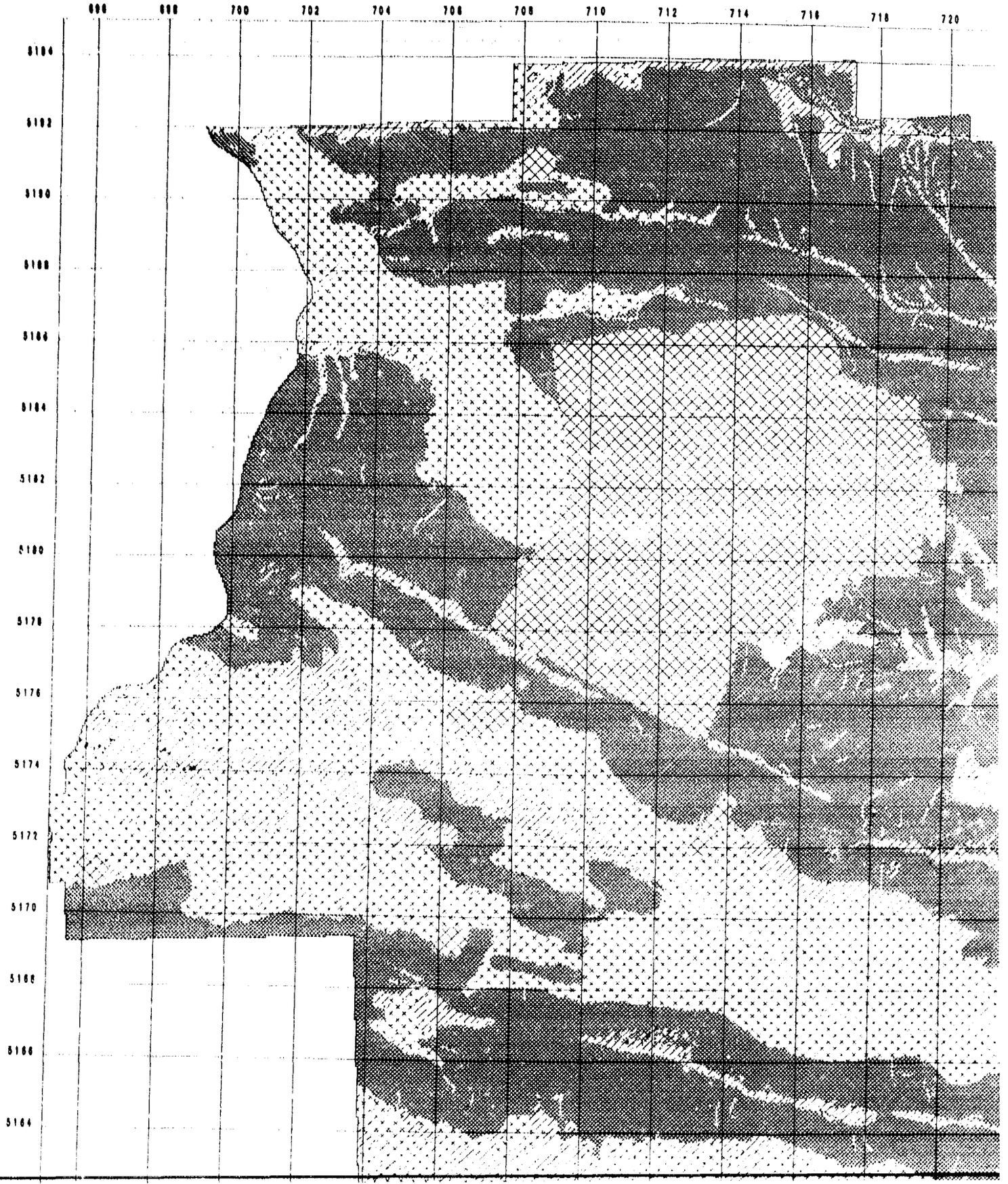
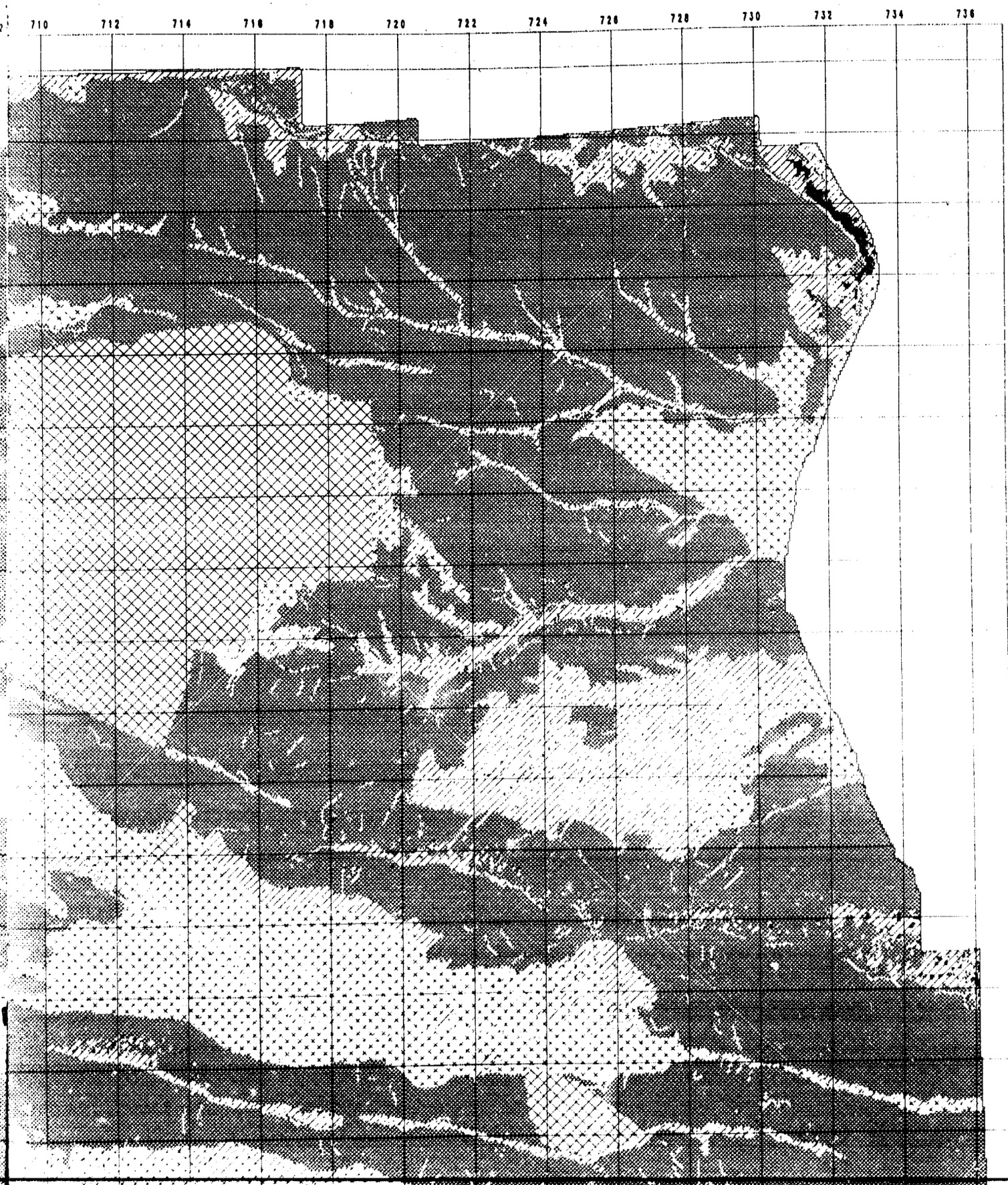


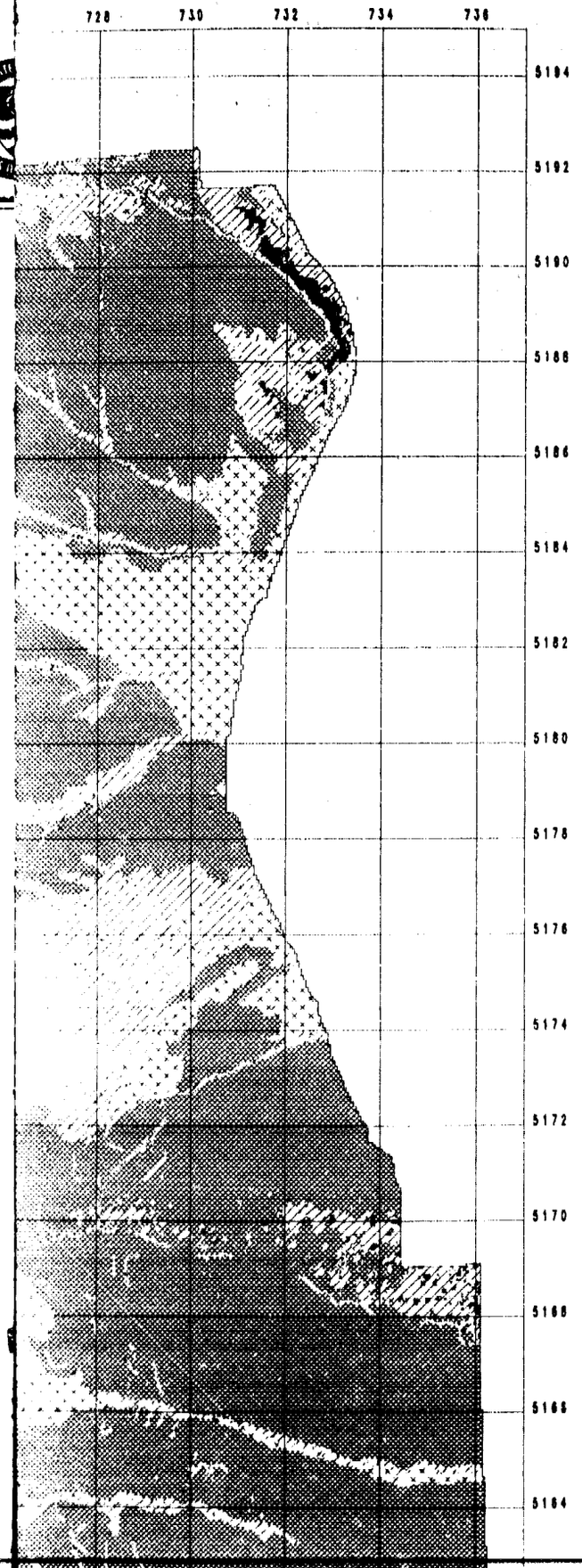
Plate 8. Speed map for M60A3 combat tank in the wet-wet slippery surface condition



wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

HMMWV
DRY SEASON
NORMAL CONDITION

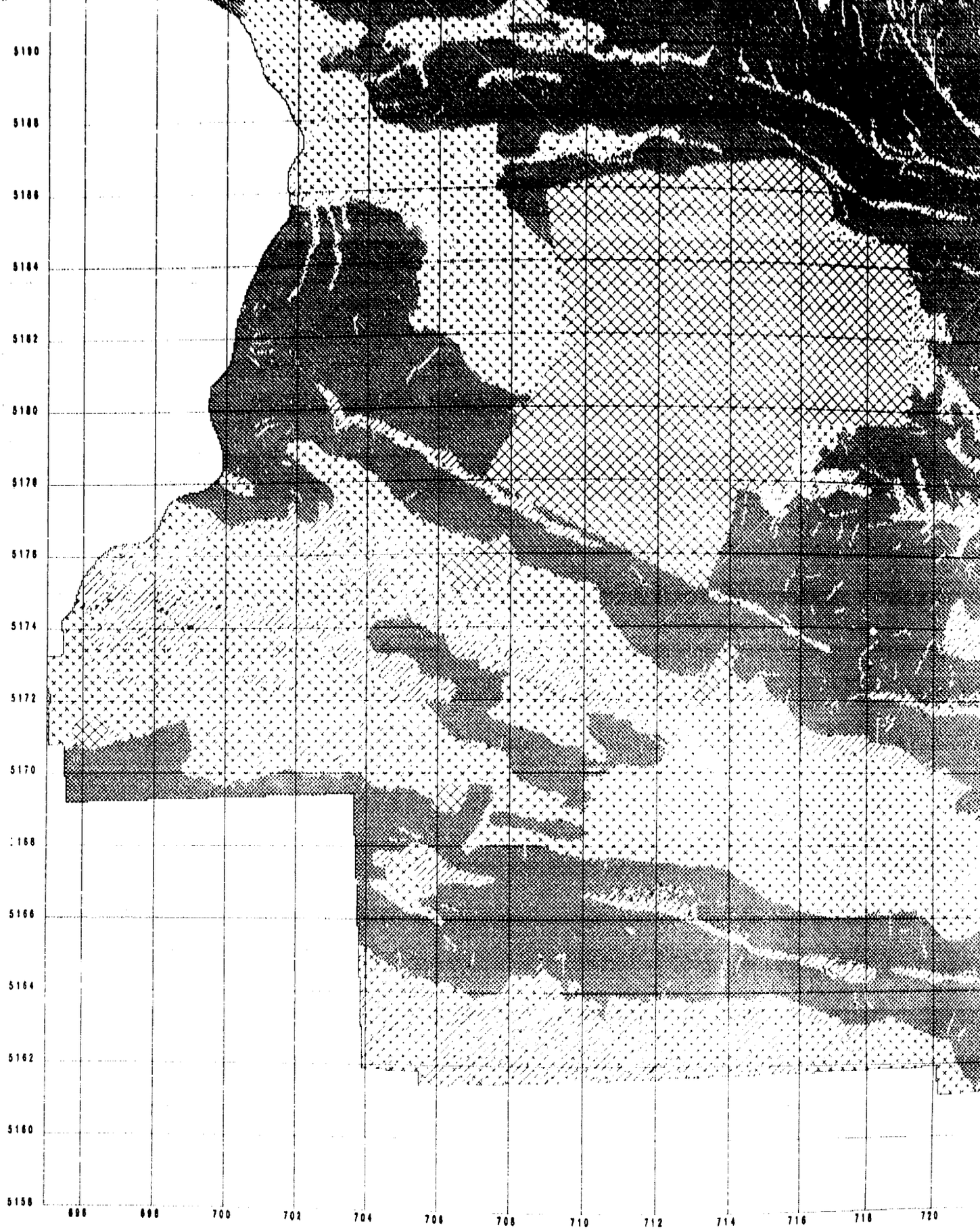


Plate 9. Speed limiting reason map for M998 (

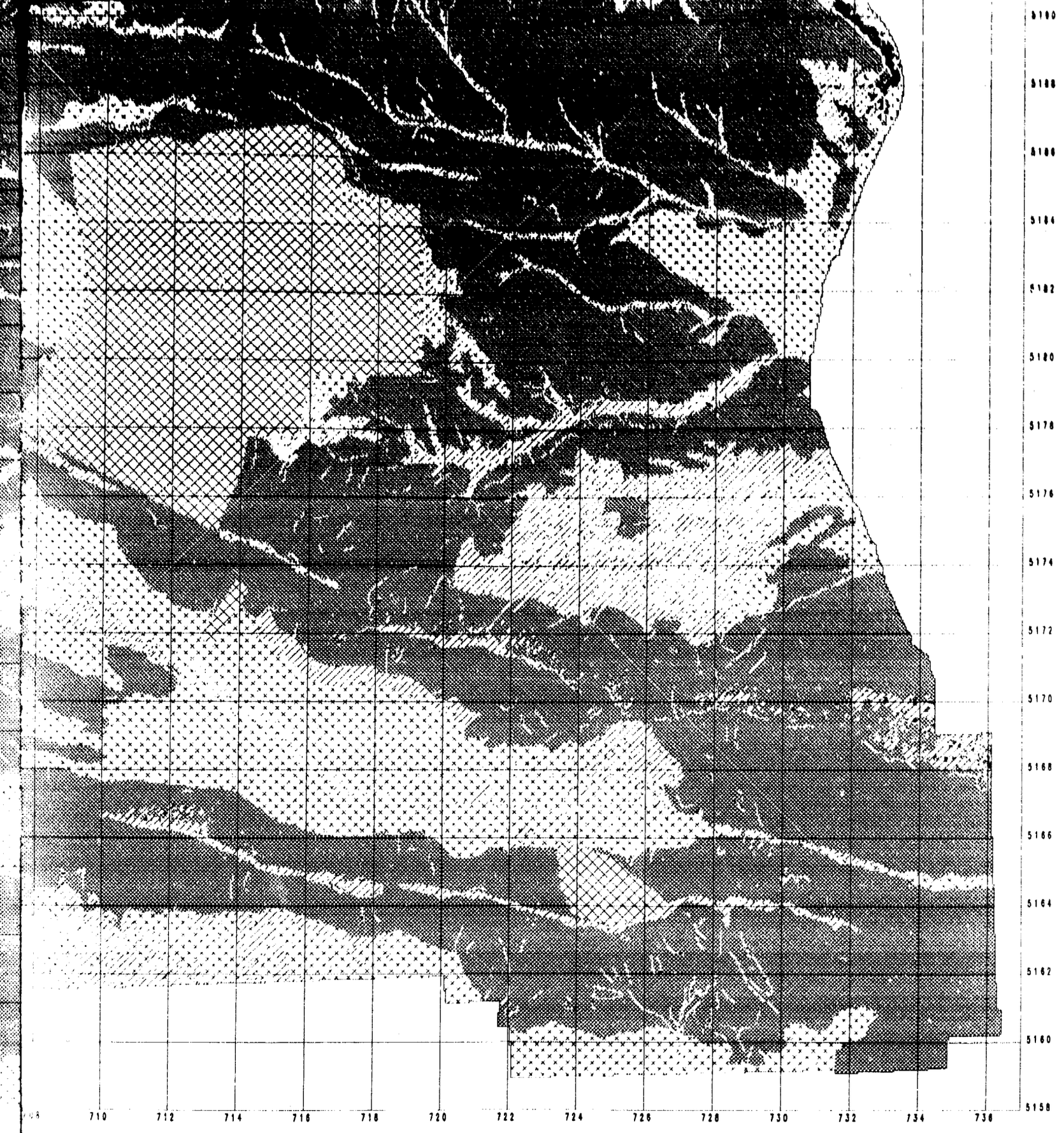
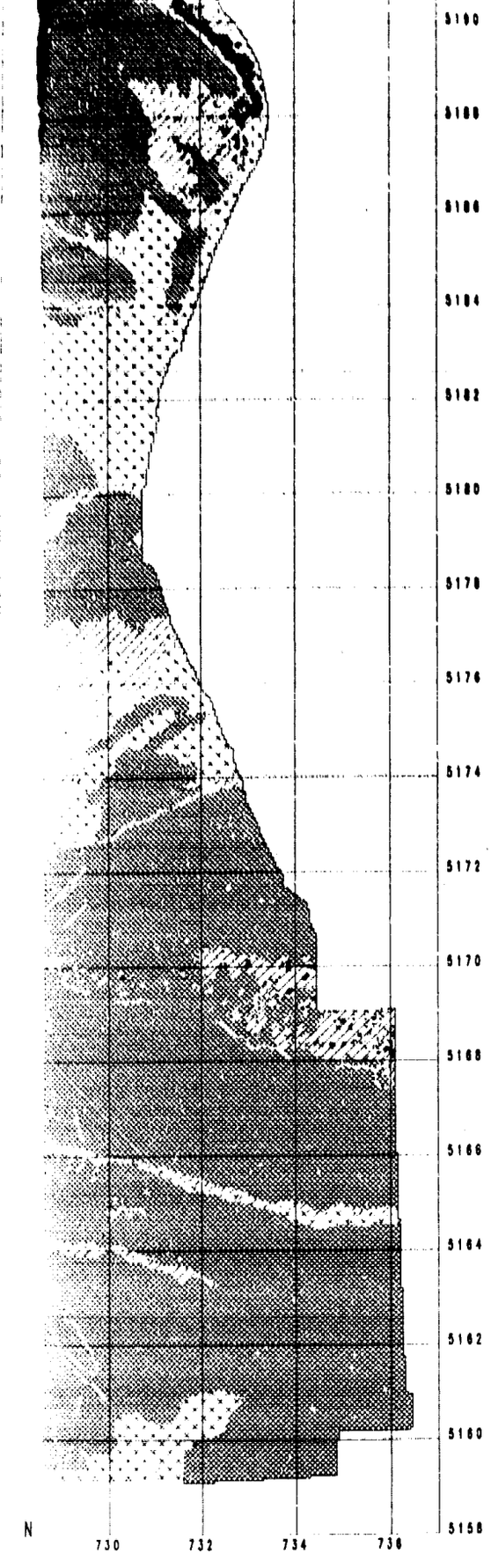


Plate 9. Speed limiting reason map for M998 (HMMWV) wheeled vehicle in the dry normal surface condition



SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

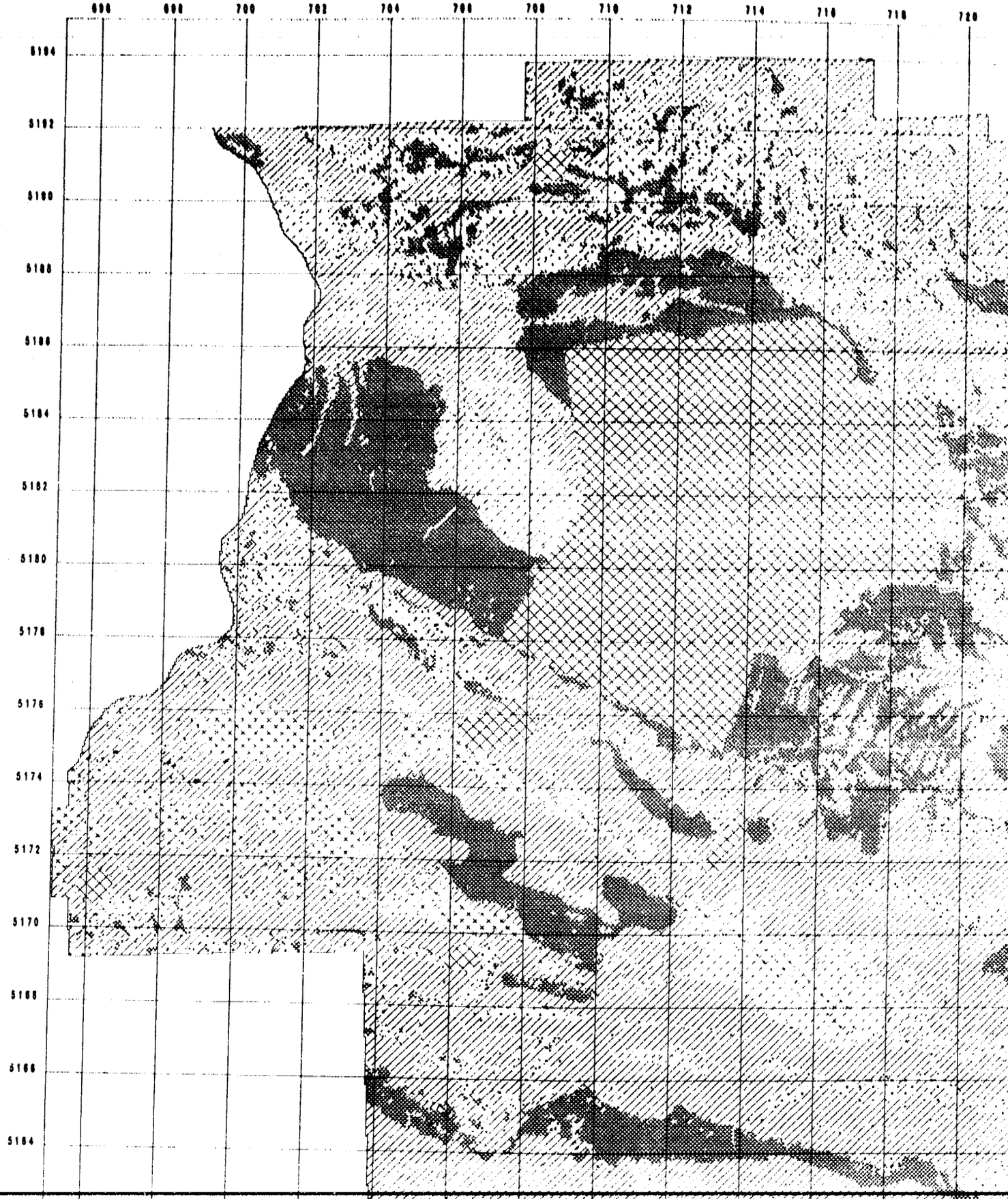
HMMWV
DRY SEASON
NORMAL CONDITION

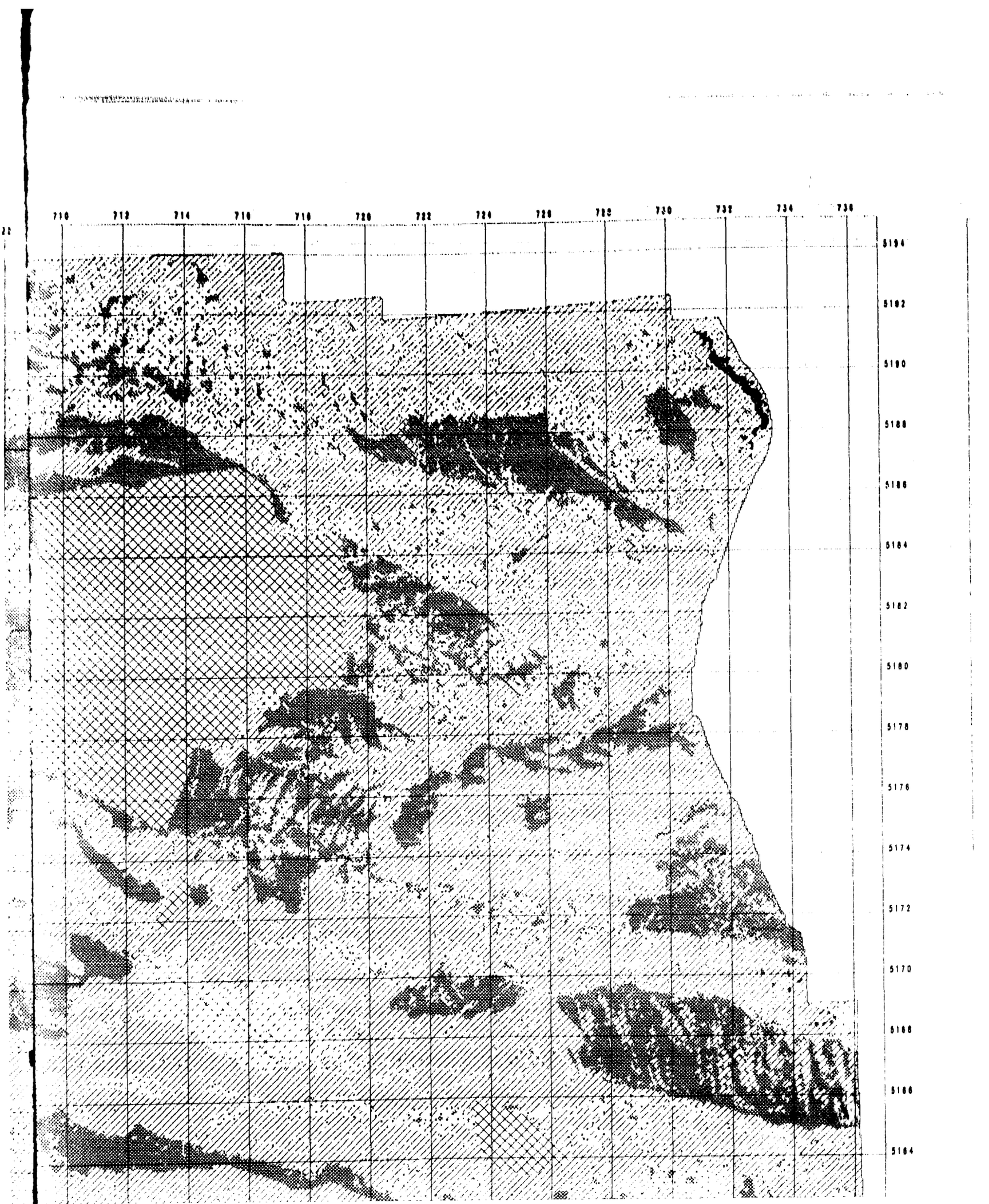
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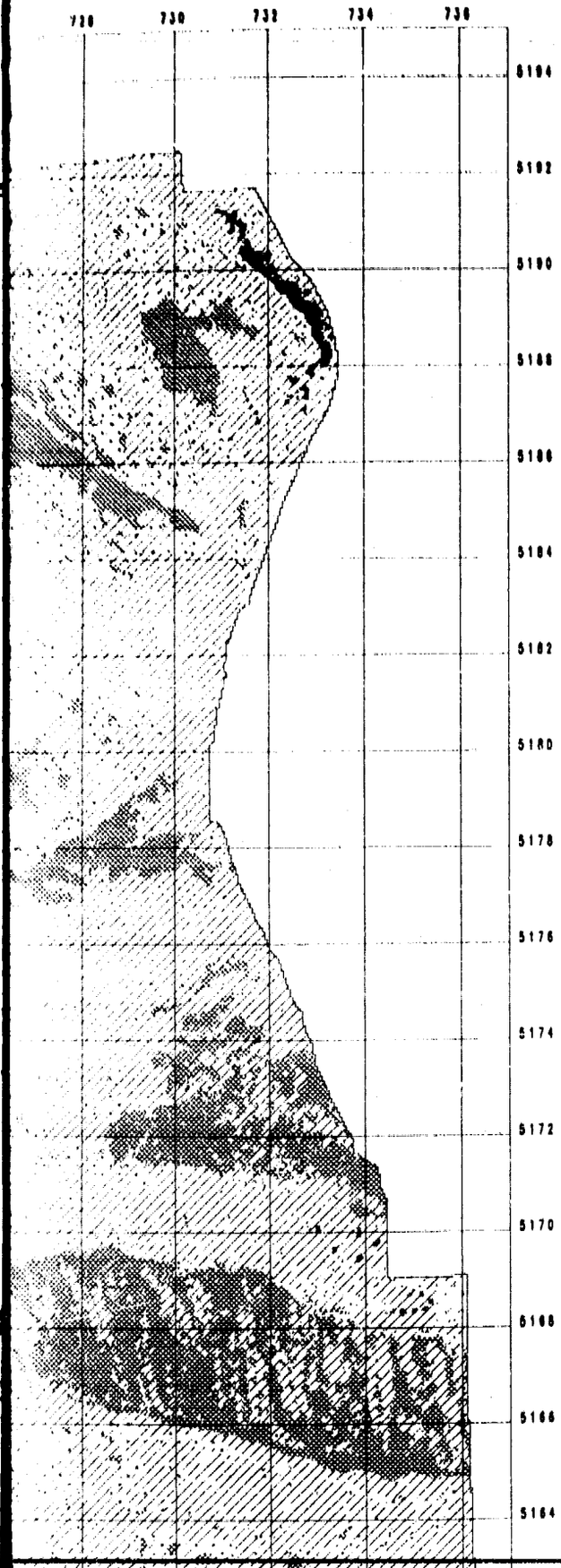
METERS

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dry normal surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

8X8 WHEELED COMBAT VEHICLE
DRY SEASON
NORMAL CONDITION

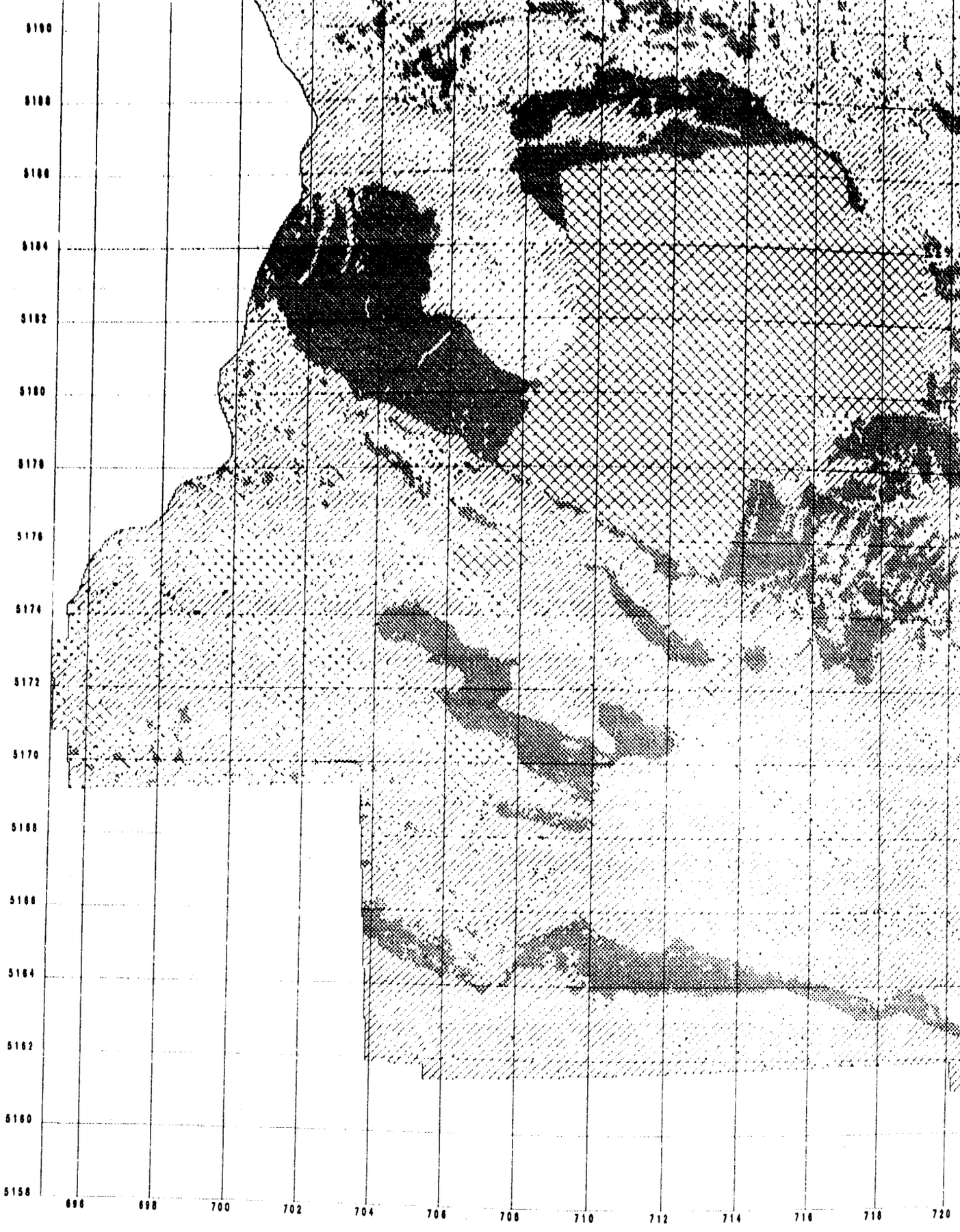


Plate 10. Speed limiting reason map

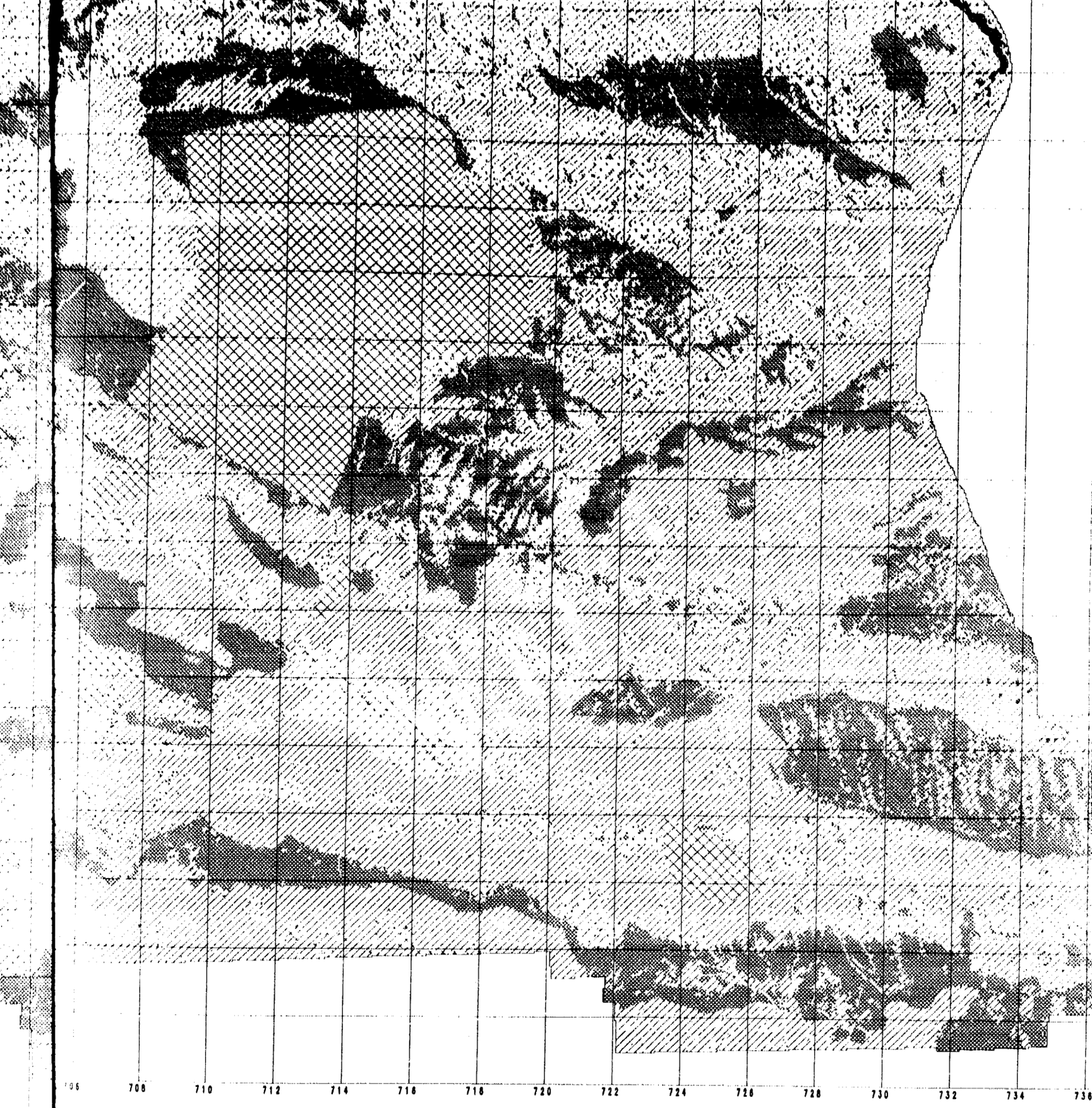
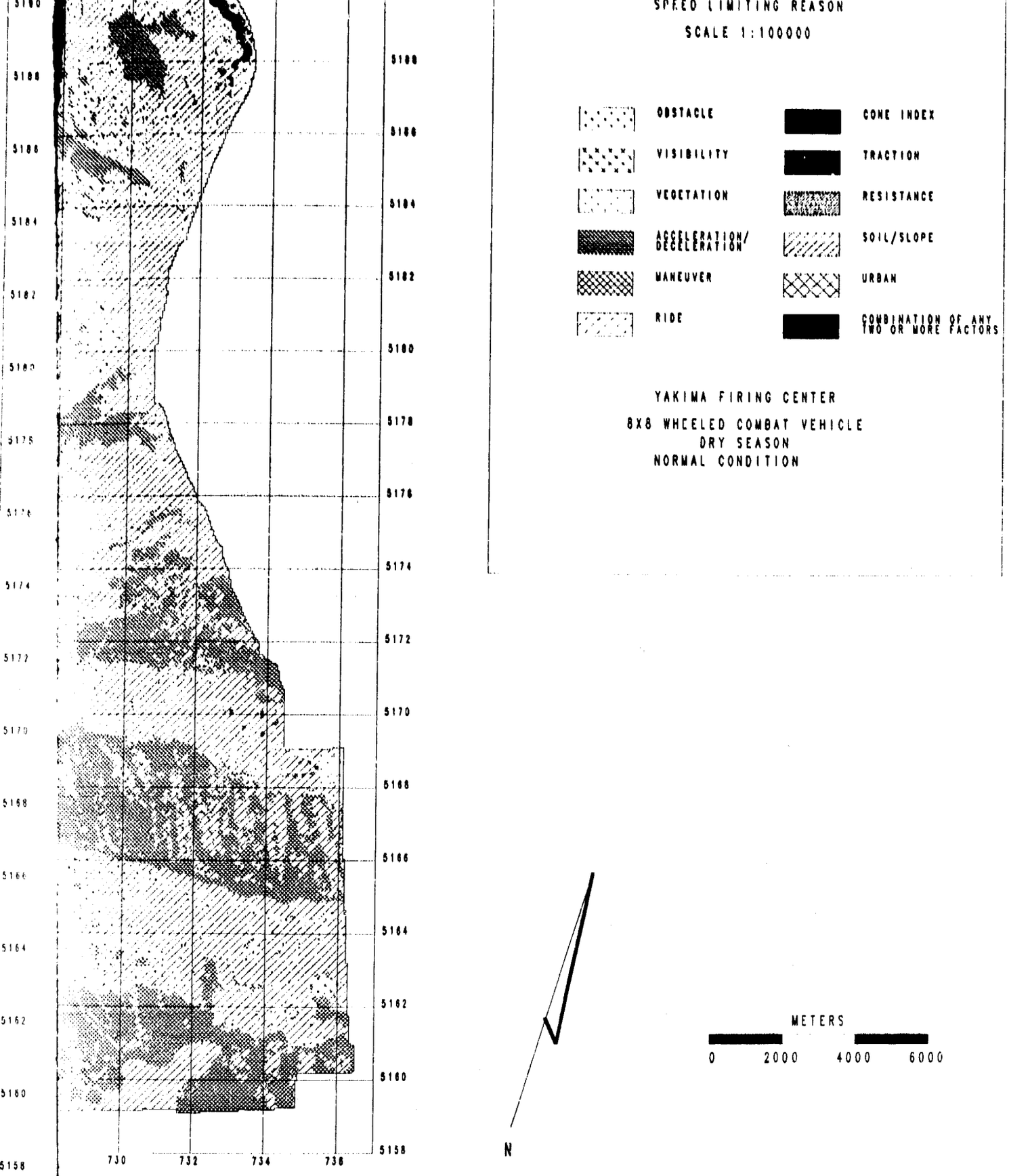
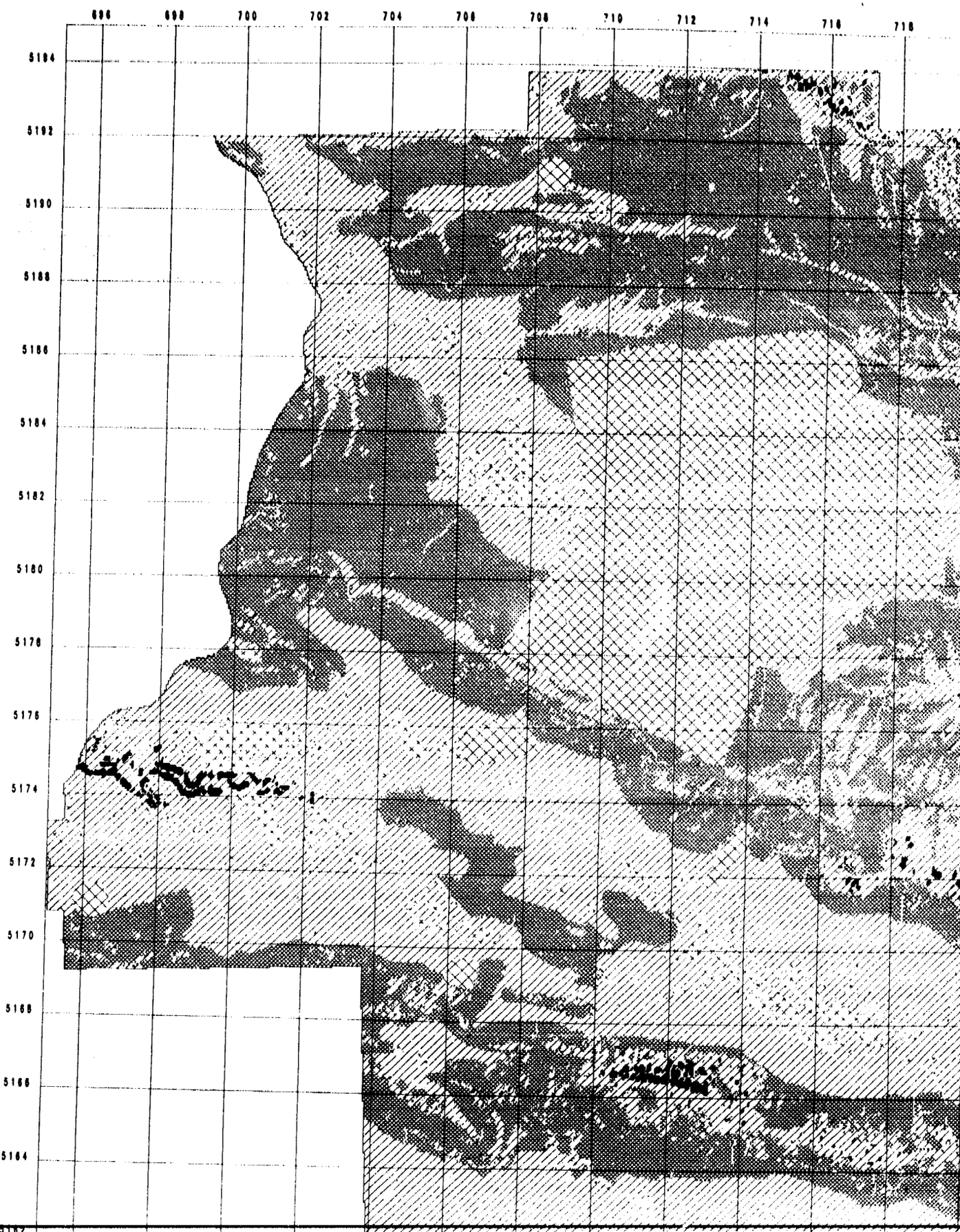
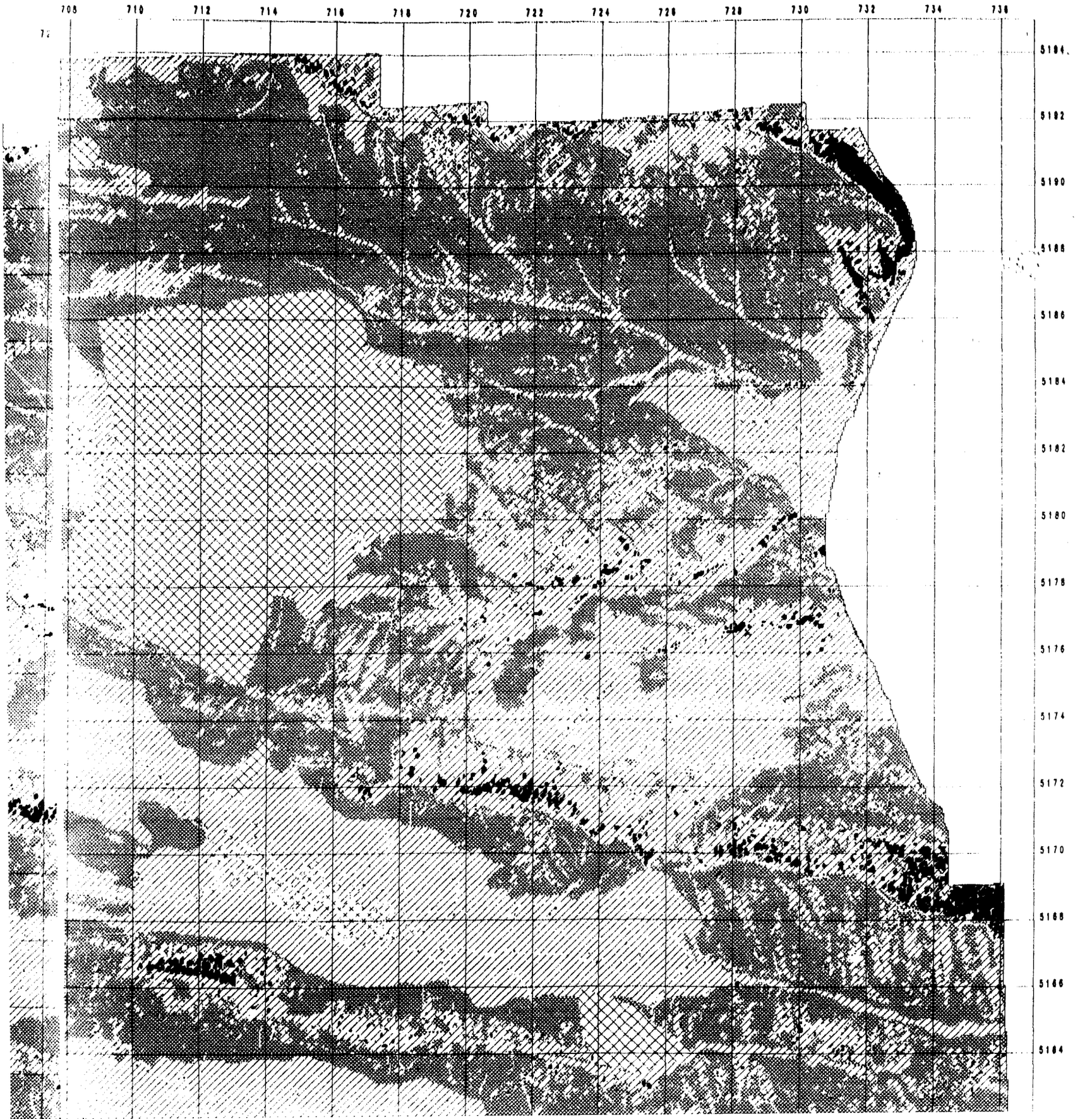


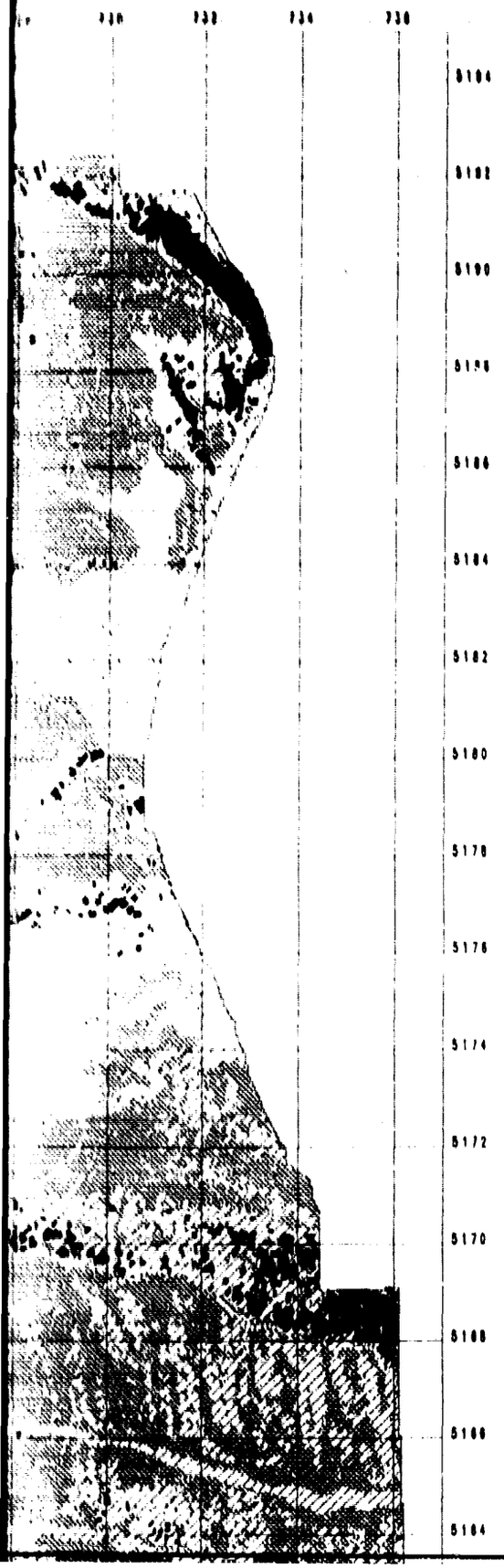
Plate 10. Speed limiting reason map for 8X8 wheeled combat vehicle in the dry normal surface condit



n the dry normal surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

M60A3
DRY SEASON
NORMAL CONDITION

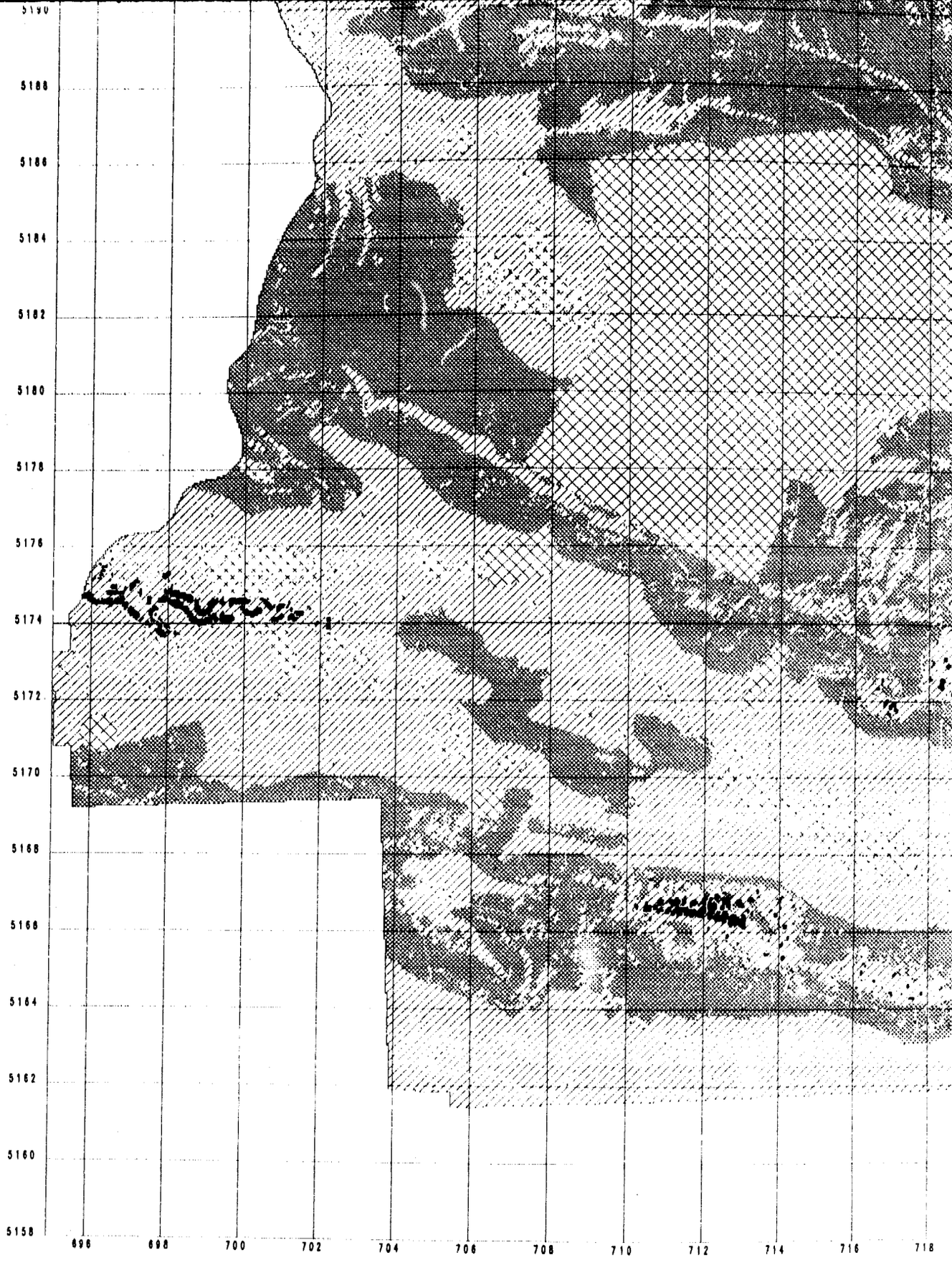


Plate 11. Speed limiting rea

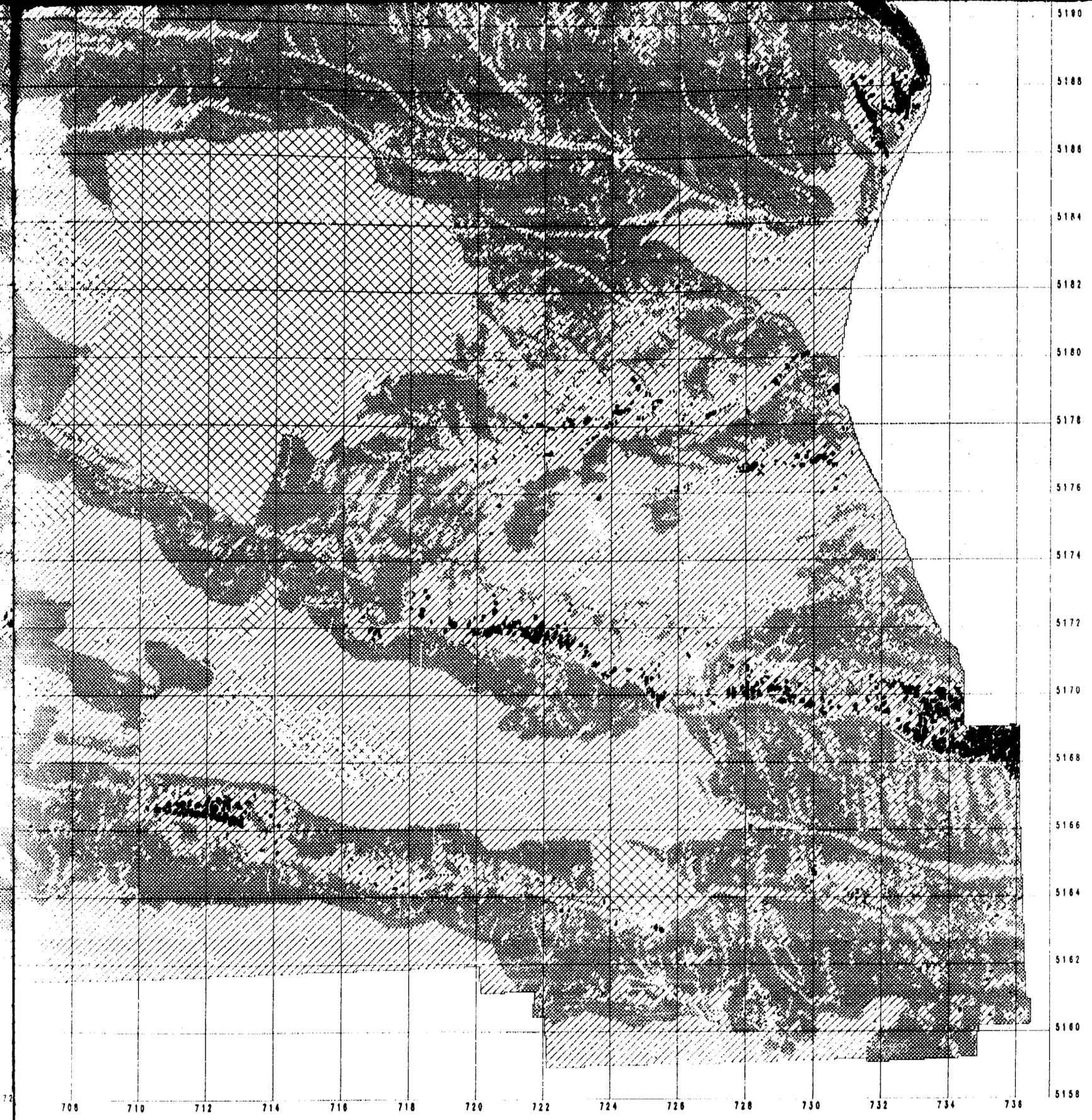
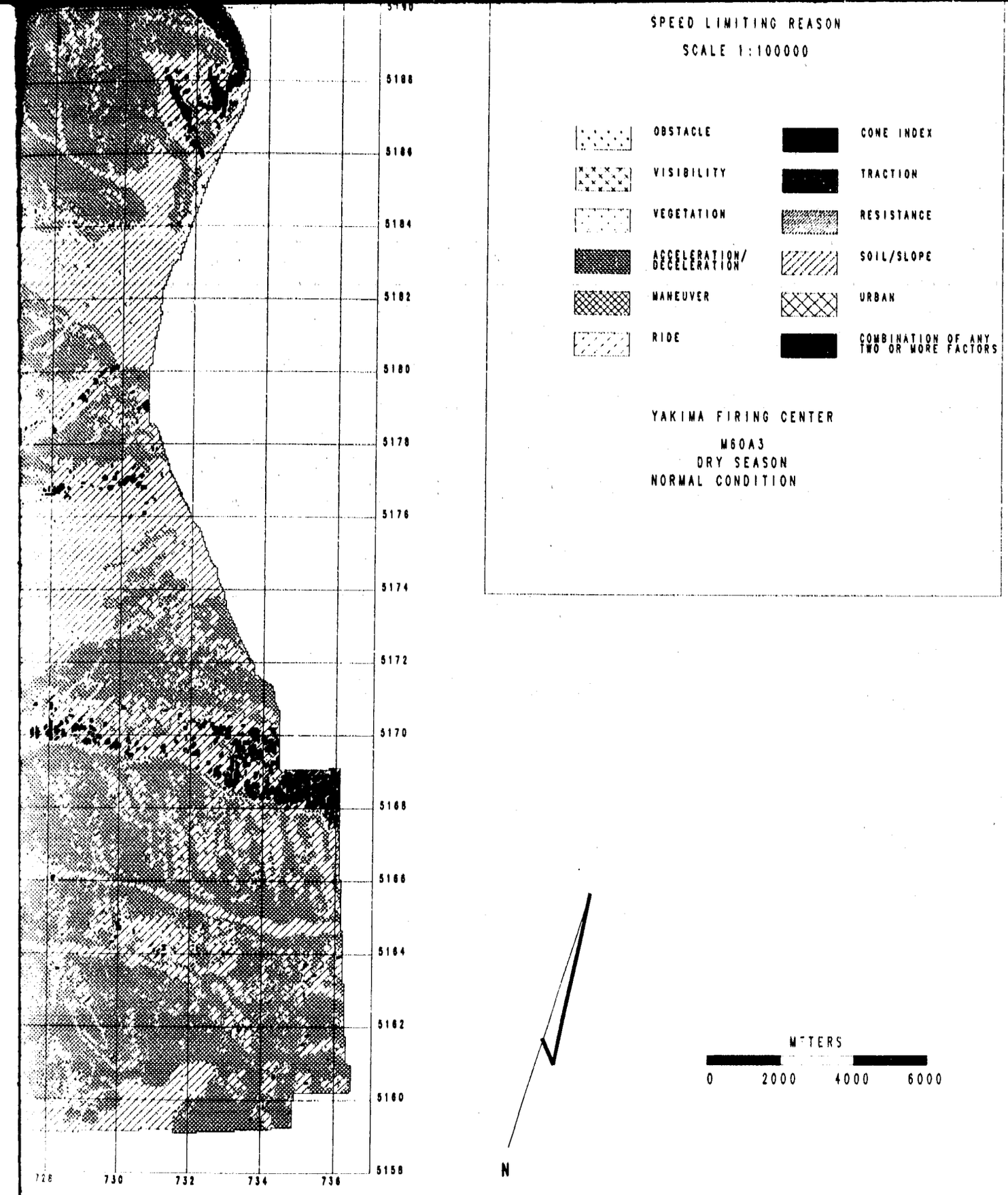
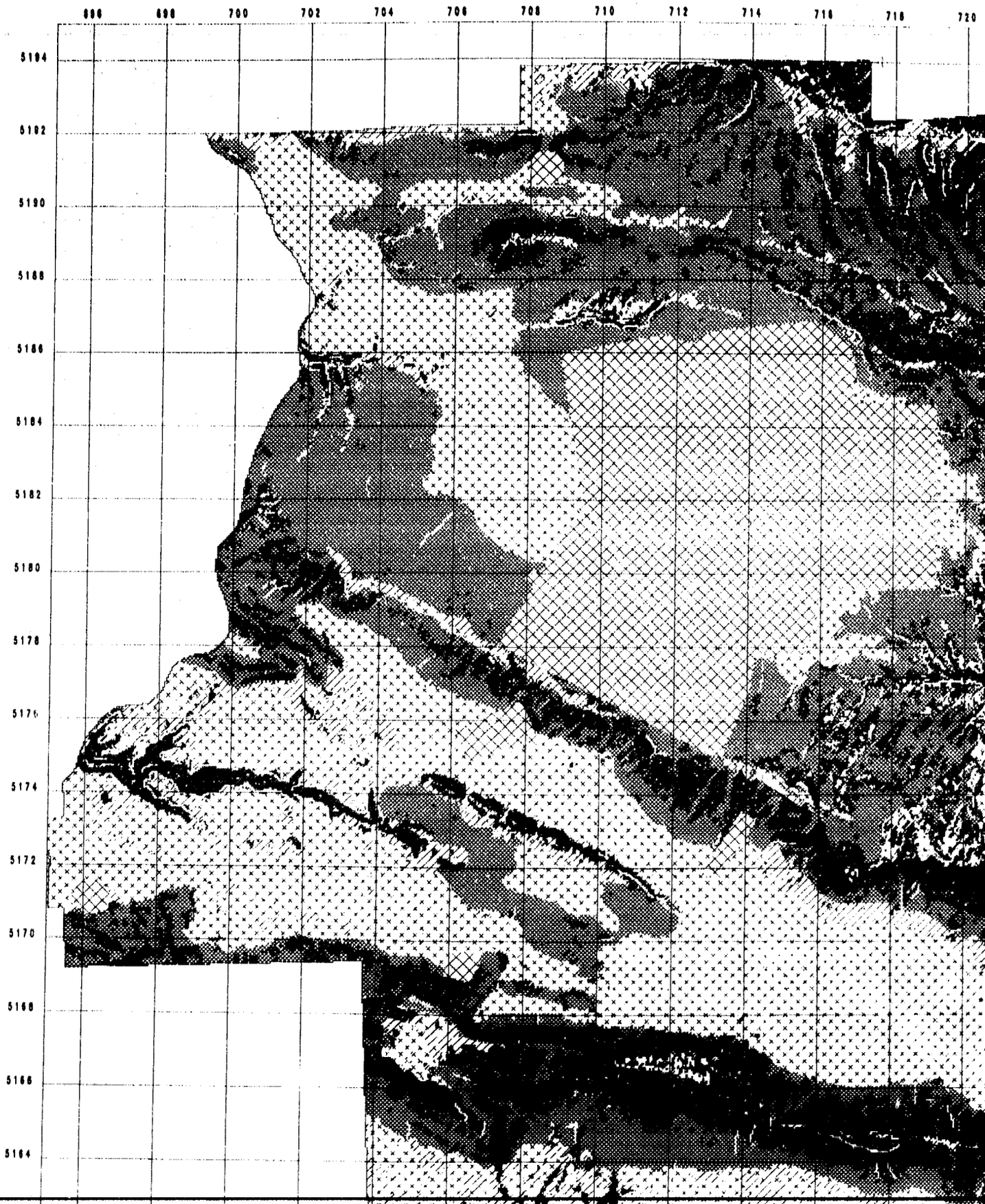
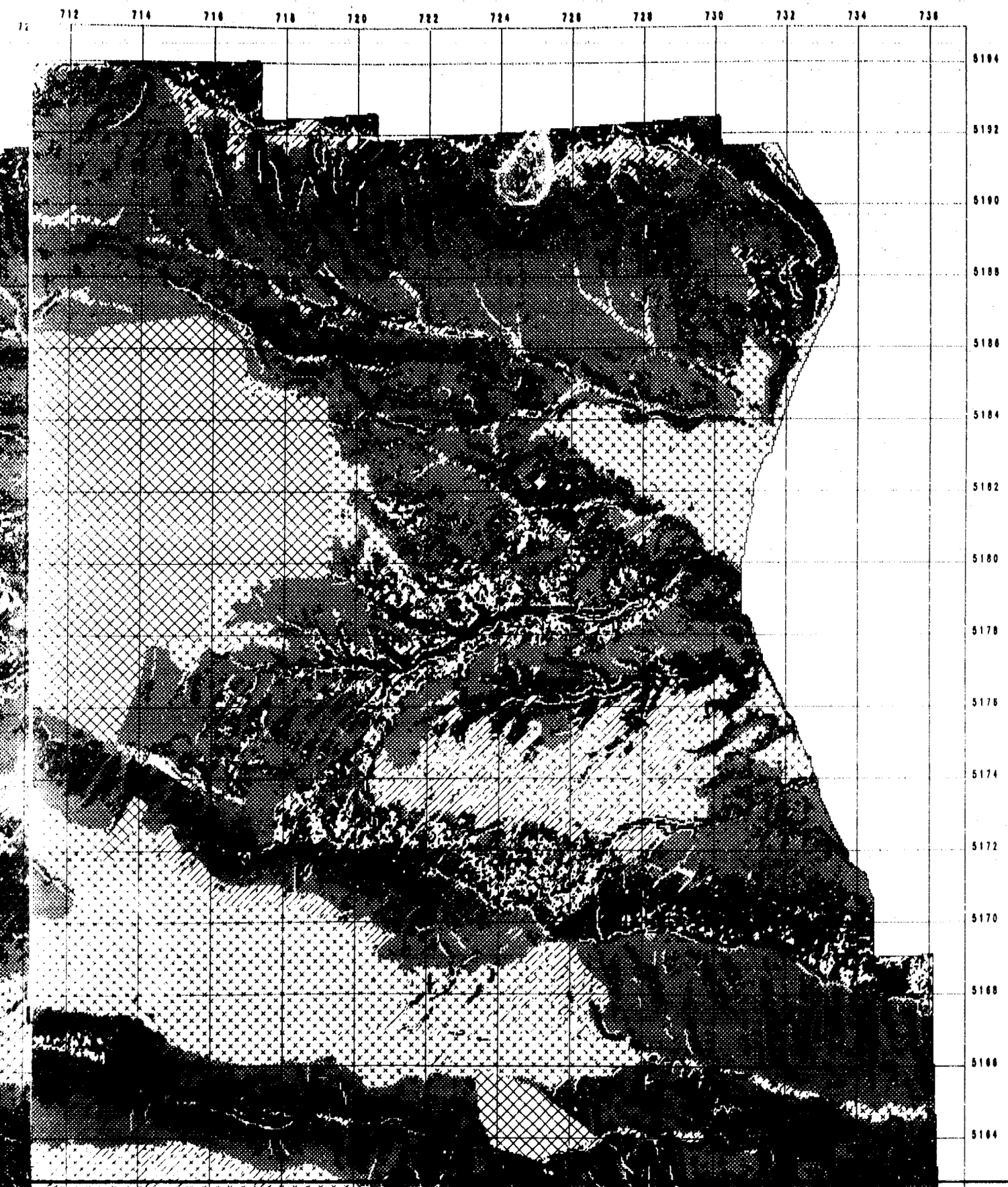


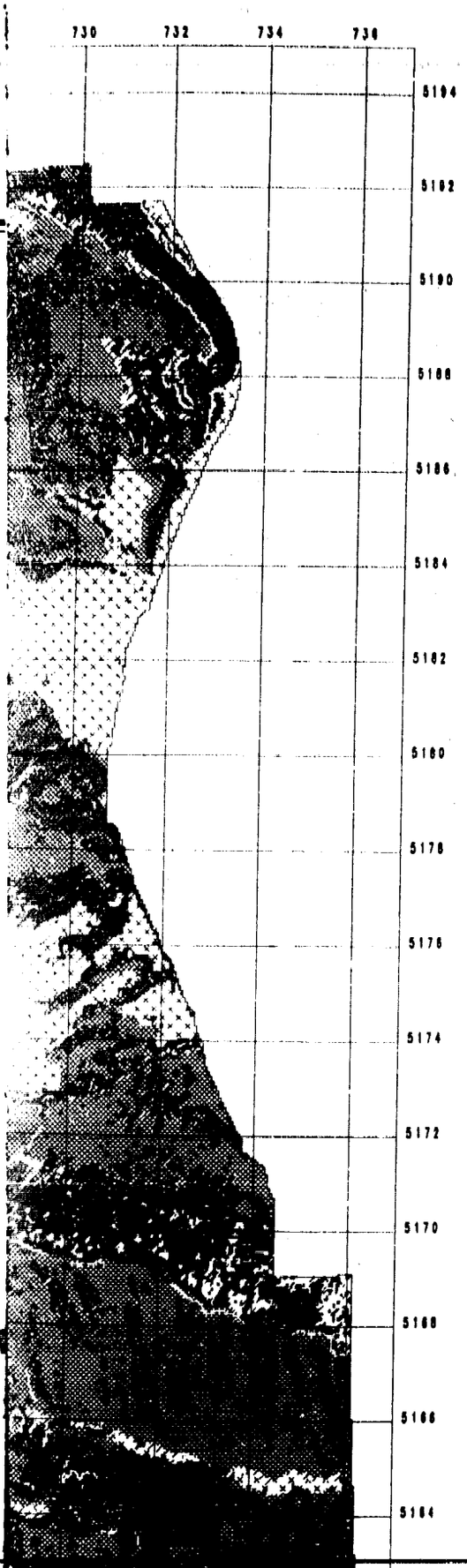
Plate 11. Speed limiting reason map for M60A3 combat tank in the dry normal surface condition



the dry normal surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

HMMWV
WET-WET SEASON
SLIPPERY CONDITION

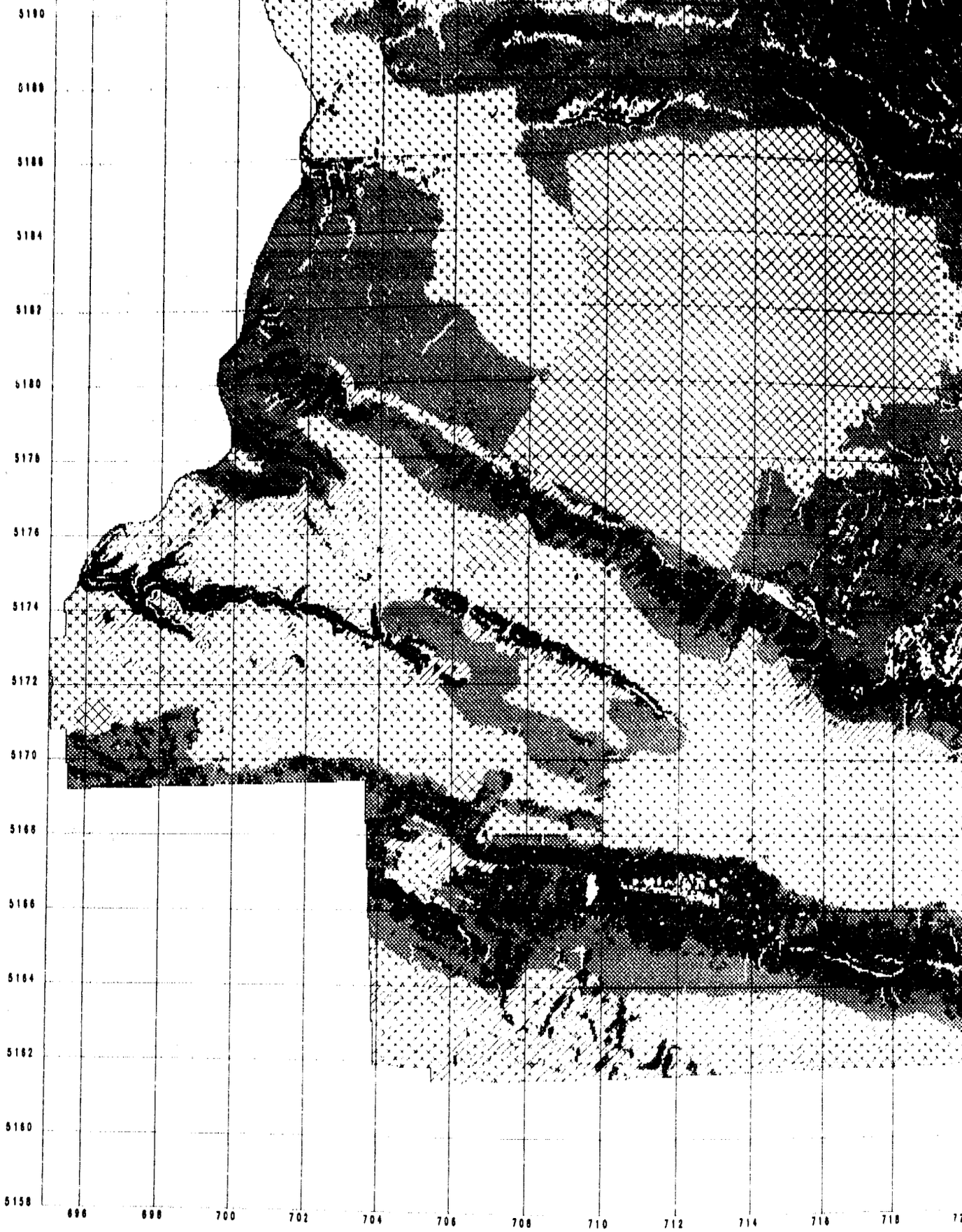


Plate 12. Speed limiting reason map fo

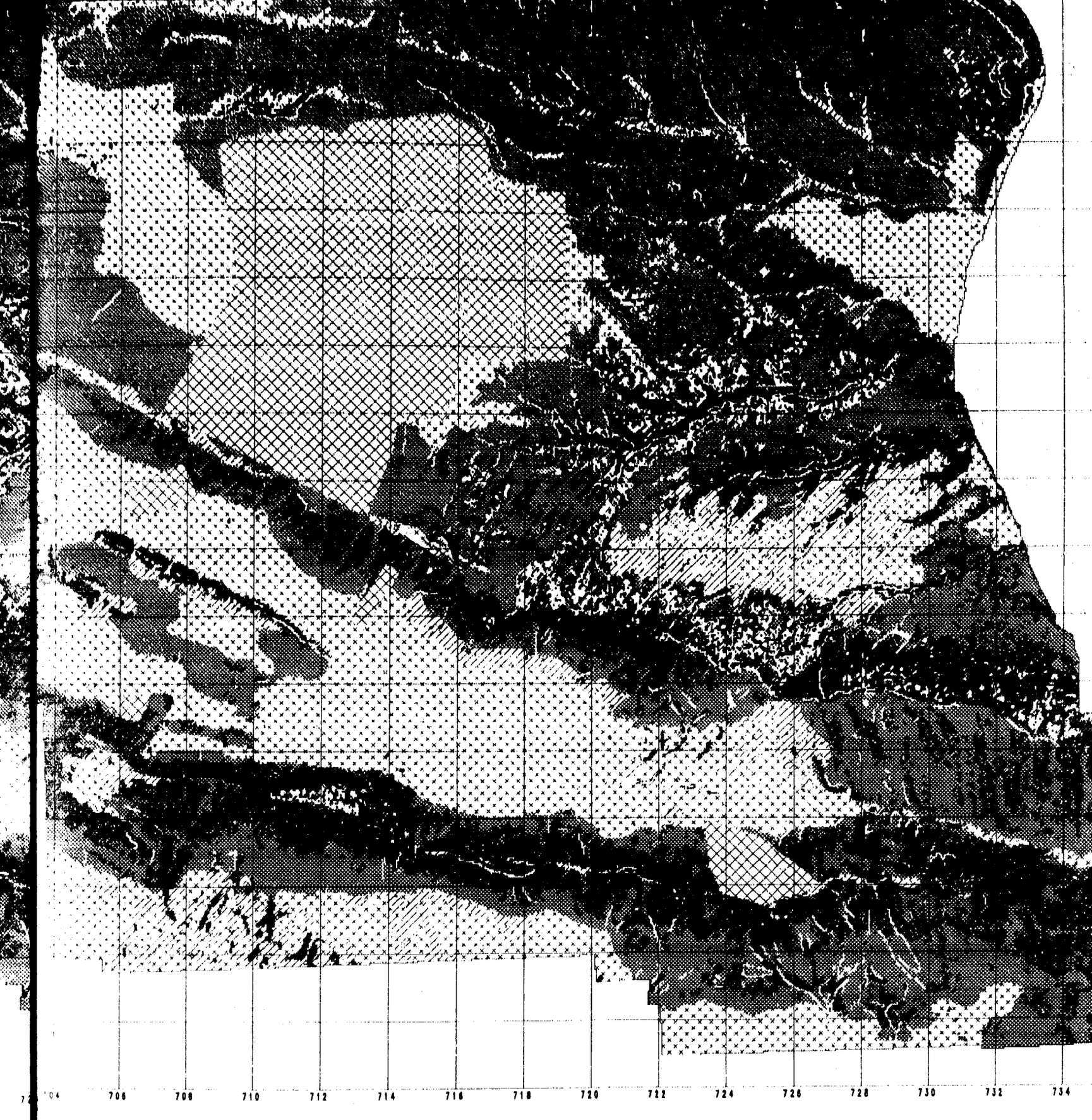
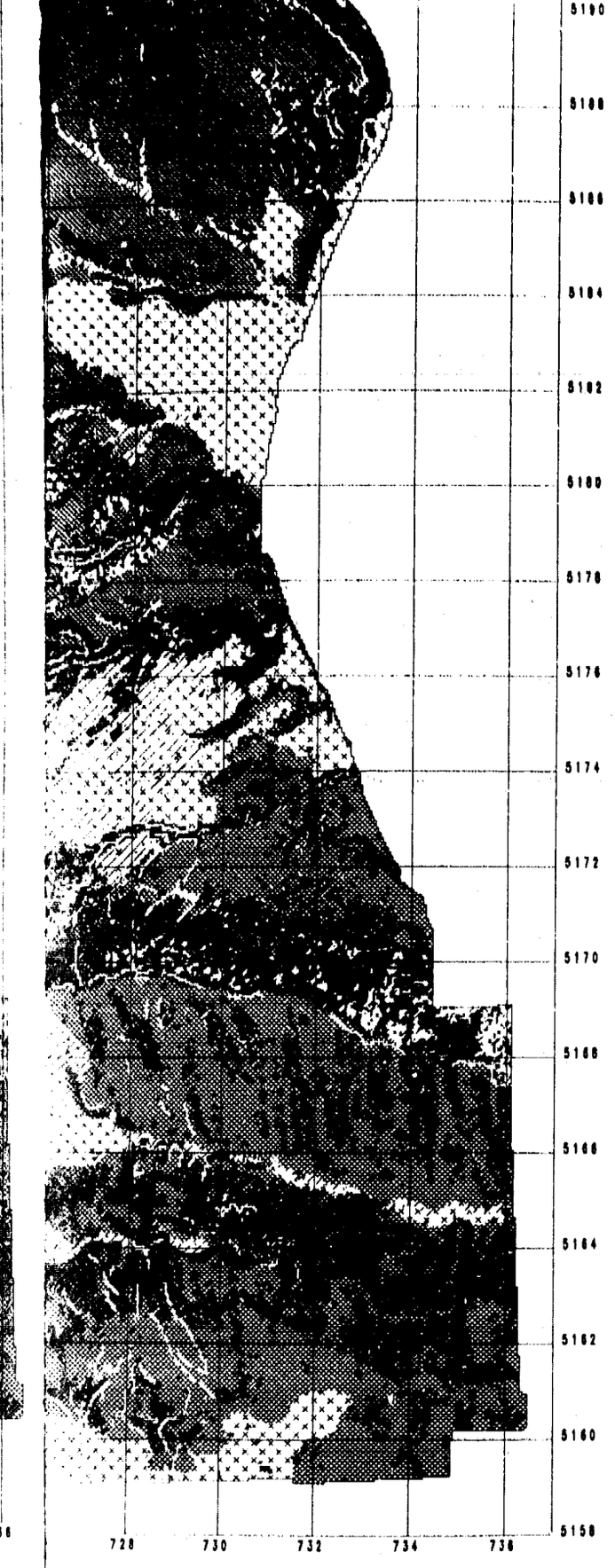


Plate 12. Speed limiting reason map for M998 (HMMWV) wheeled vehicle in the wet-wet slippery surf



SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

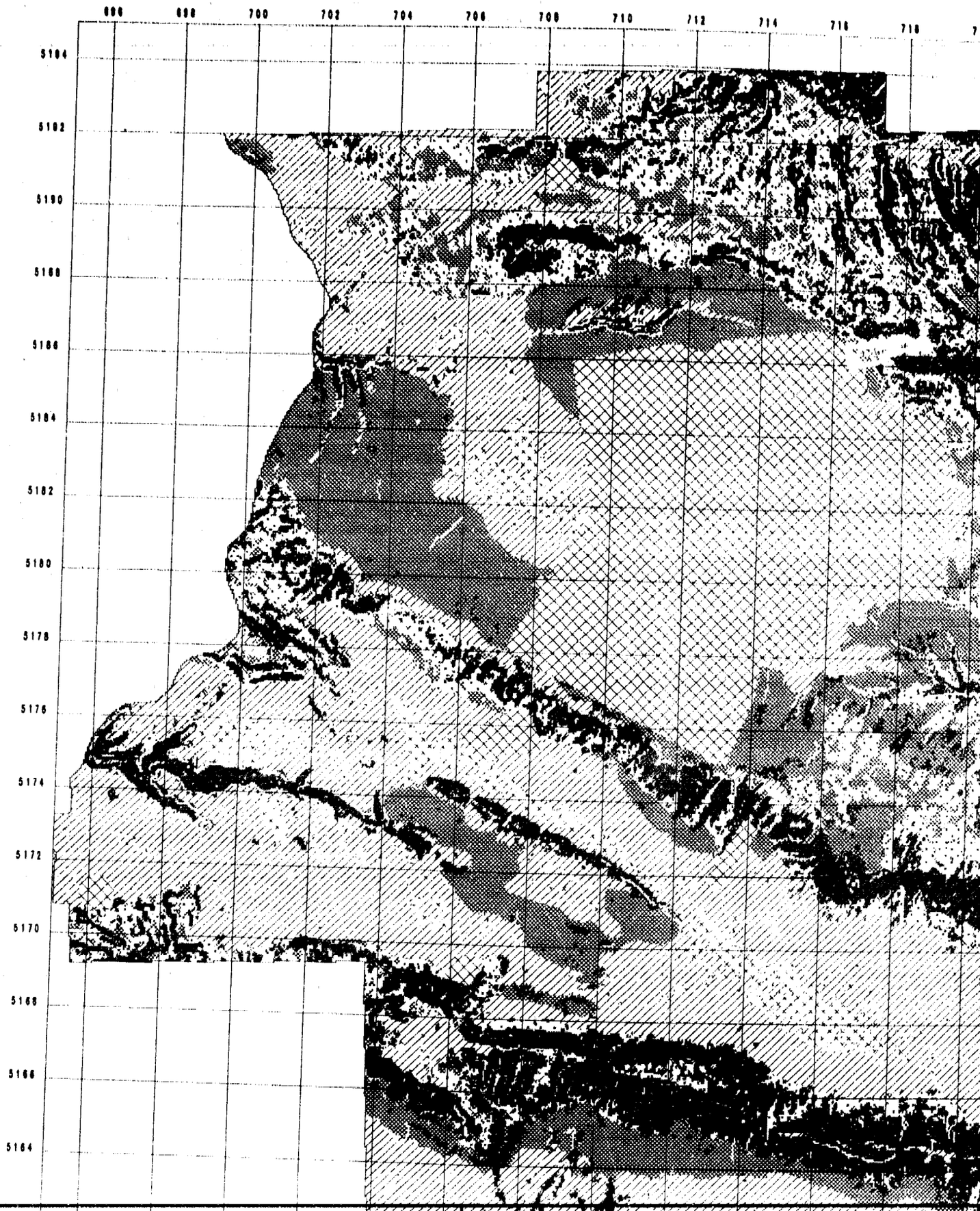
HMMWV
WET-WET SEASON
SLIPPERY CONDITION

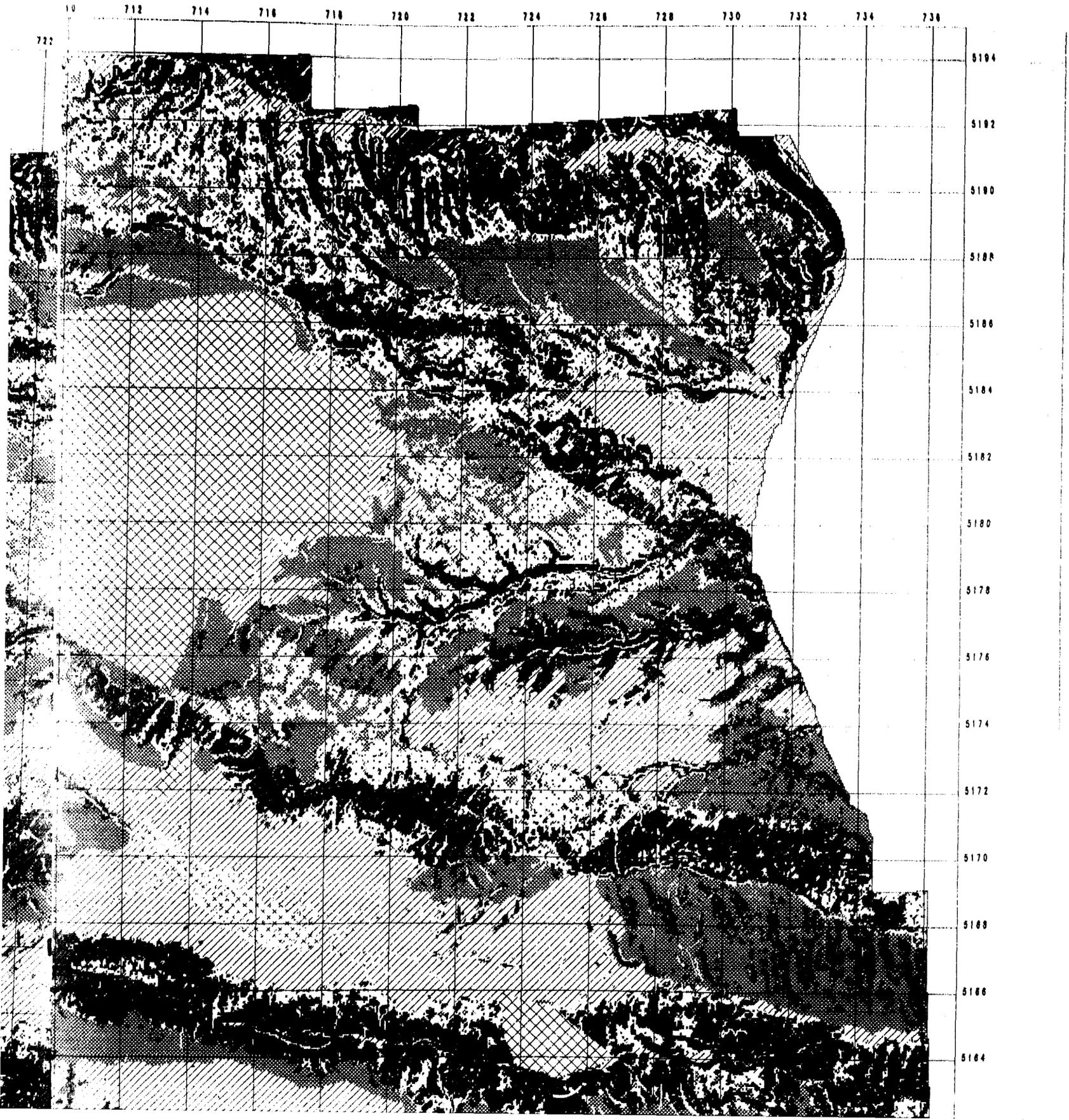
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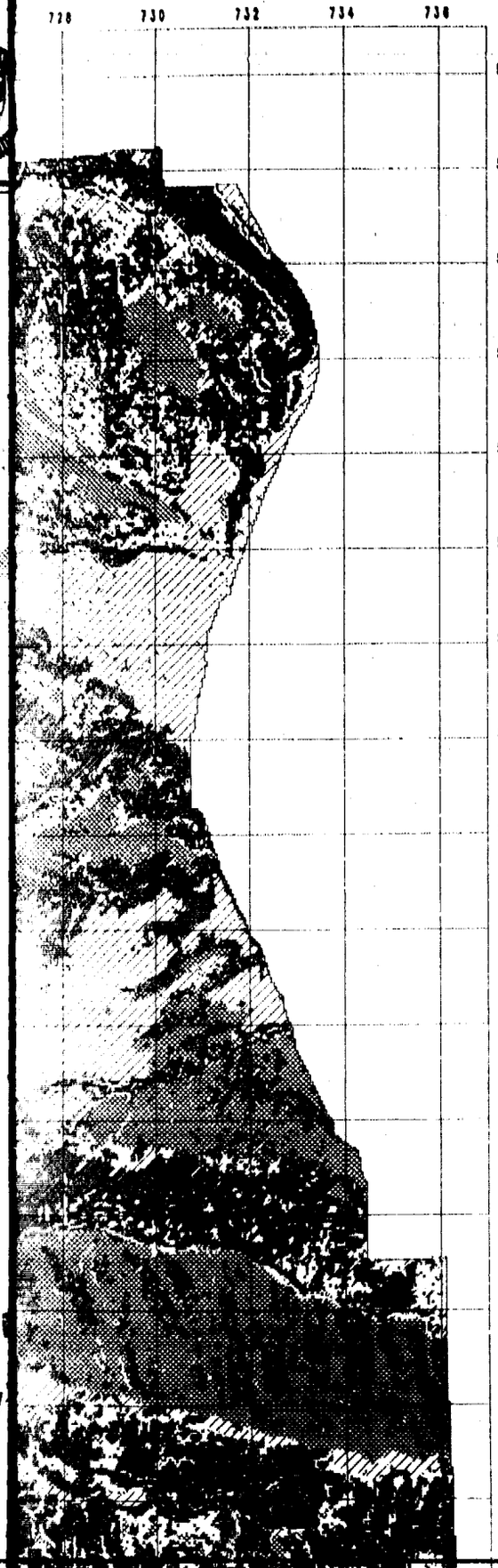
METERS

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cond hicle in the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

8X8 WHEELED COMBAT VEHICLE
WET-WET SEASON
SLIPPERY CONDITION

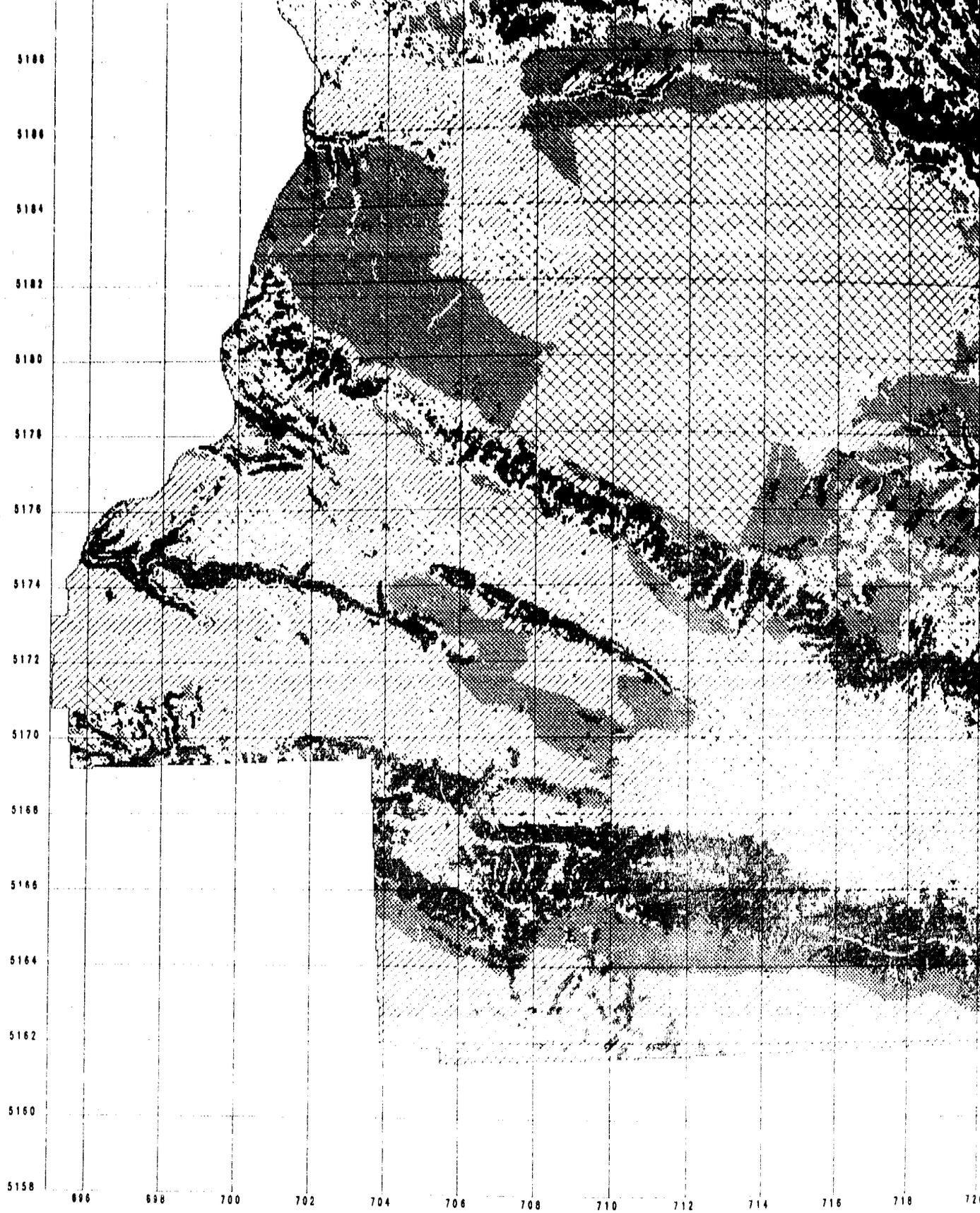


Plate 13. Speed limiting reason map

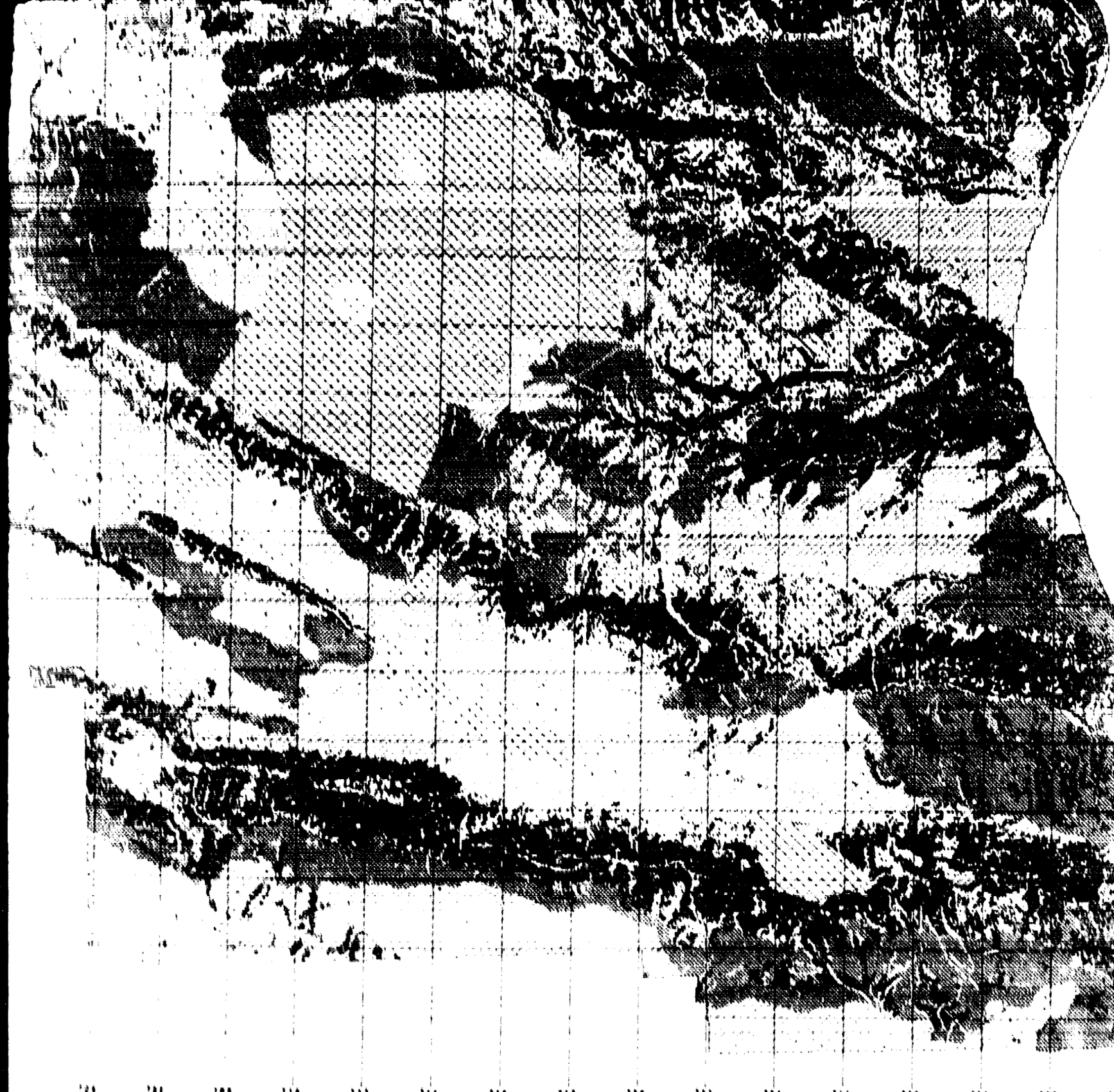
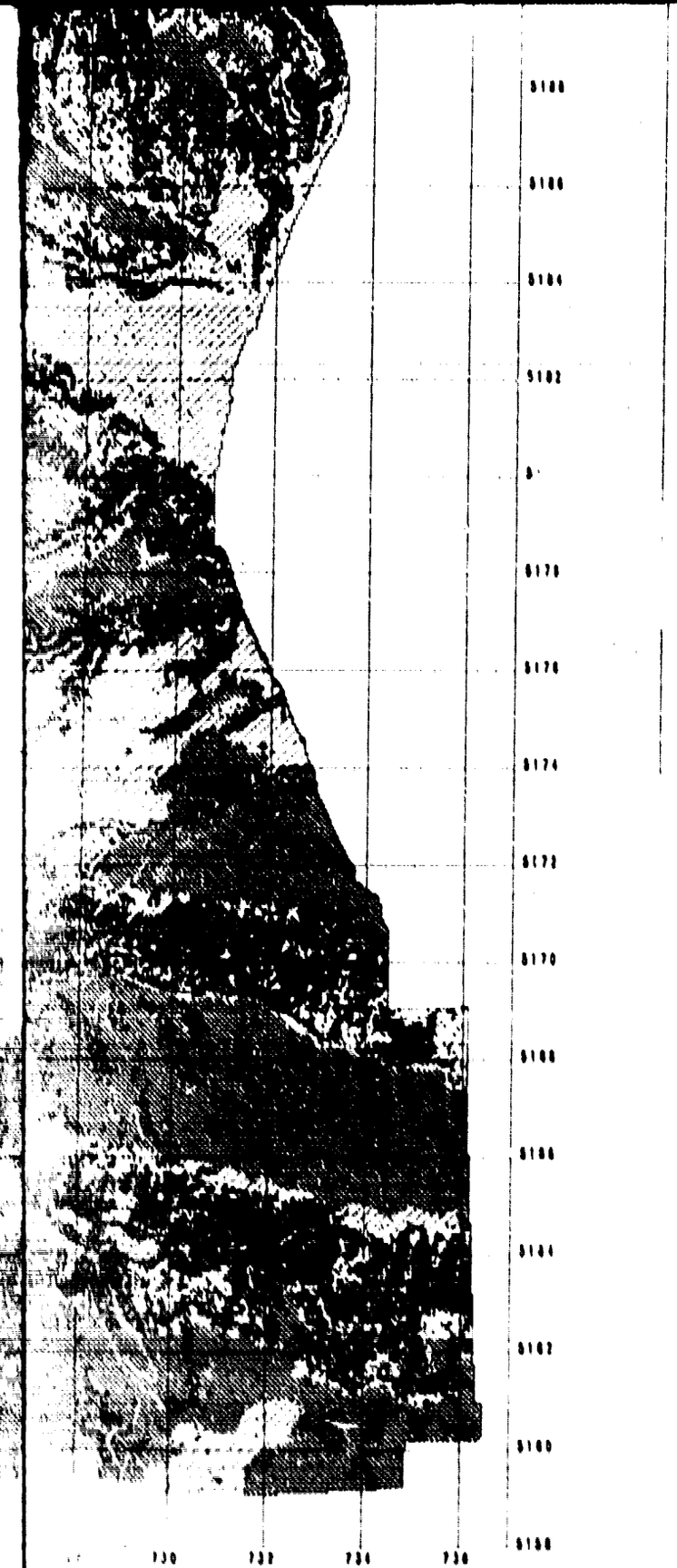


Plate 13. Speed limiting reason map for 8X8 wheeled combat vehicle in the wet-wet slippery



SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

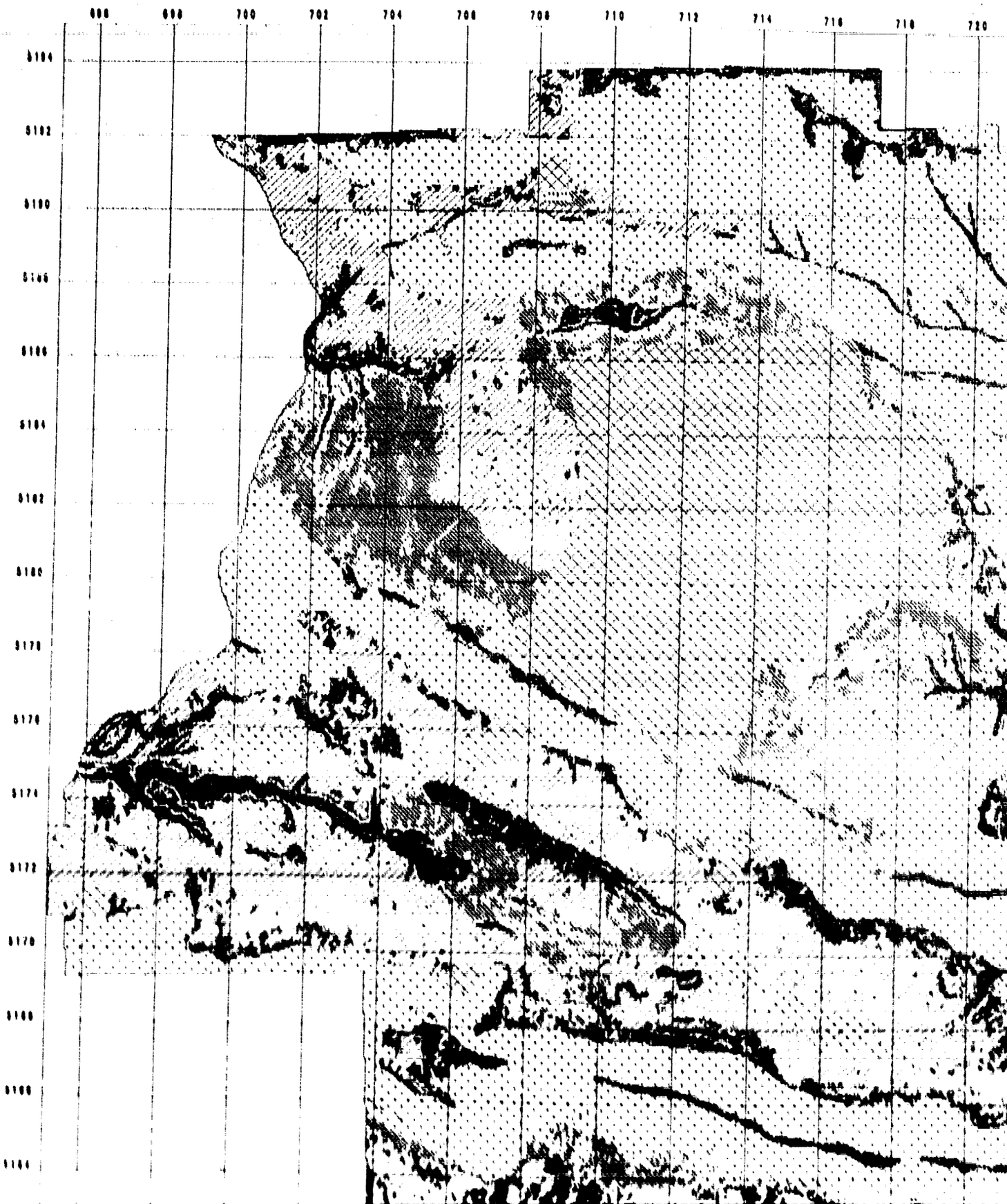
8X8 WHEELED COMBAT VEHICLE
WET-WET SEASON
SLIPPERY CONDITION

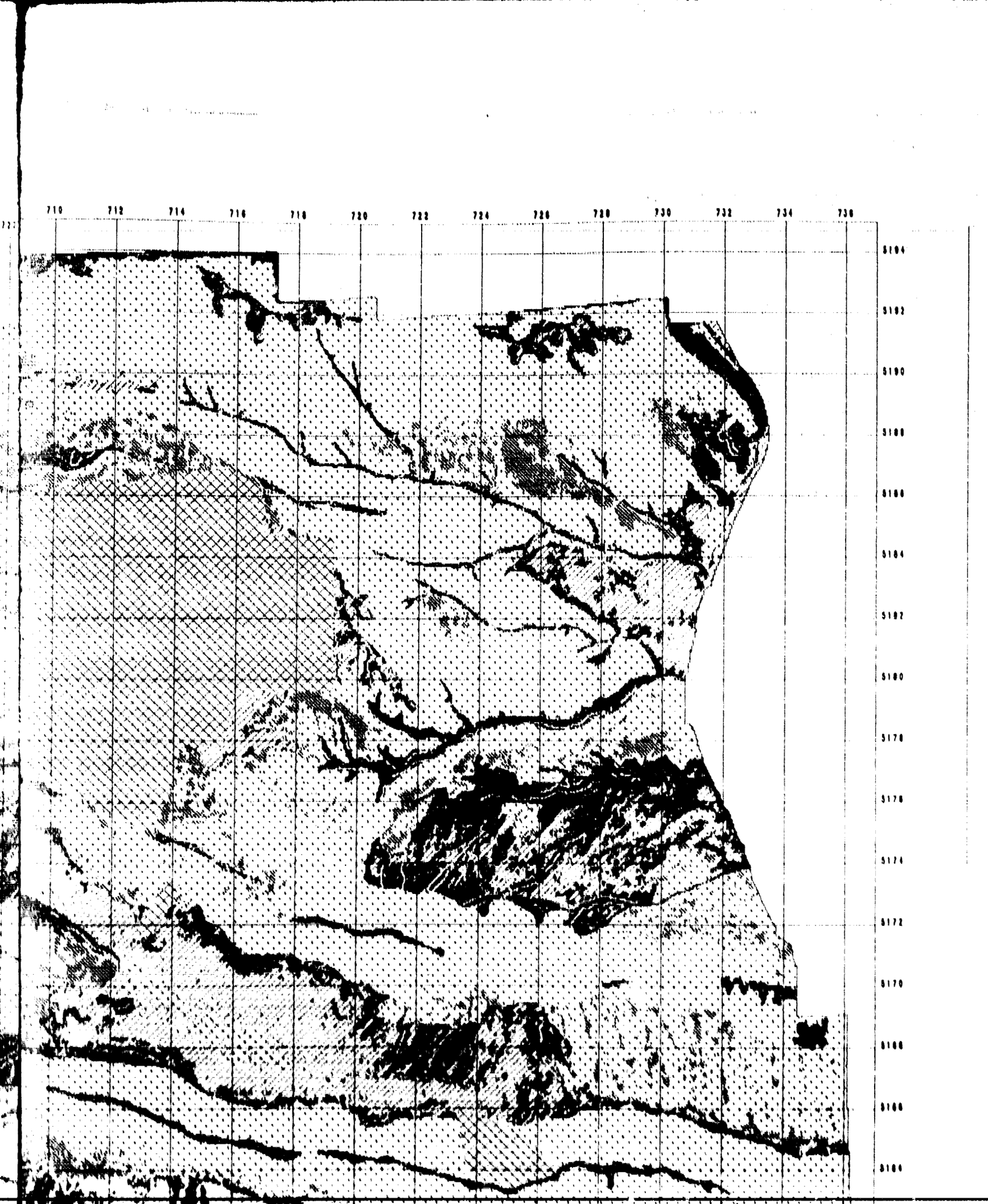
N

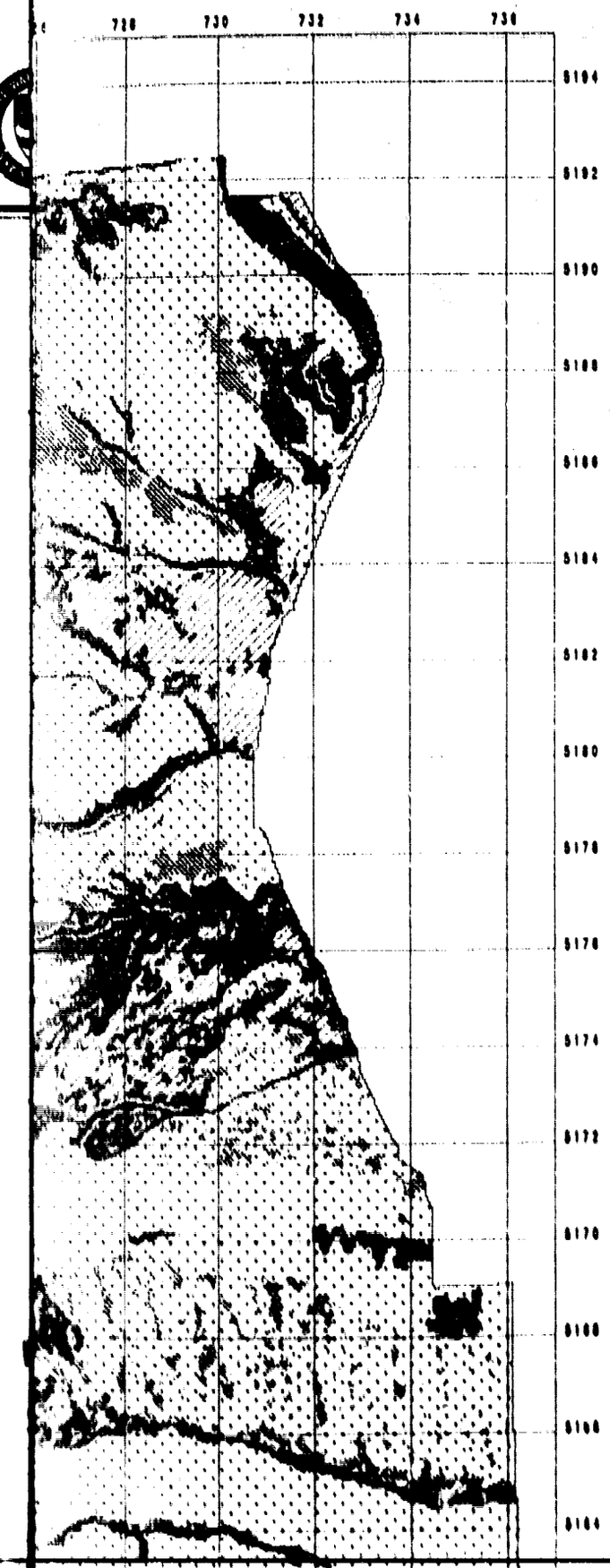
METERS

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in the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SPEED LIMITING REASON

SCALE 1:100000

OBSTACLE	CONE INDEX
VISIBILITY	TRACTION
VEGETATION	RESISTANCE
ACCELERATION/ DECELERATION	SOIL/SLOPE
MANEUVER	URBAN
RIDE	COMBINATION OF ANY TWO OR MORE FACTORS

YAKIMA FIRING CENTER

M60A3
WET-WET SEASON
SLIPPERY CONDITION

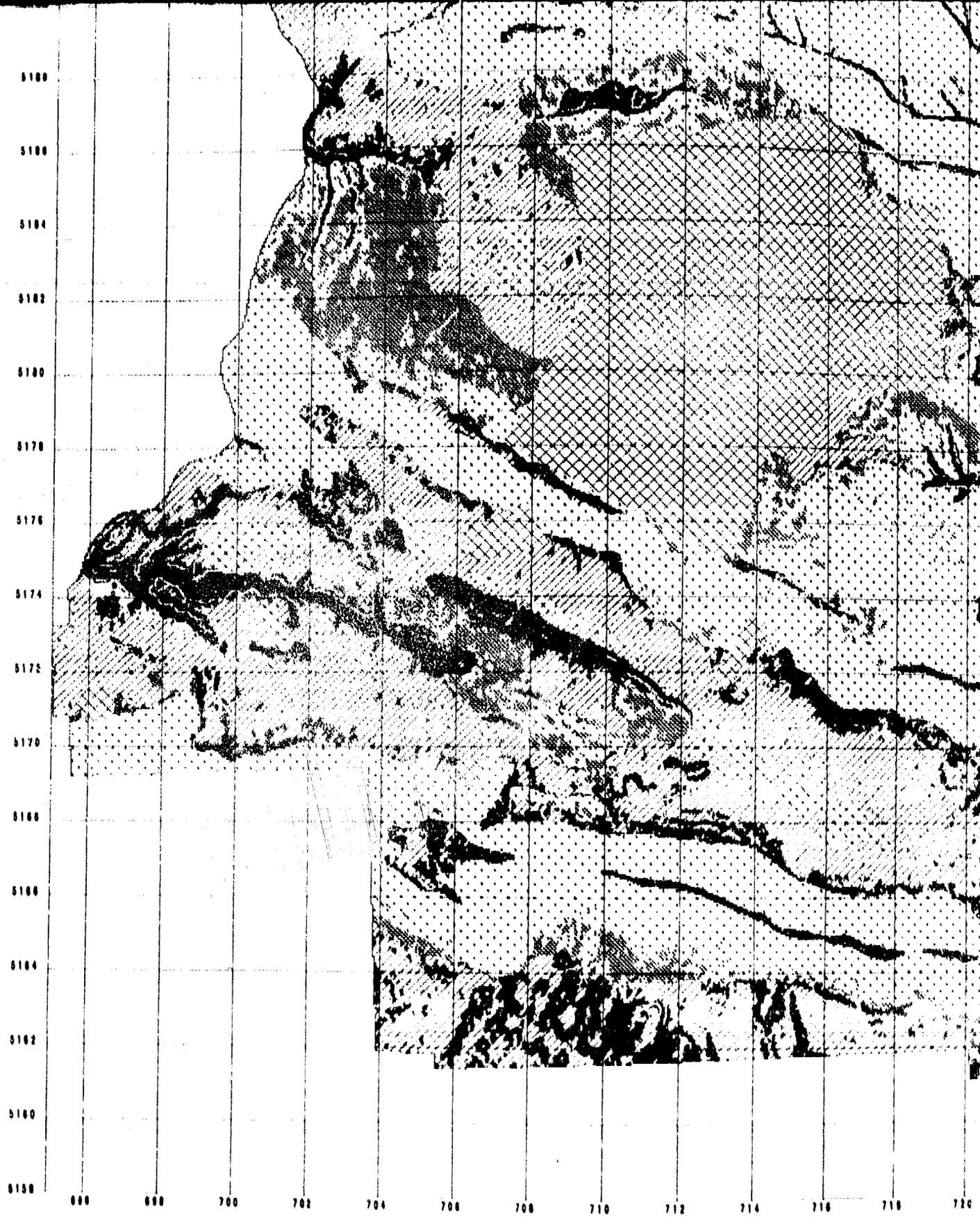


Plate 14. Speed limiting reason ma

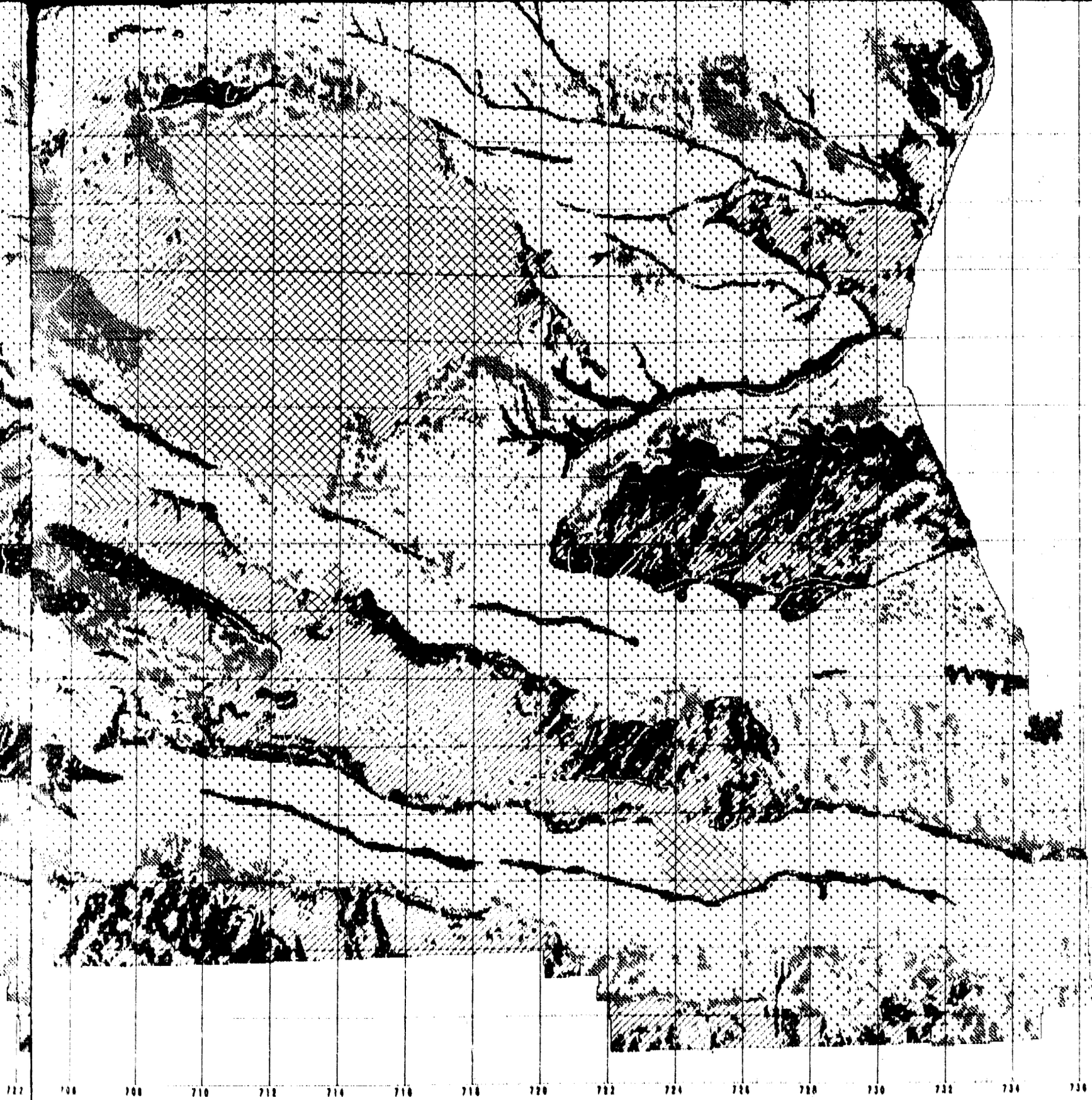
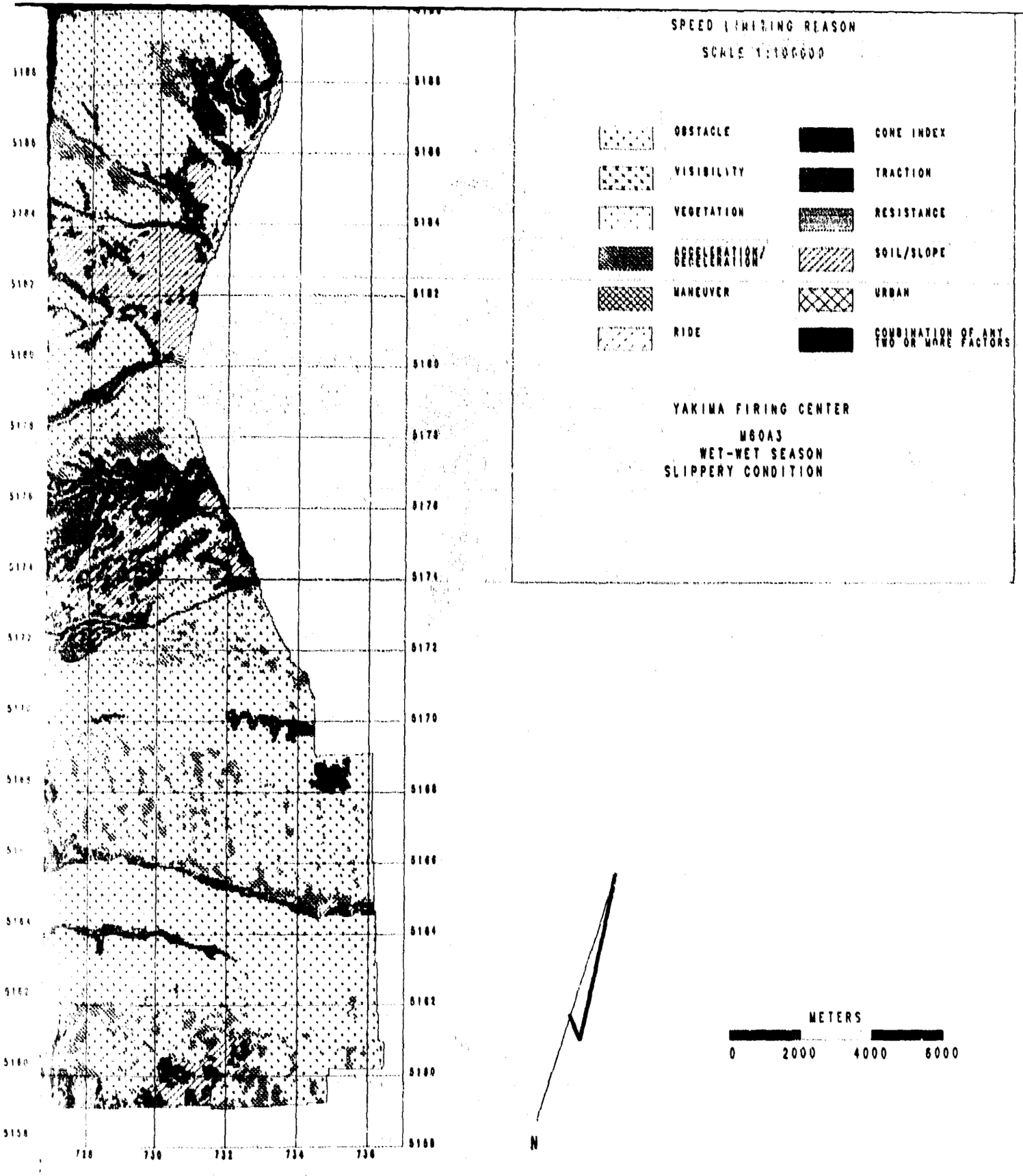
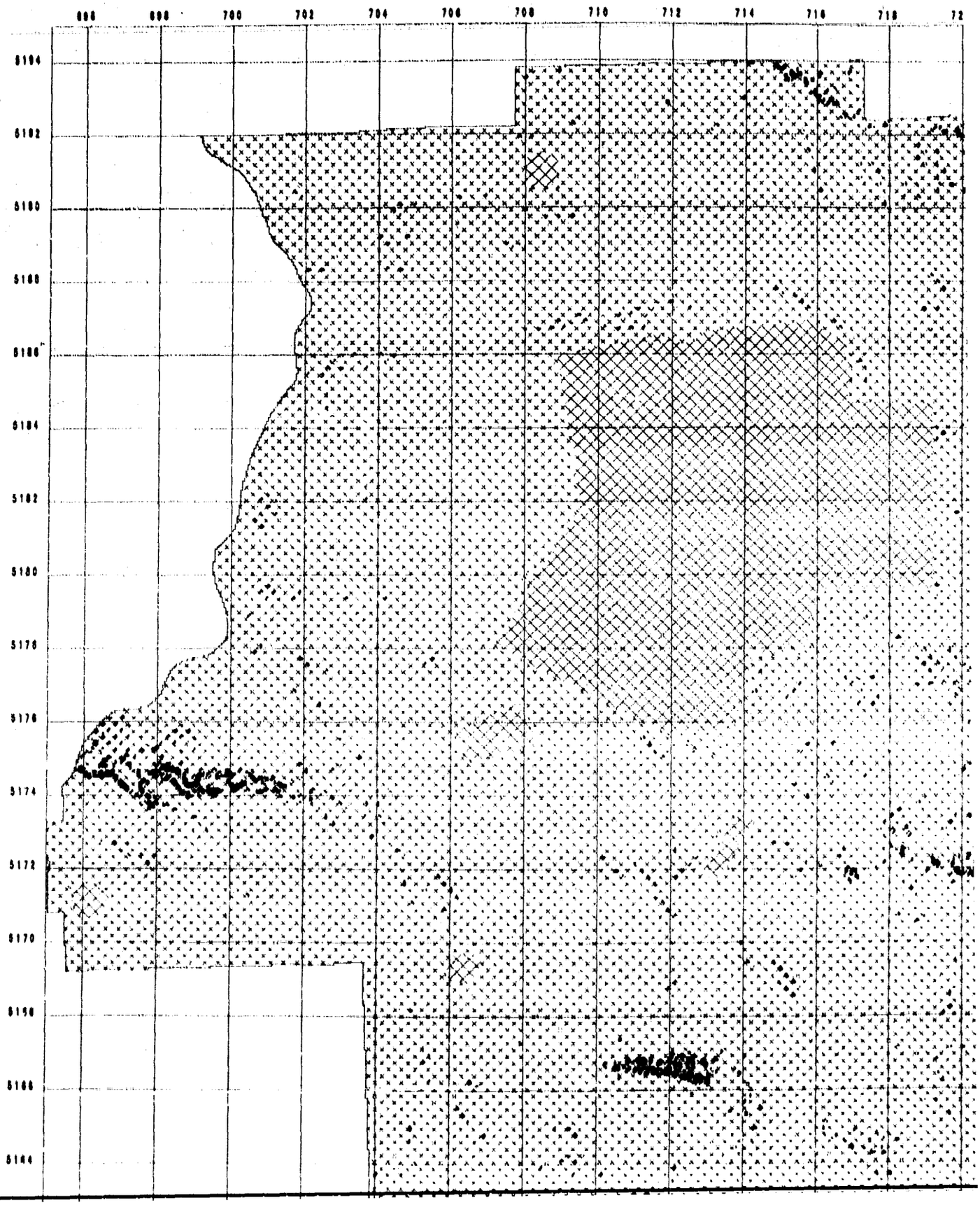
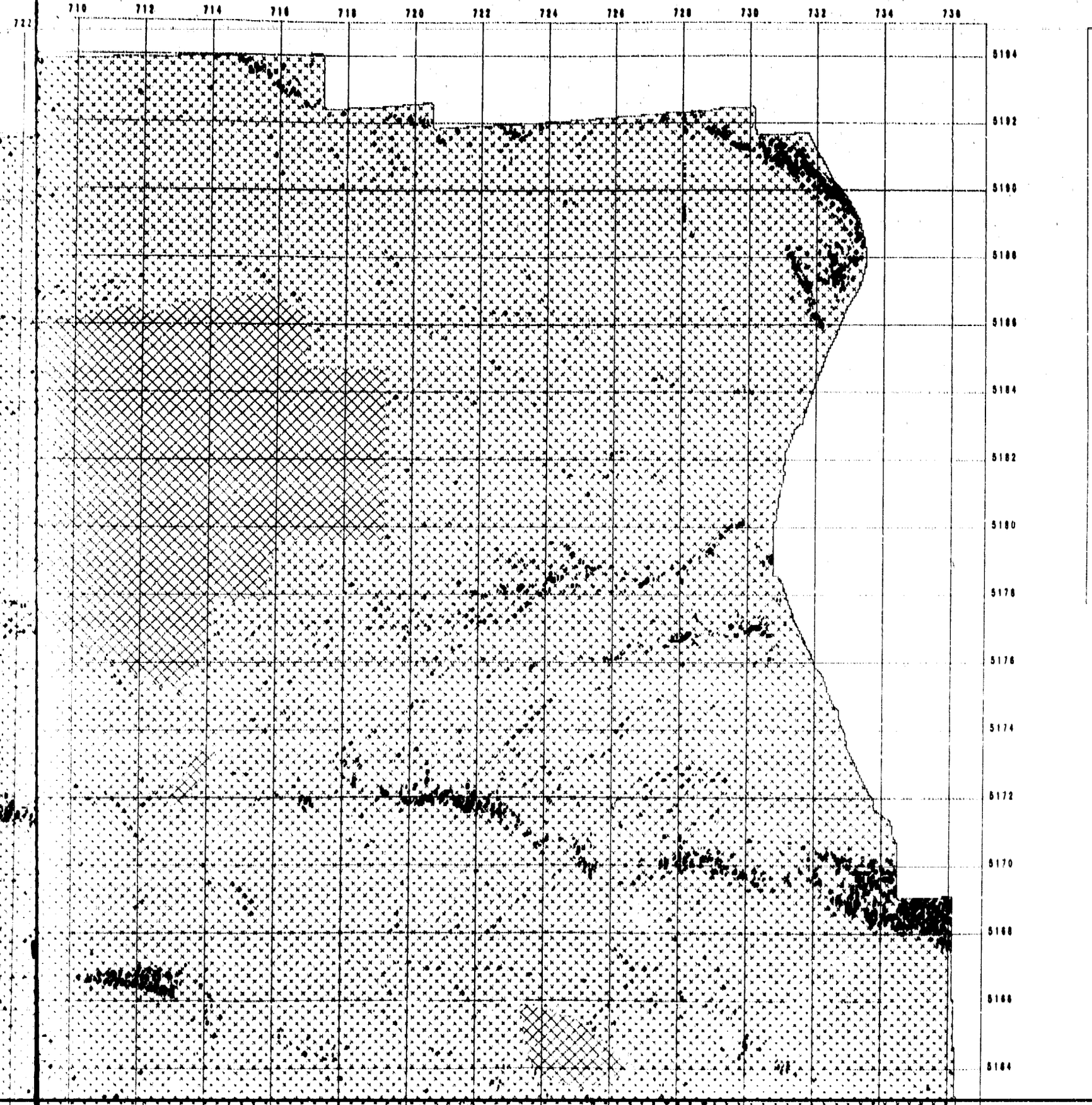


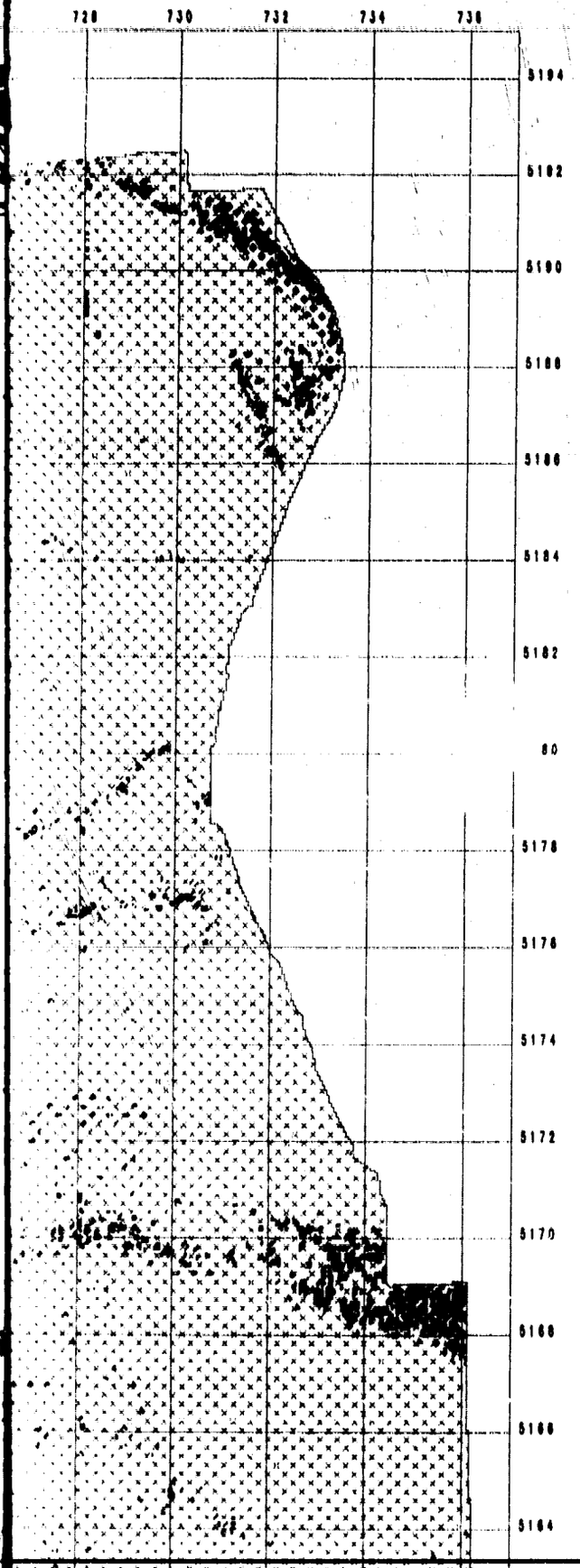
Plate 14. Speed limiting reason map for M60A3 combat tank in the wet-wet slippery surface condit



n the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
10 PASSES

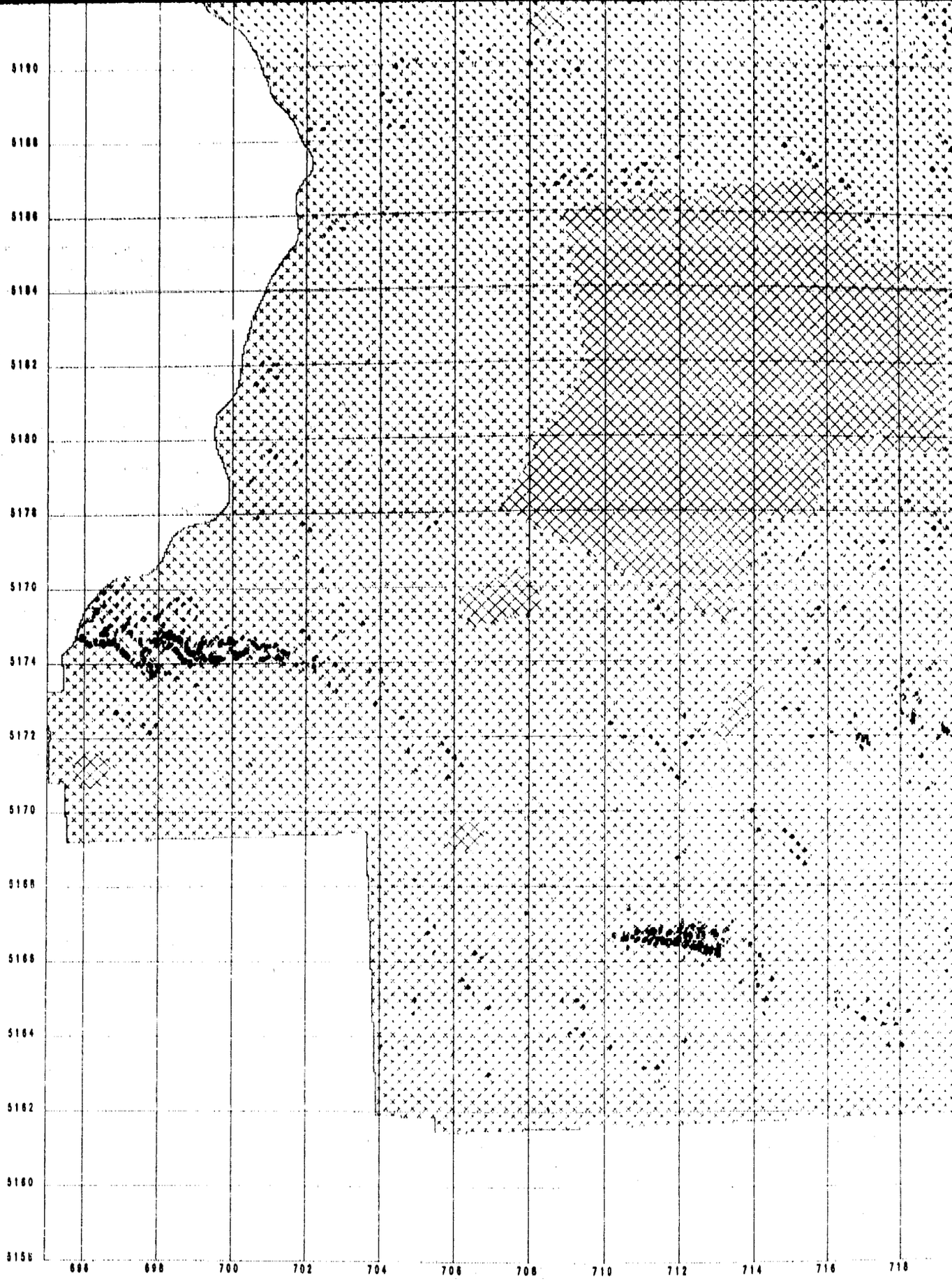


Plate 15. Ten pass soil disturbance level ma

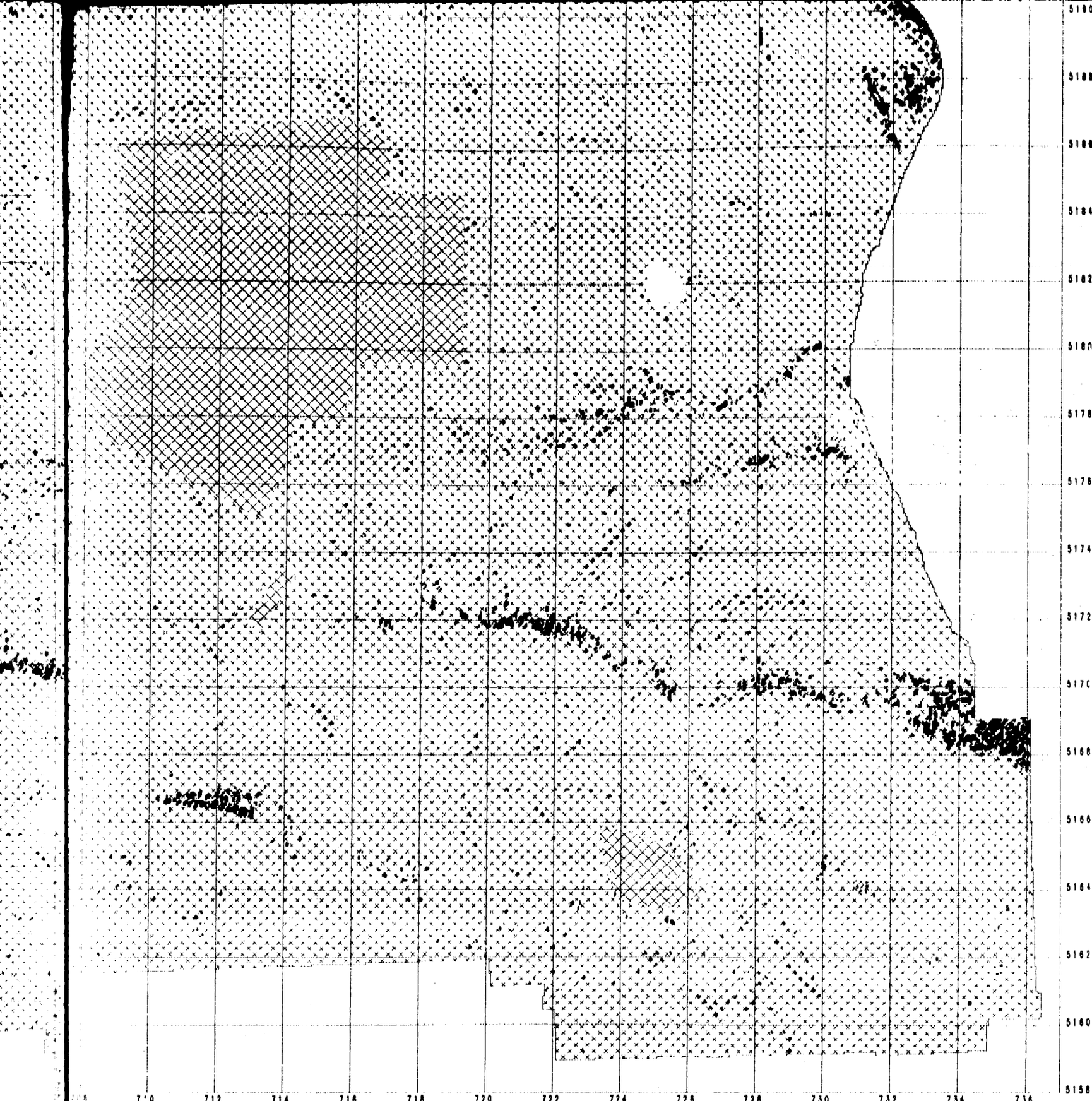
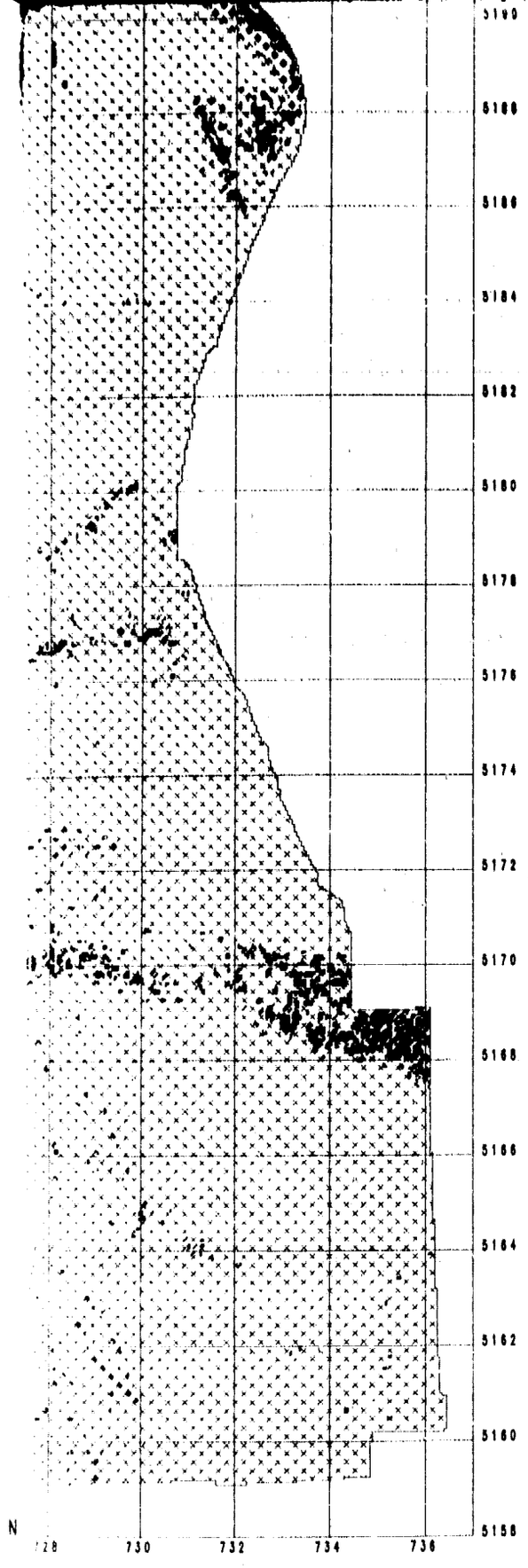


Plate 15. Ten pass soil disturbance level map for 3-3-5 and 4-3-3 (HMMWV) force structures in the dry normal surface



SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>8-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-8in)	WATER

YAKIMA FIRING CENTER

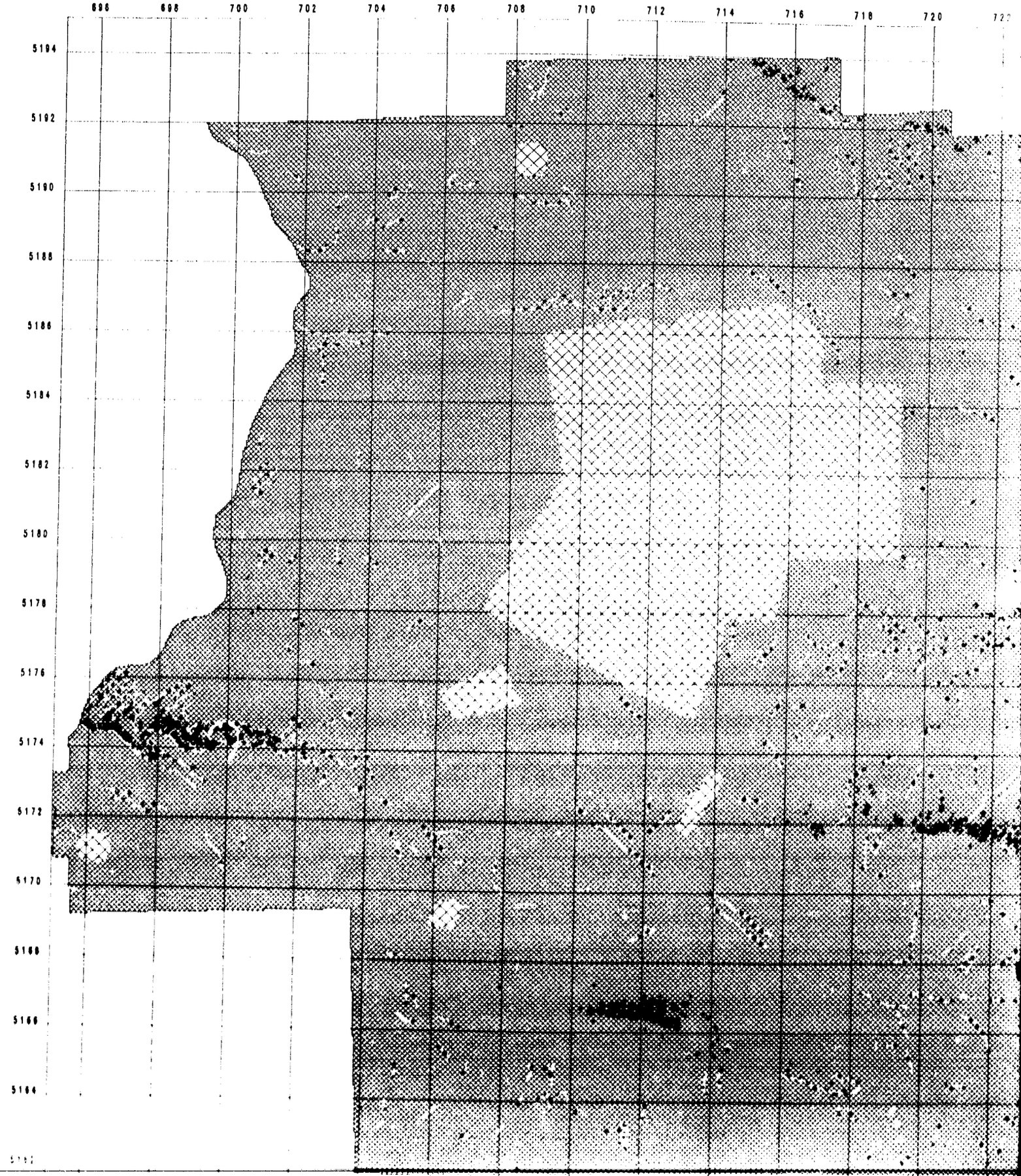
3-3-5 FORCE STRUCTURE

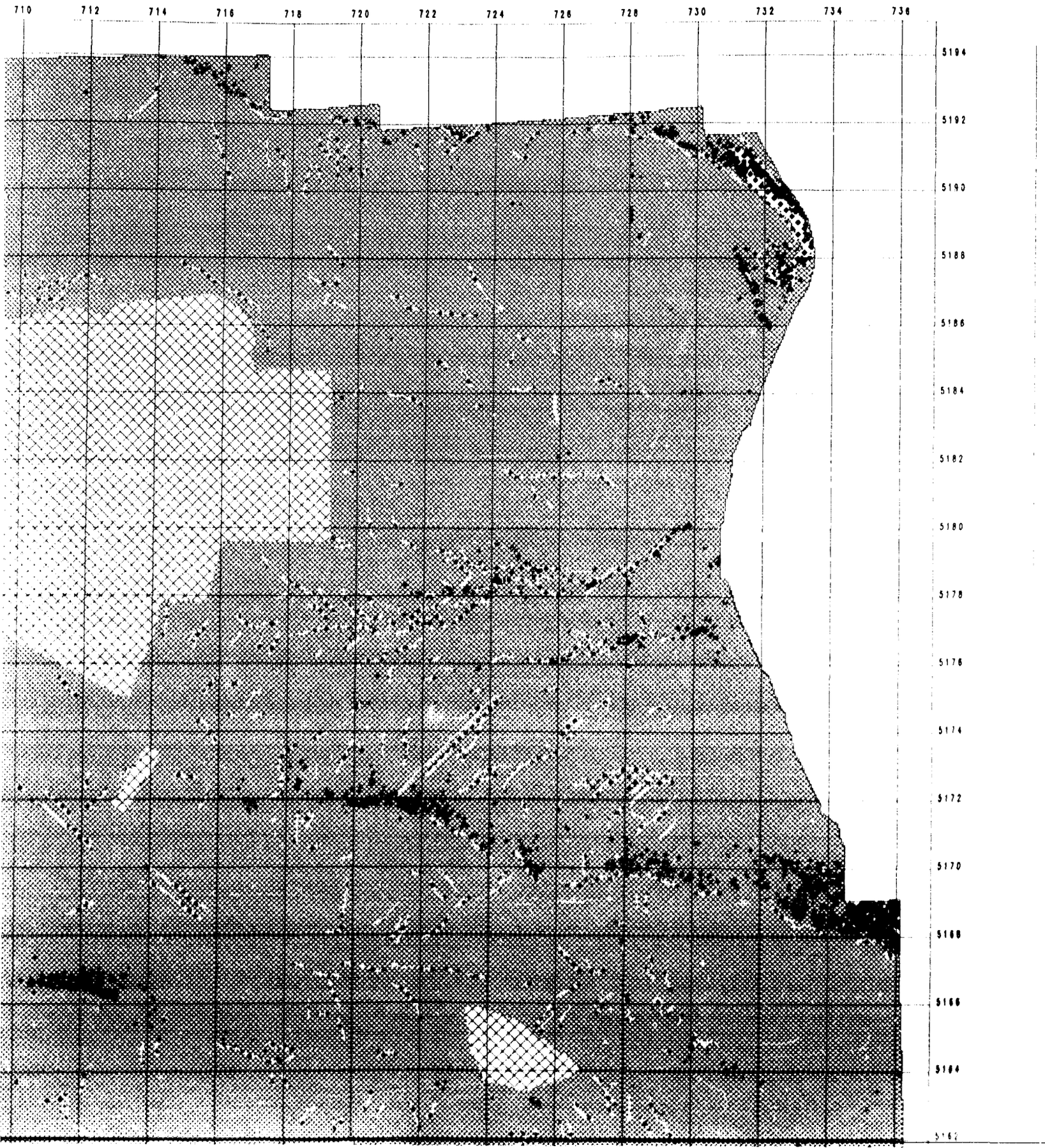
DRY SEASON
NORMAL CONDITION
10 PASSES

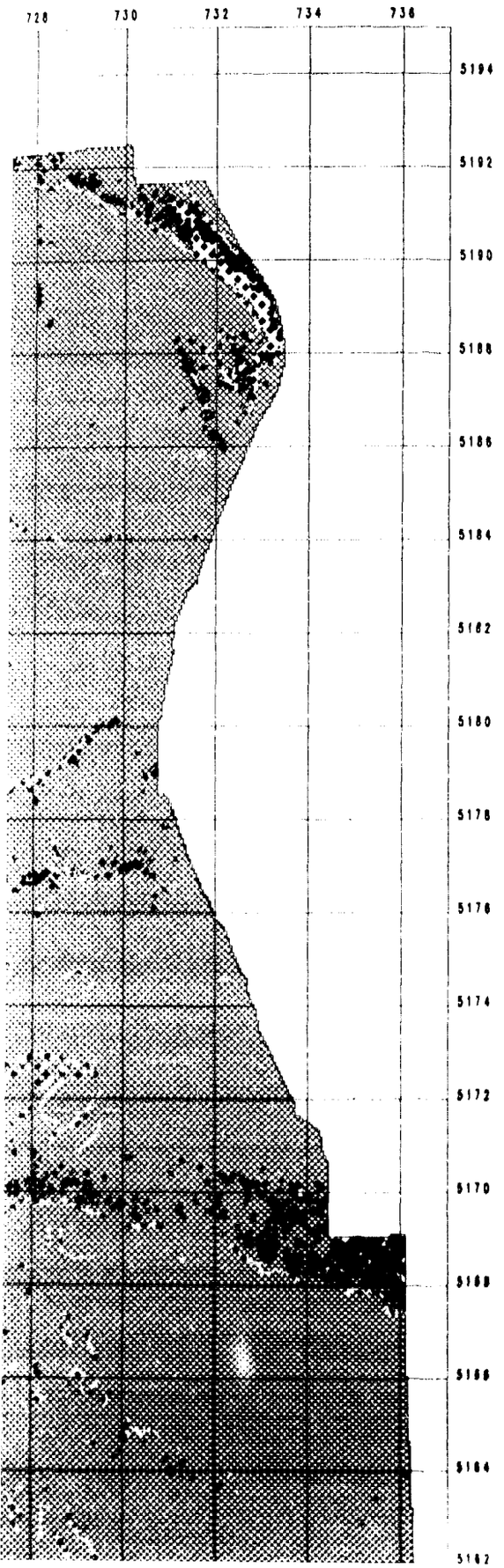




ition rce structures in the dry normal surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO

MINIMUM (0-.5in)

SLIGHT (>.5-2in)

MODERATE (>2-5in)

HIGH (>5-12in)

SEVERE (>12in)

URBAN/ OFF LIMITS

WATER

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
50 PASSES

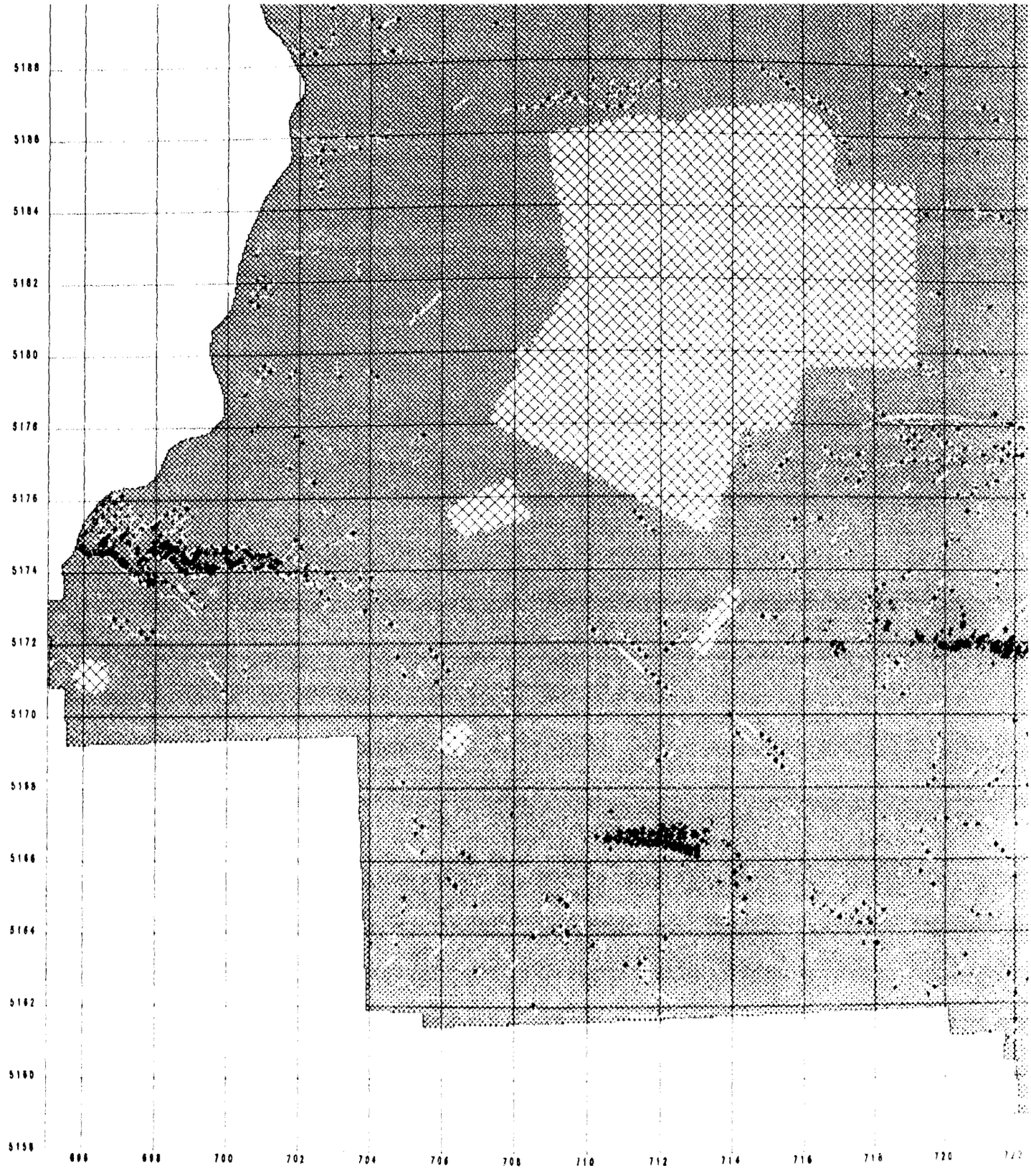
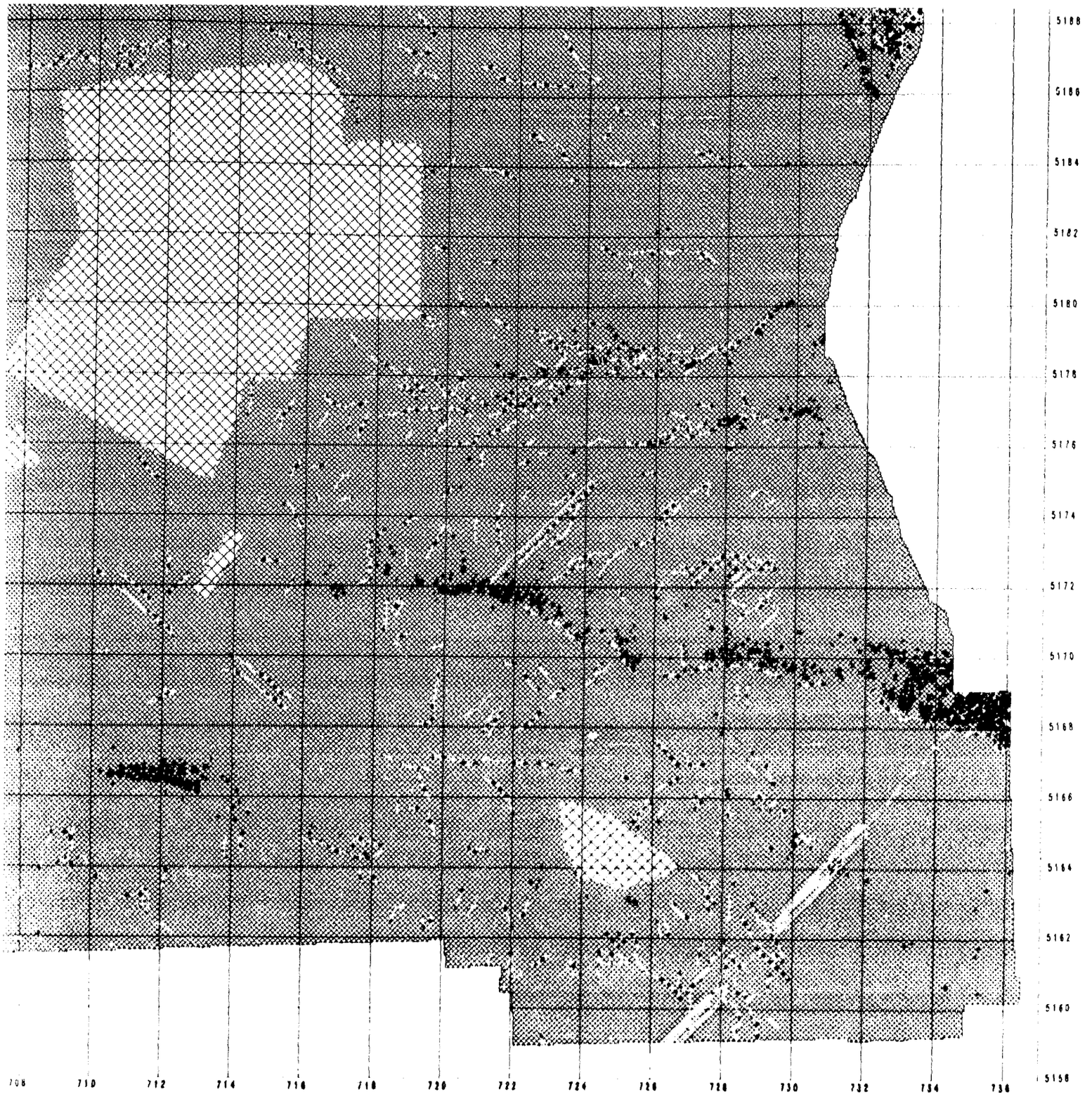
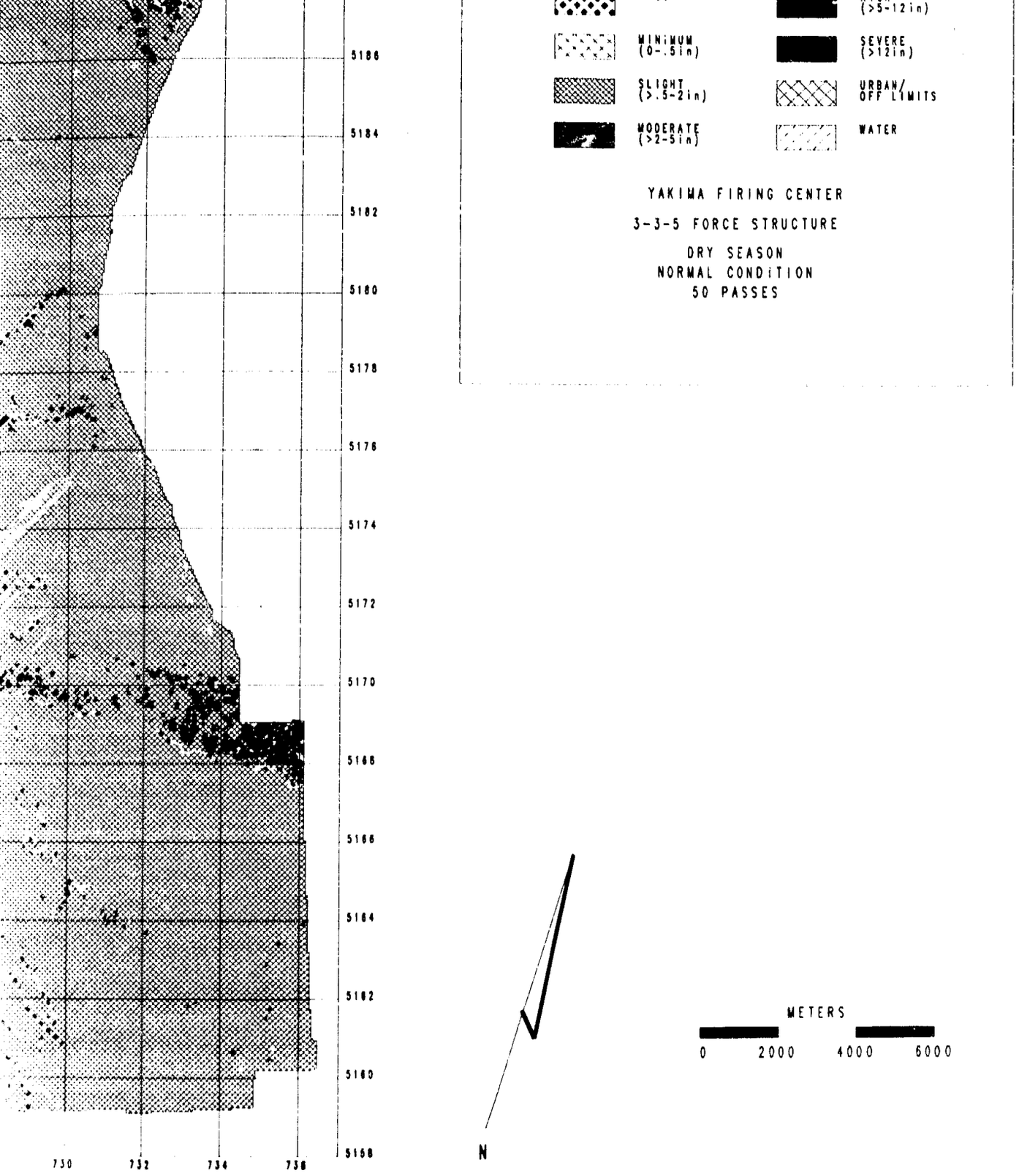


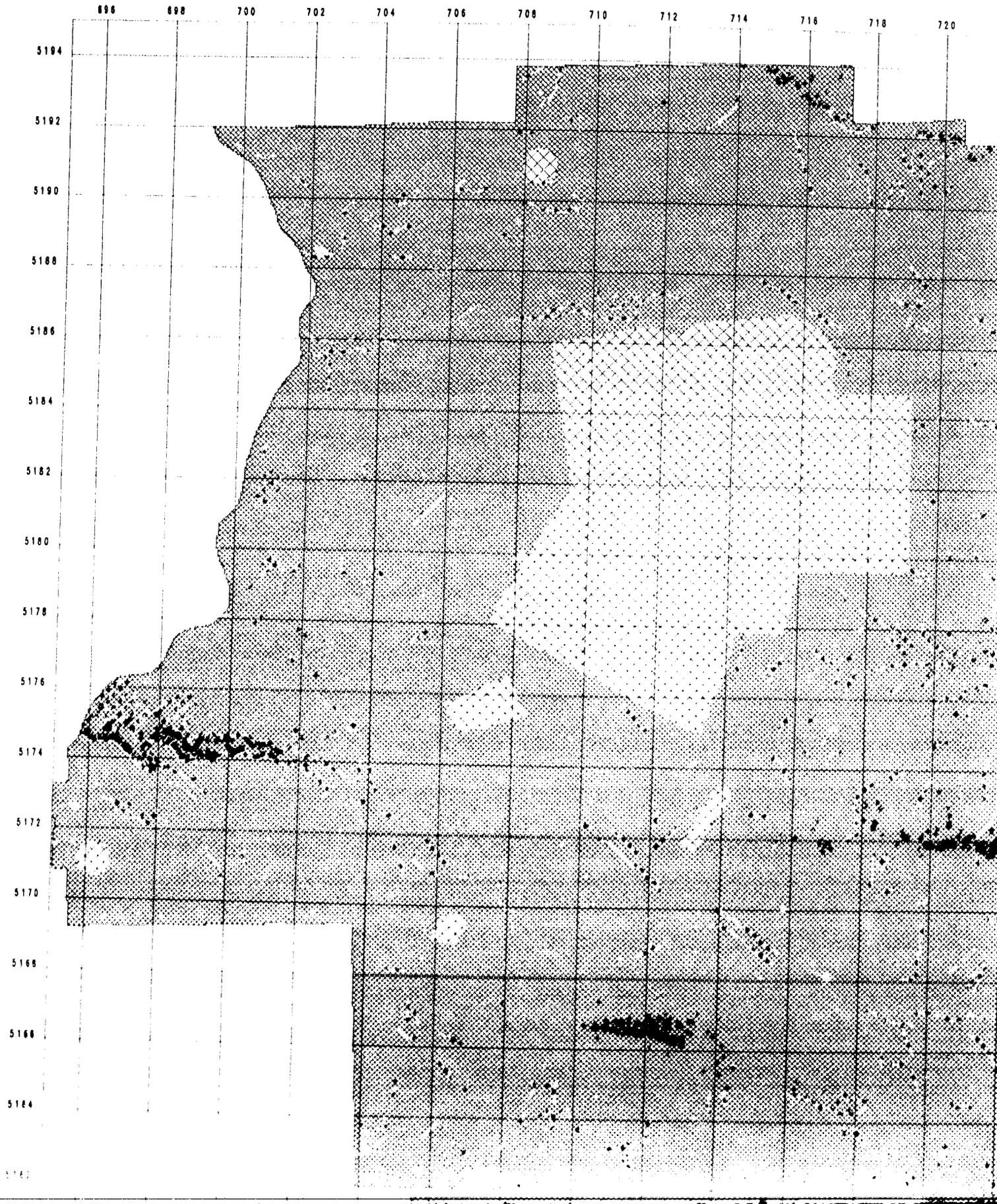
Plate 16. Fifty pass soil disturbance level map for 3-3-5 a

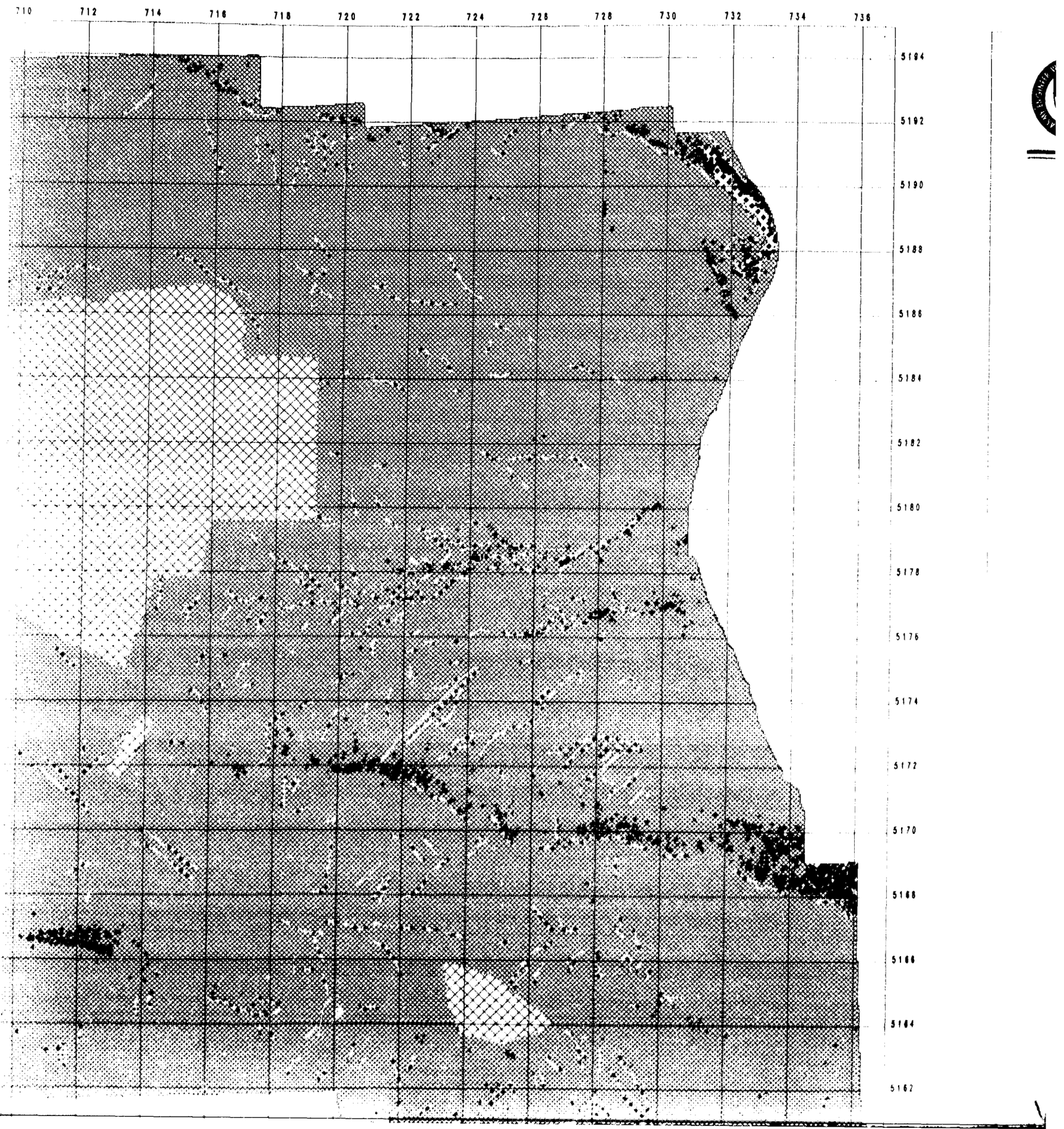


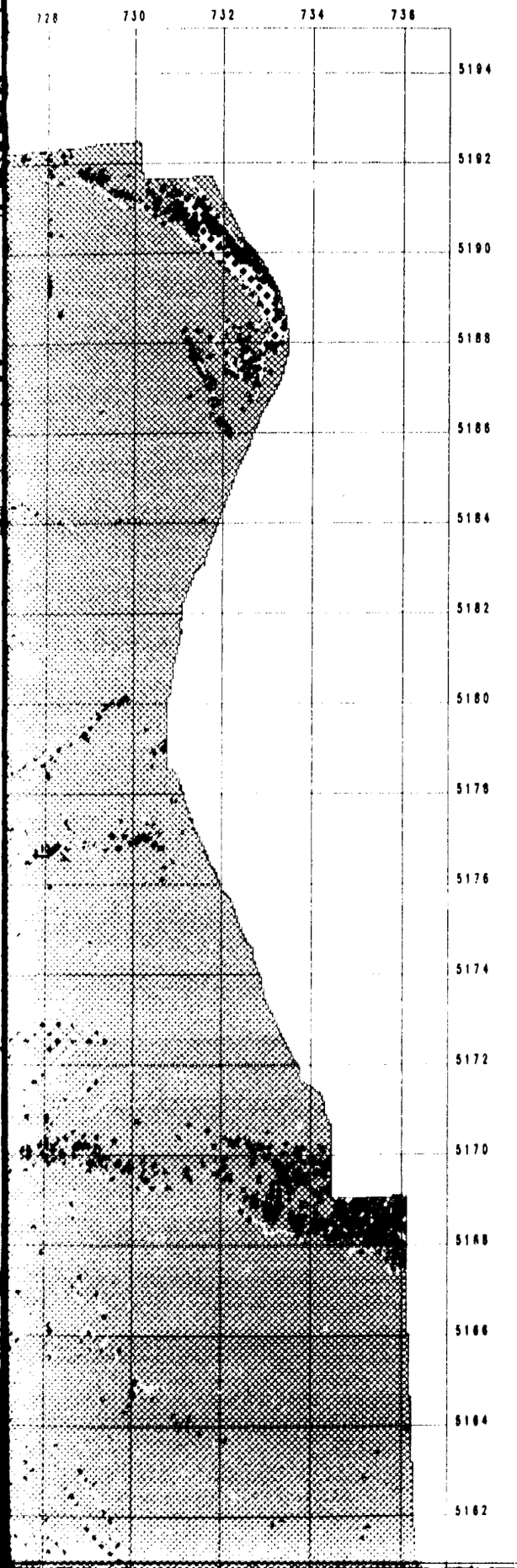
ate 16. **Fifty pass soil disturbance level map for 3-3-5 and 4-3-3 (HMMWV) force structures in the dry normal surface condition**



structures in the dry normal surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO

MINIMUM (0-.5in)

SLIGHT (>.5-2in)

MODERATE (>2-5in)

HIGH (>5-12in)

SEVERE (>12in)

URBAN/ OFF LIMITS

WATER

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
1000 PASSES

METERS

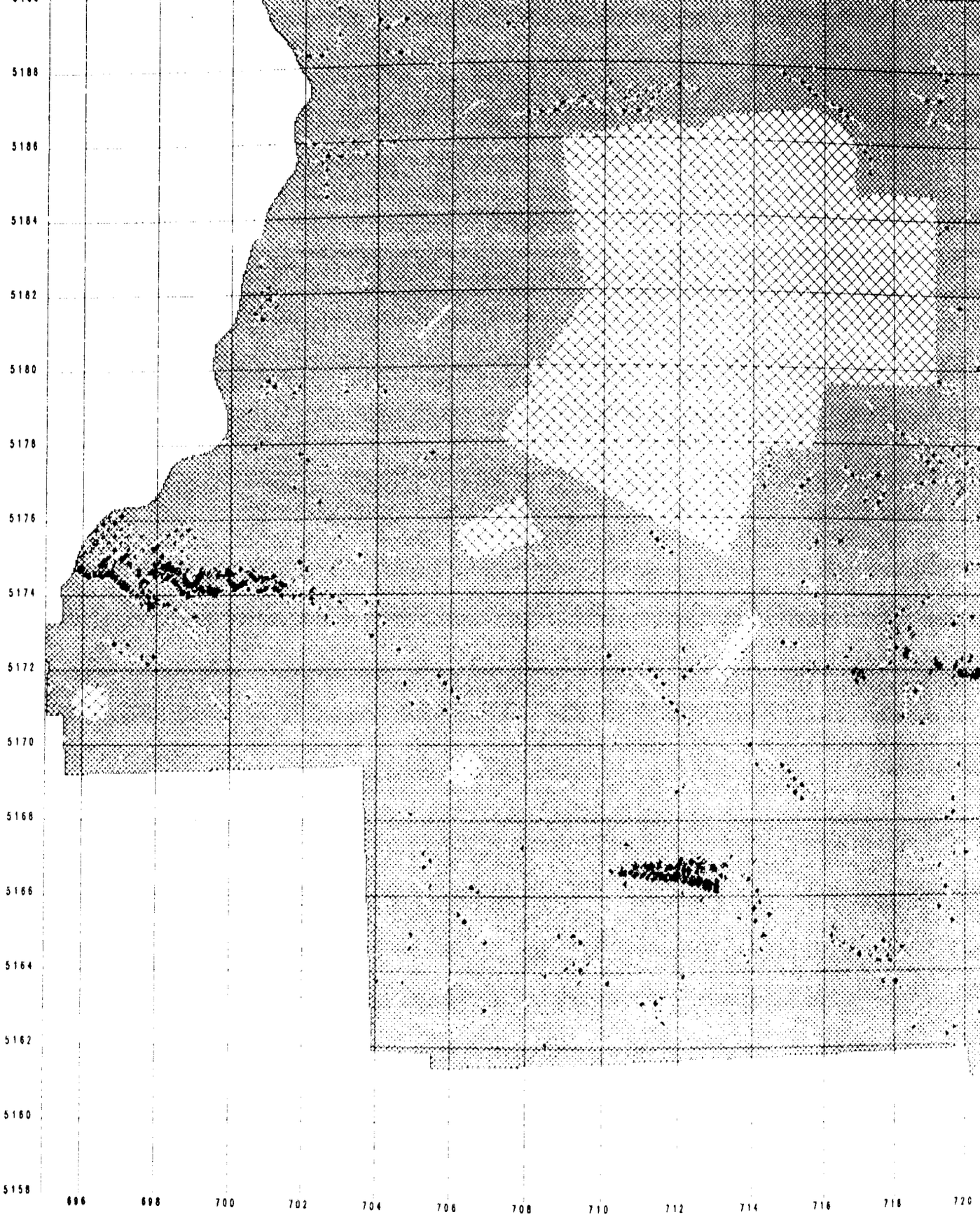
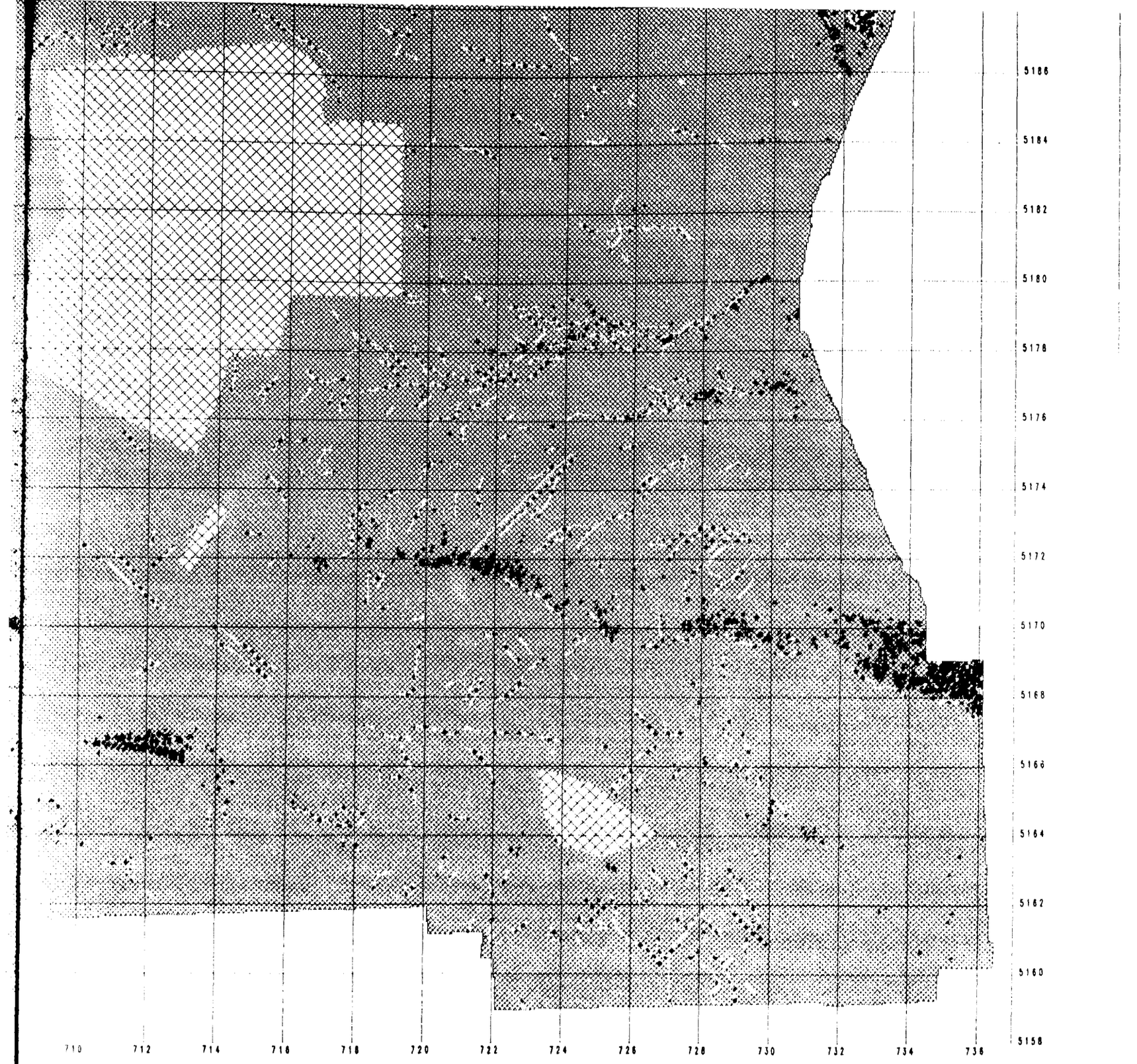
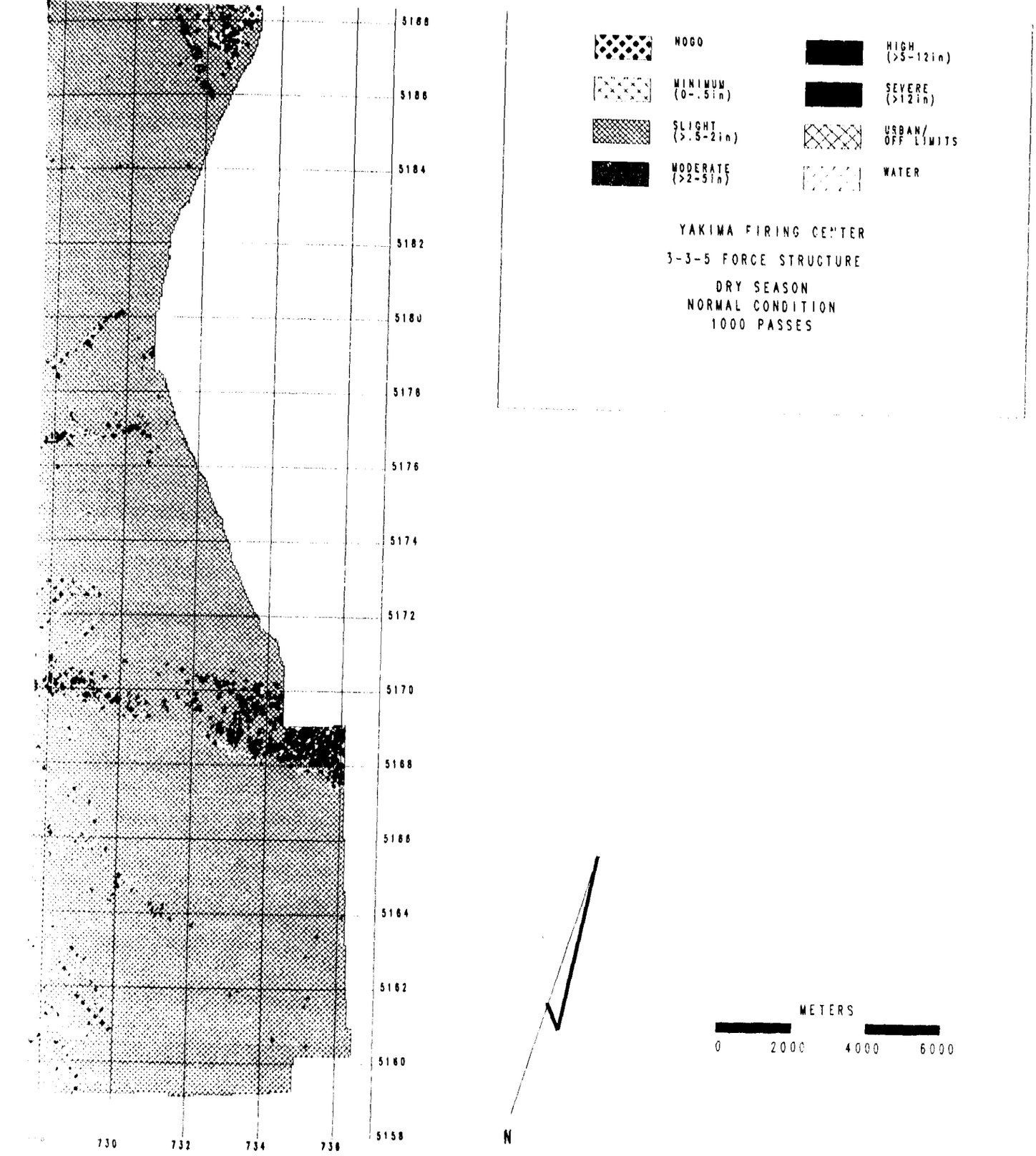


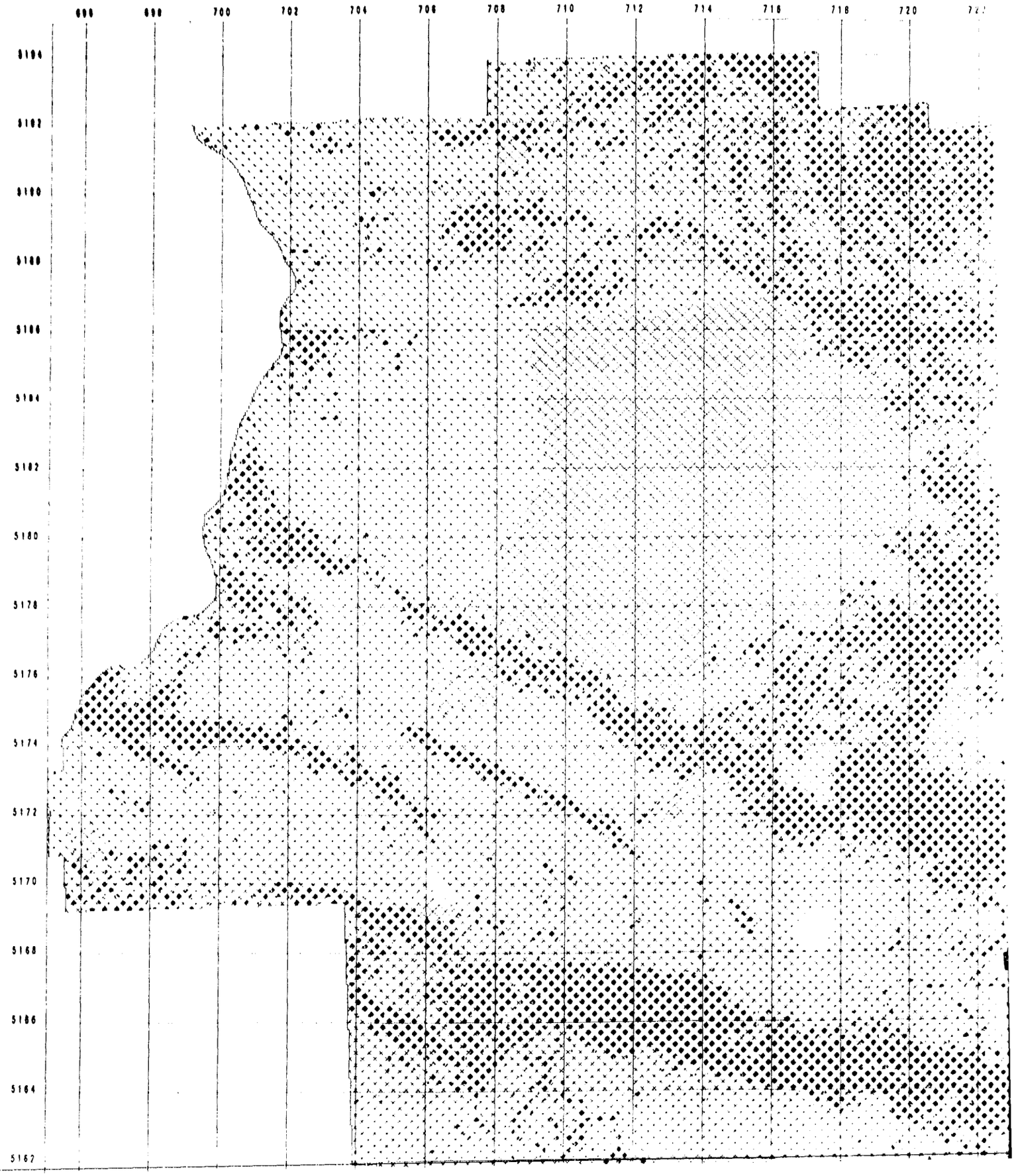
Plate 17. One thousand pass soil disturbance level ma

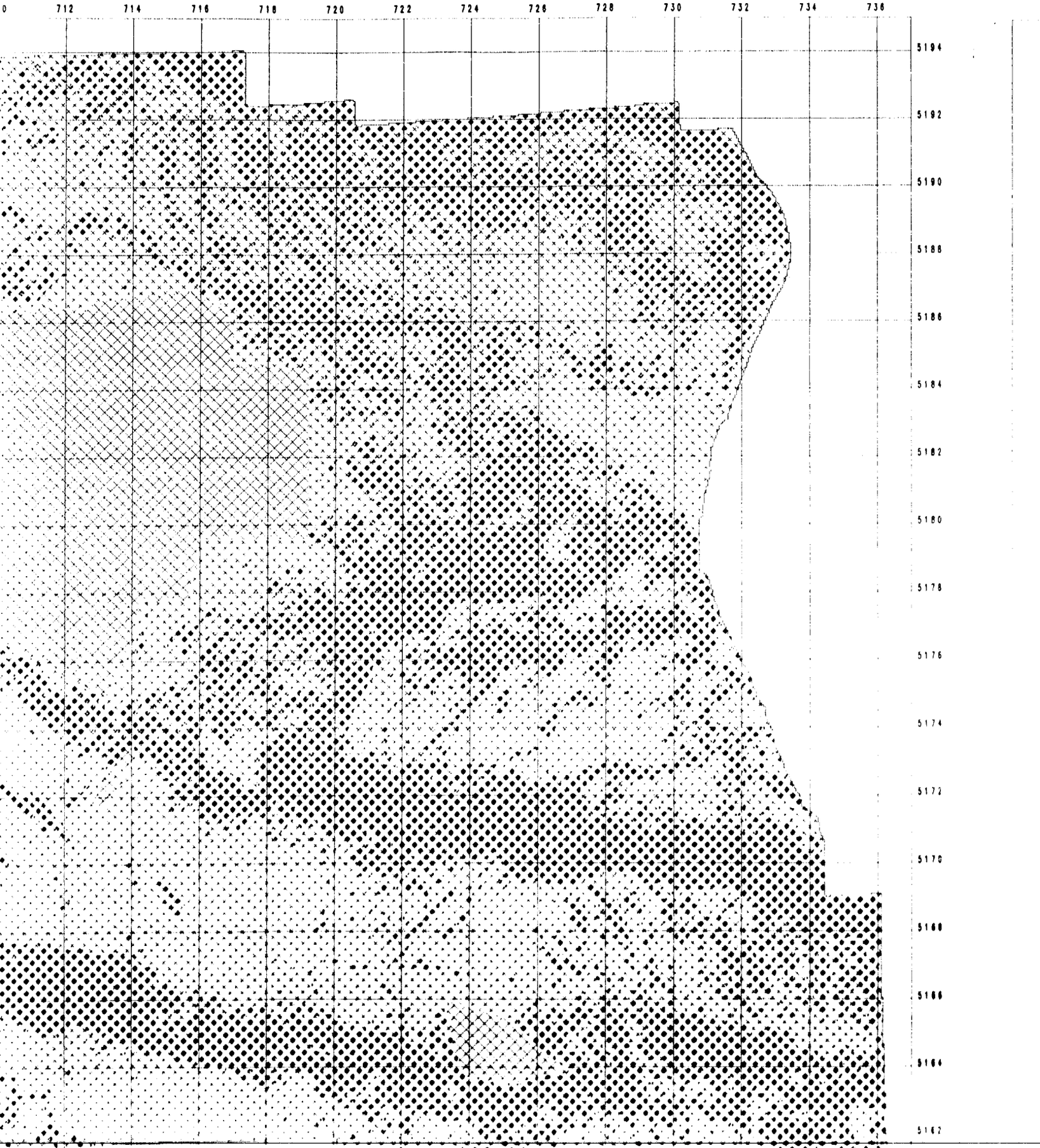


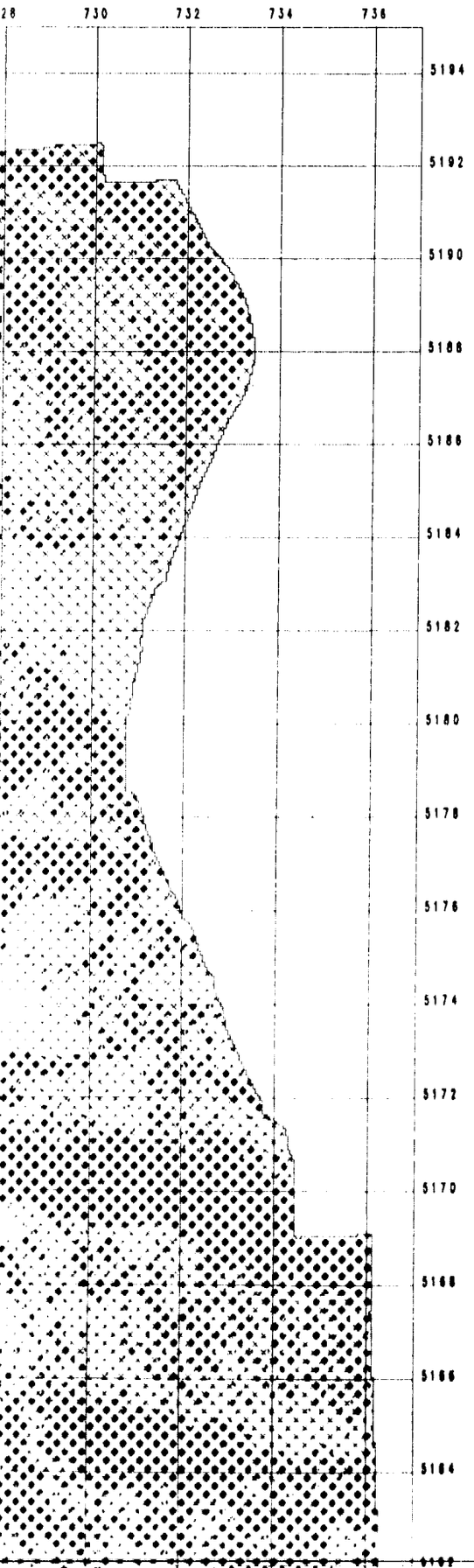
/. One thousand pass soil disturbance level map for 3-3-5 and 4-3-3 (HMMWV) force structures in the dry normal surface condi



force structures in the dry normal surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO

MINIMUM (0-.5in)

SLIGHT (>.5-2in)

MODERATE (>2-5in)

HIGH (>5-12in)

SEVERE (>12in)

URBAN/ OFF LIMITS

WATER

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
10 PASSES

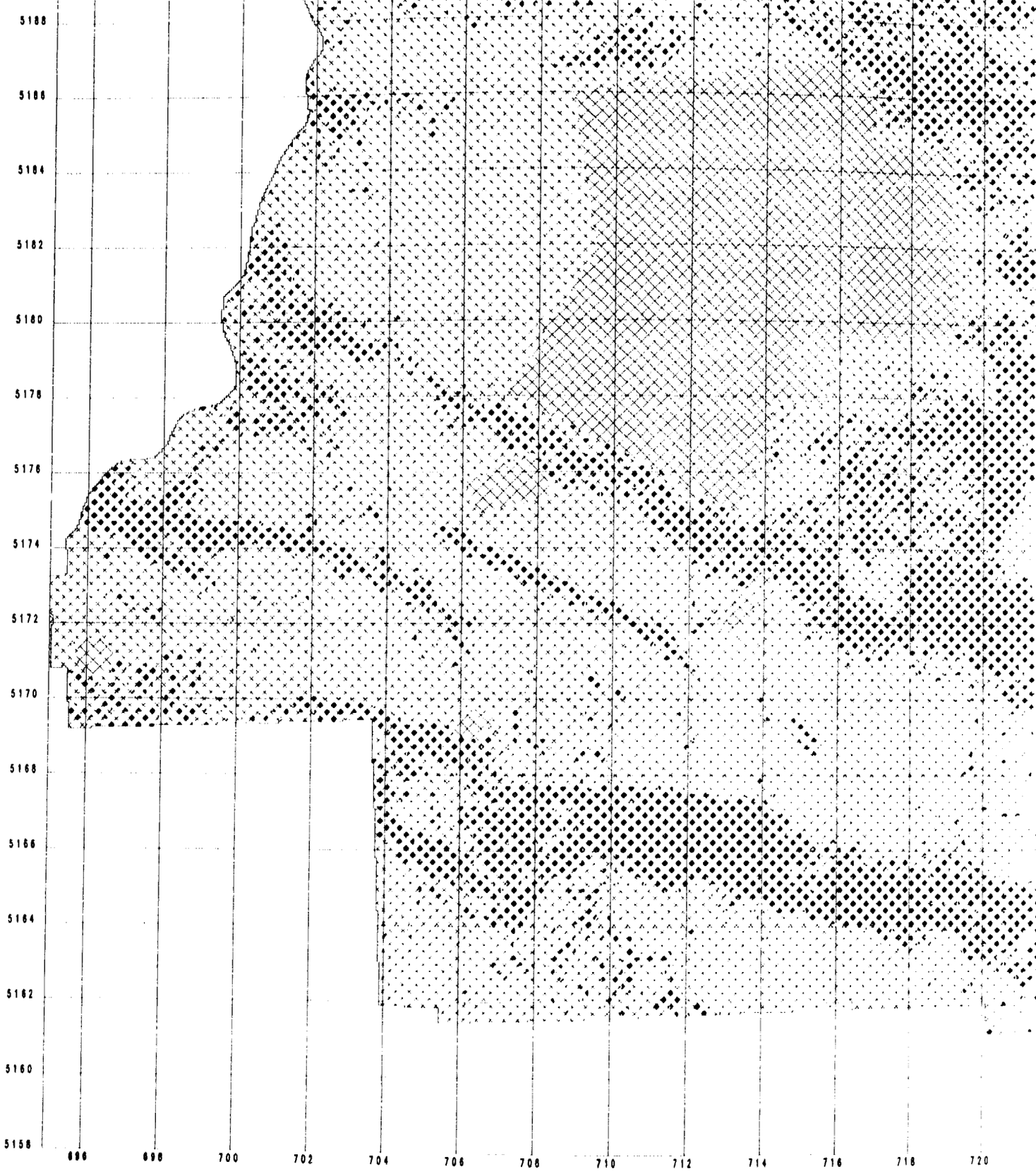
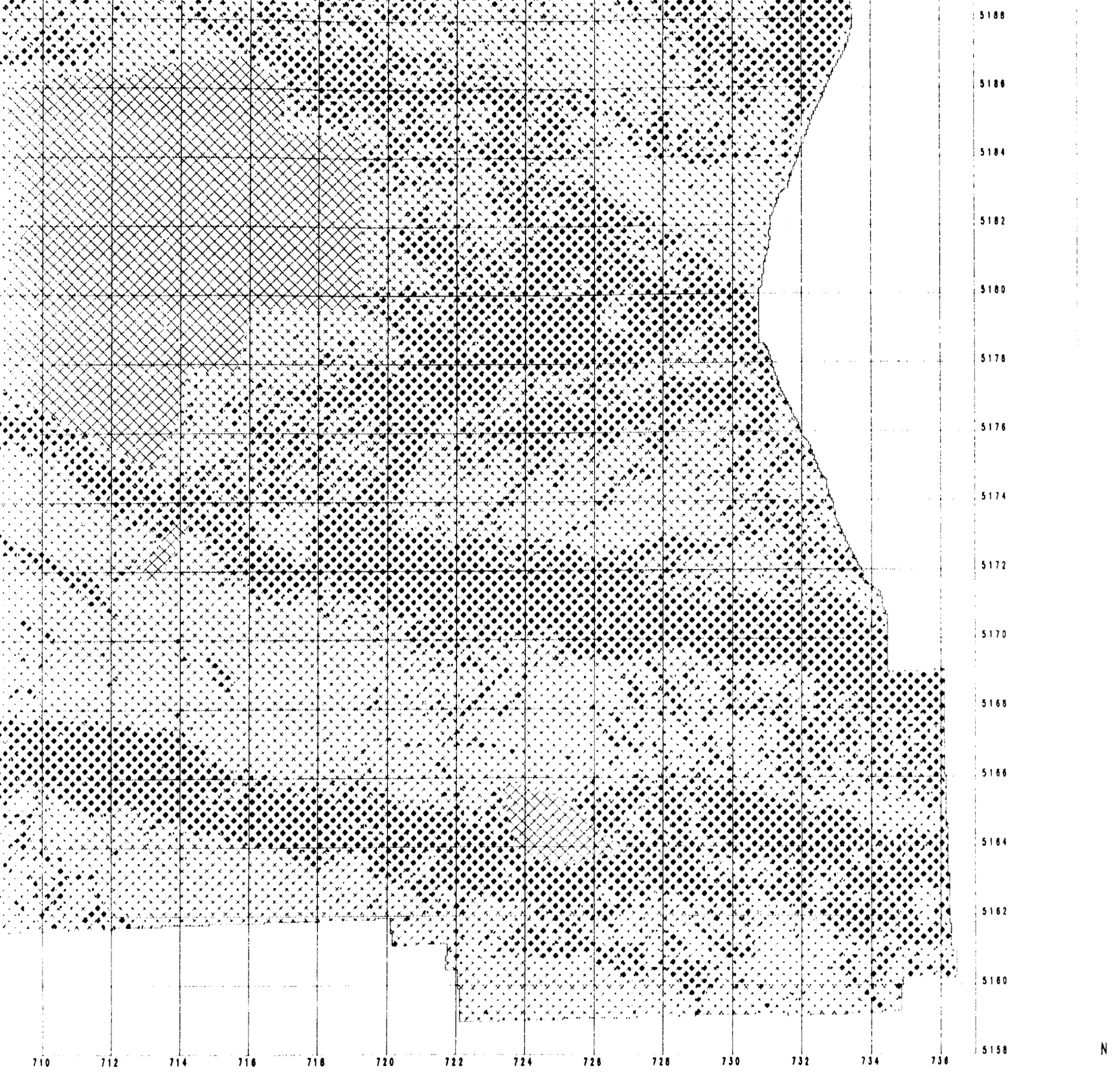
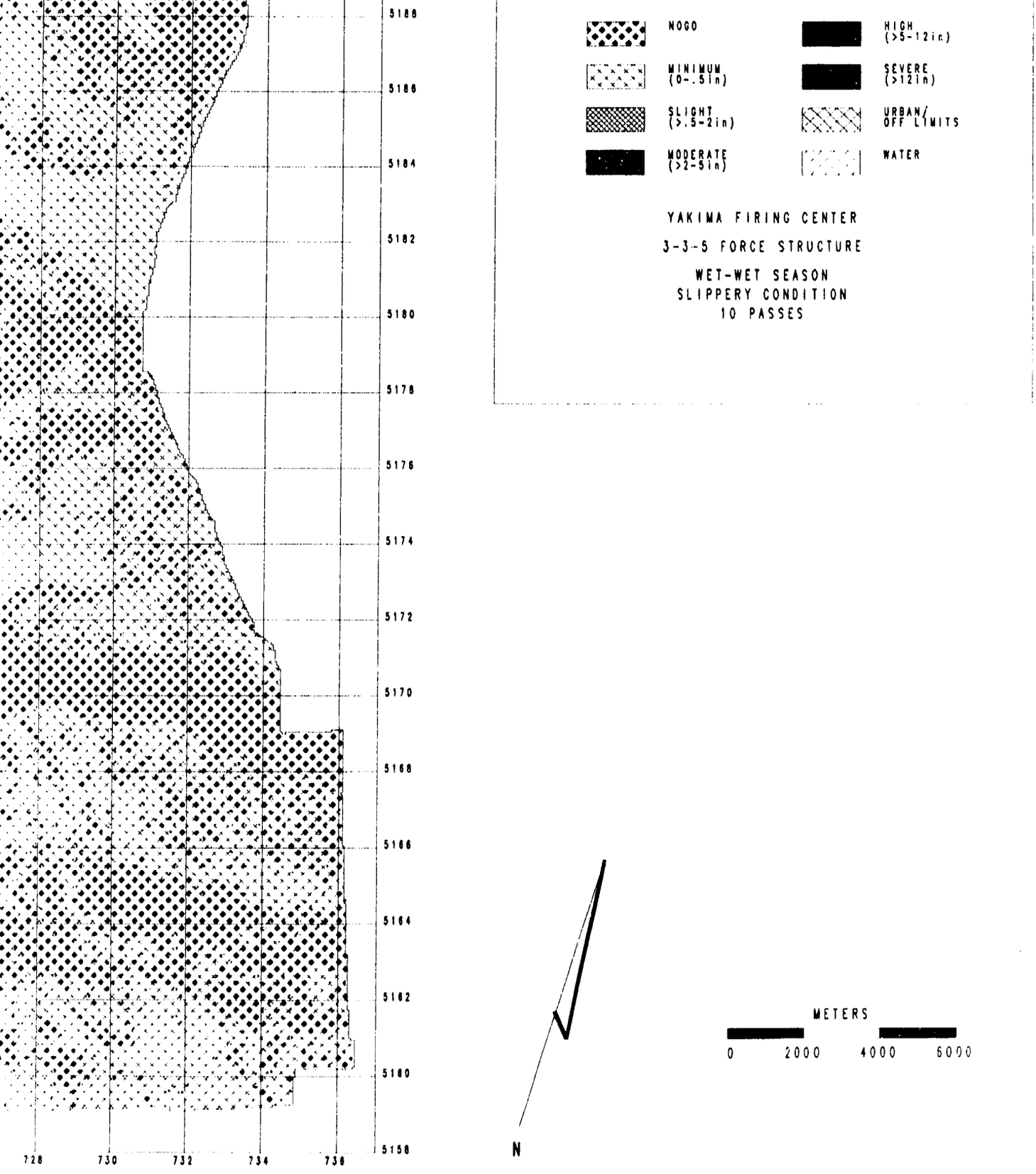


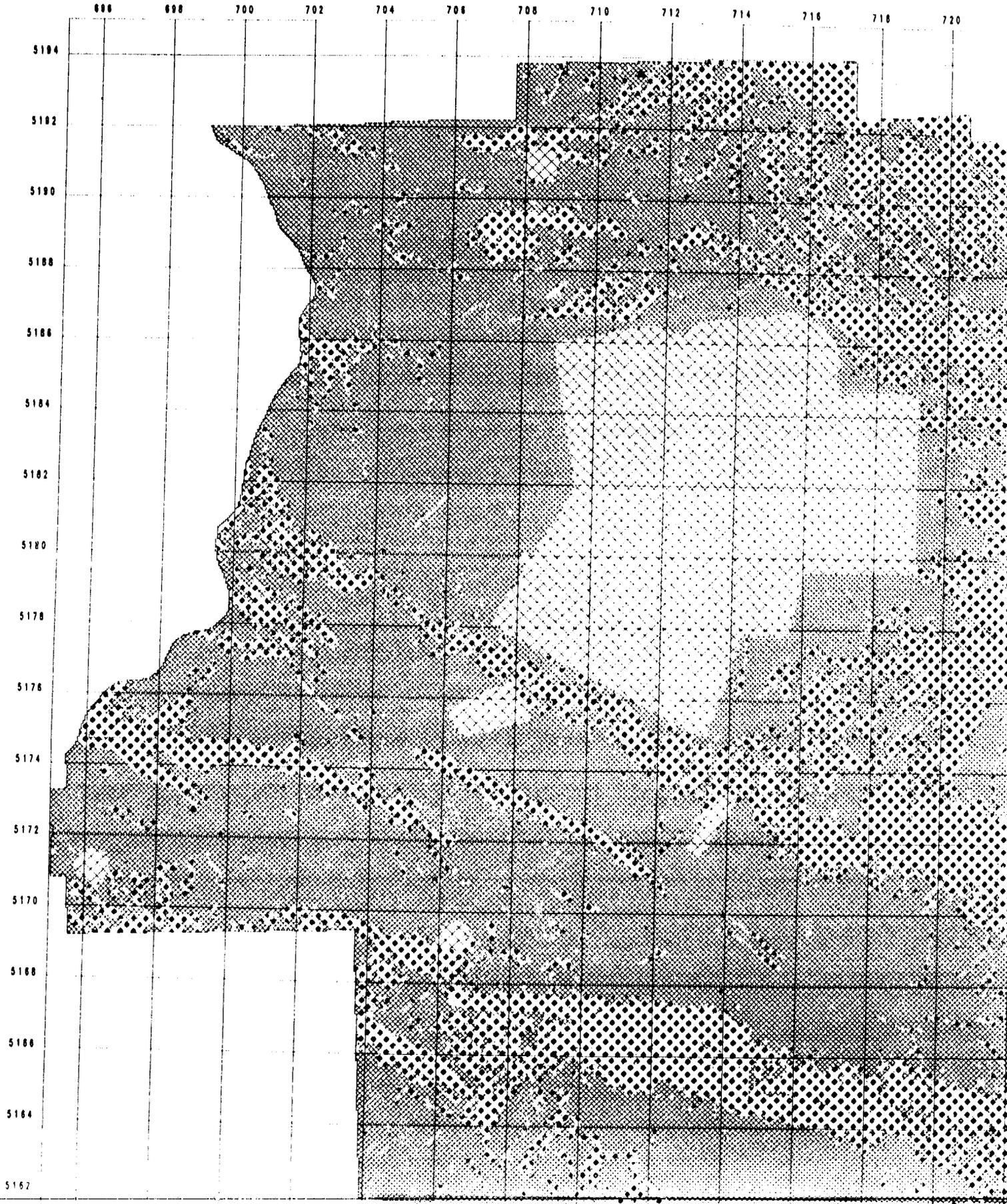
Plate 18. Ten pass soil disturbance level map for 3

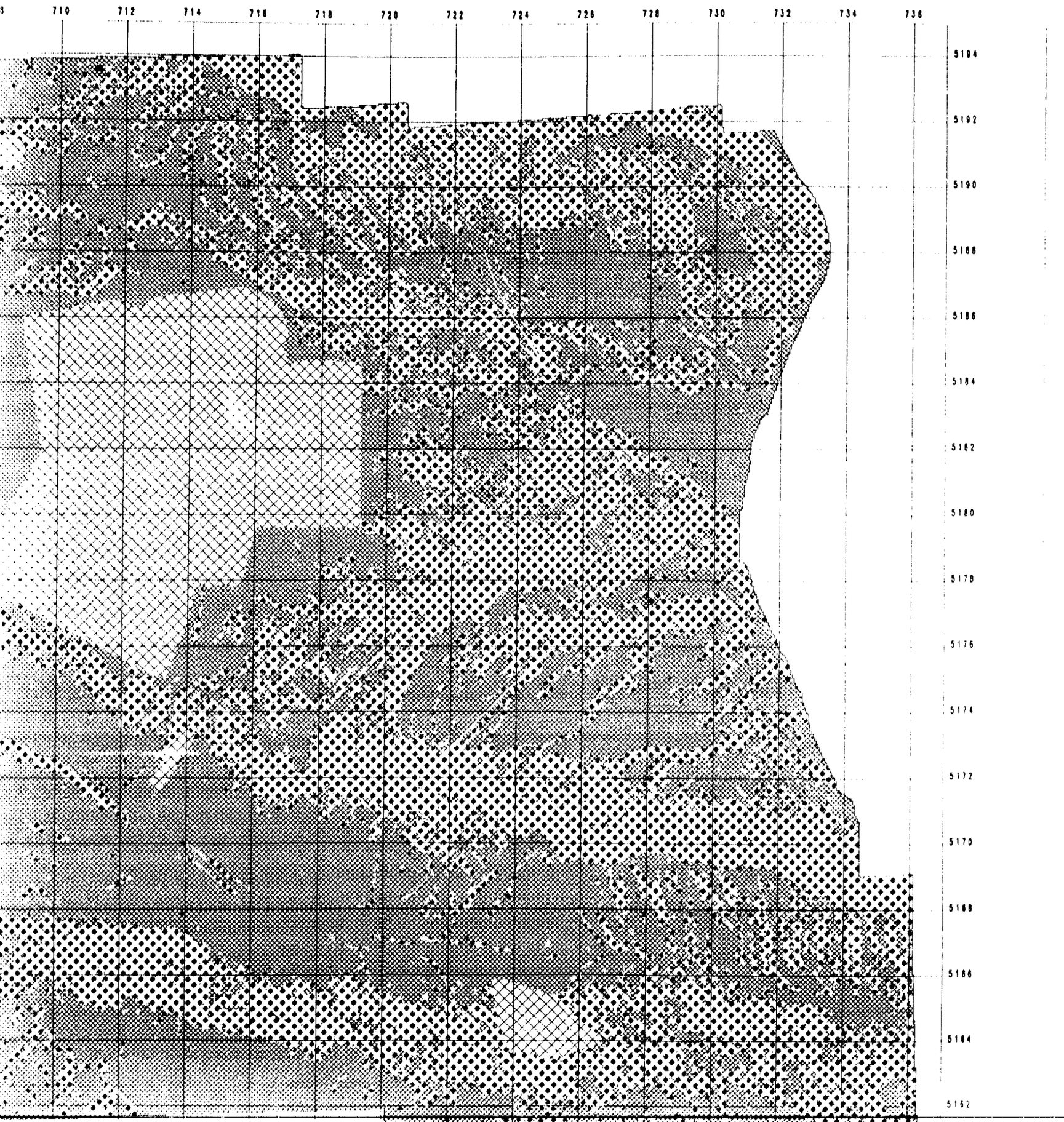


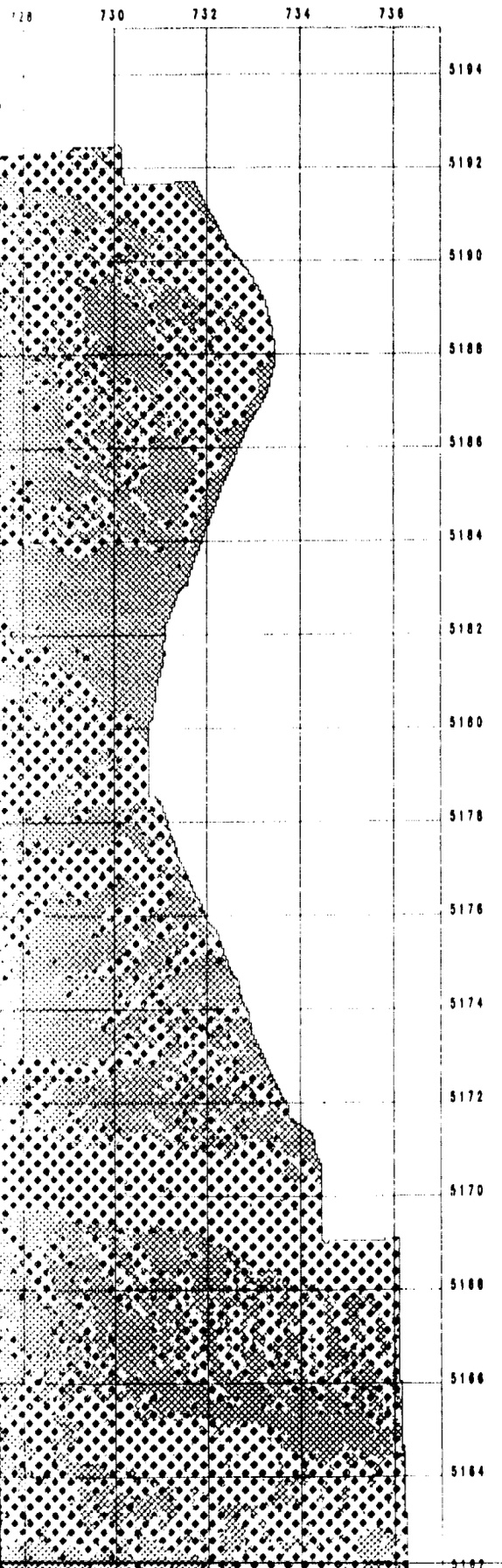
ate 18. Ten pass soil disturbance level map for 3-3-5 and 4-3-3 (HMMWV) force structures in the wet-wet slippery surface condi



force structures in the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
50 PASSES

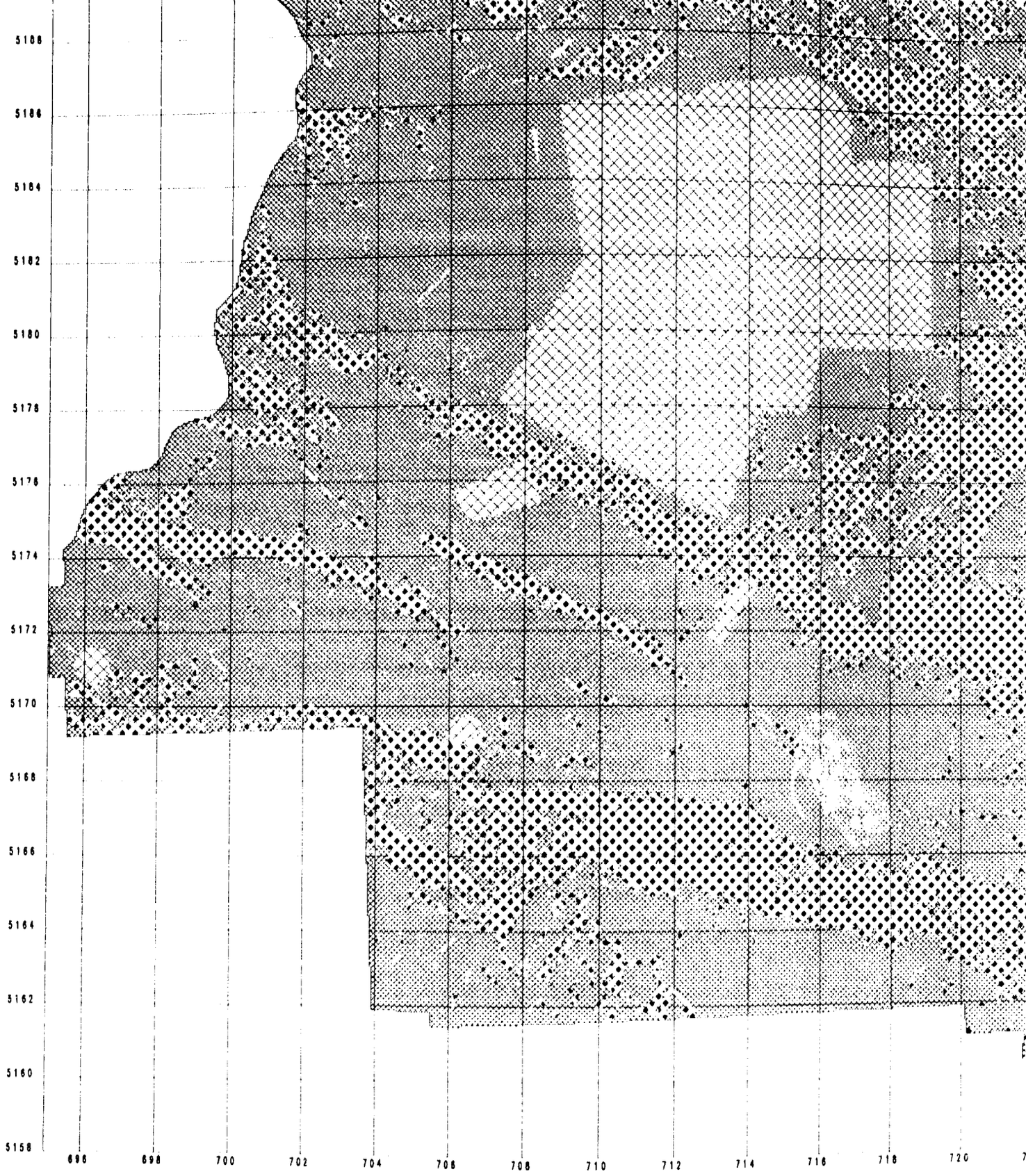


Plate 19. Fifty pass soil disturbance level map for

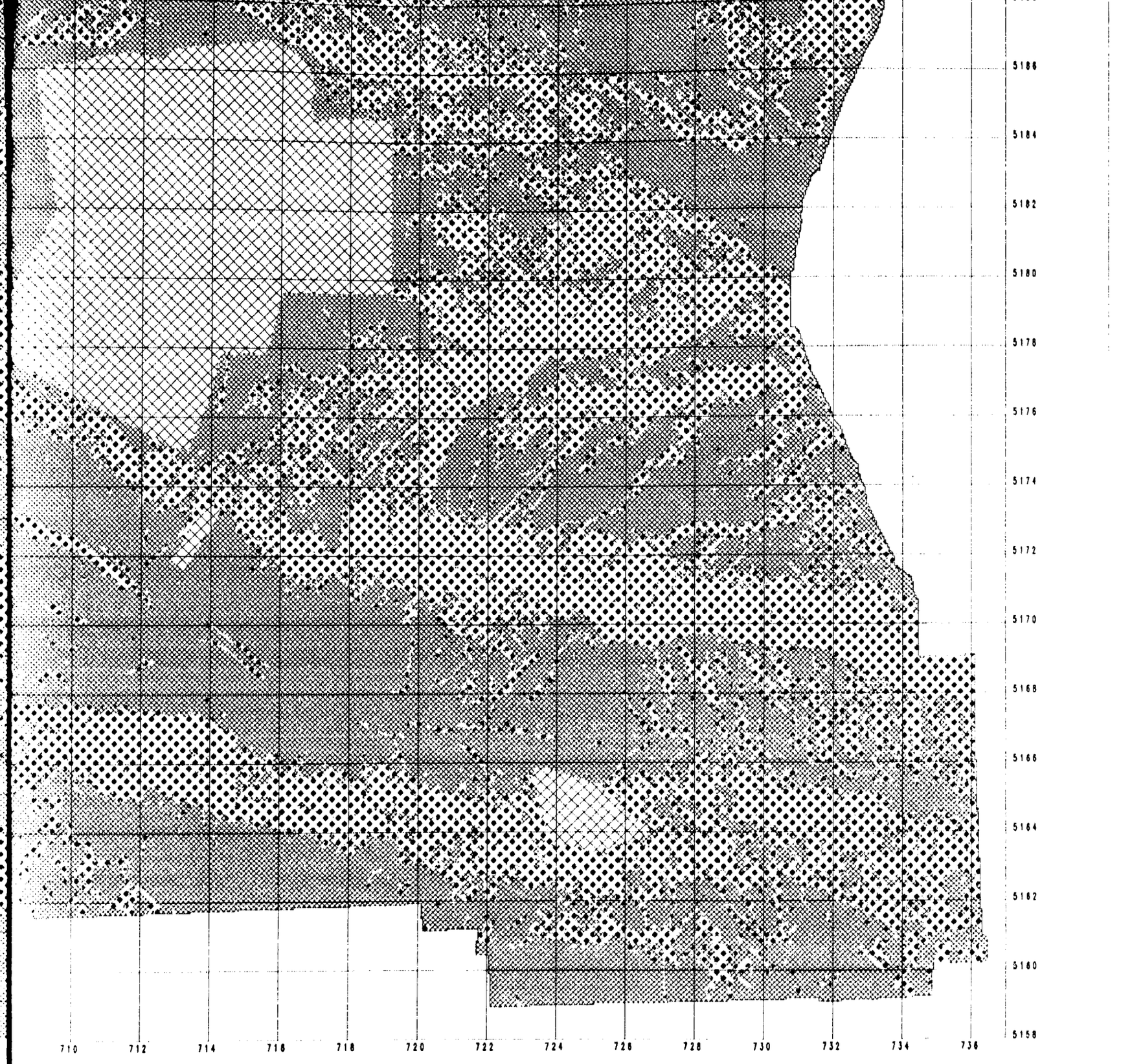
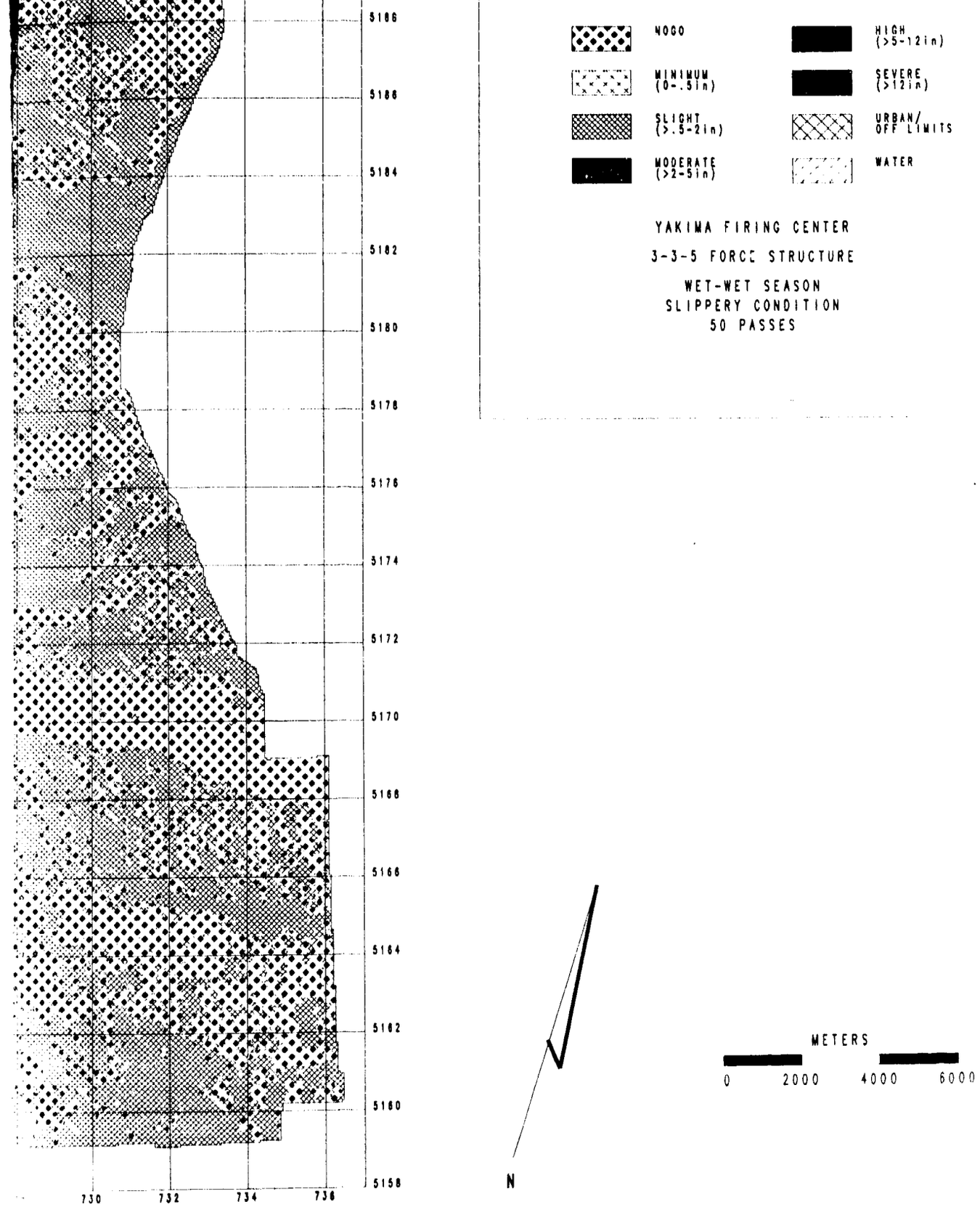
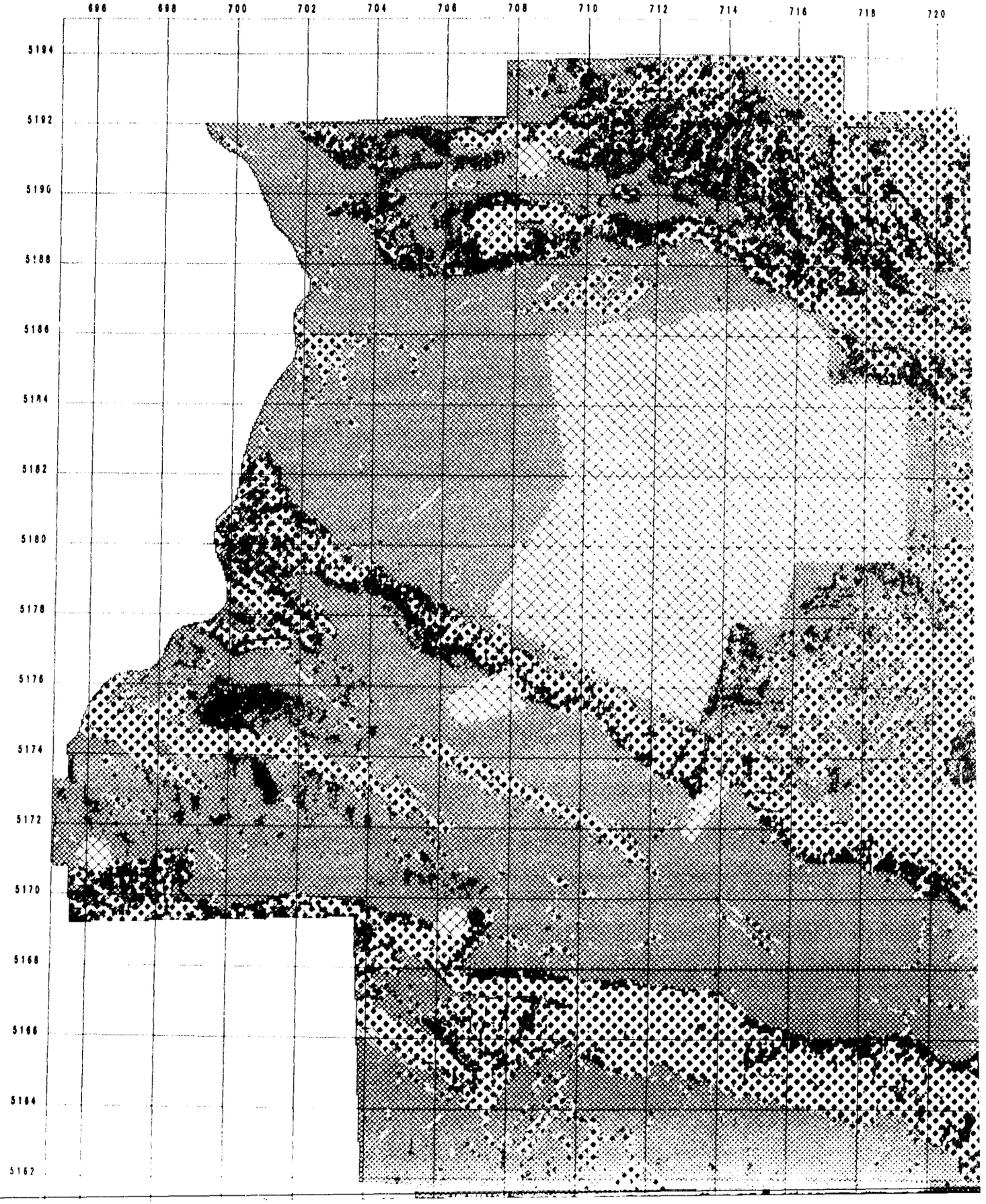
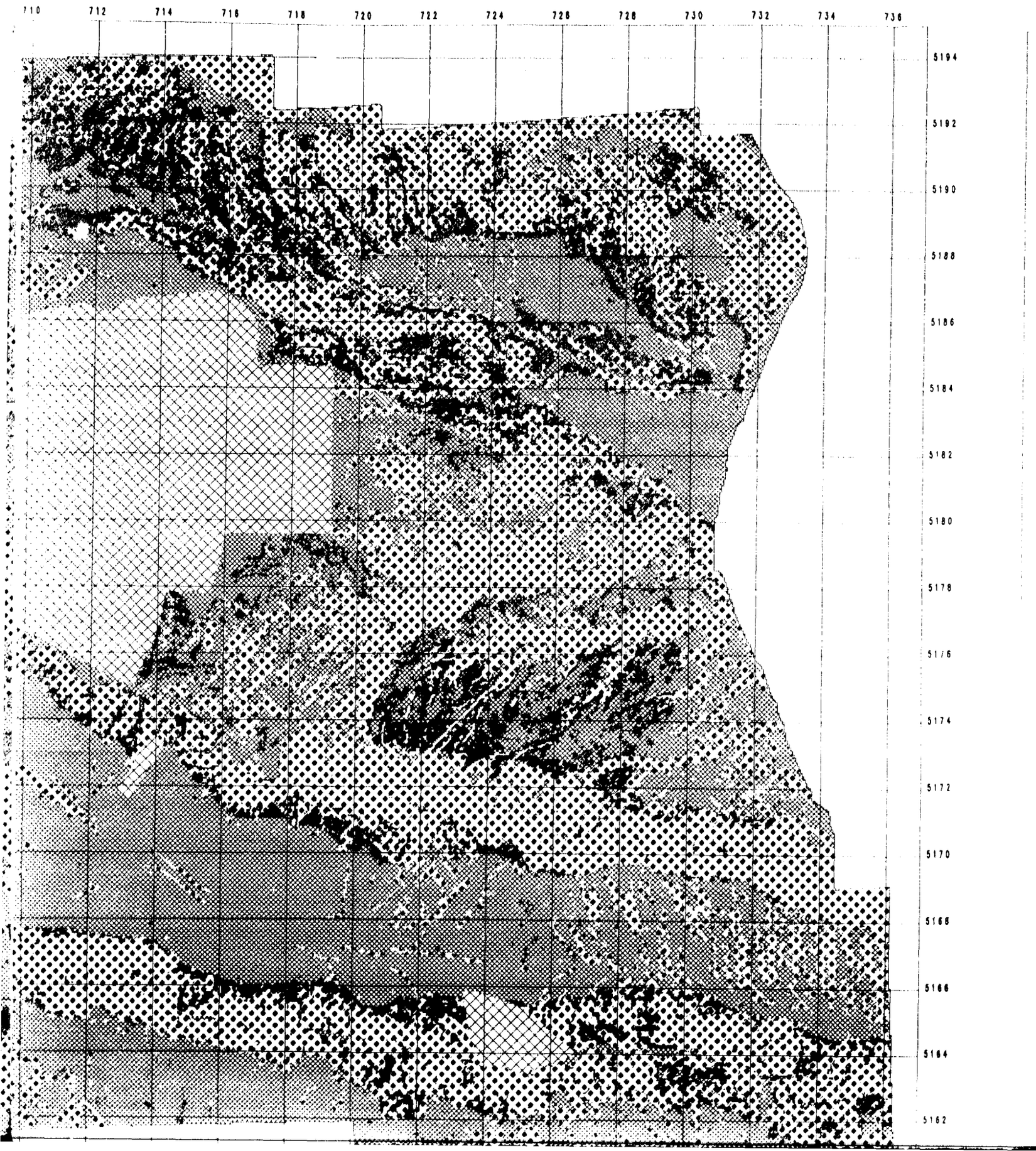


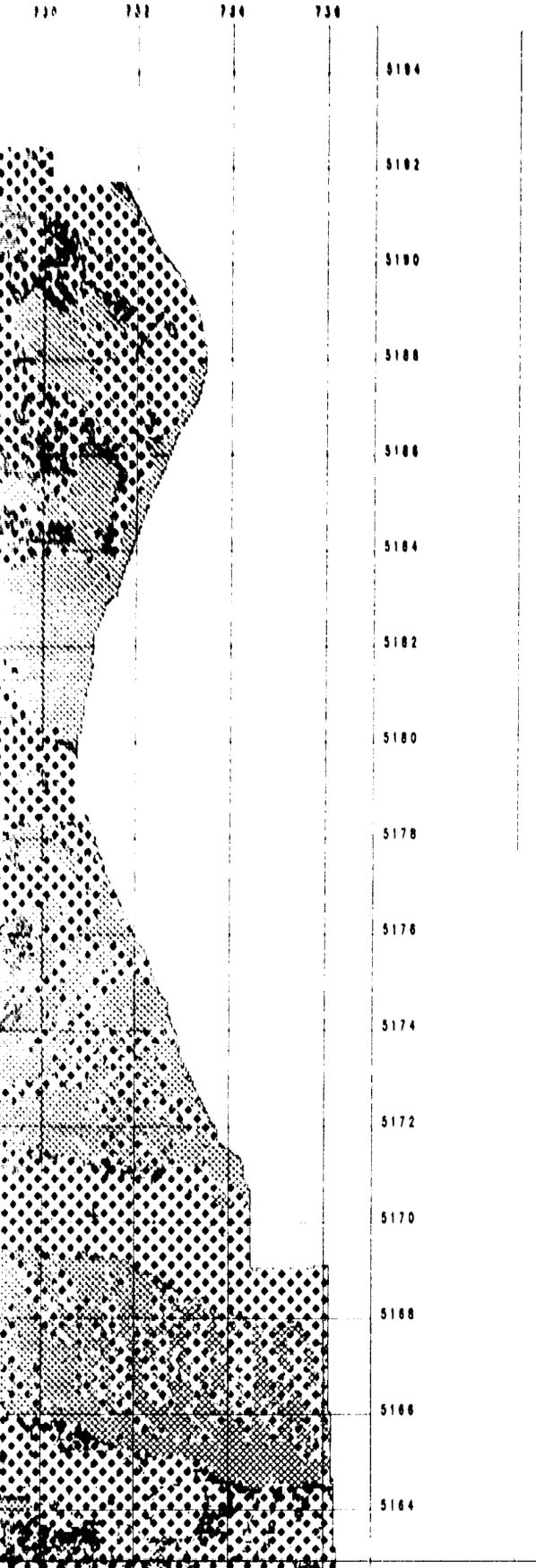
Plate 19. **Fifty pass soil disturbance level map for 3-3-5 and 4-3-3 (HMMWV) force structures in the wet-wet slippery surface**



orce structures in the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
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Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
1000 PASSES

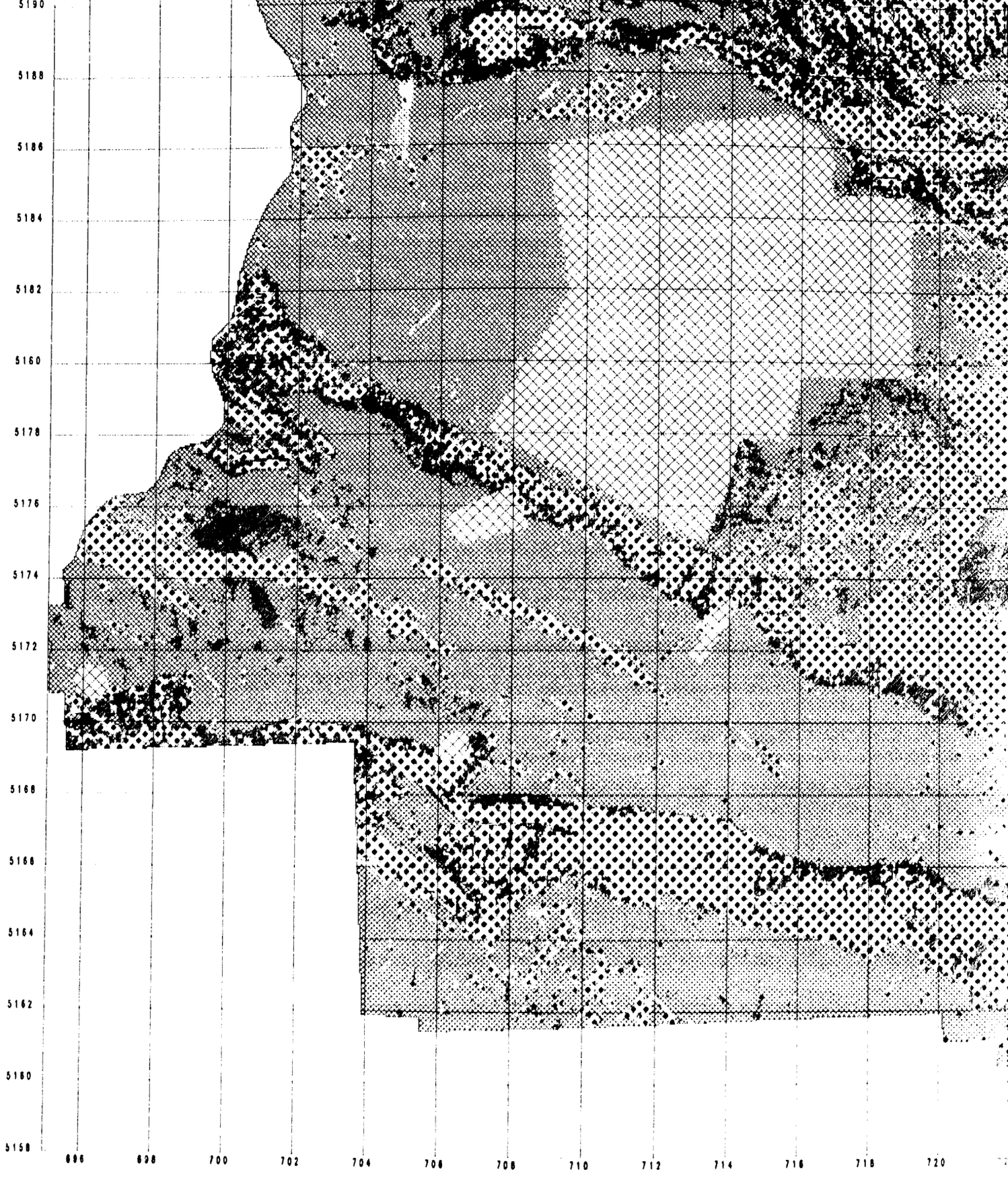
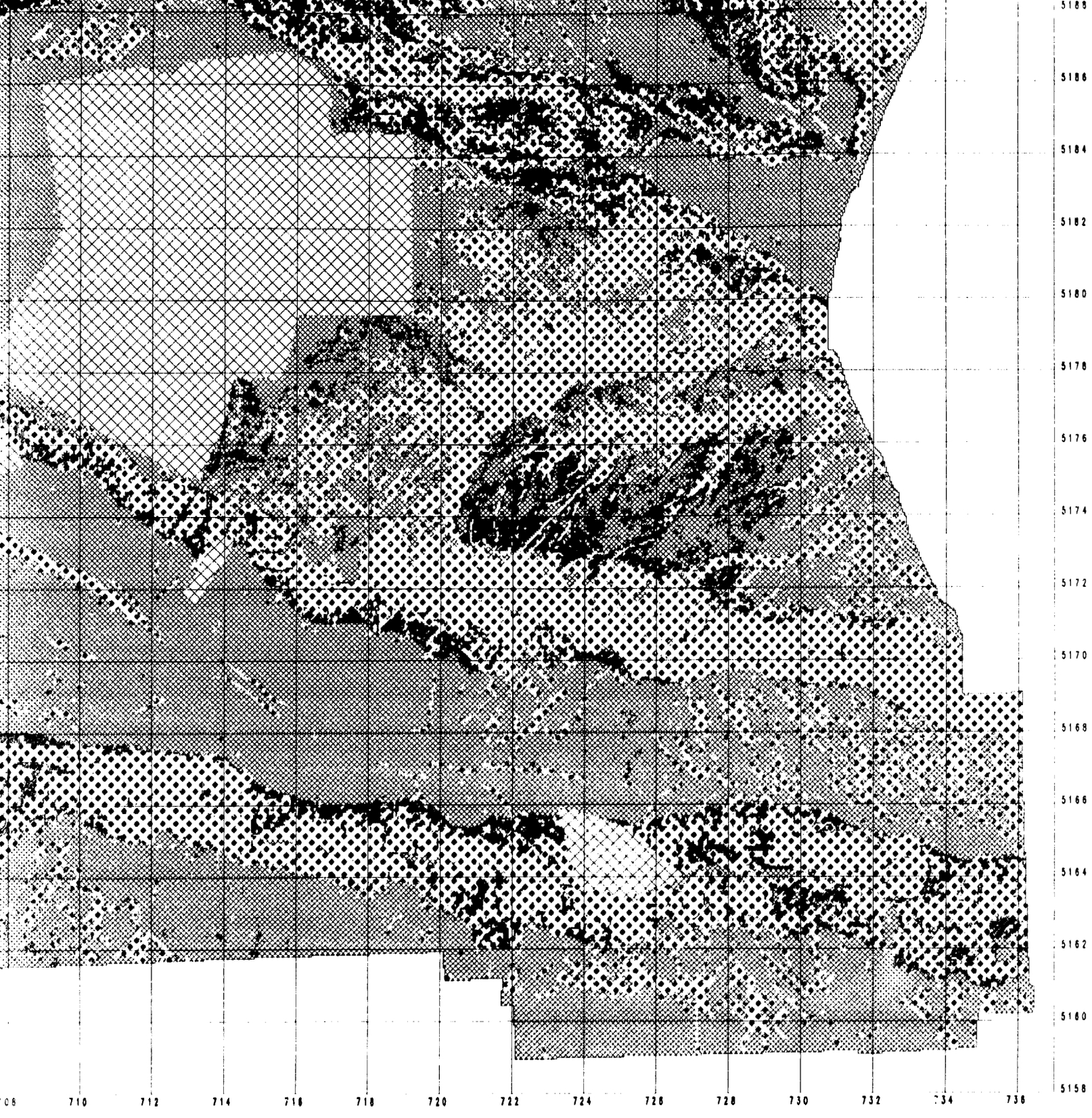
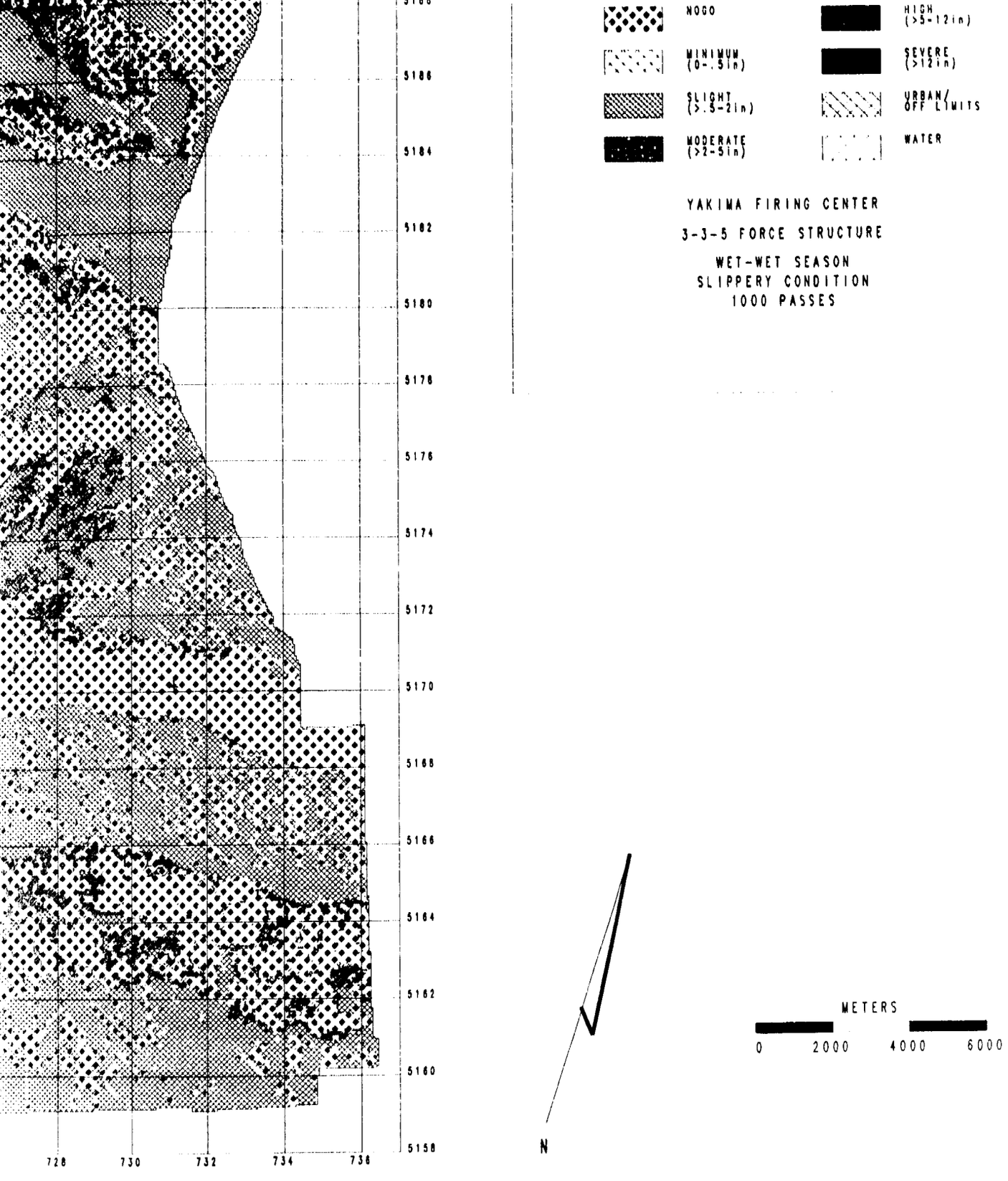


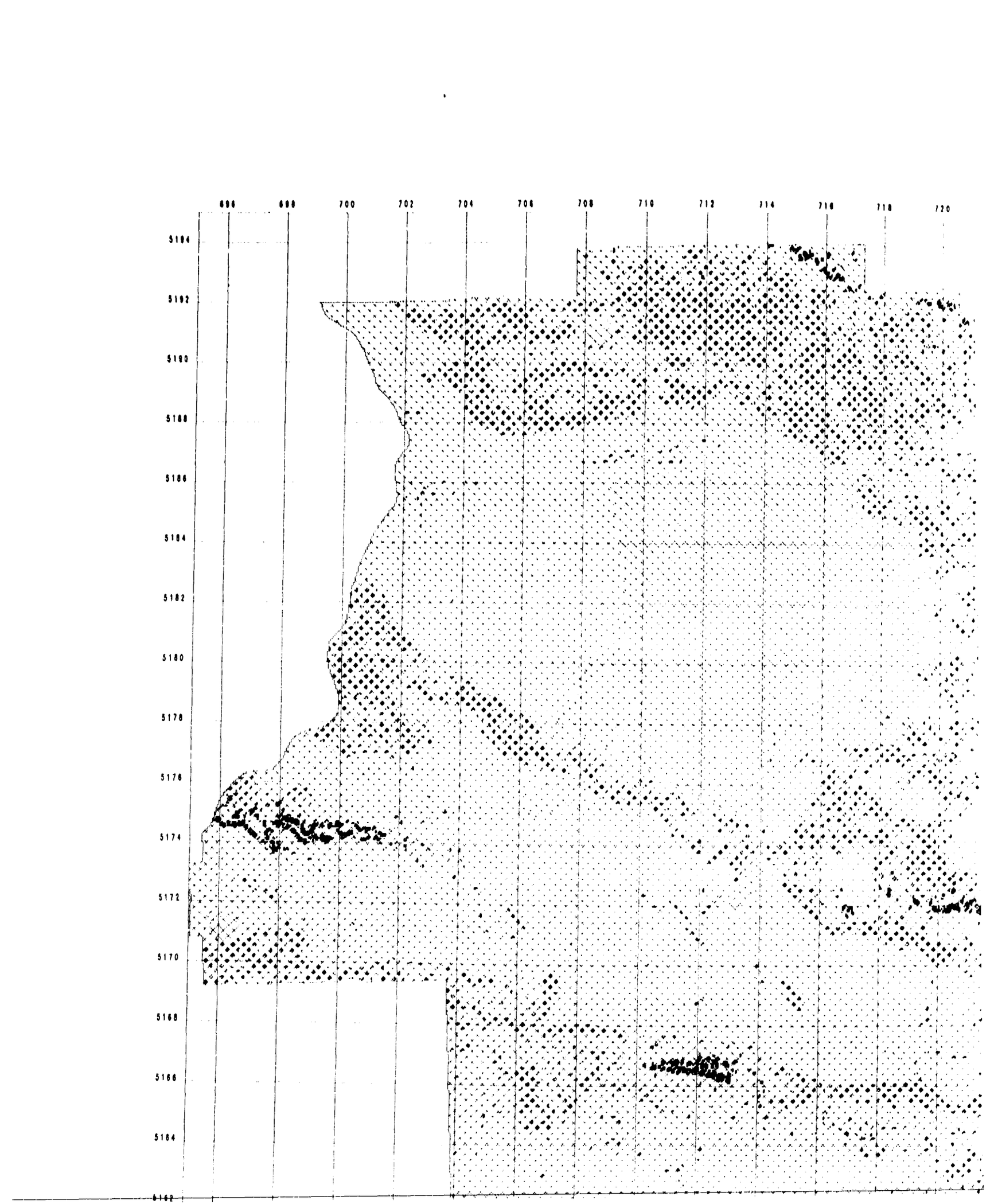
Plate 20. One thousand pass soil disturbance level map f

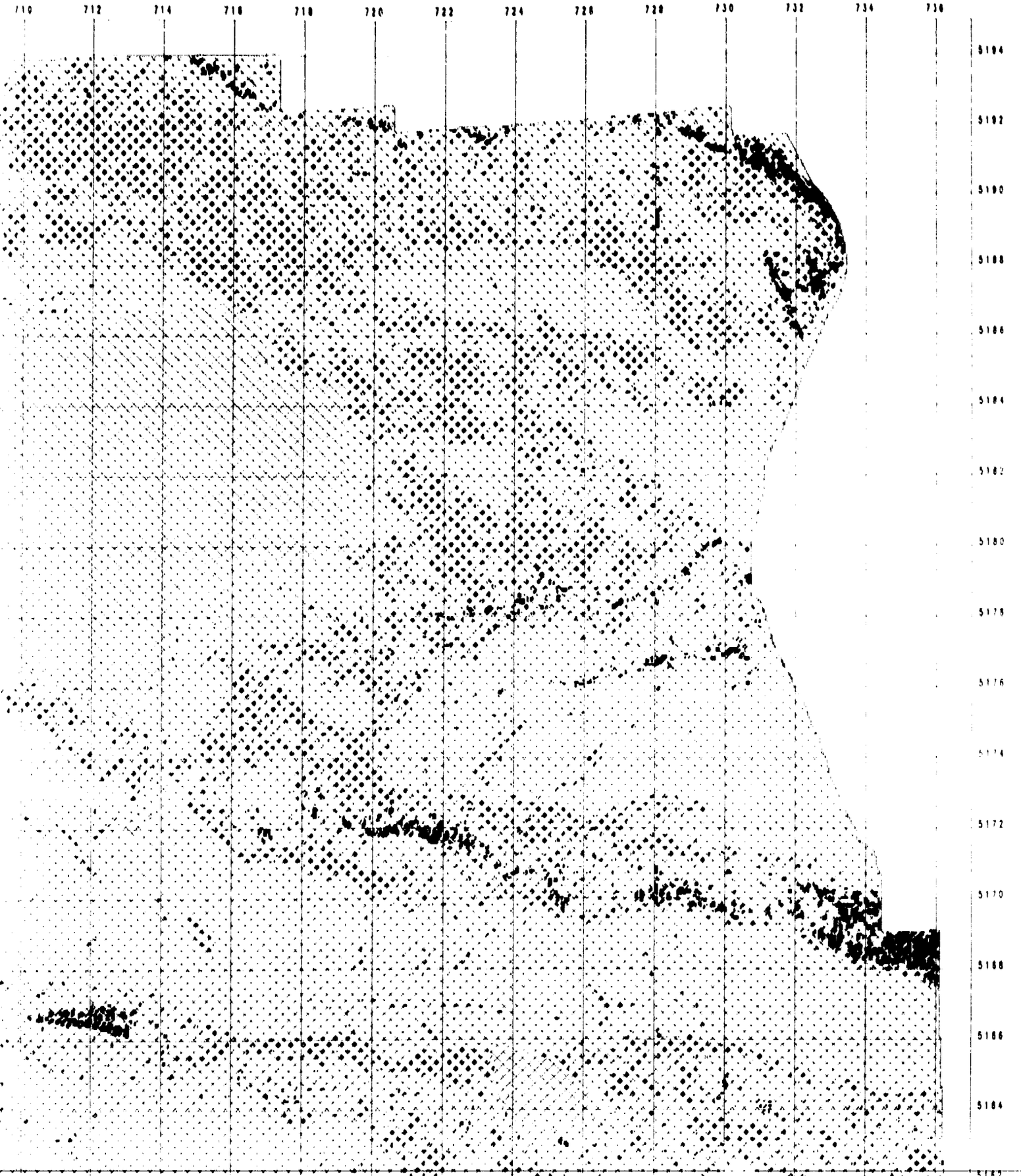


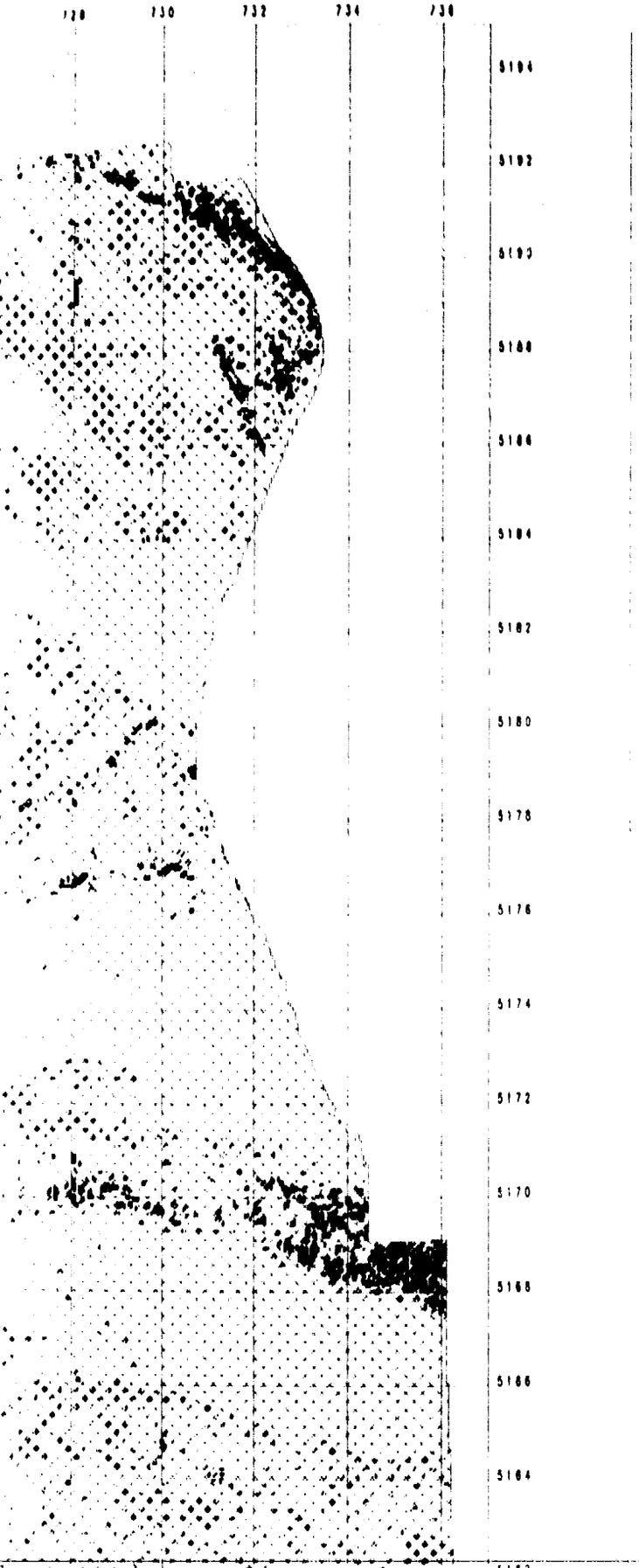
ıte 20. One thousand pass soil disturbance level map for 3-3-5 and 4-3-3 (HMMWV) force structures in the wet-wet slippery surfa



(HMMWV) force structures in the wet-wet slippery surface condition


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SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO

MINIMUM (0-.5in)

SLIGHT (.5-2in)

MODERATE (2-5in)

HIGH (5-12in)

SEVERE (>12in)

URBAN/ OFF LIMITS

WATER

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
10 PASSES

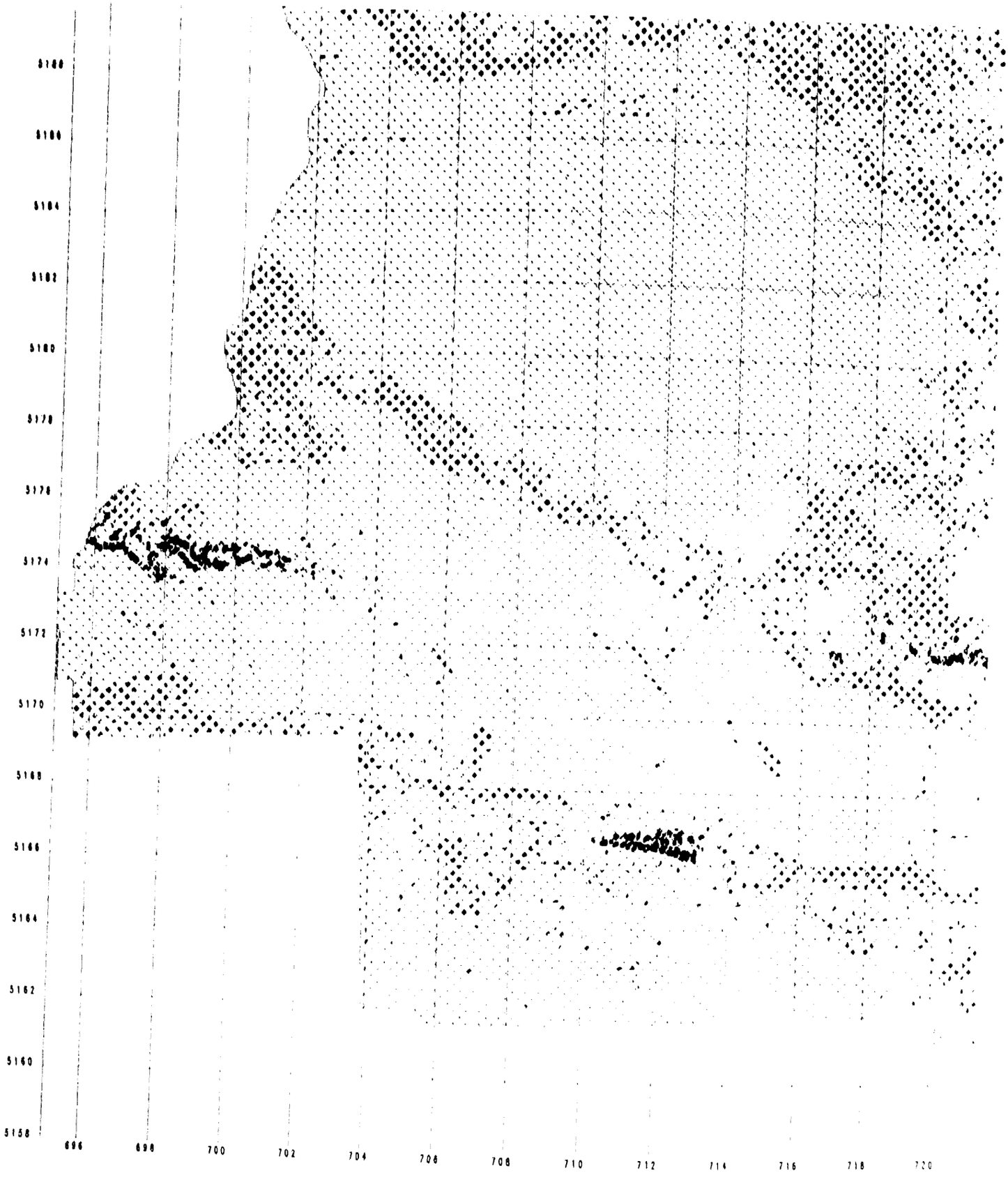


Plate 21. Ten pass soil disturbance level map

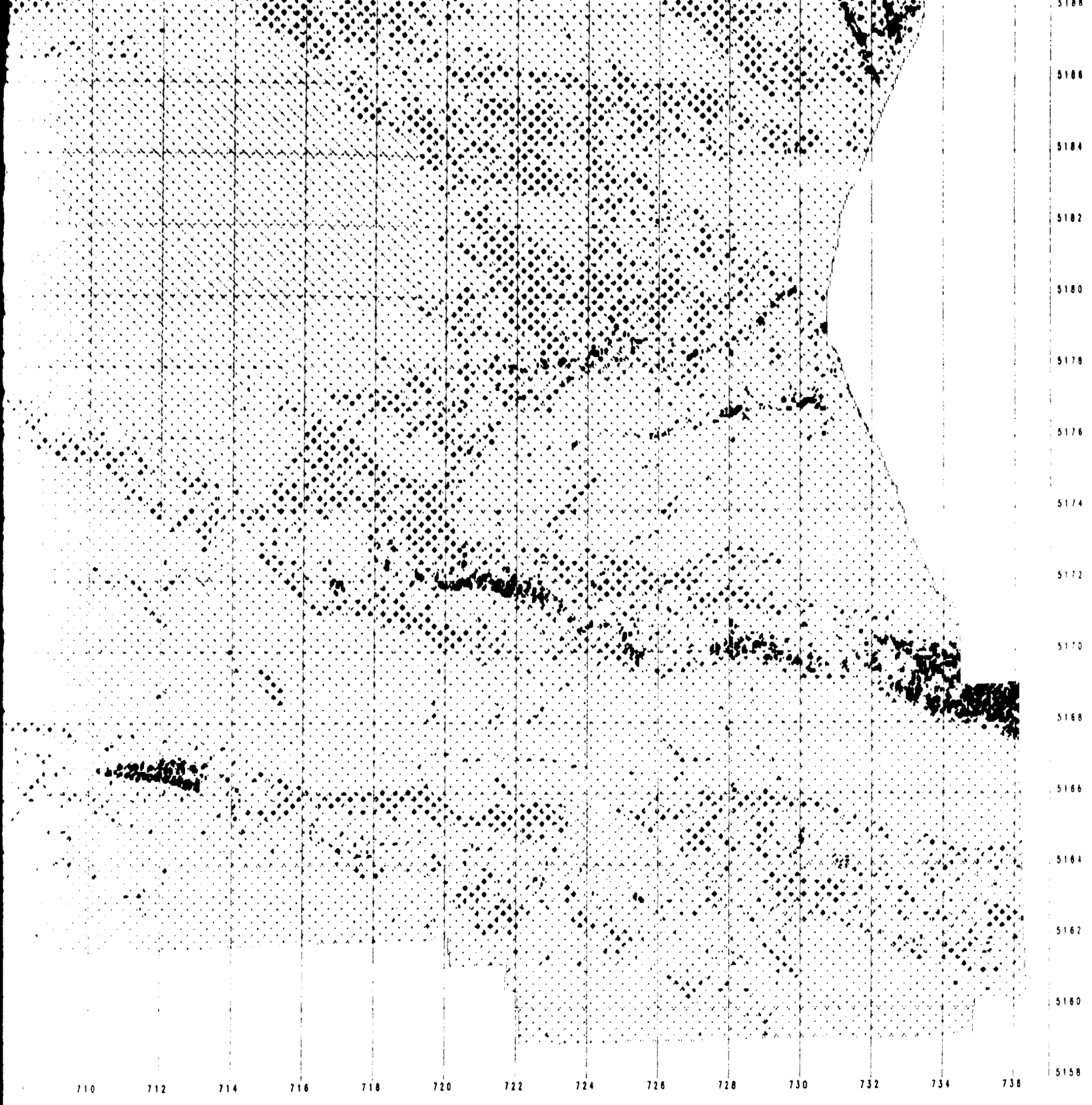
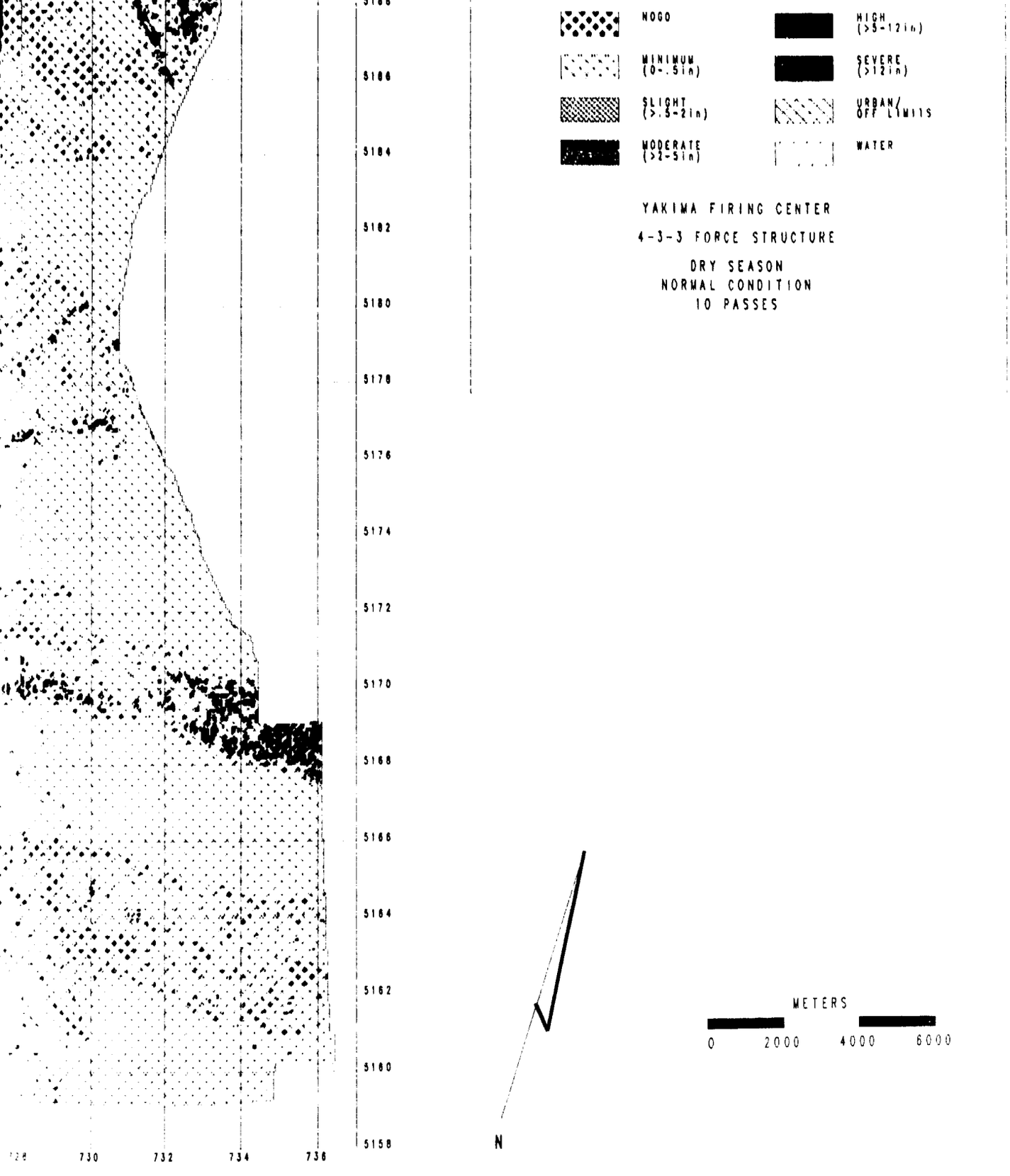
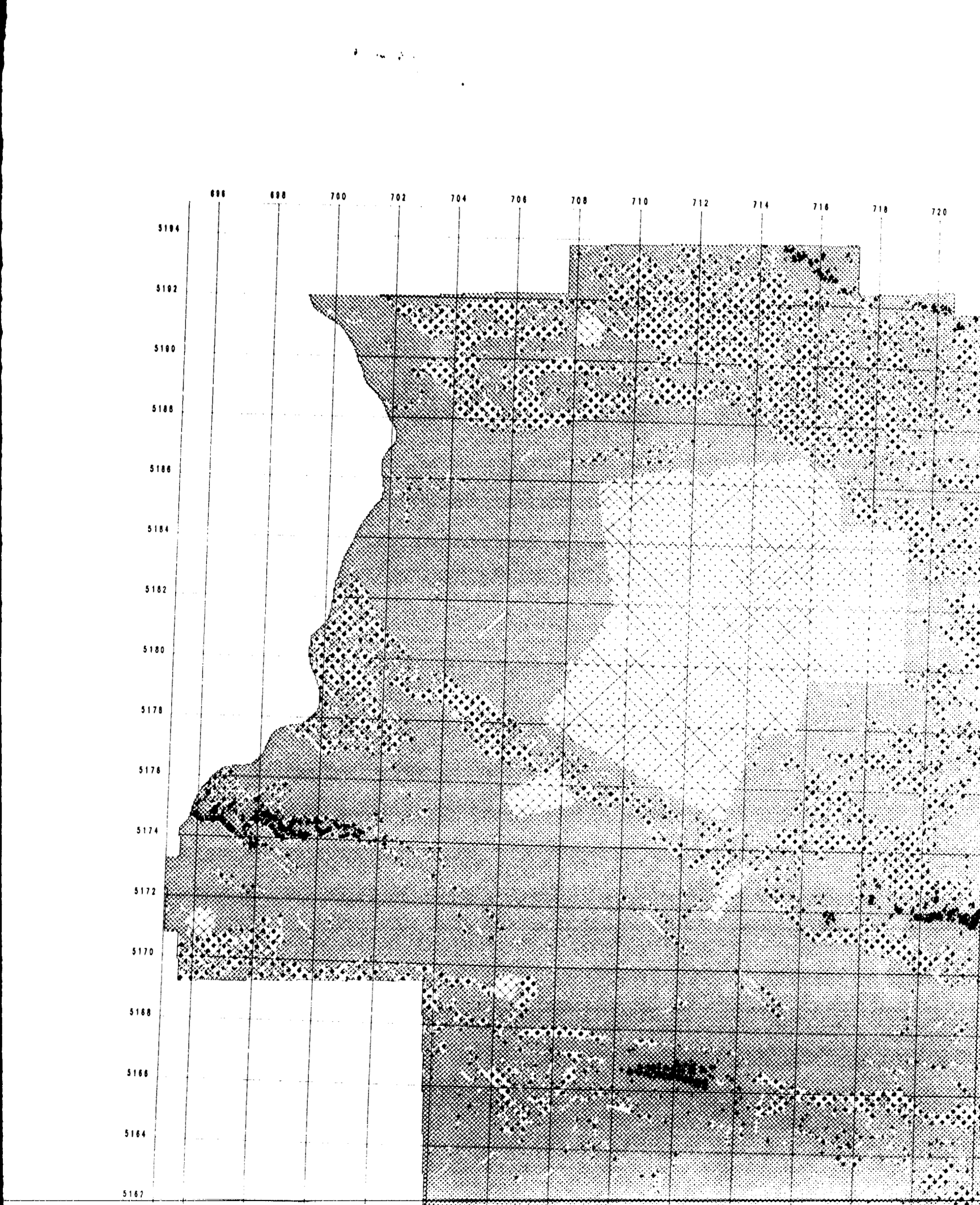
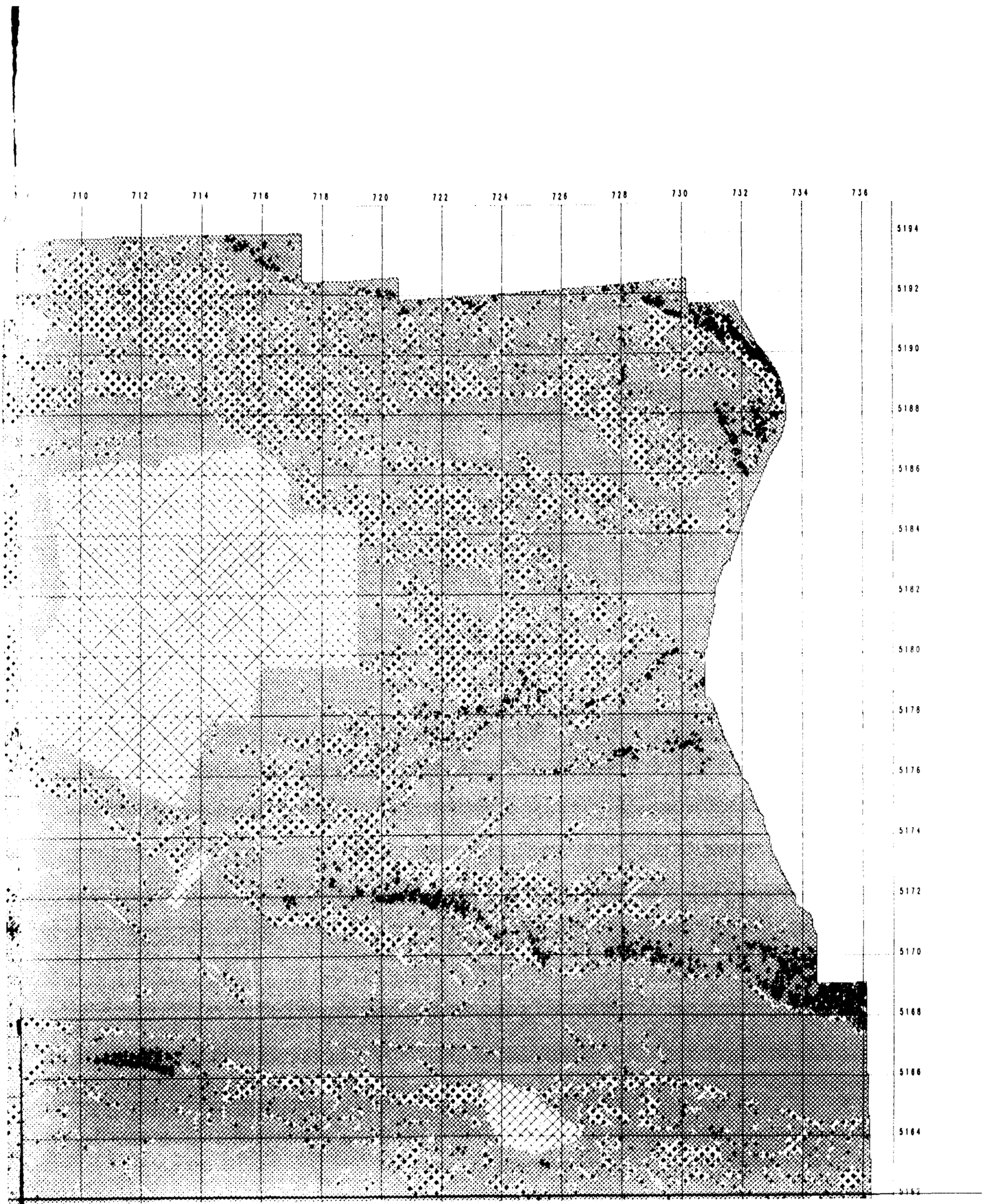


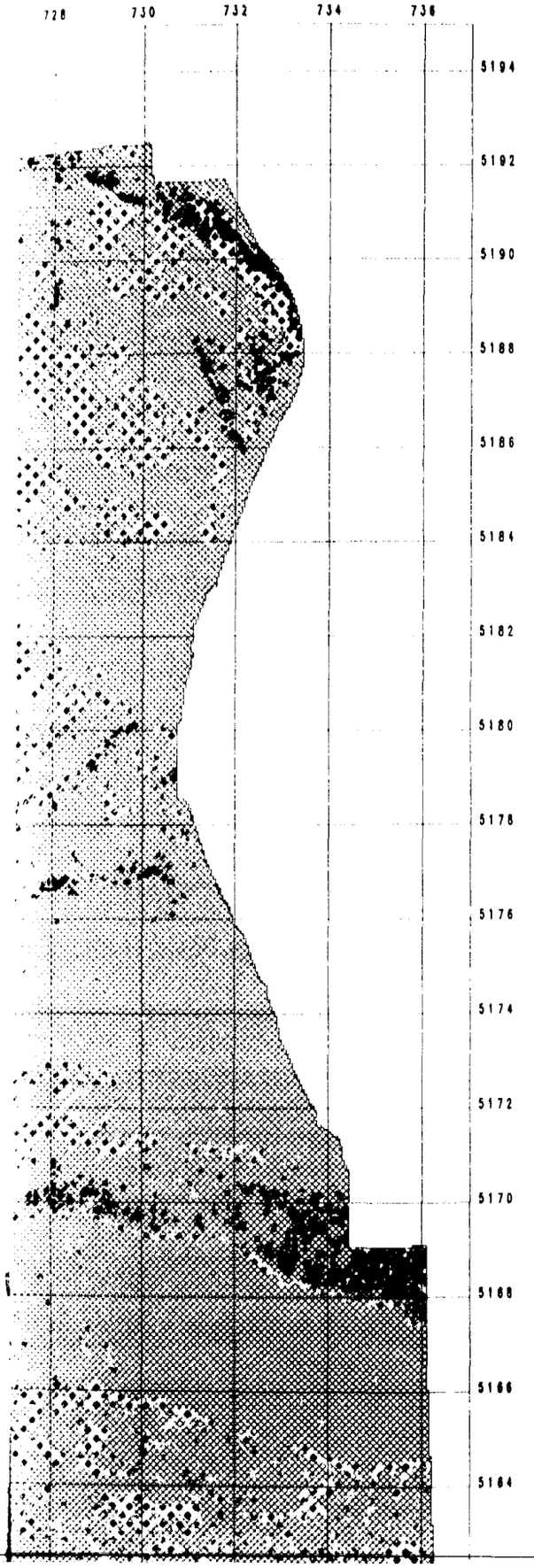
Plate 21. Ten pass soil disturbance level map for the 4-3-3 (6X8) force structure in the dry normal surface condition



ce structure in the dry normal surface condition


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SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
50 PASSES

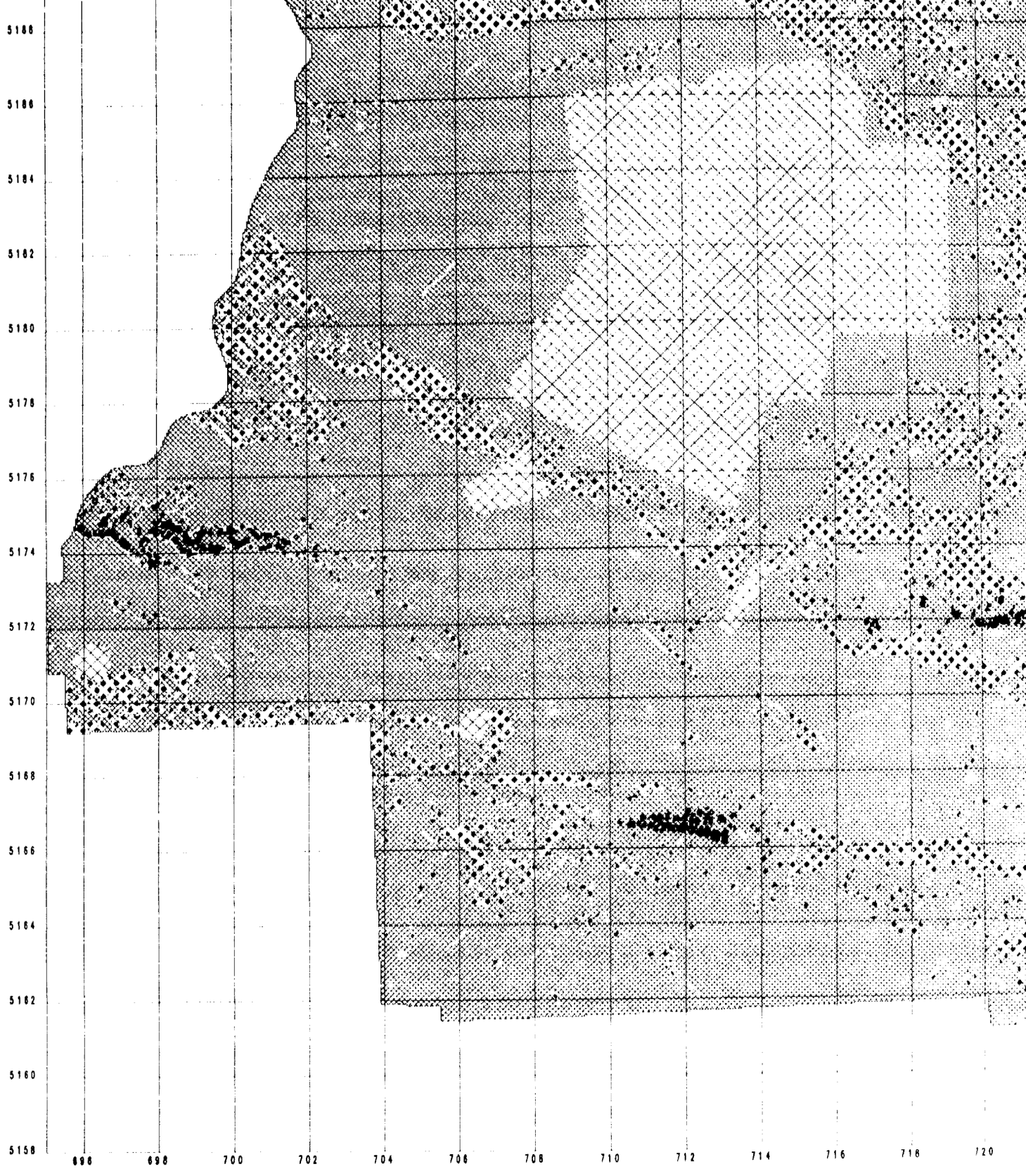


Plate 22. Fifty pass soil disturbance level

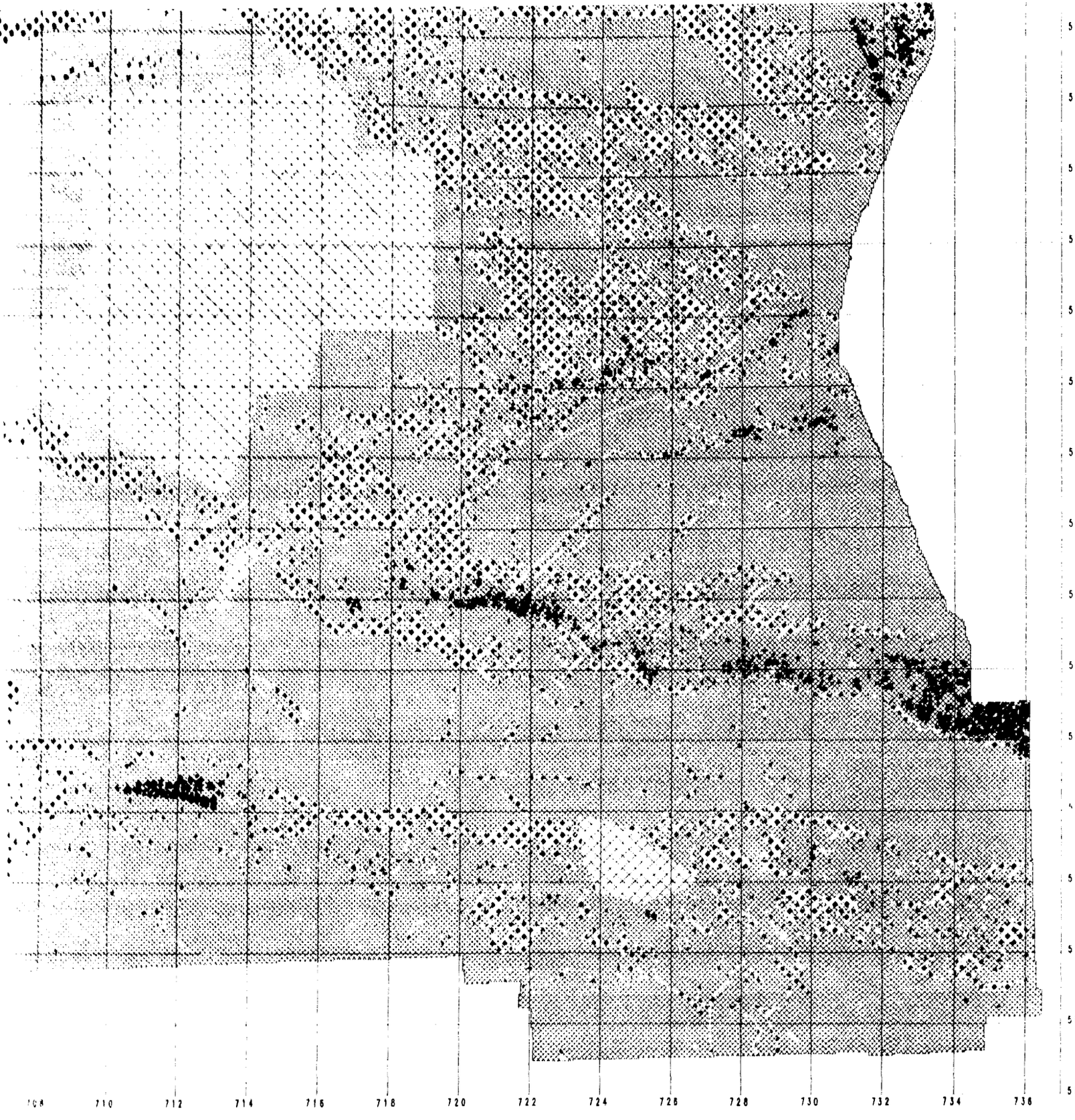
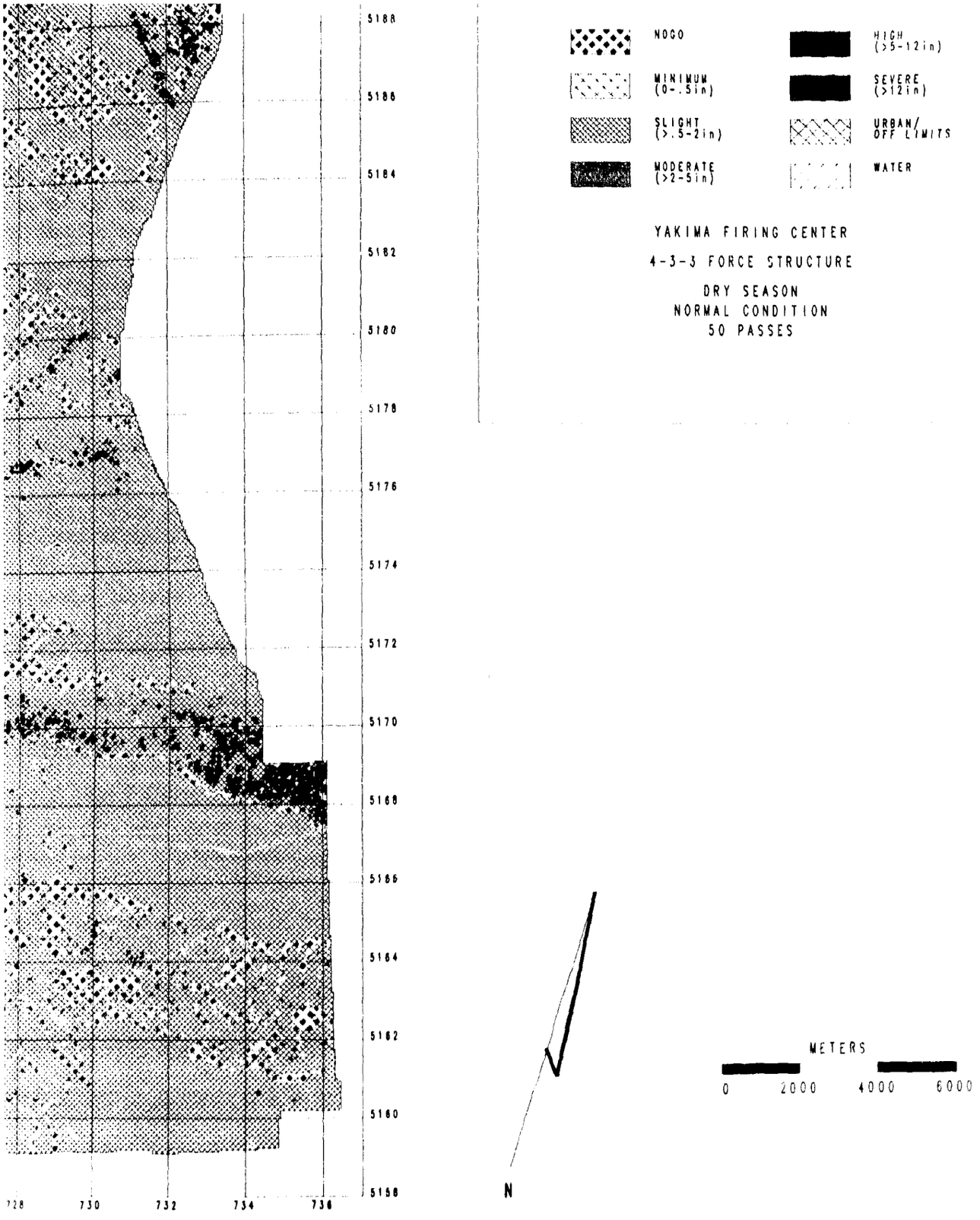
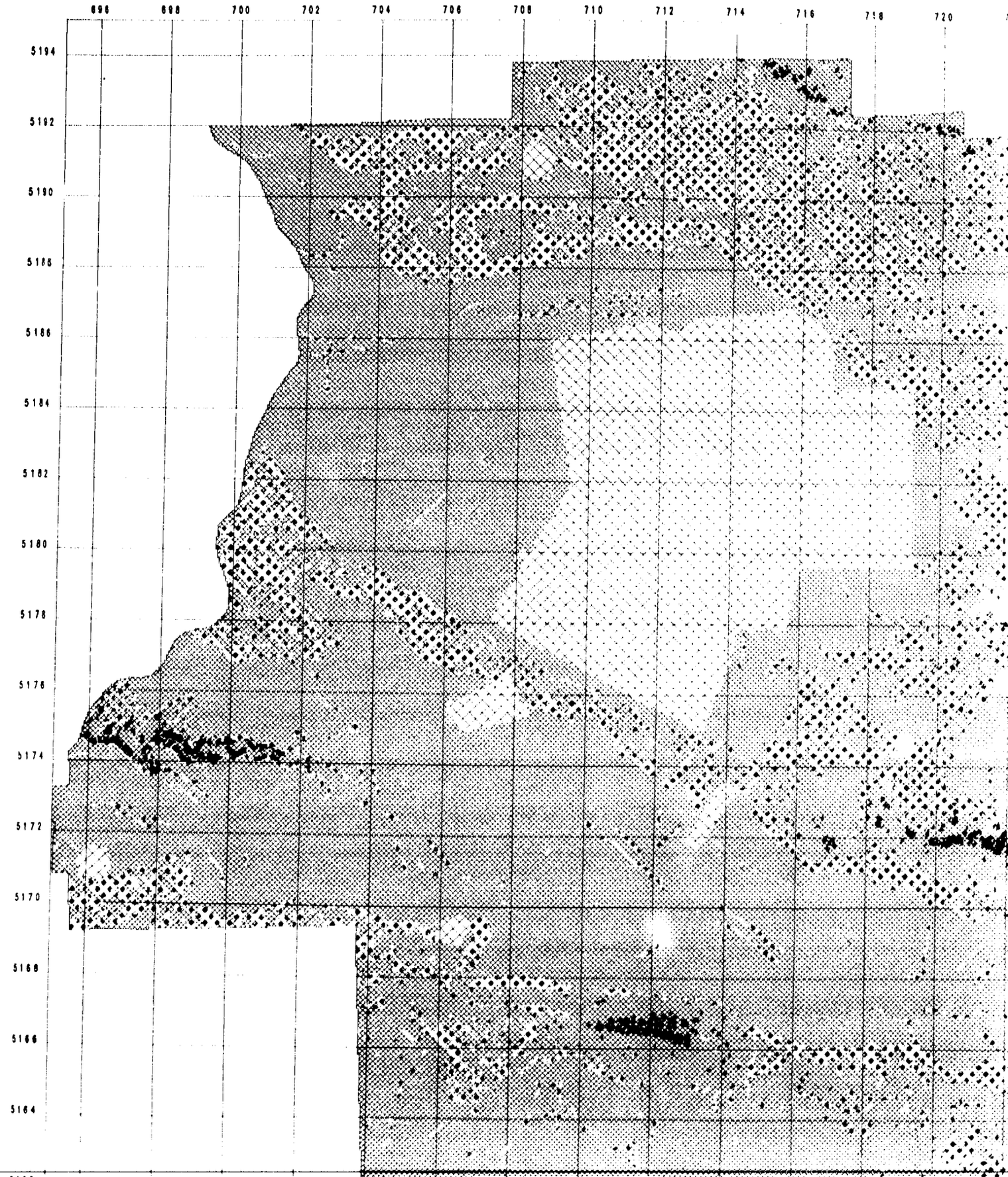
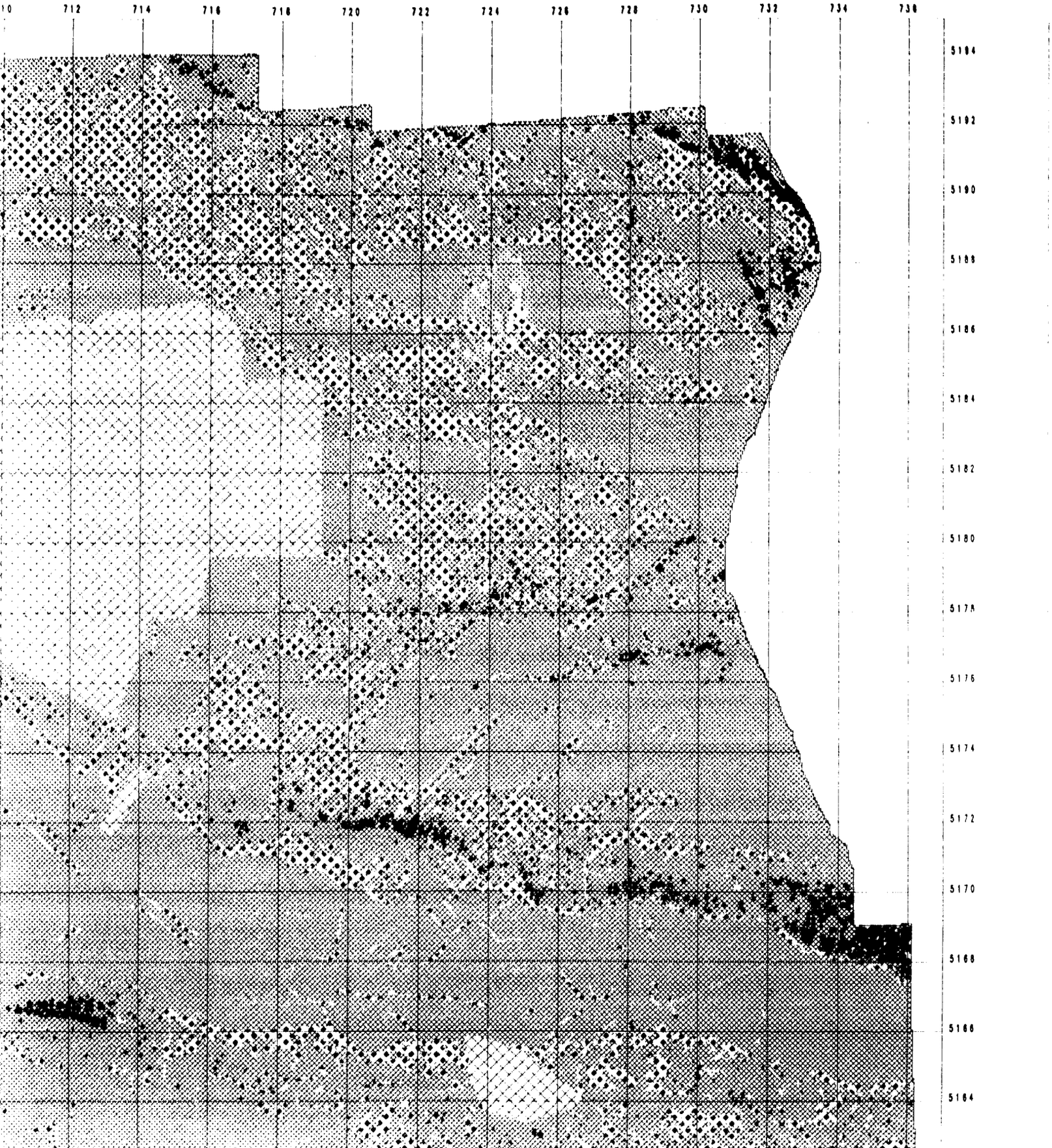


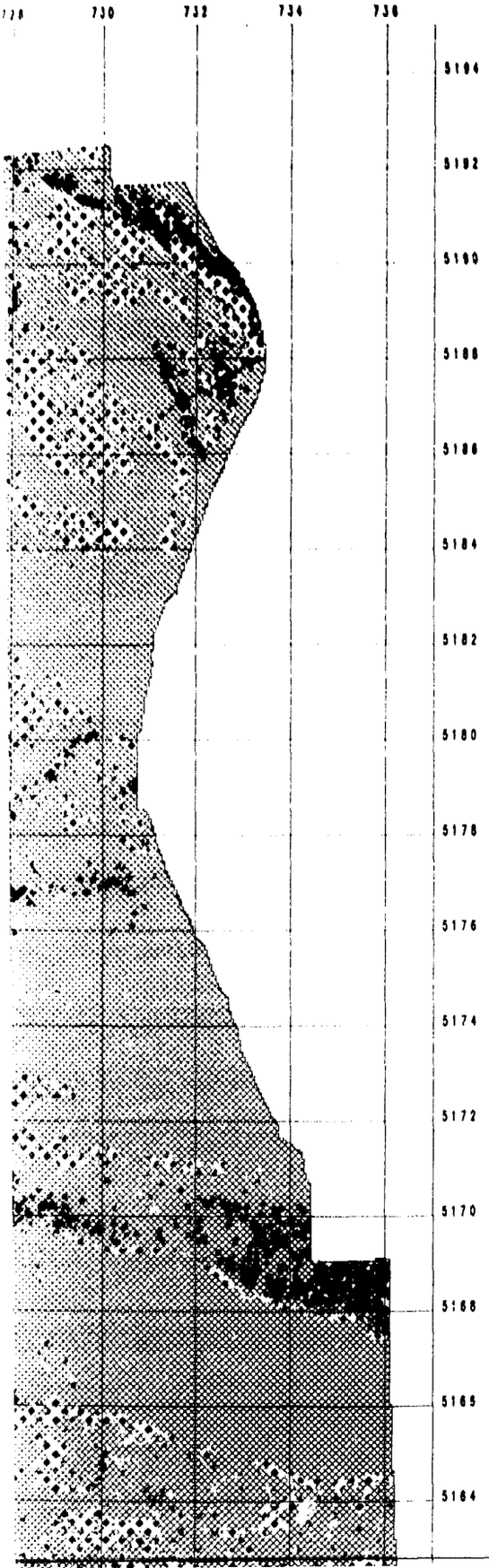
Plate 22. Fifty pass soil disturbance level map for the 4-3-3 (8X8) force structure in the dry normal surface condit



orce structure in the dry normal surface condition


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SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
1000 PASSES

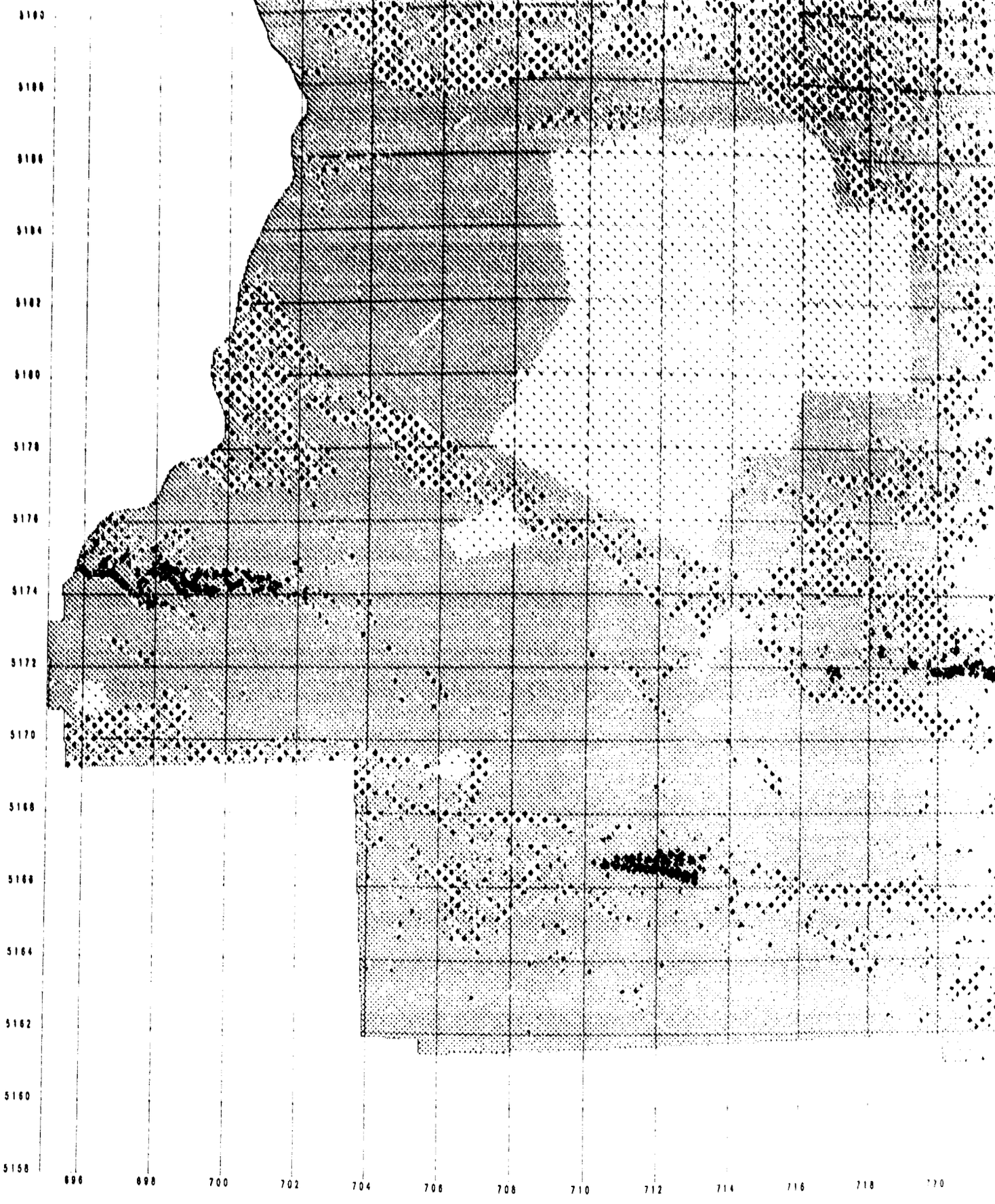


Plate 23. One thousand pass soil disturbance level ma

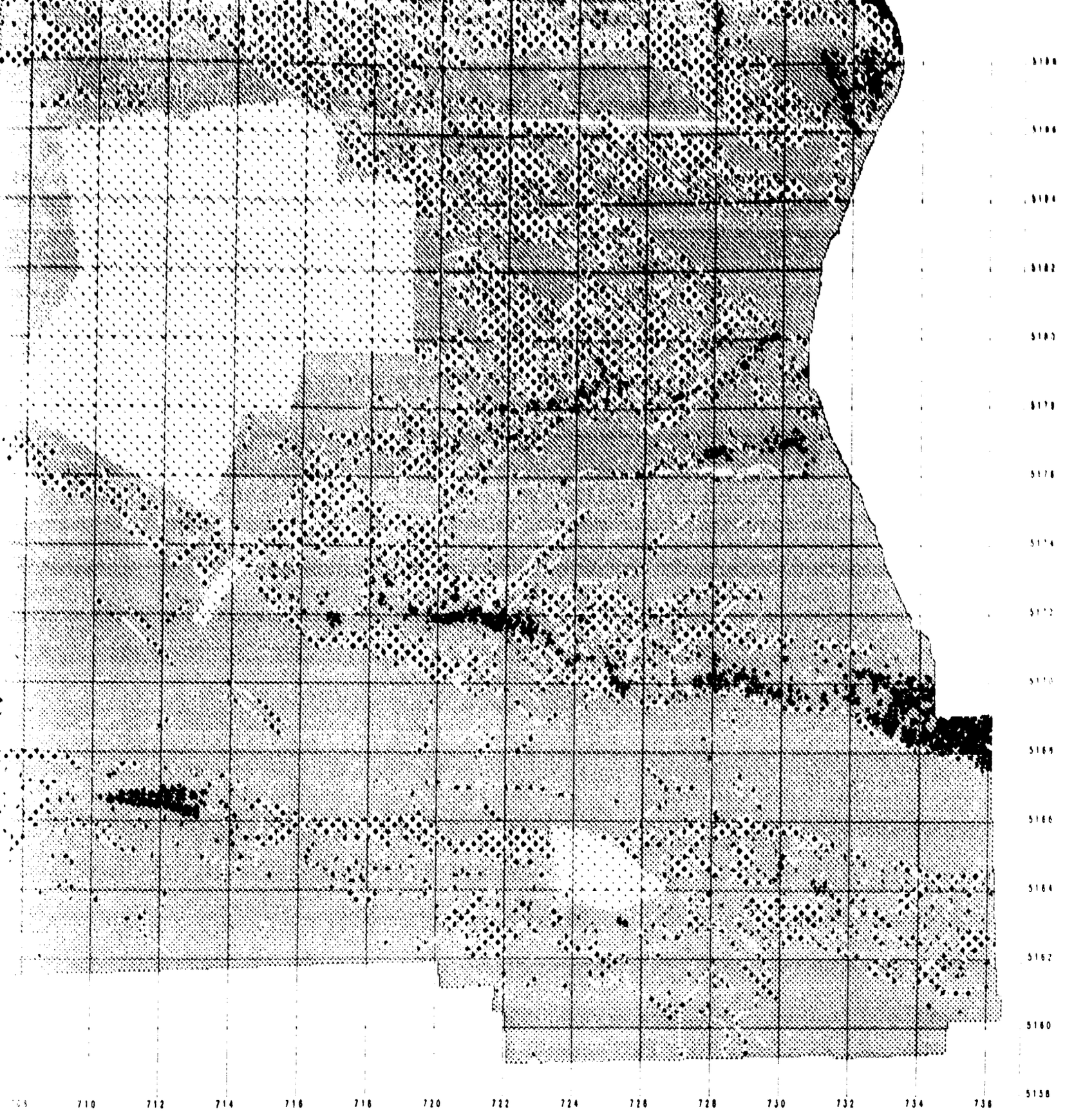
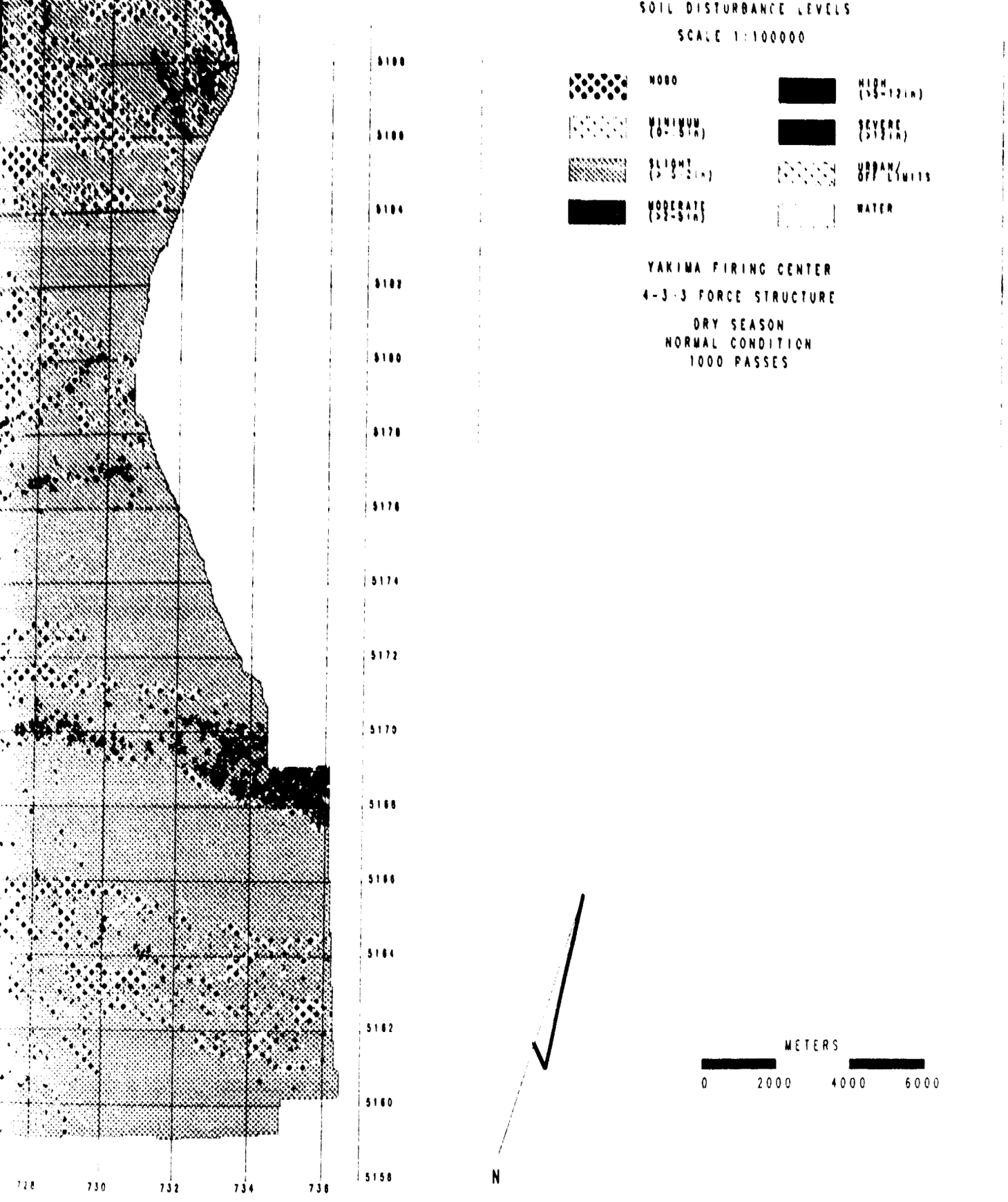
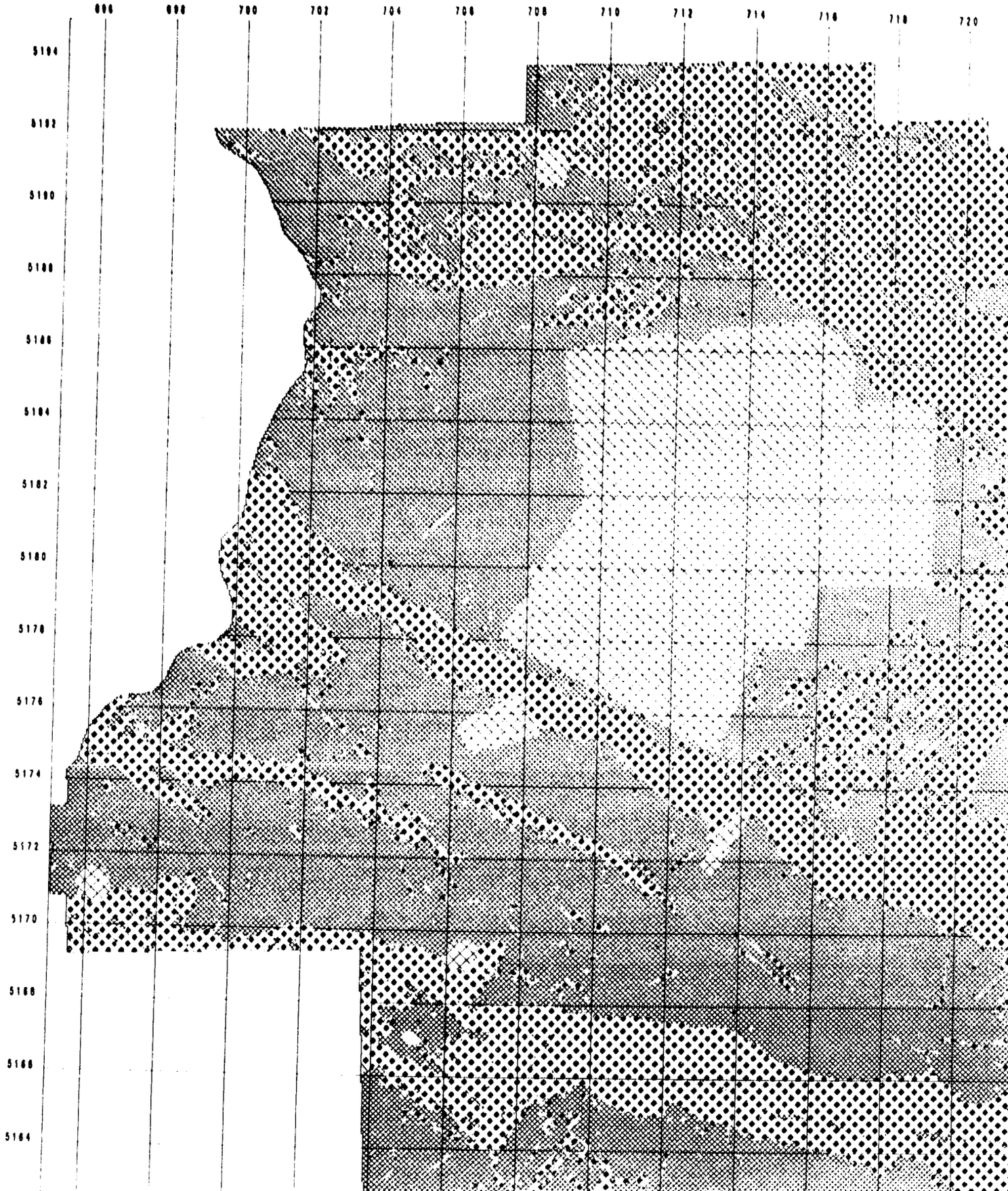
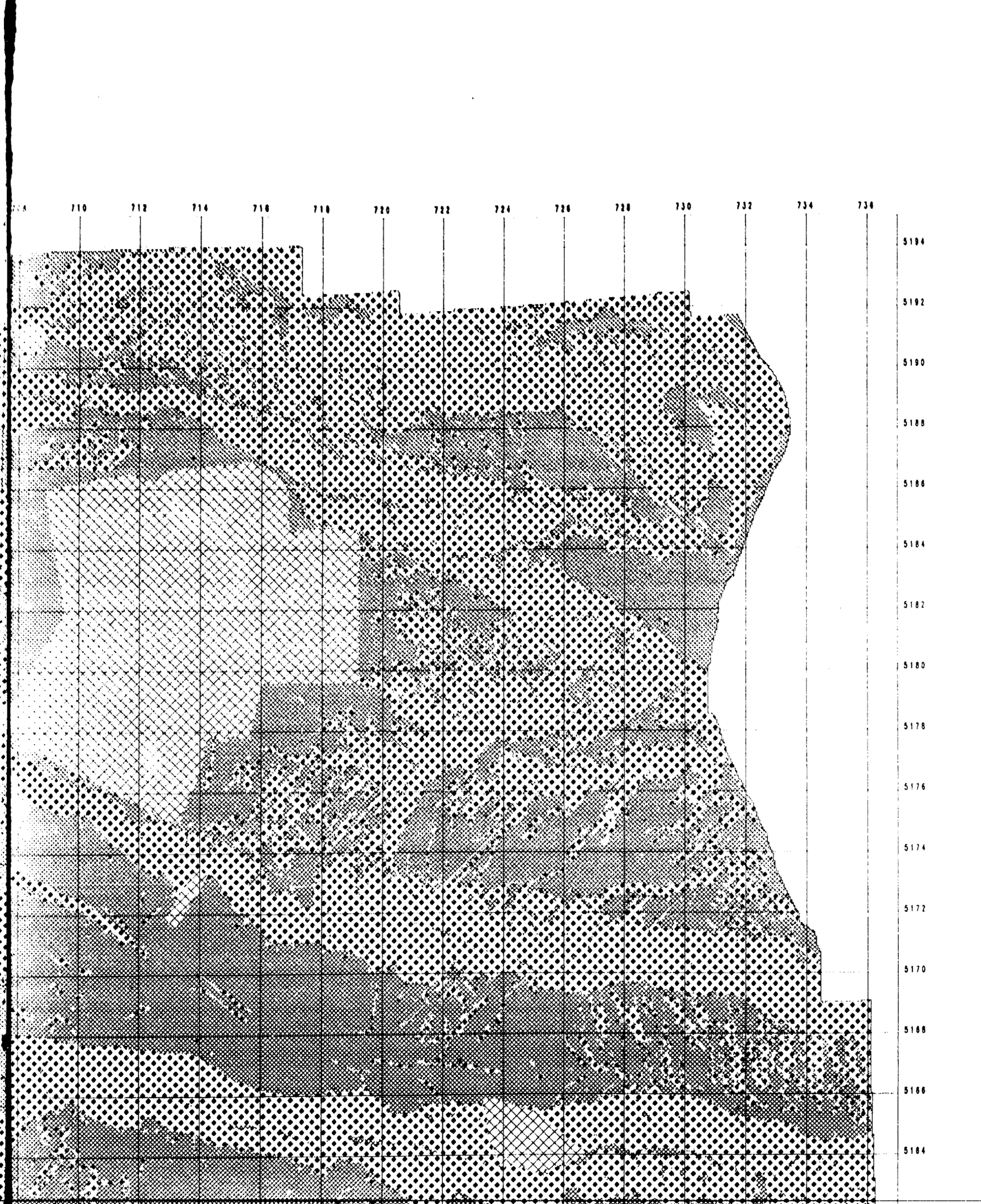


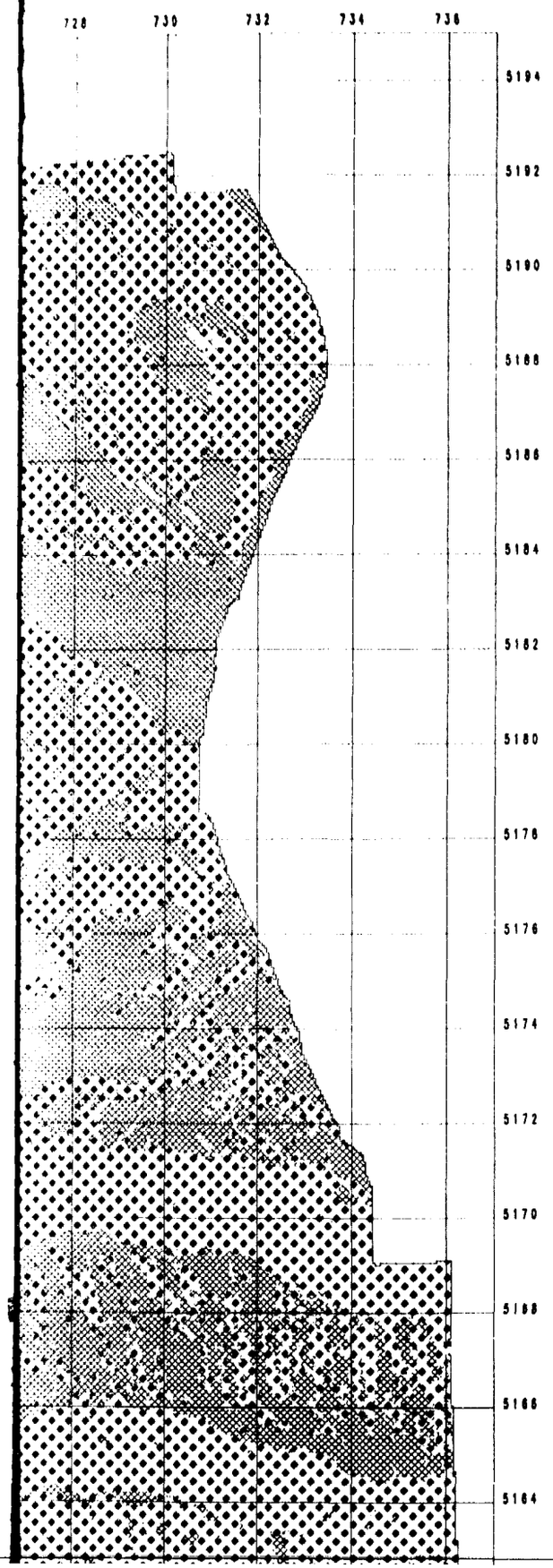
Plate 23. One thousand pass soil disturbance level map for the 4-3-3 (8X8) force structure in the dry normal surface conditi



force structure in the dry normal surface condition


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SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
10 PASSES

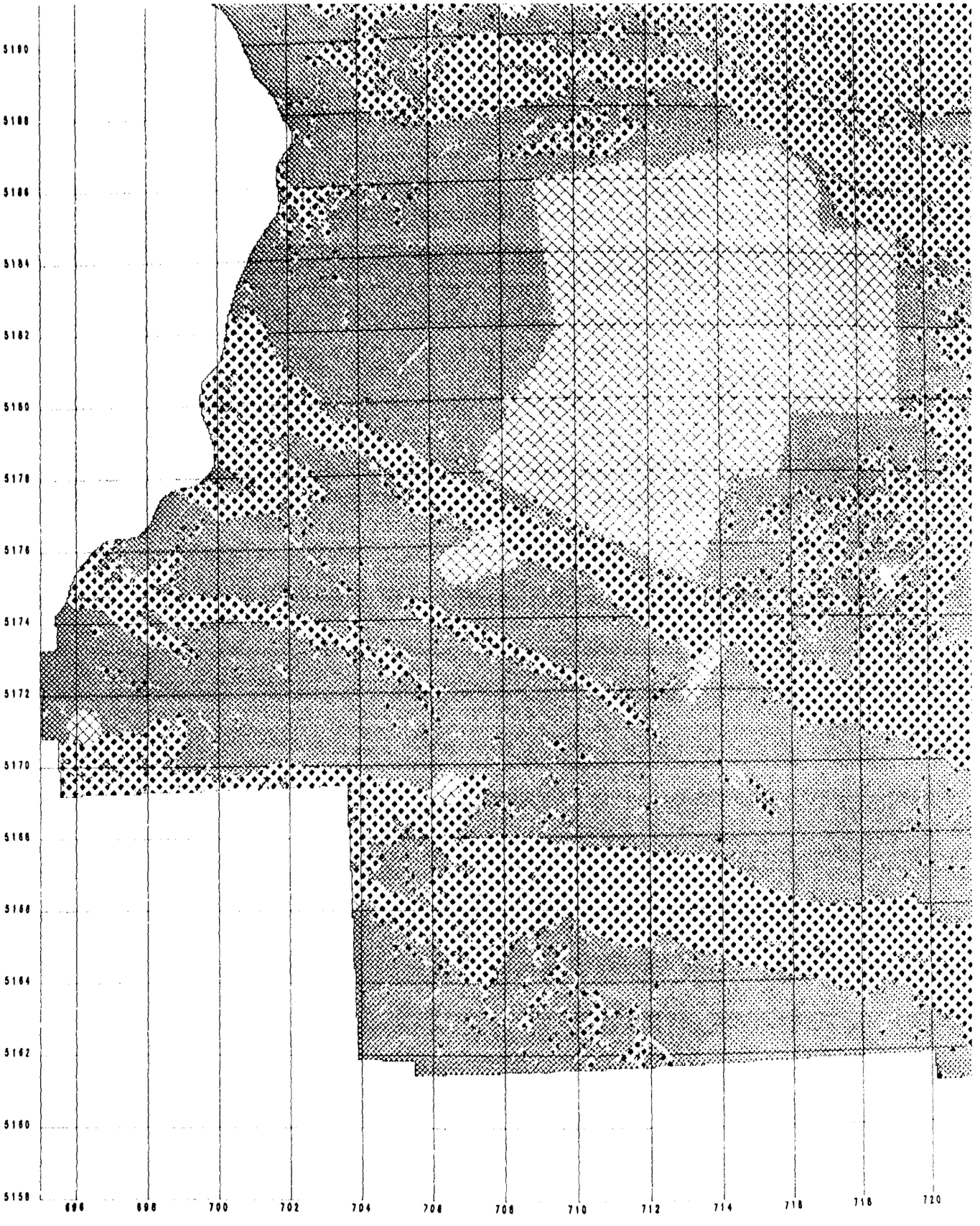


Plate 24. Ten pass soil disturbance level

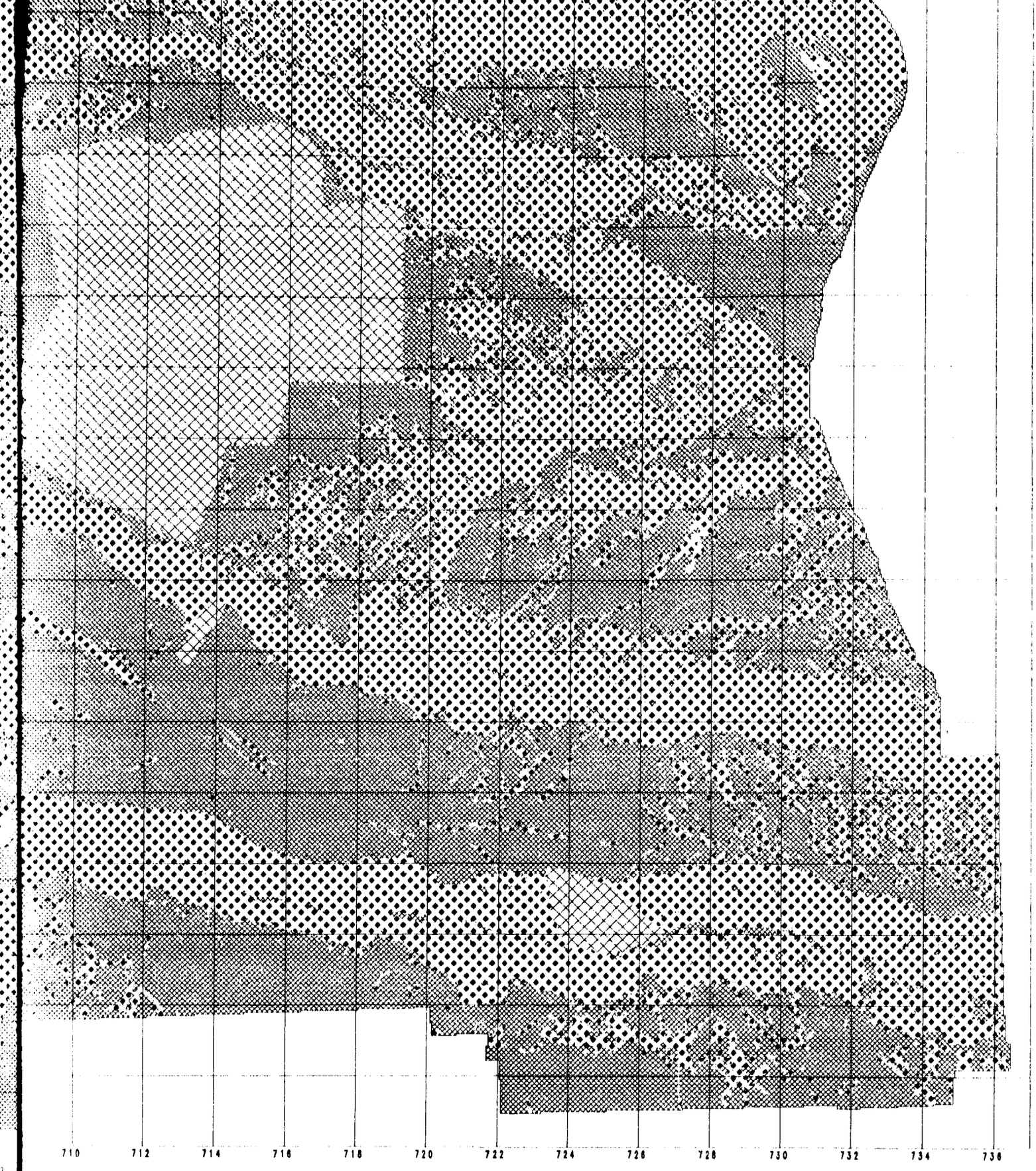
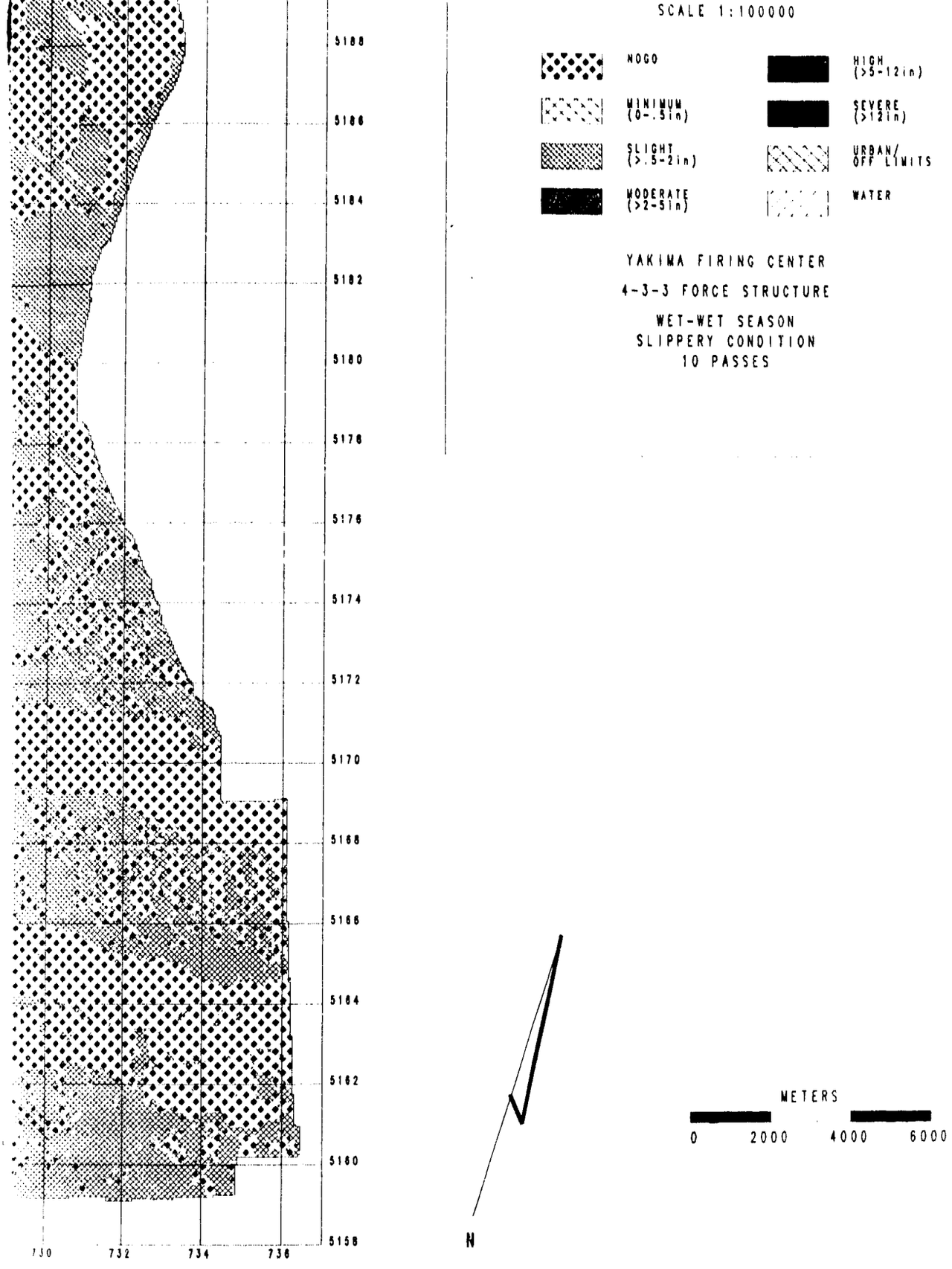
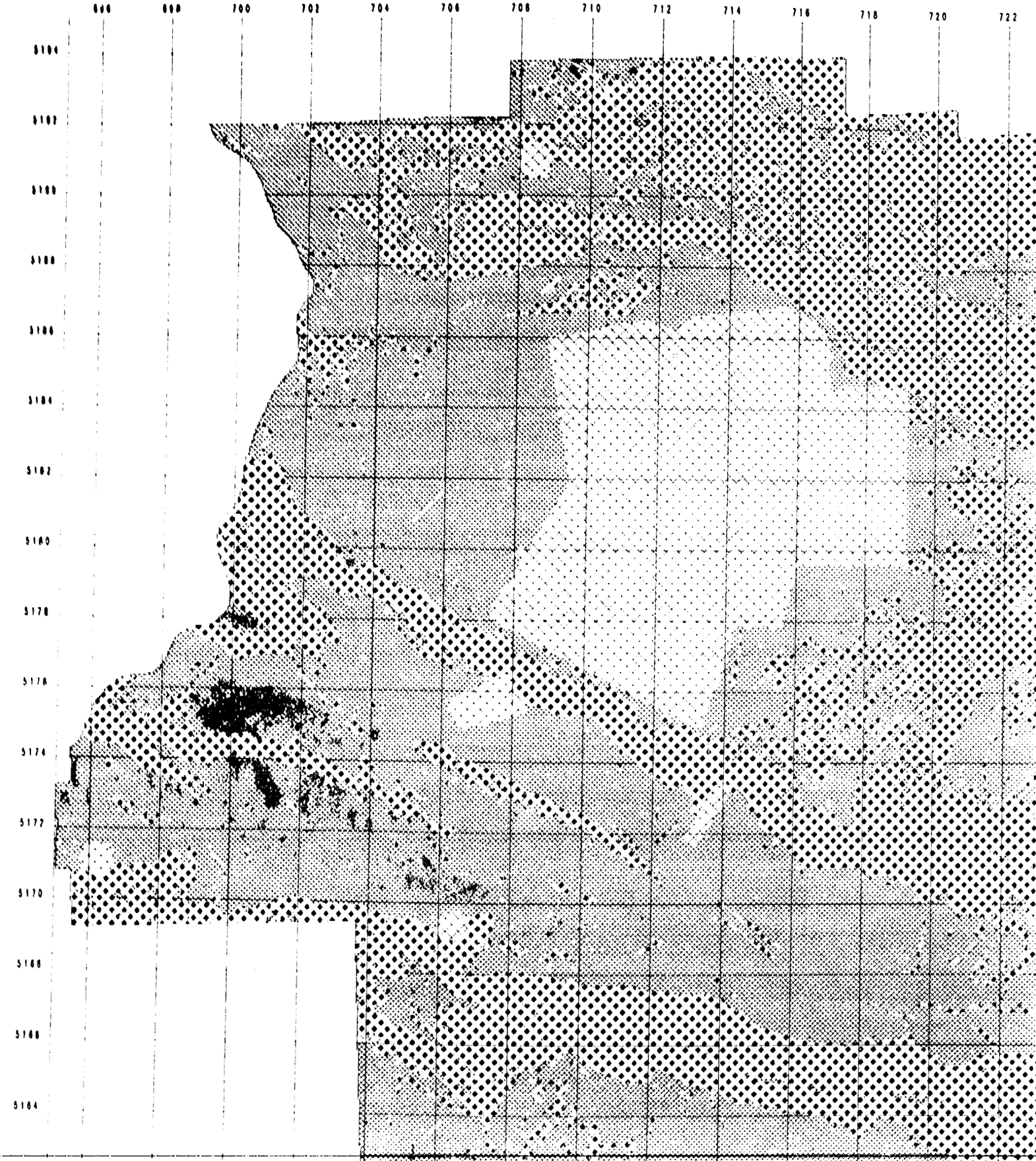


Plate 24. Ten pass soil disturbance level map for the 4-3-3 (8X8) force structure in the wet-wet slippery surface con

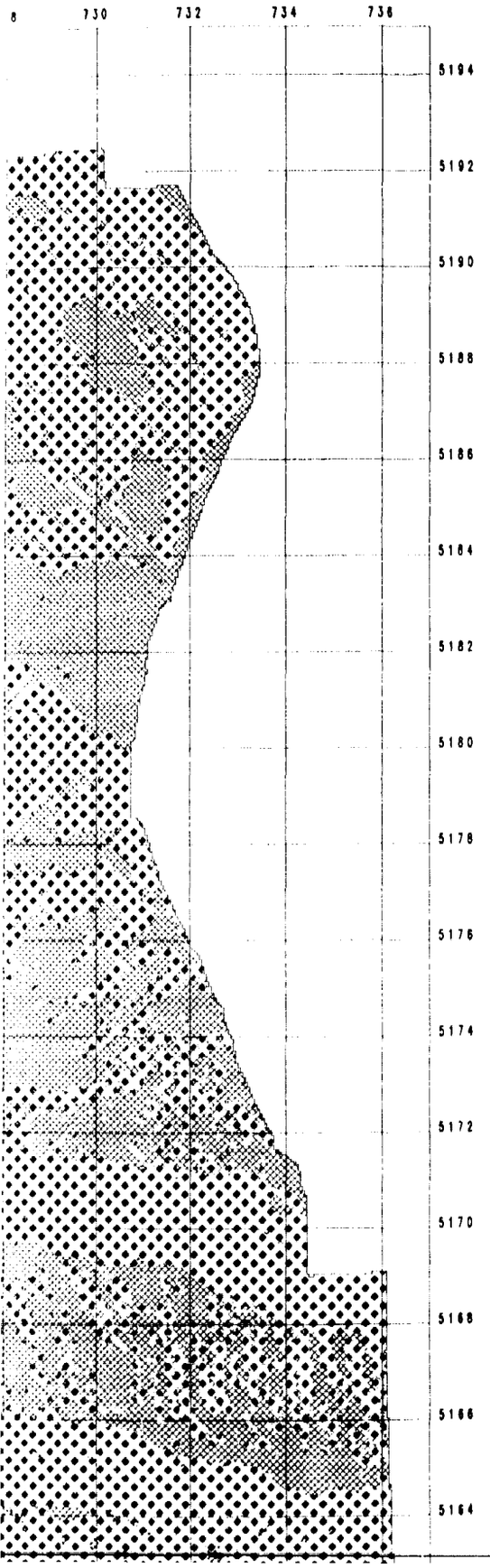


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U. S. Army Corps of Engineers
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SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
50 PASSES

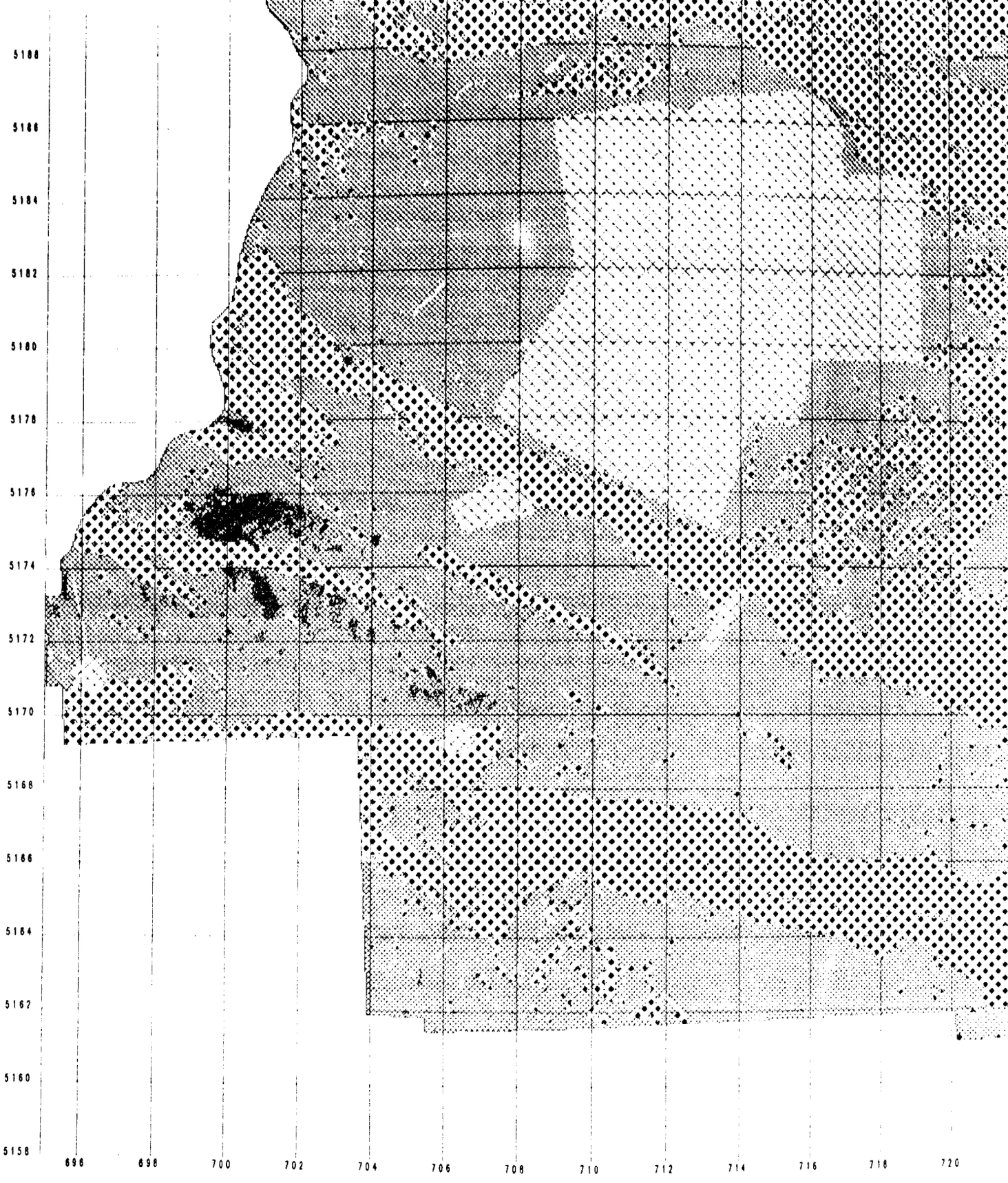


Plate 25. Fifty pass soil disturbance level

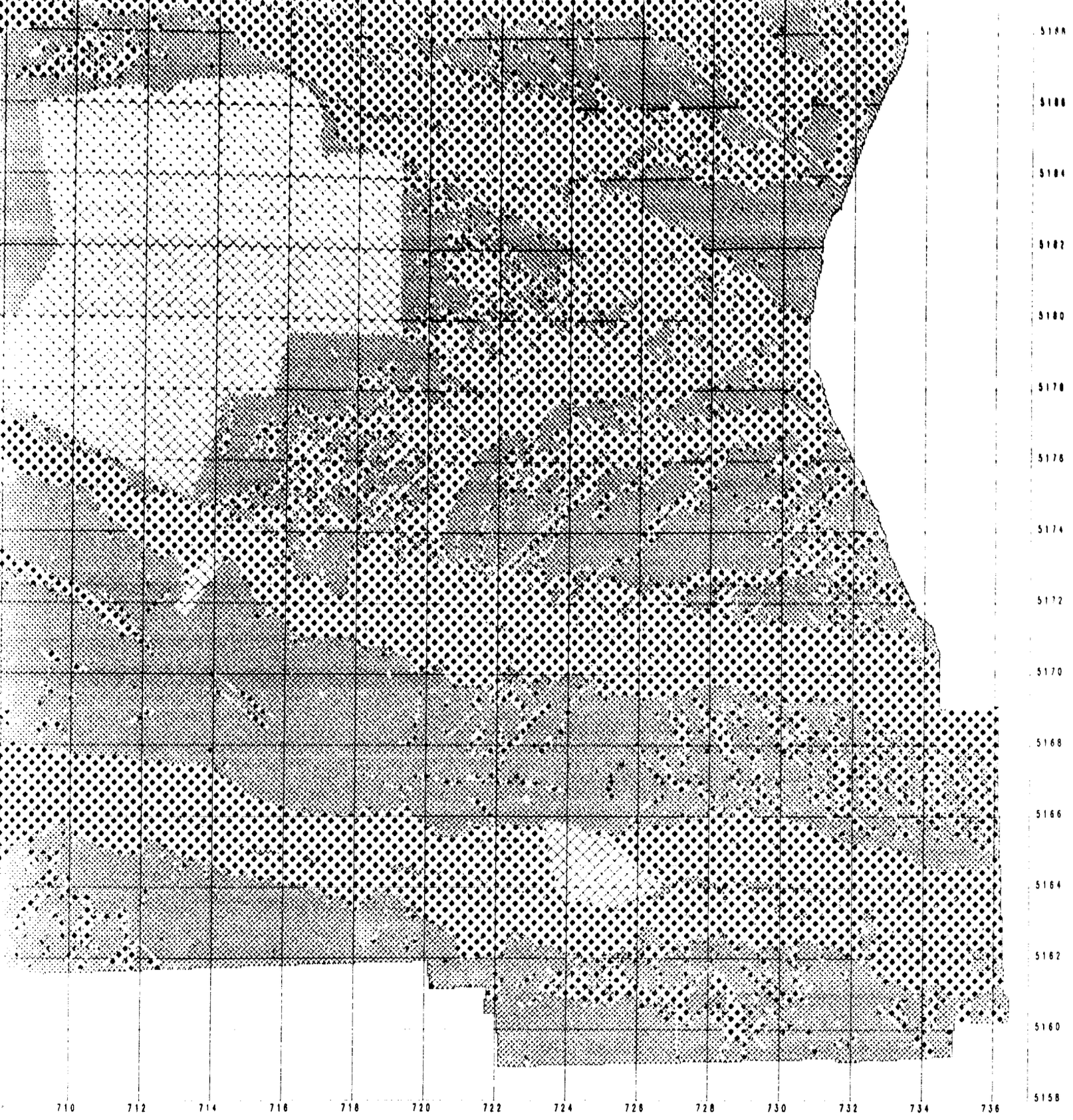
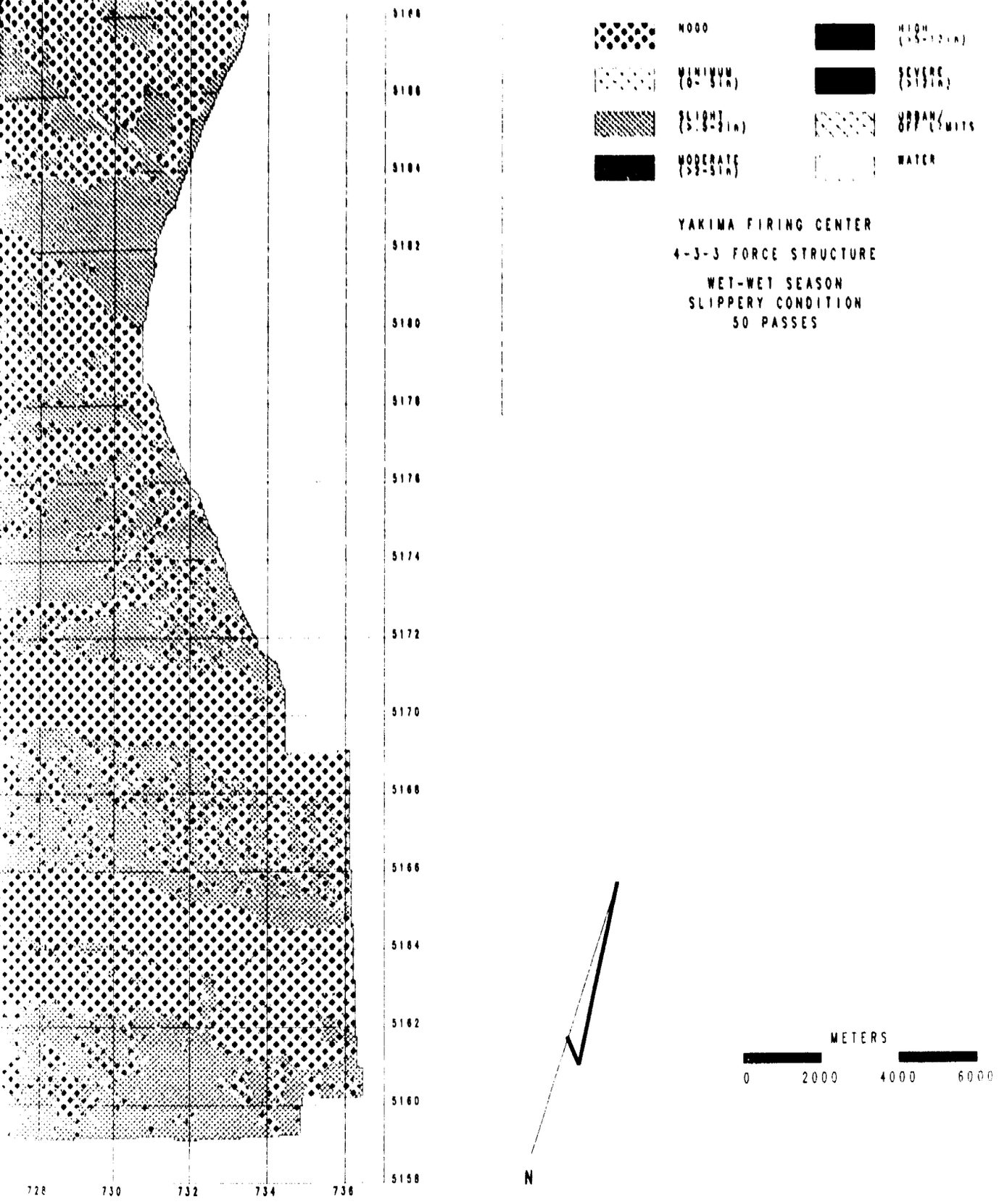
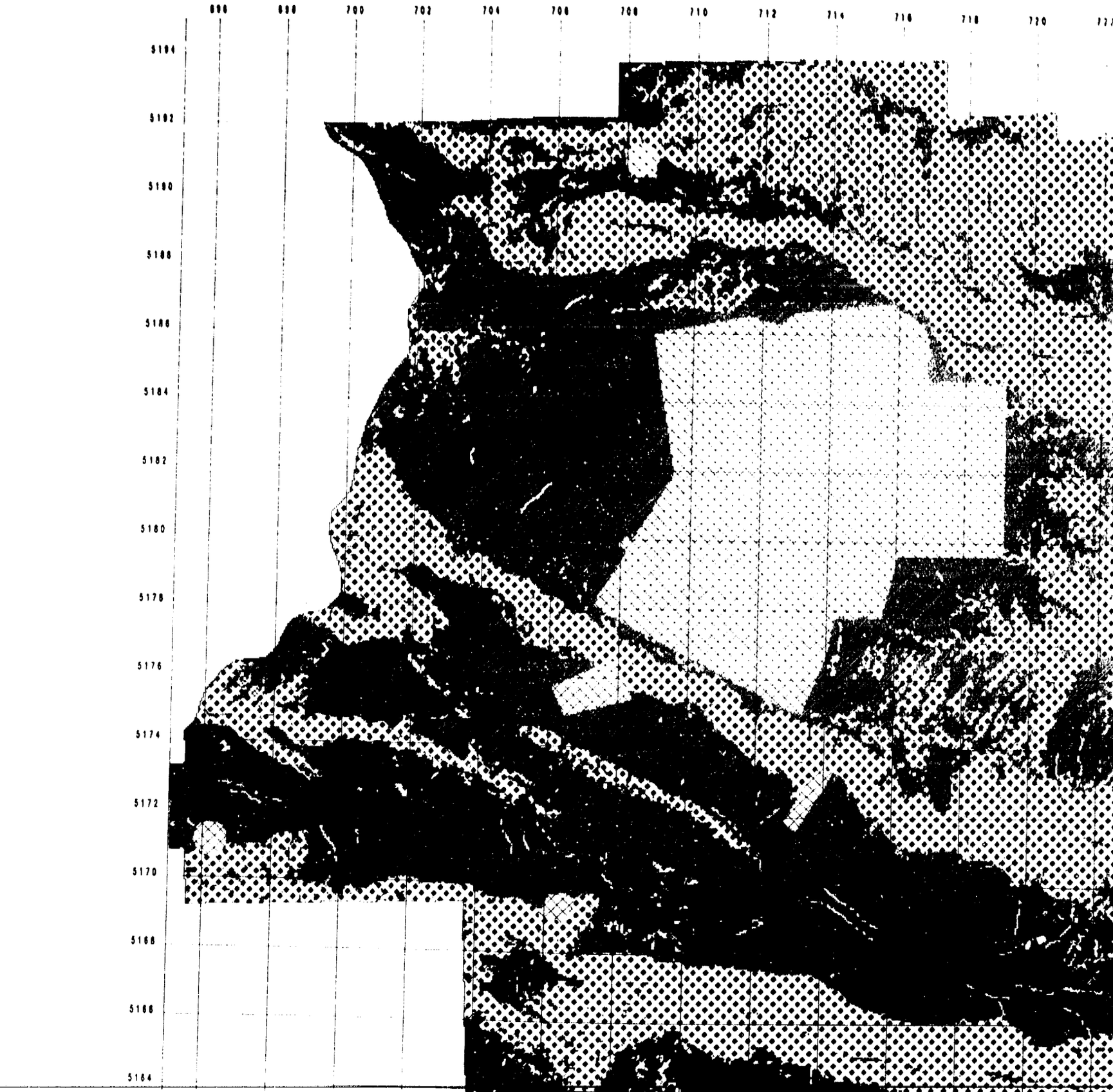
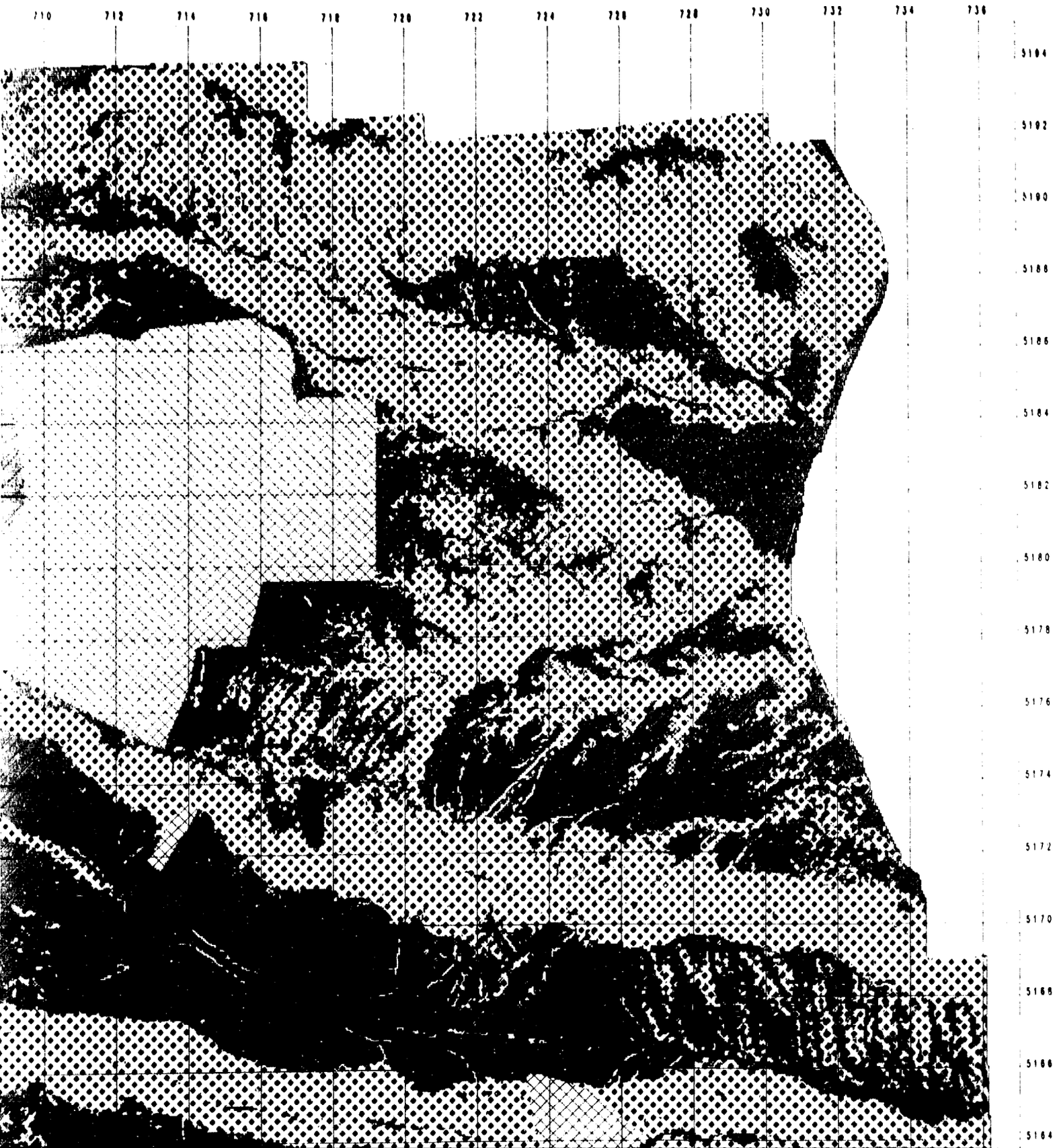


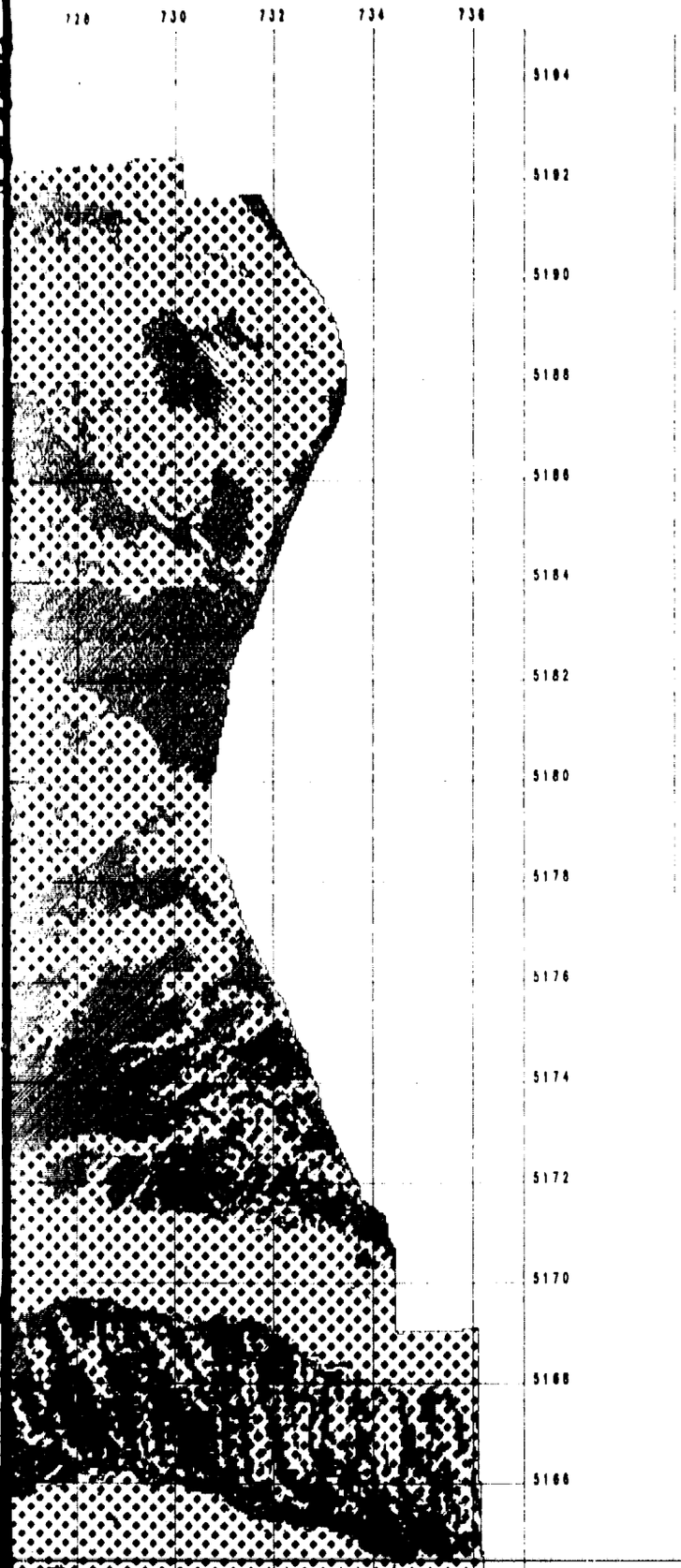
Plate 25. Fifty pass soil disturbance level map for the 4-3-3 (8X8) force structure in the wet-wet slippery surface con



(b) force structure in the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO

MINIMUM (0-.5in)

SLIGHT (>.5-2in)

MODERATE (>2-5in)

HIGH (>5-12in)

SEVERE (>12in)

URBAN/ OFF LIMITS

WATER

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
1000 PASSES

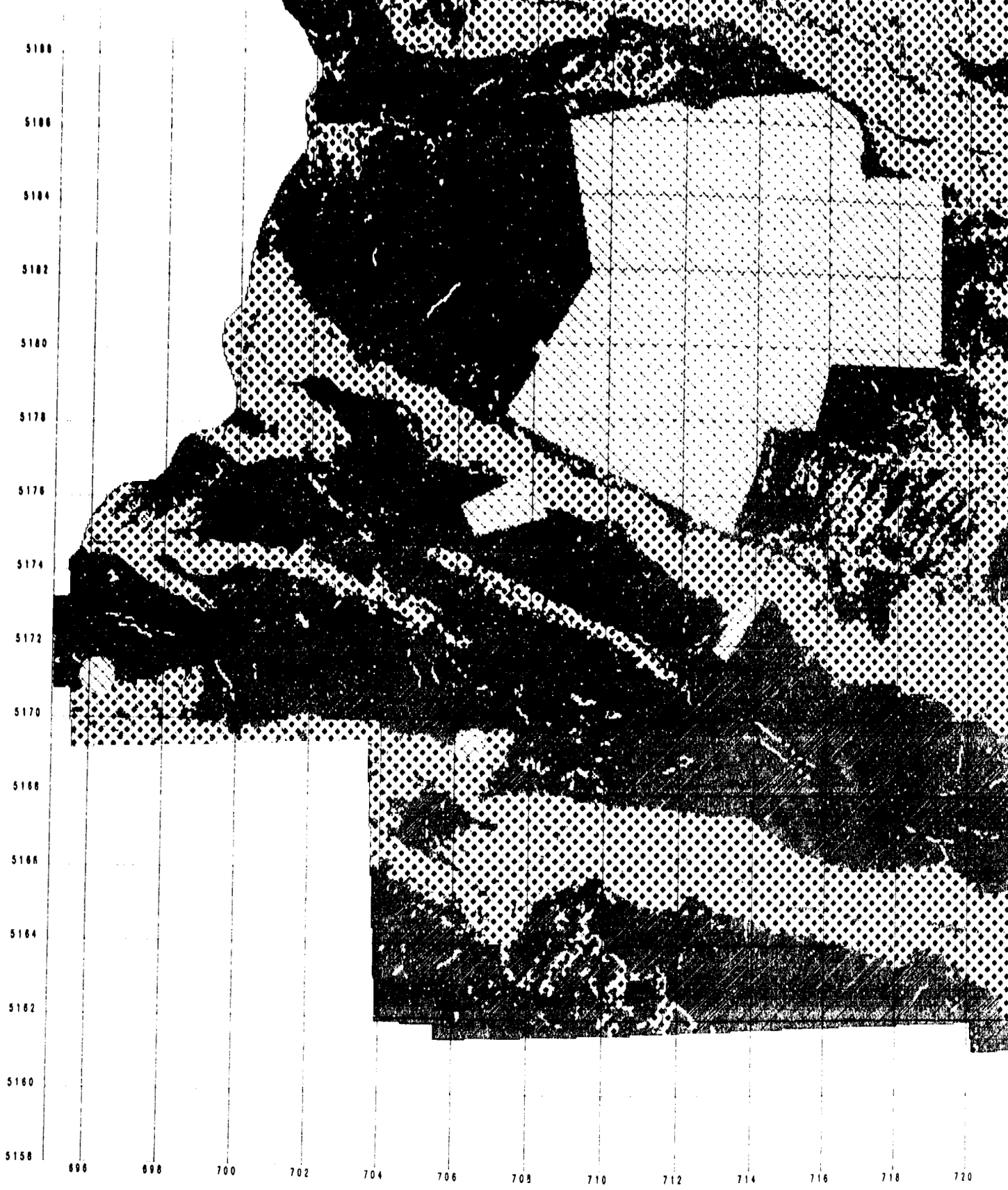


Plate 26. One thousand pass soil disturbance level

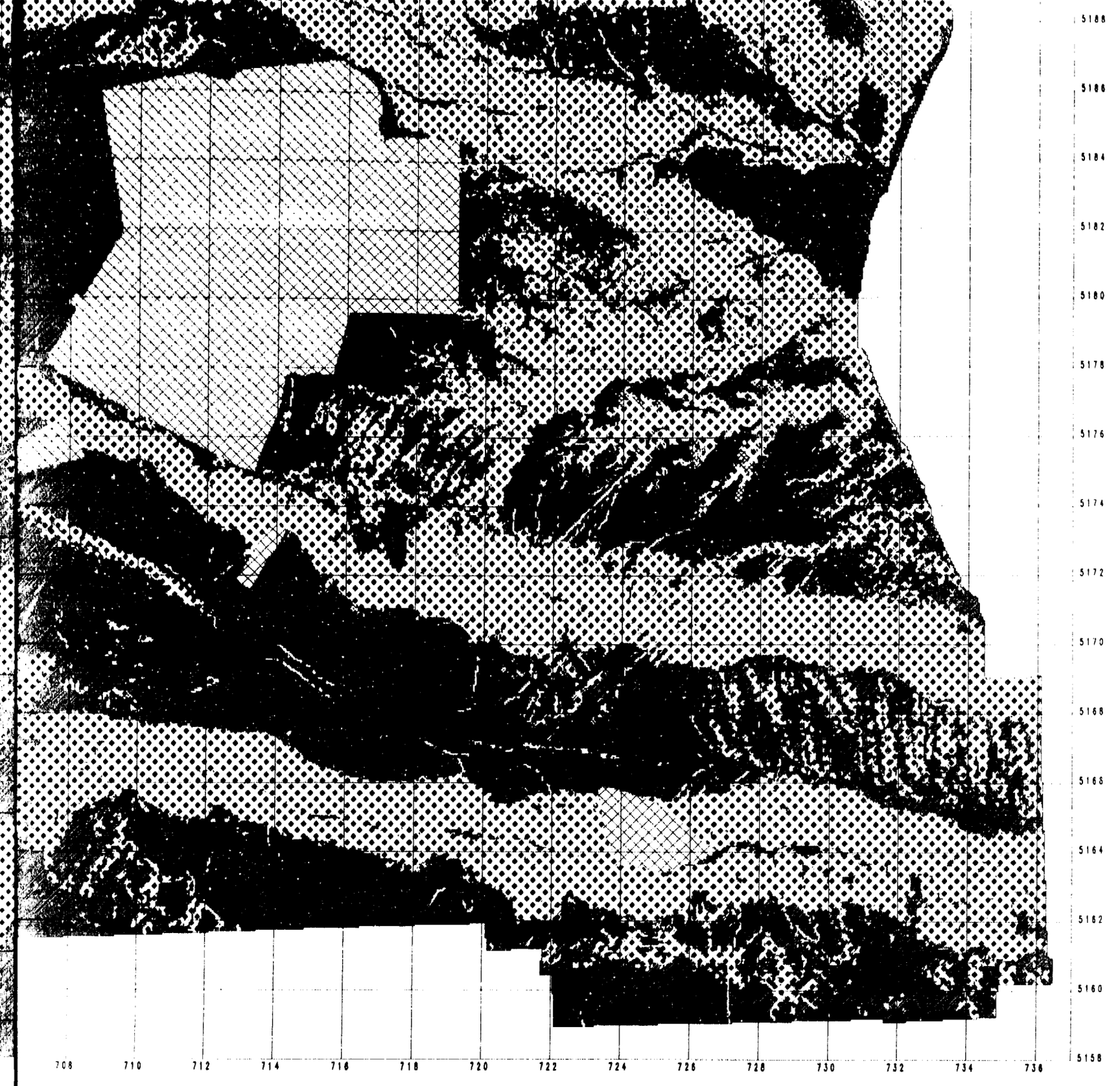
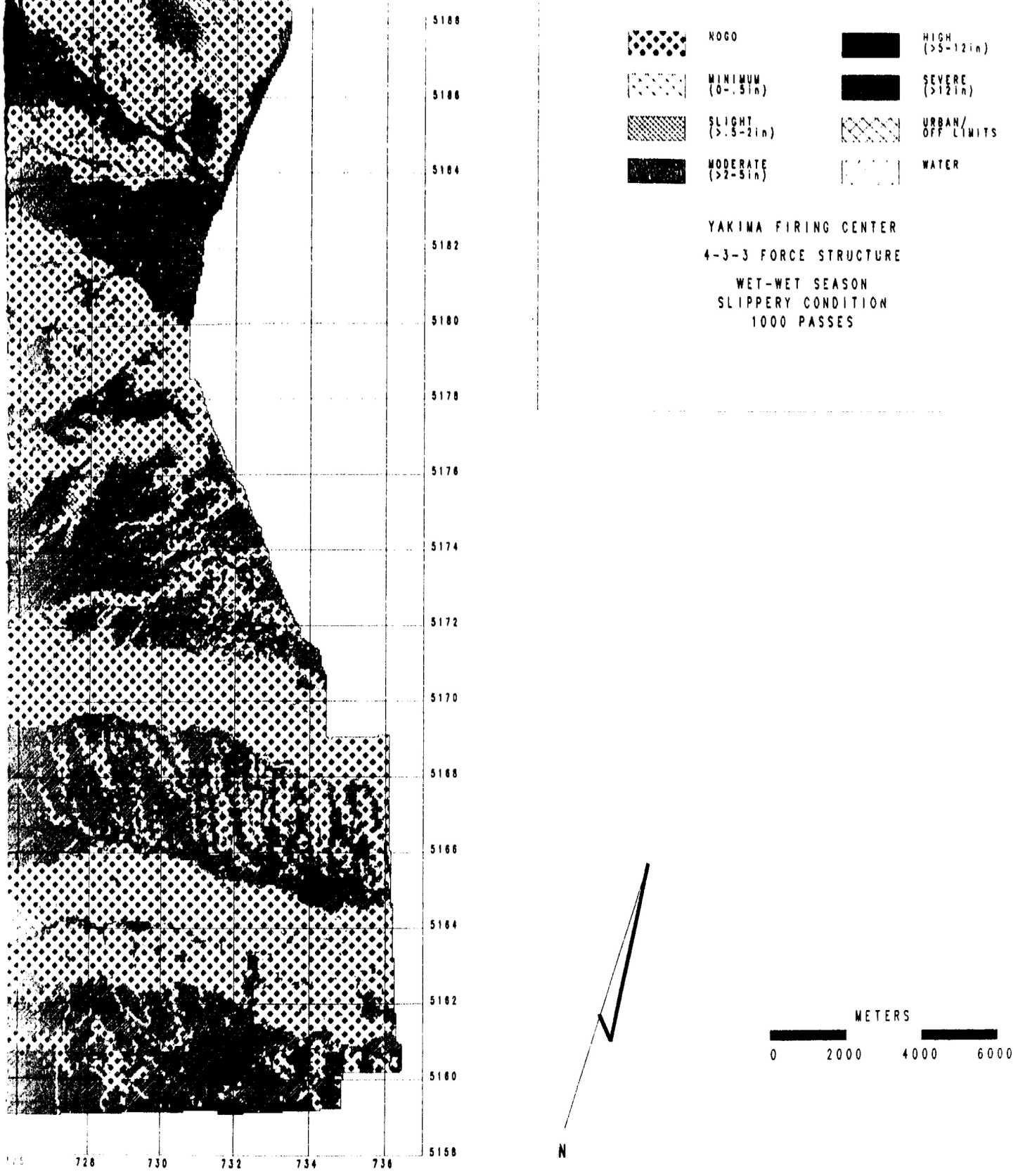
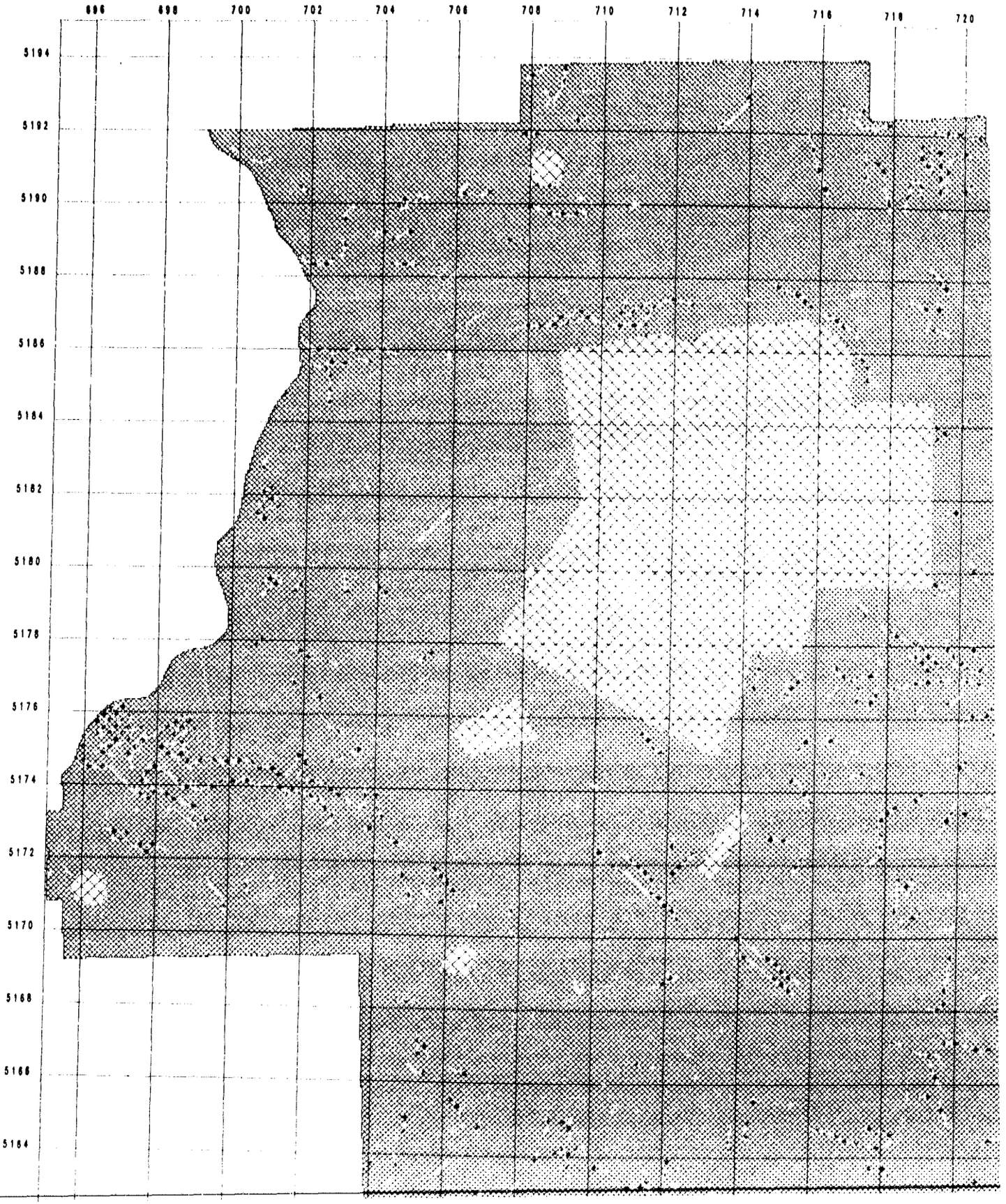
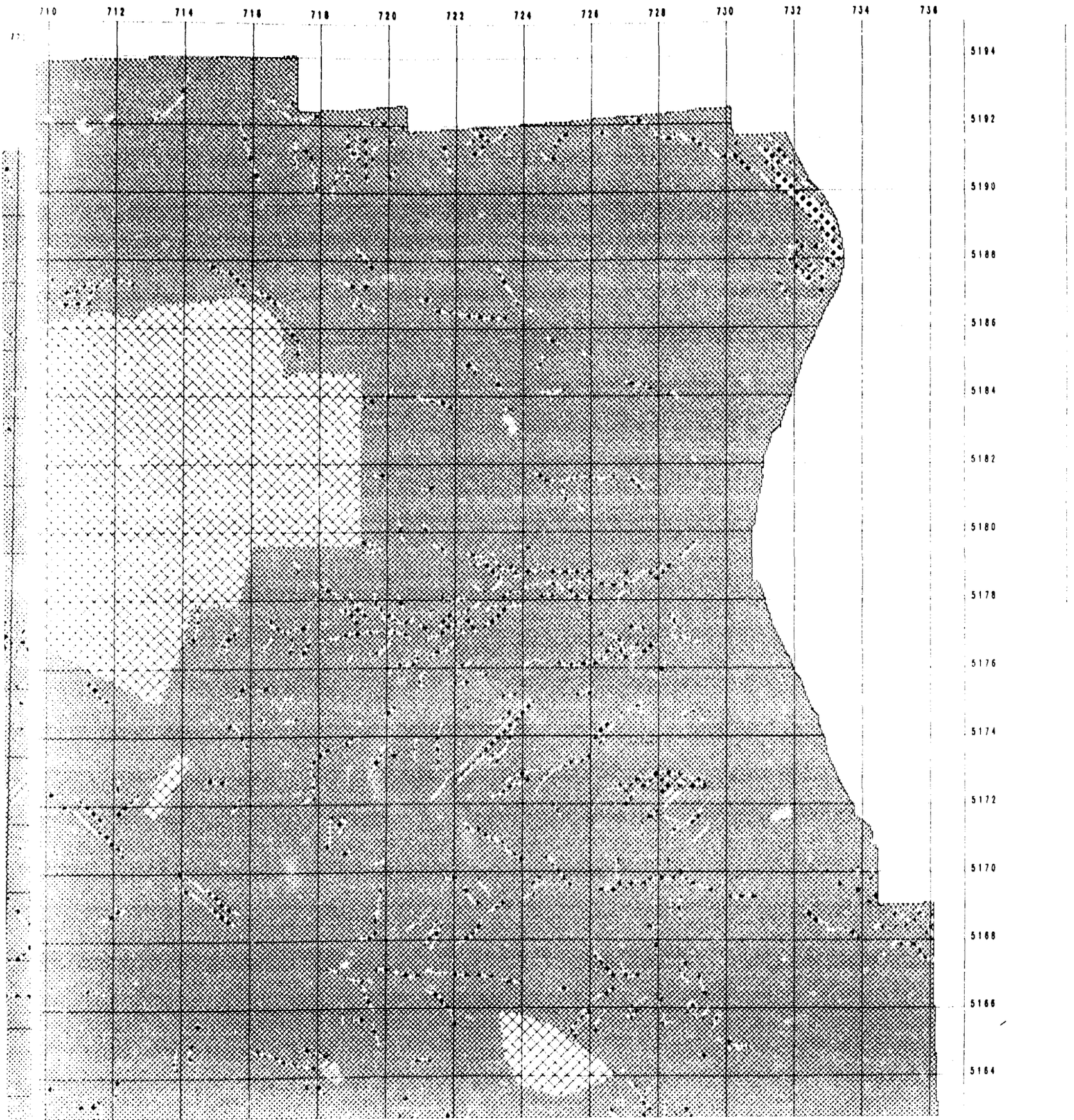


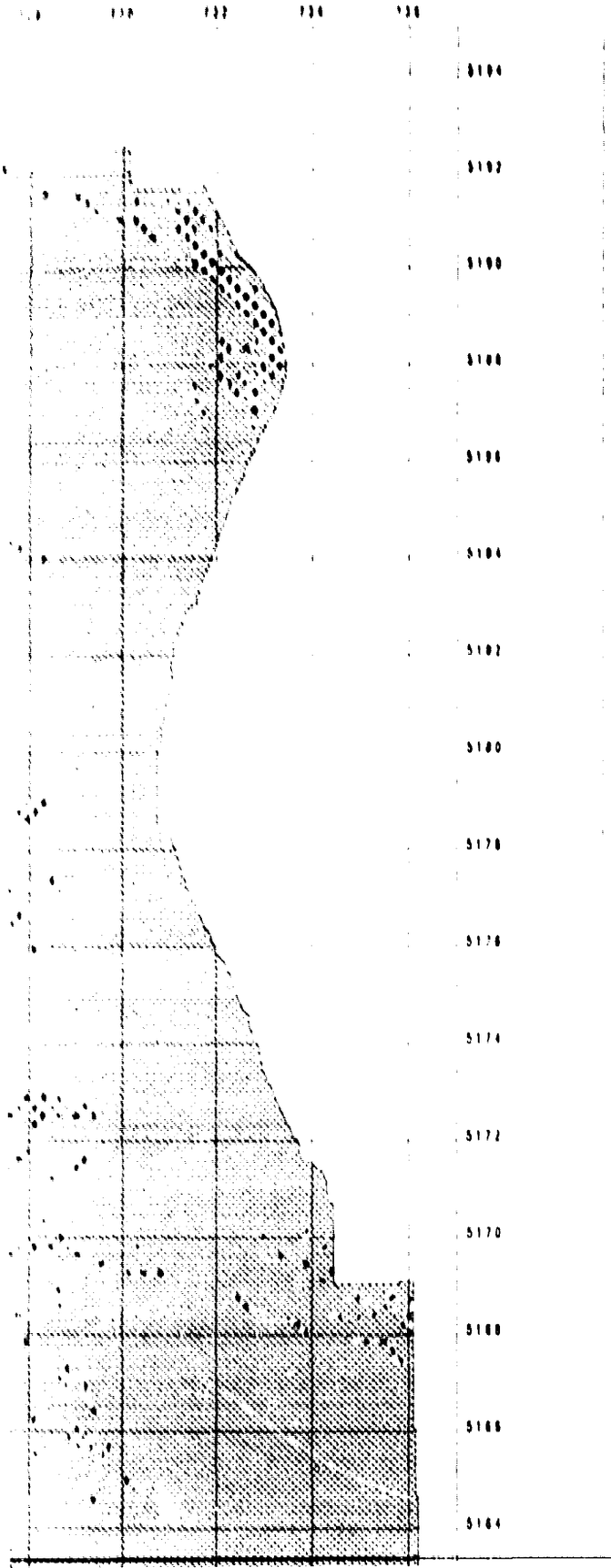
Plate 26. One thousand pass soil disturbance level map for the 4-3-3 (8X8) force structure in the wet-wet slippery su



ce (8X8) force structure in the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NUGO	HIGH (>5-12in)
MINIMUM (0-5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
10 PASSES

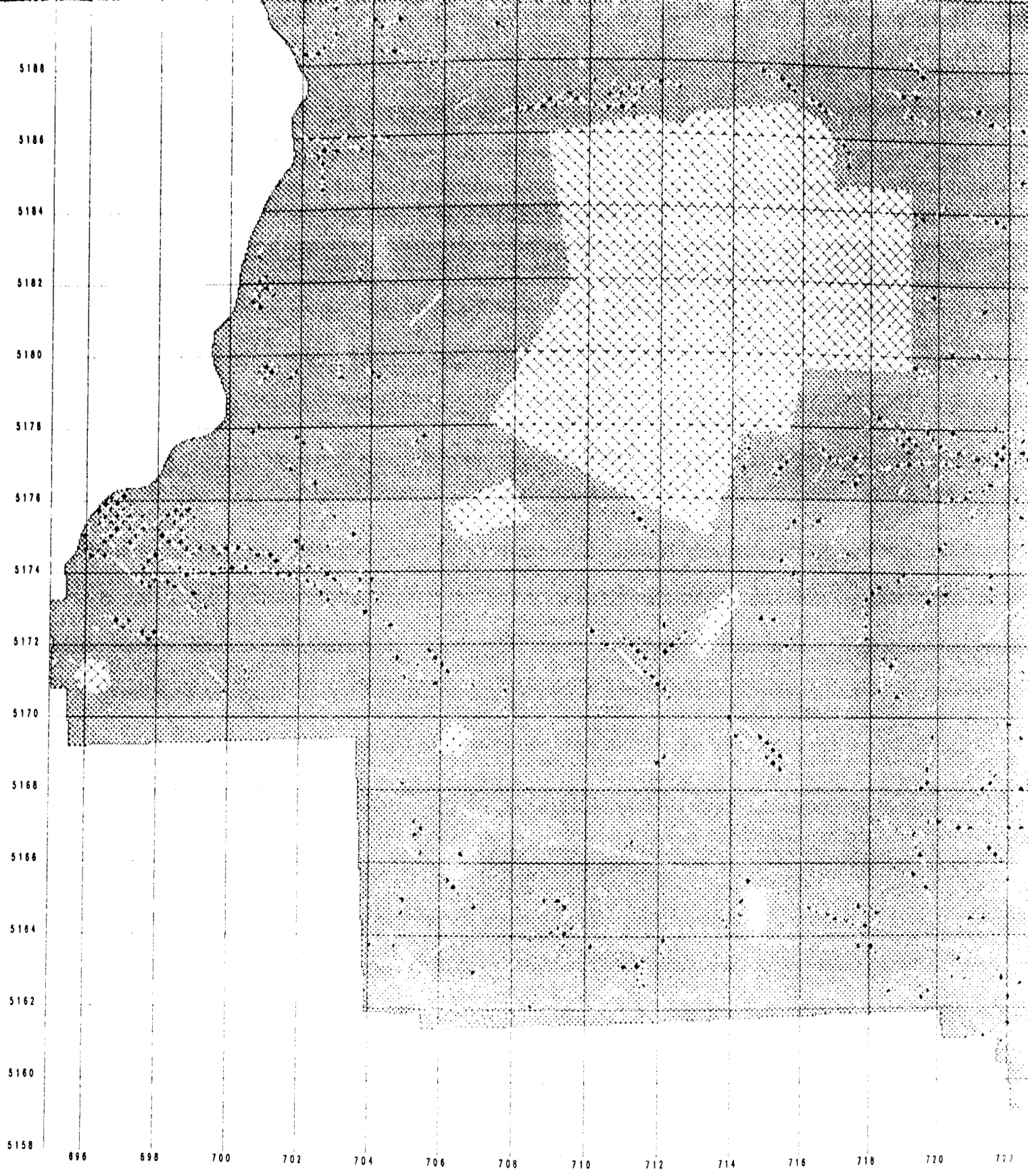


Plate 27. Ten pass soil disturbance level m

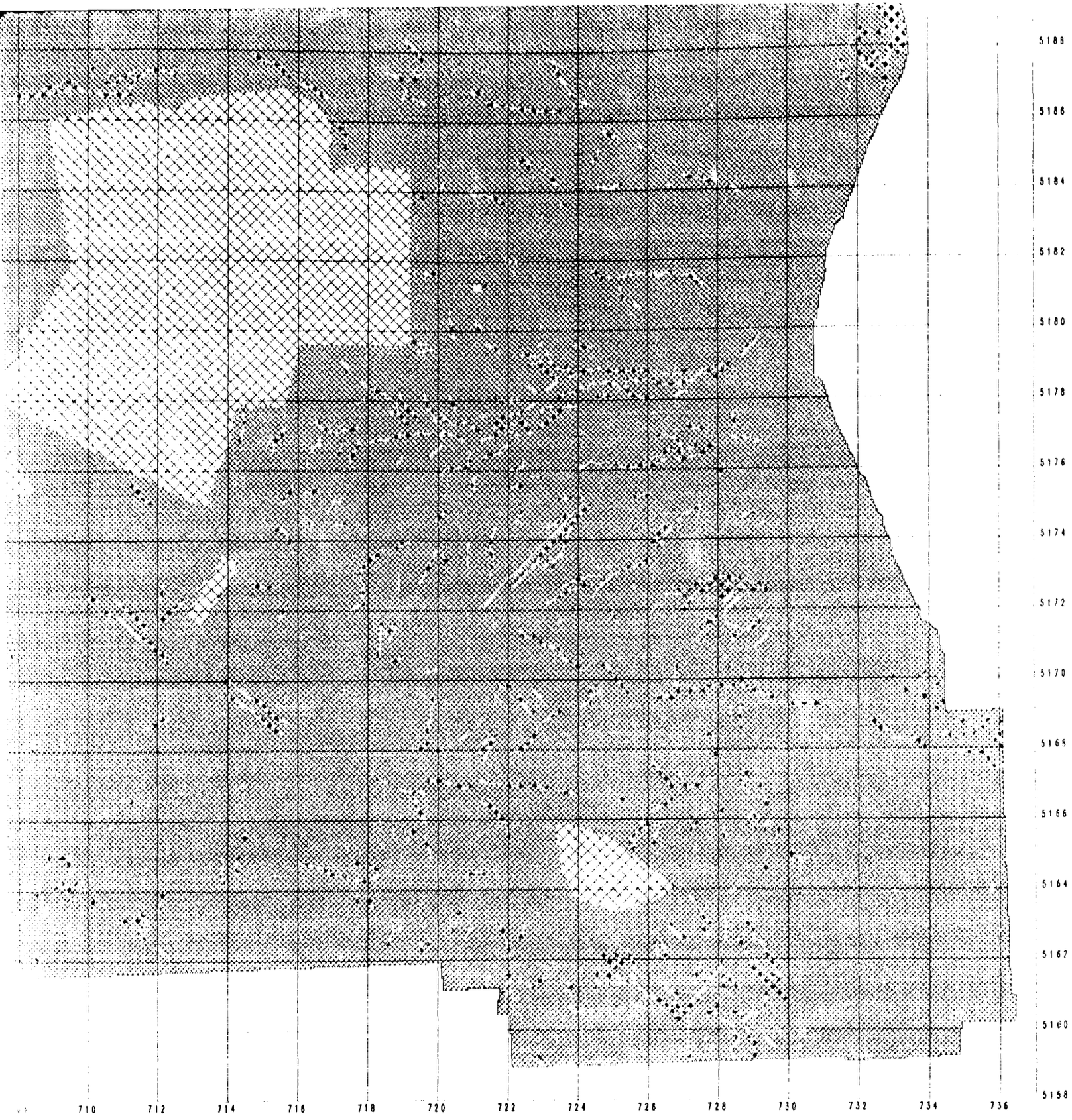
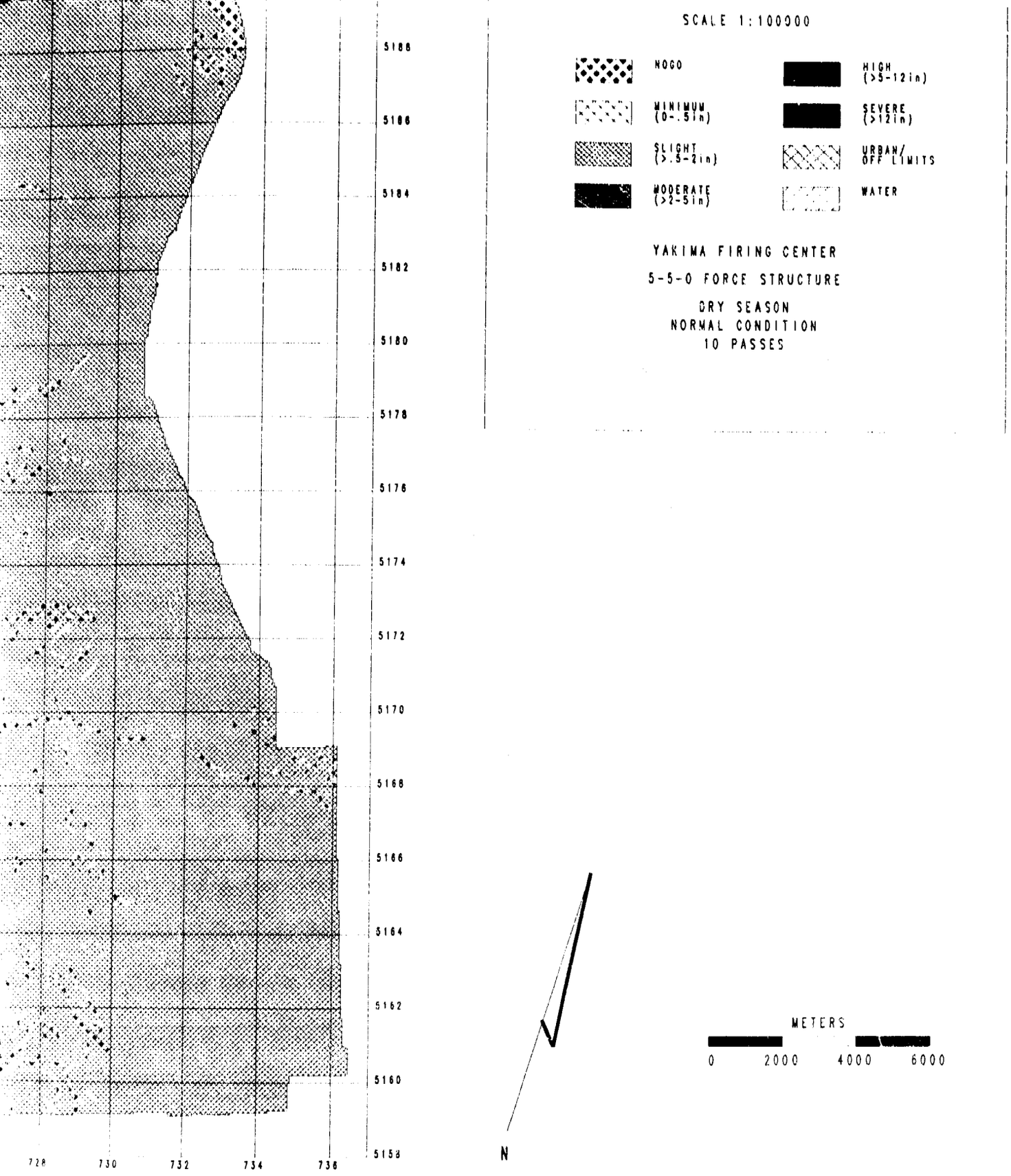
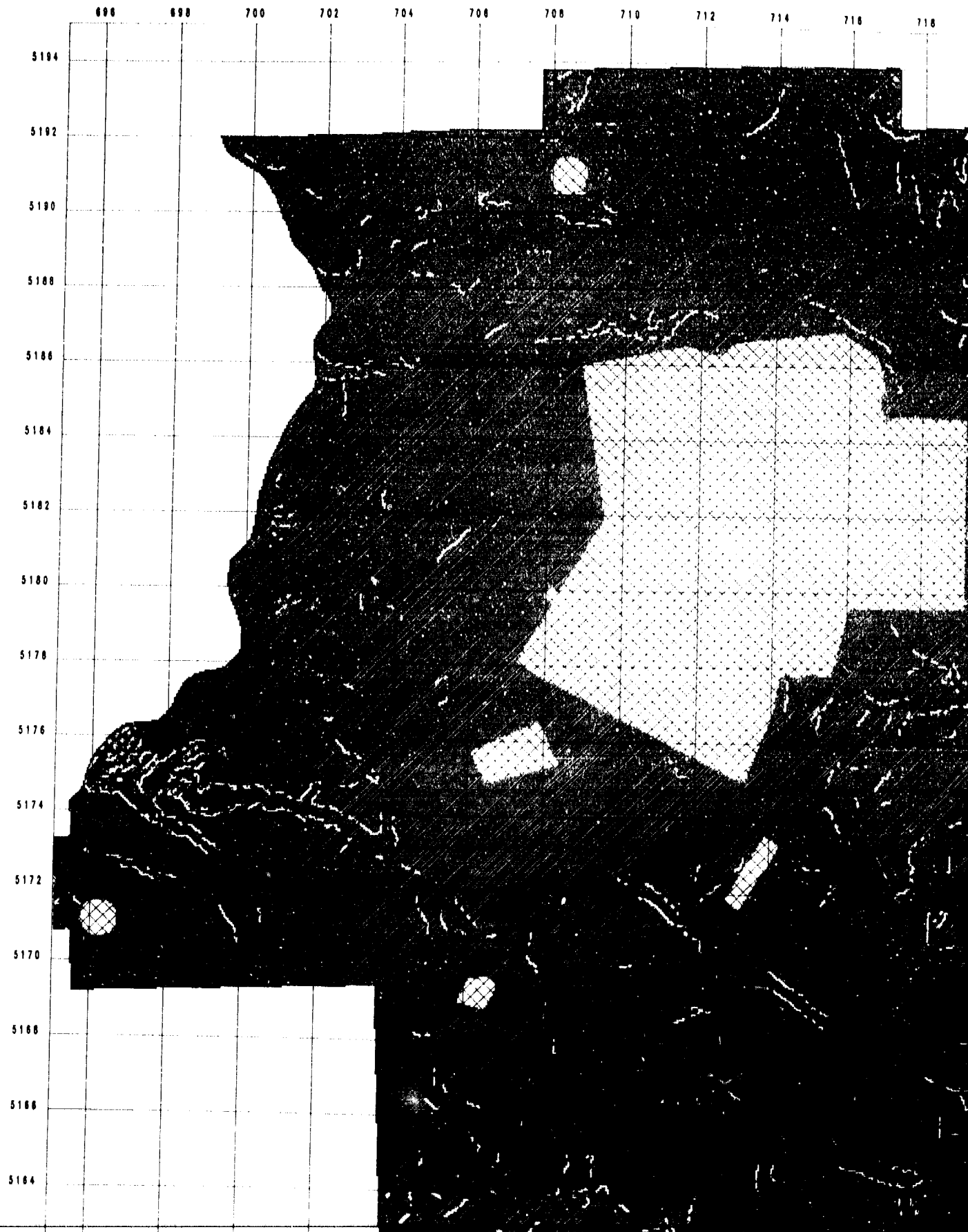
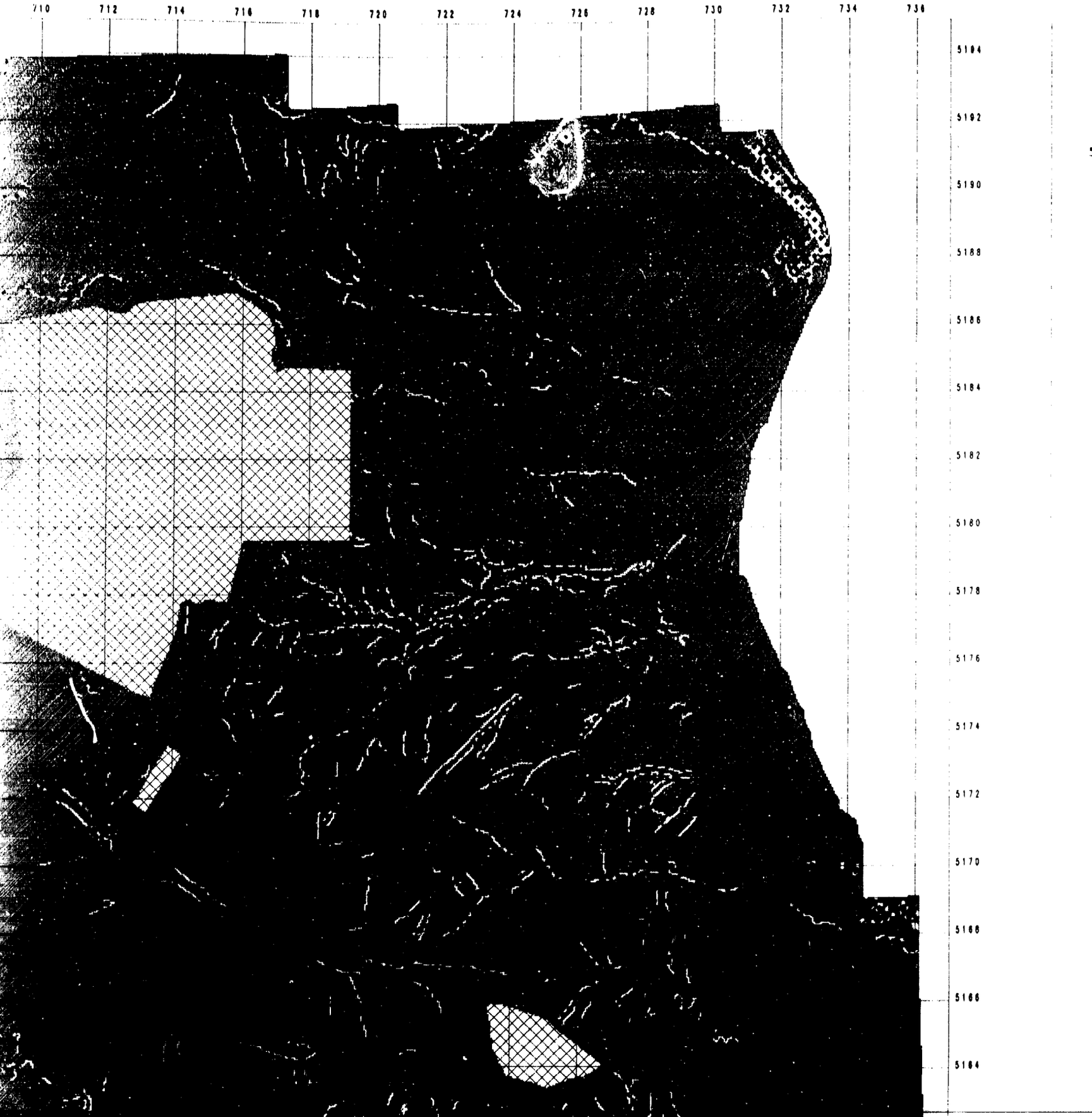


Plate 27. Ten pass soil disturbance level map for the 5-5-0 force structure in the dry normal surface condition



force structure in the dry normal surface condition


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Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12 in)
MINIMUM (0-.5 in)	SEVERE (>12 in)
SLIGHT (>.5-2 in)	URBAN/ OFF LIMITS
MODERATE (>2-5 in)	WATER

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
50 PASSES



Plate 28. Fifty pass soil disturbam

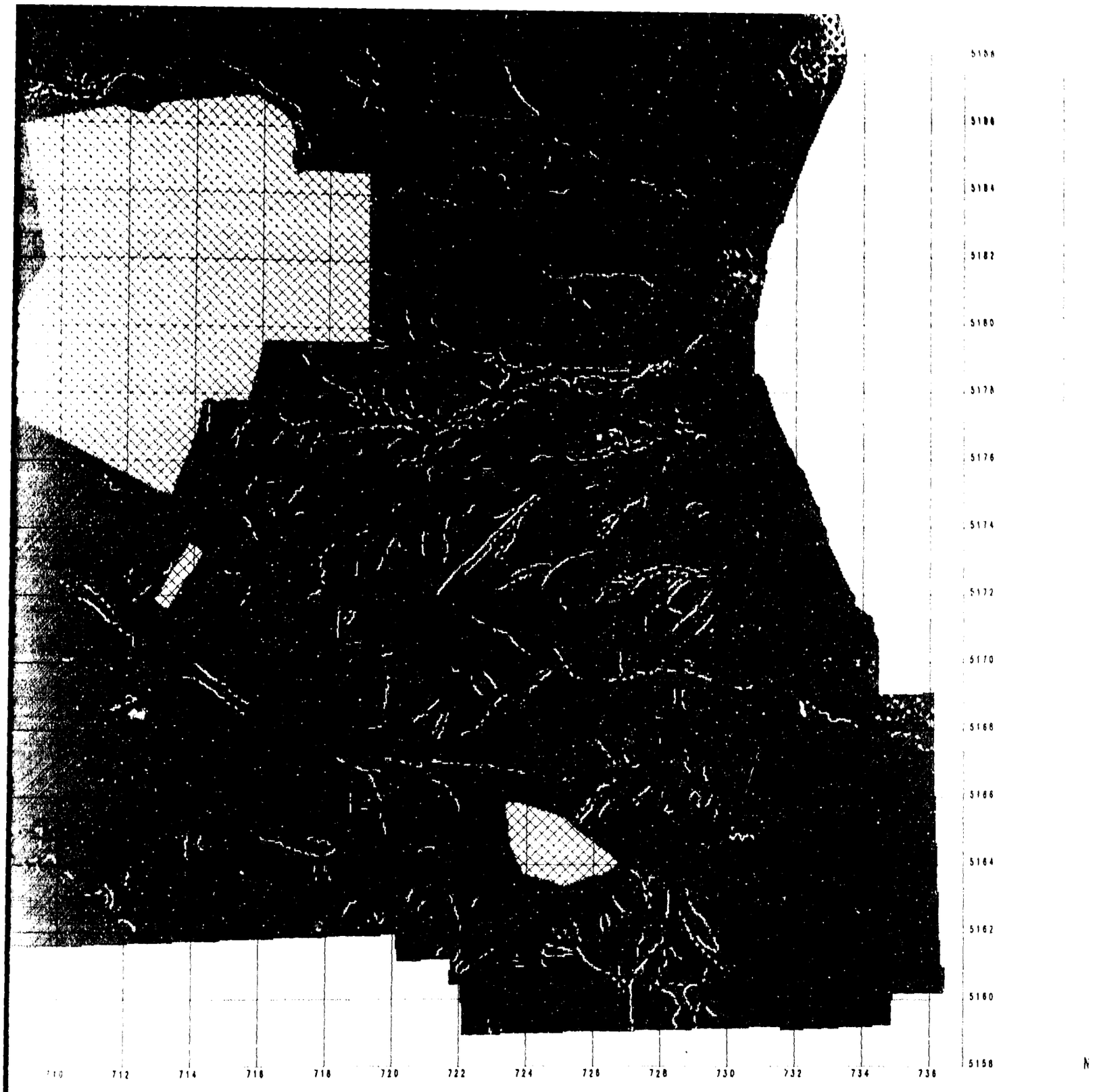
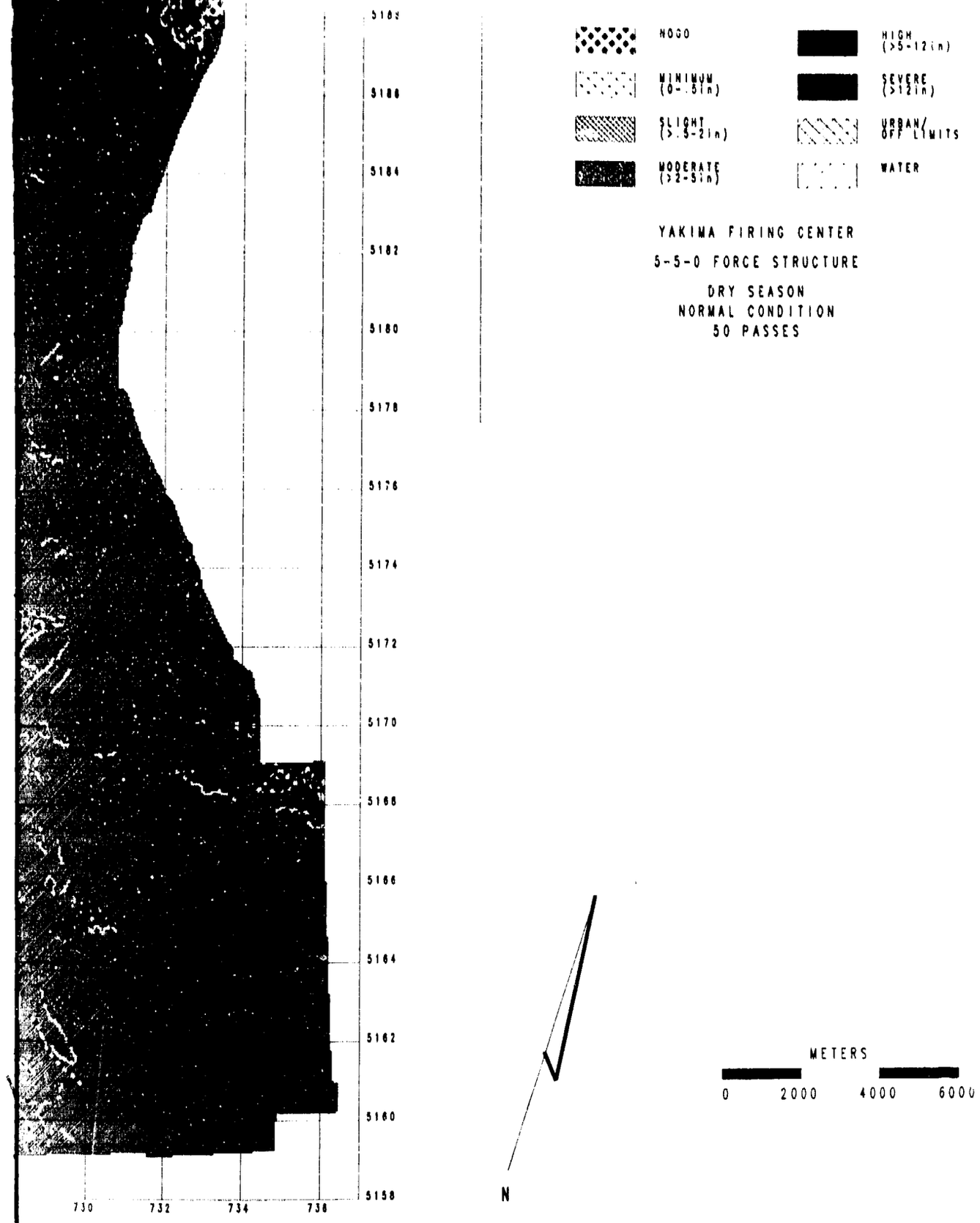
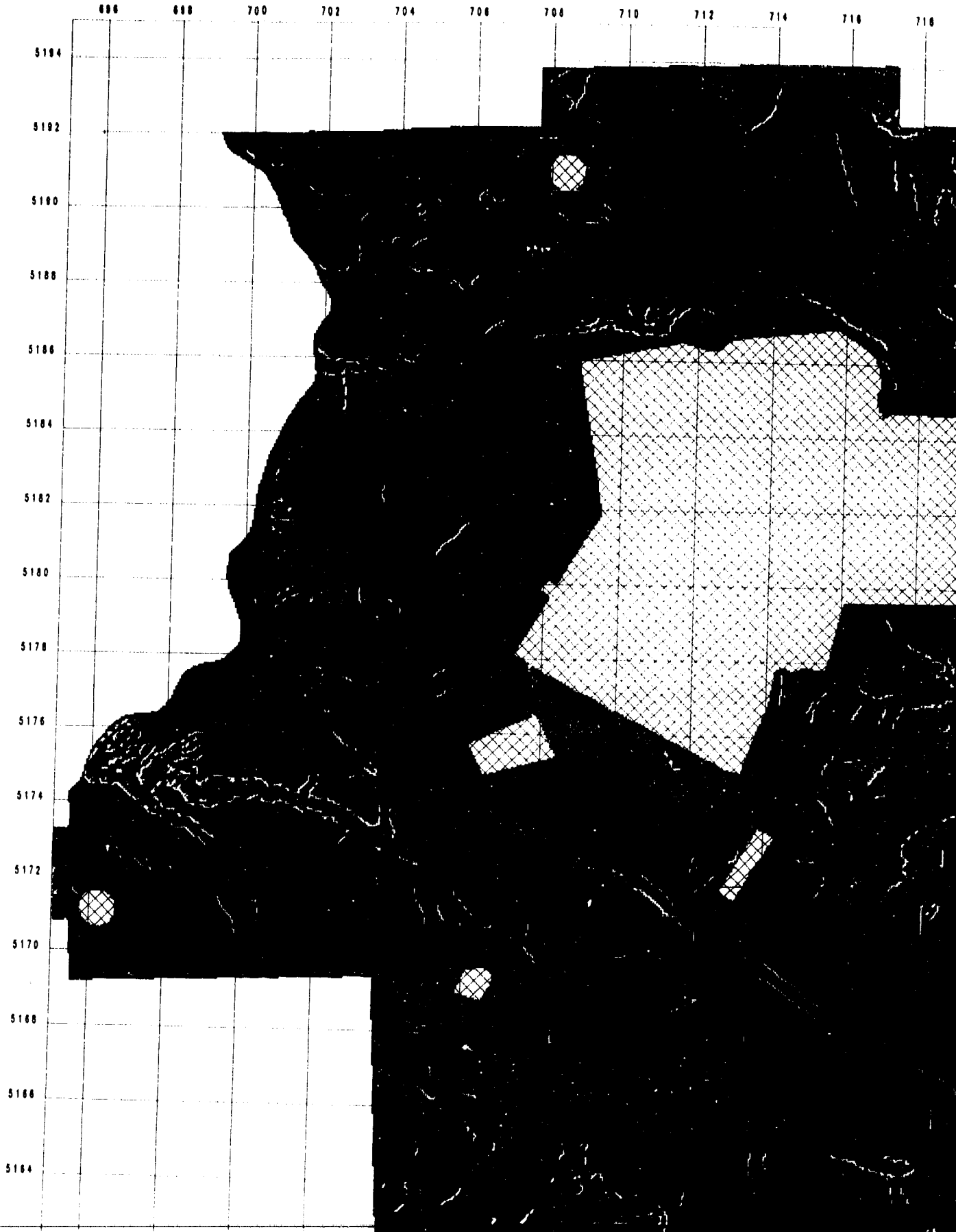


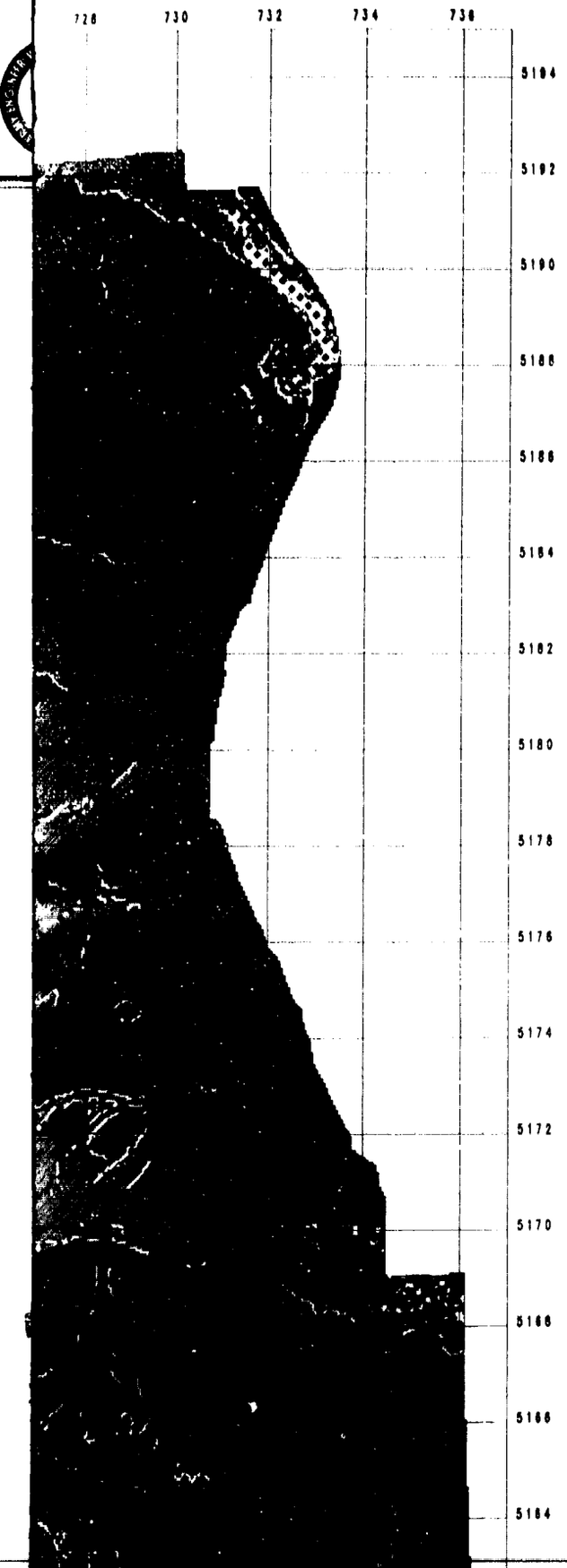
Plate 28. Fifty pass soil disturbance level map for the 5-5-0 force structure in the dry normal surface condition



ucture in the dry normal surface condition


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U. S. Army Corps of Engineers
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SOIL DISTURBANCE LEVELS

SCALE 1:100000

- NOGO
- MINIMUM (0-.5in)
- SLIGHT (>.5-2in)
- MODERATE (>2-5in)
- HIGH (>5-12in)
- SEVERE (>12in)
- URBAN/ OFF LIMITS
- WATER

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE

DRY SEASON
NORMAL CONDITION
1000 PASSES



Plate 29. One thousand pass soil distu

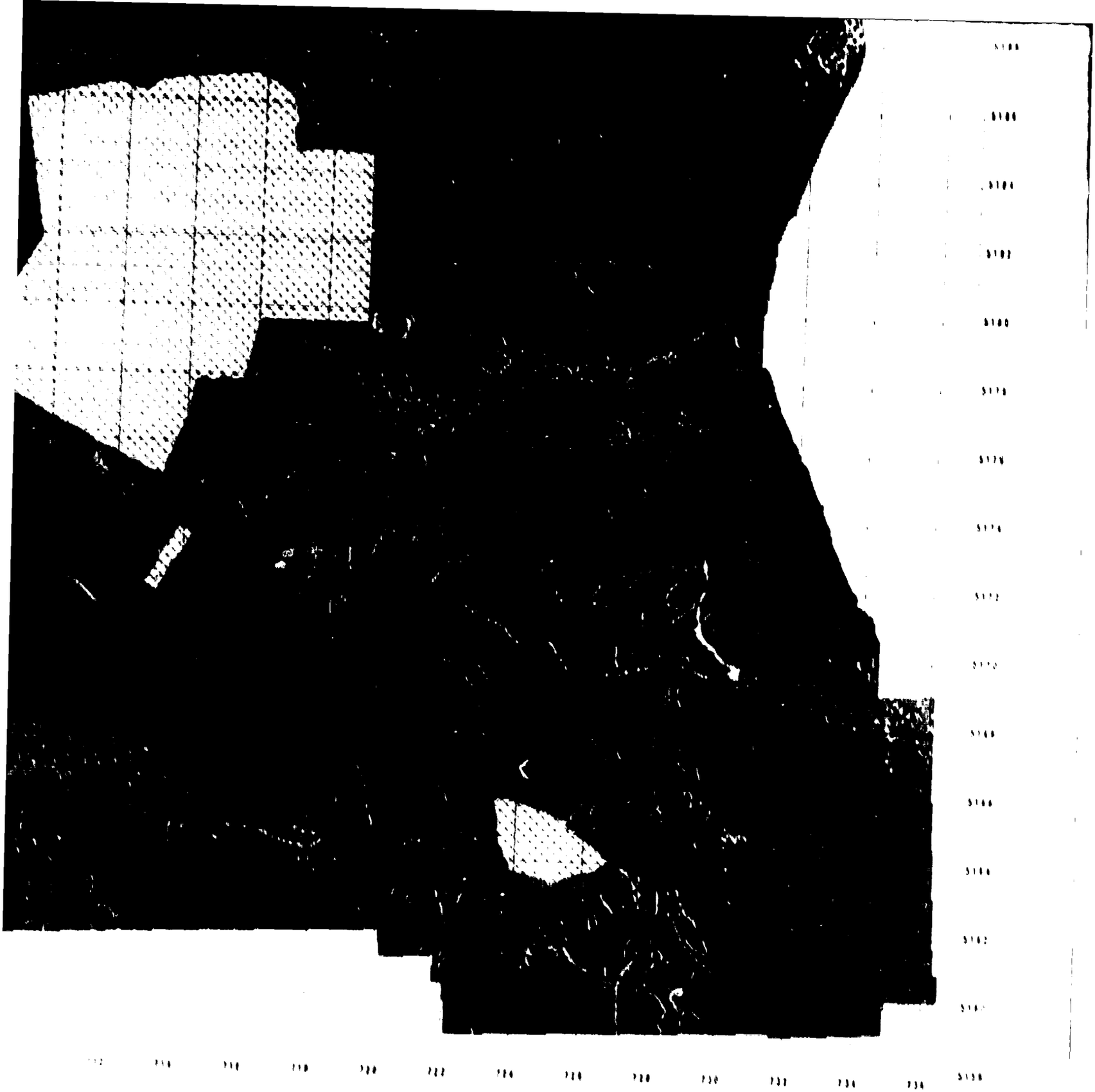
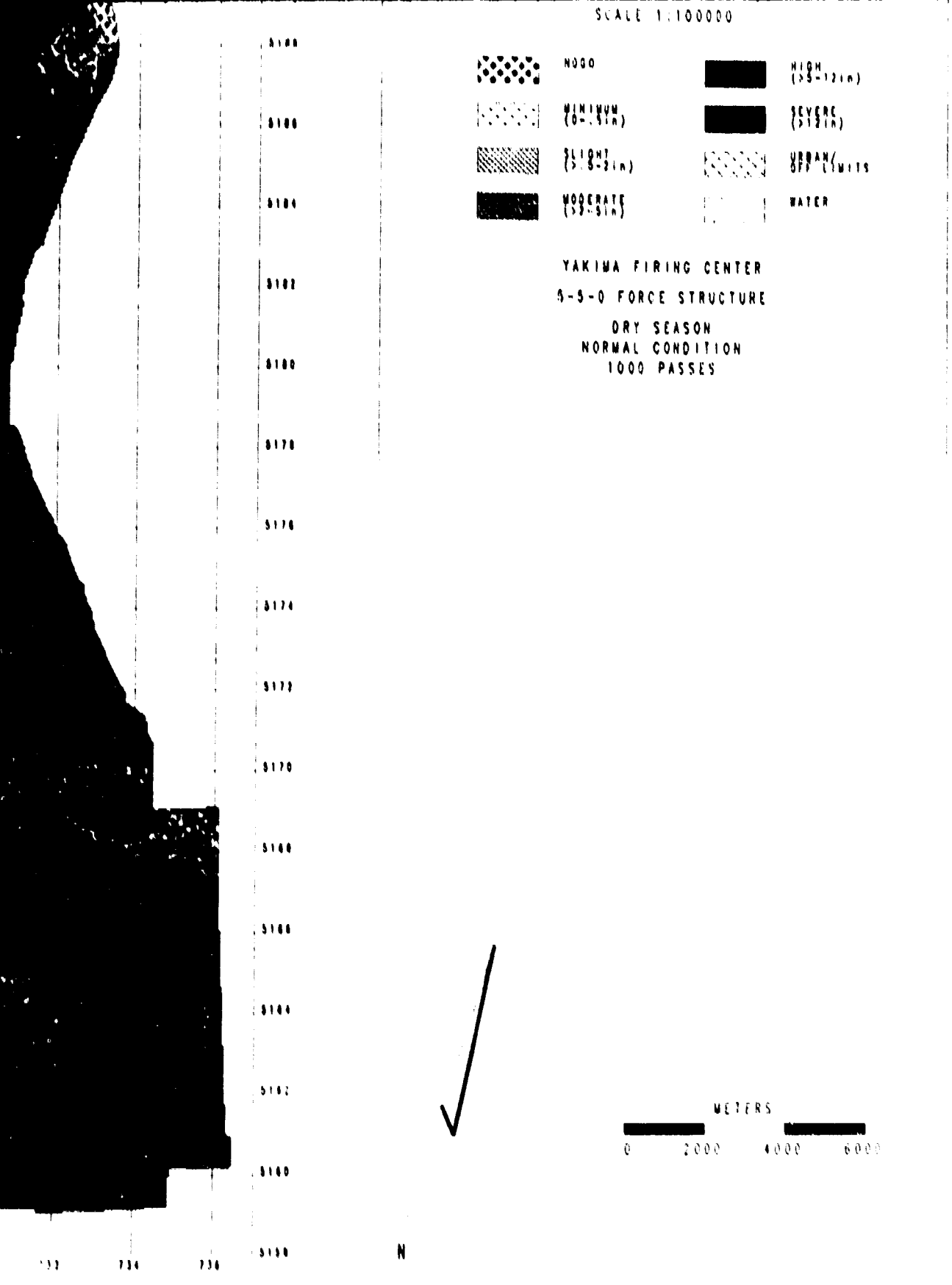
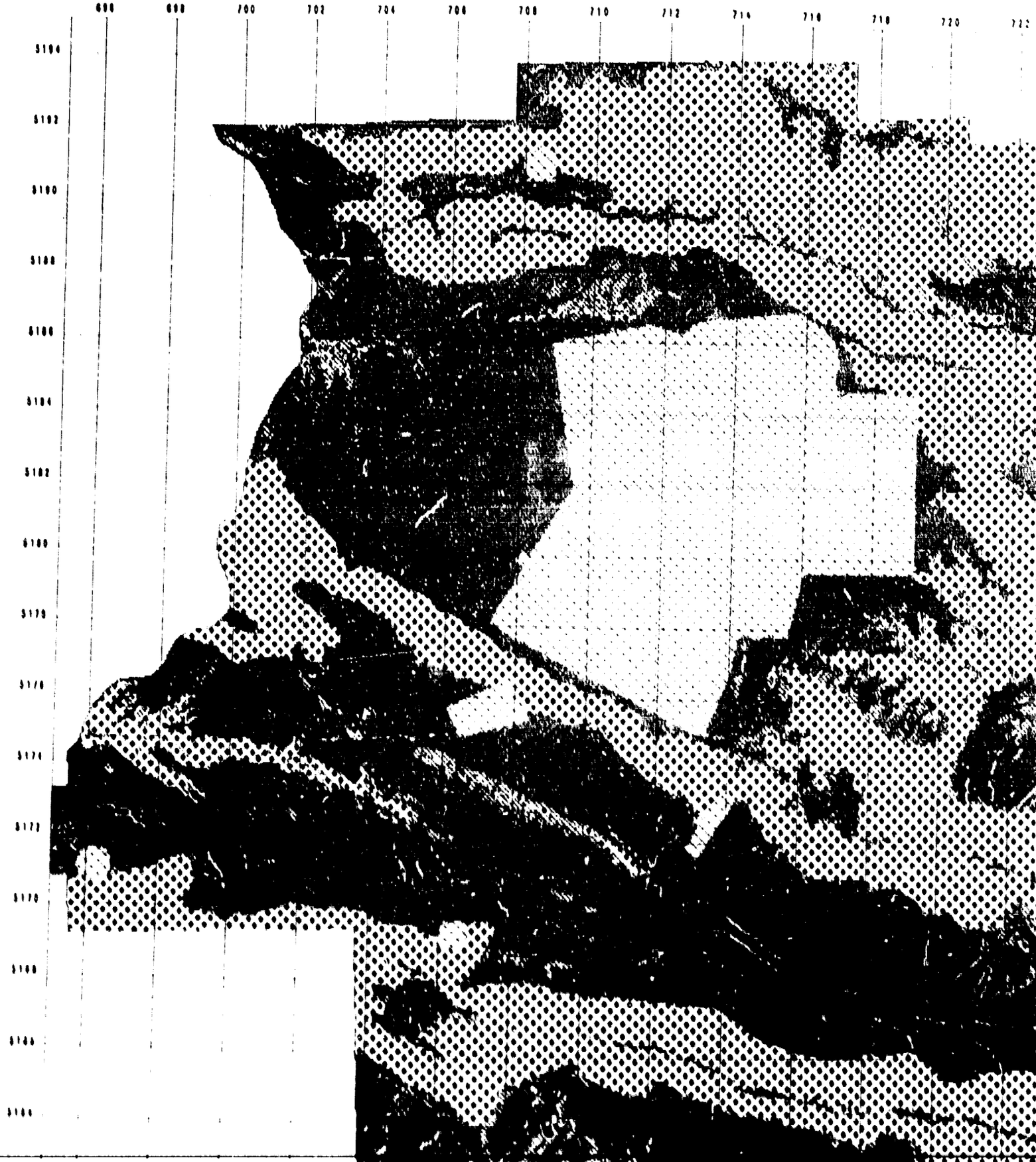


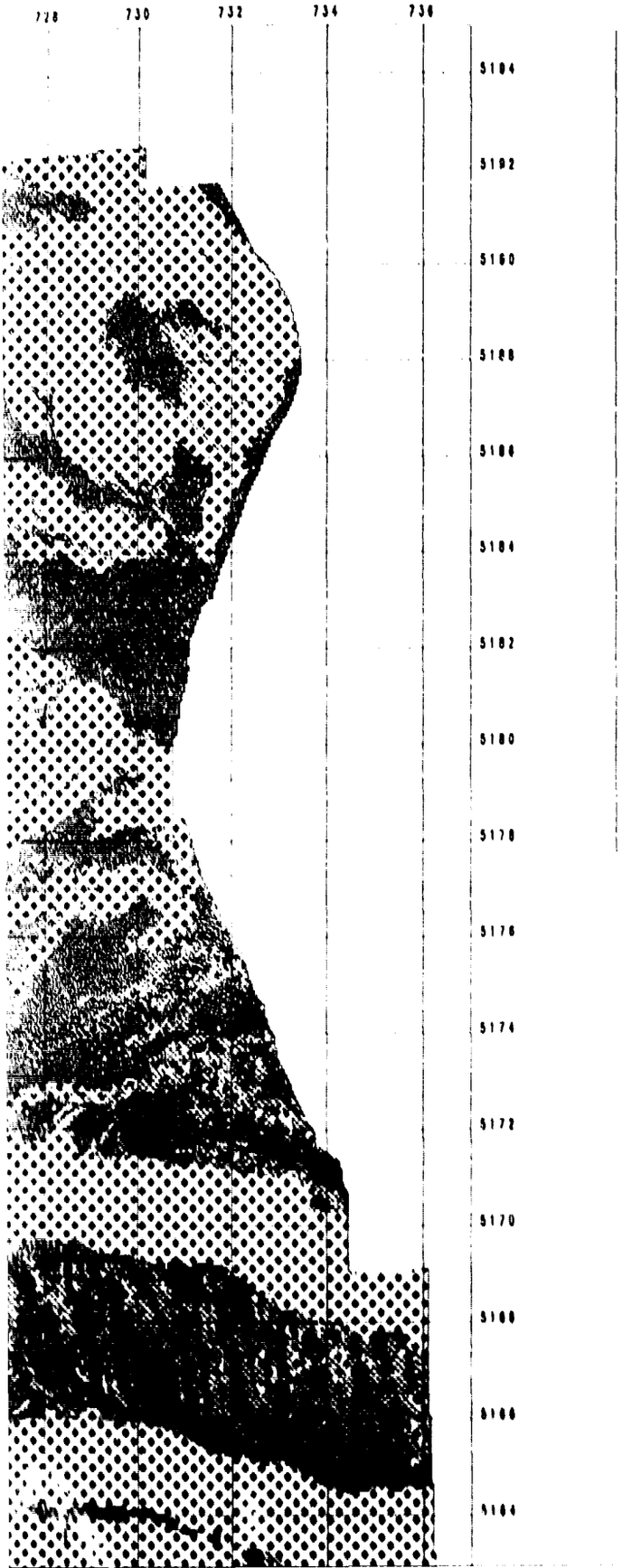
Plate 29. One thousand pass soil disturbance level map for the 5-5-0 force structure in the dry normal surface condition



e in the dry normal surface condition


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SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO

MINIMUM (0-.5in)

SLIGHT (>.5-2in)

MODERATE (>2-5in)

HIGH (>5-12in)

SEVERE (>12in)

URBAN/ OFF LIMITS

WATER

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
10 PASSES

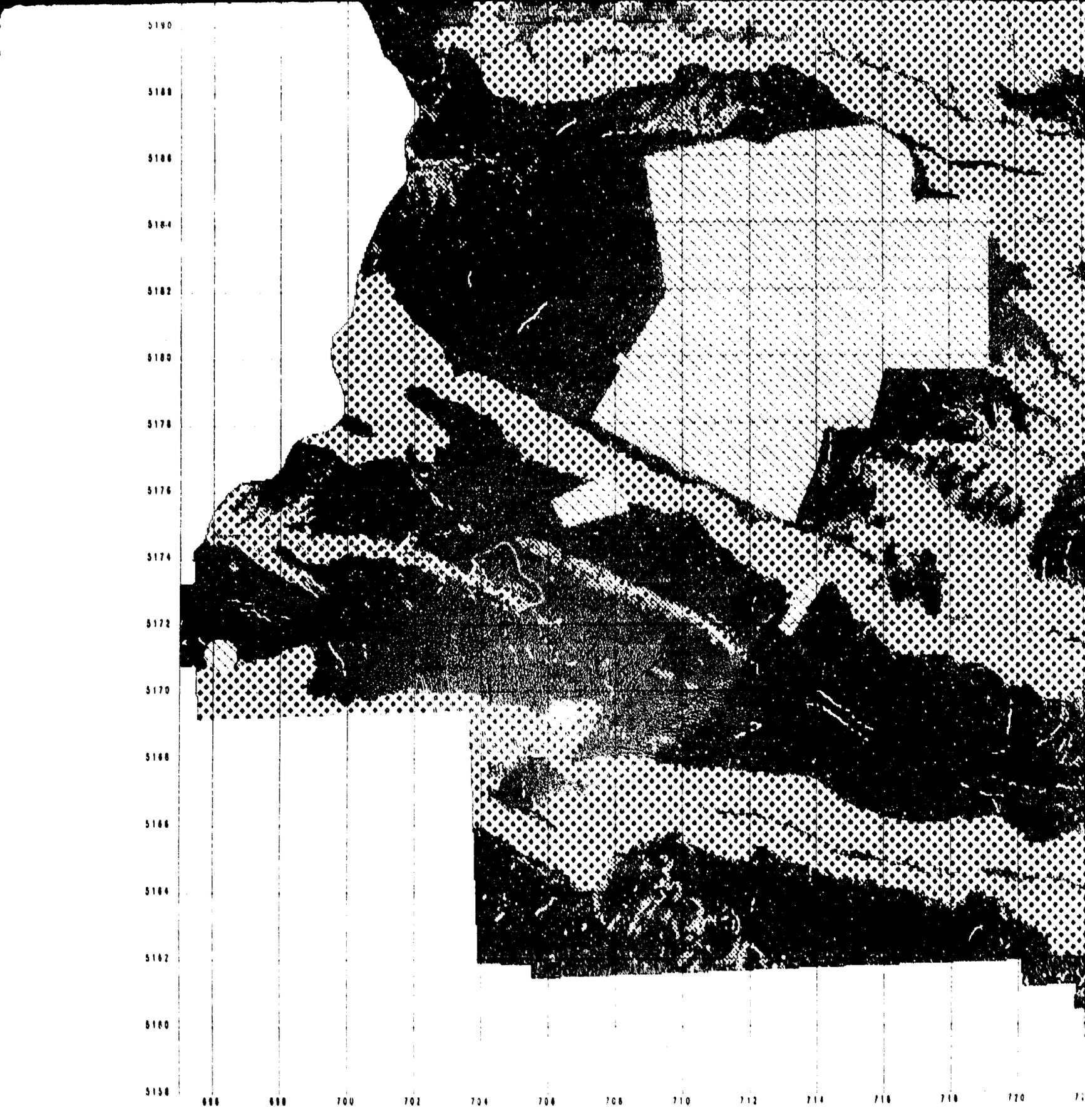


Plate 30. Ten pass soil disturbance level ma

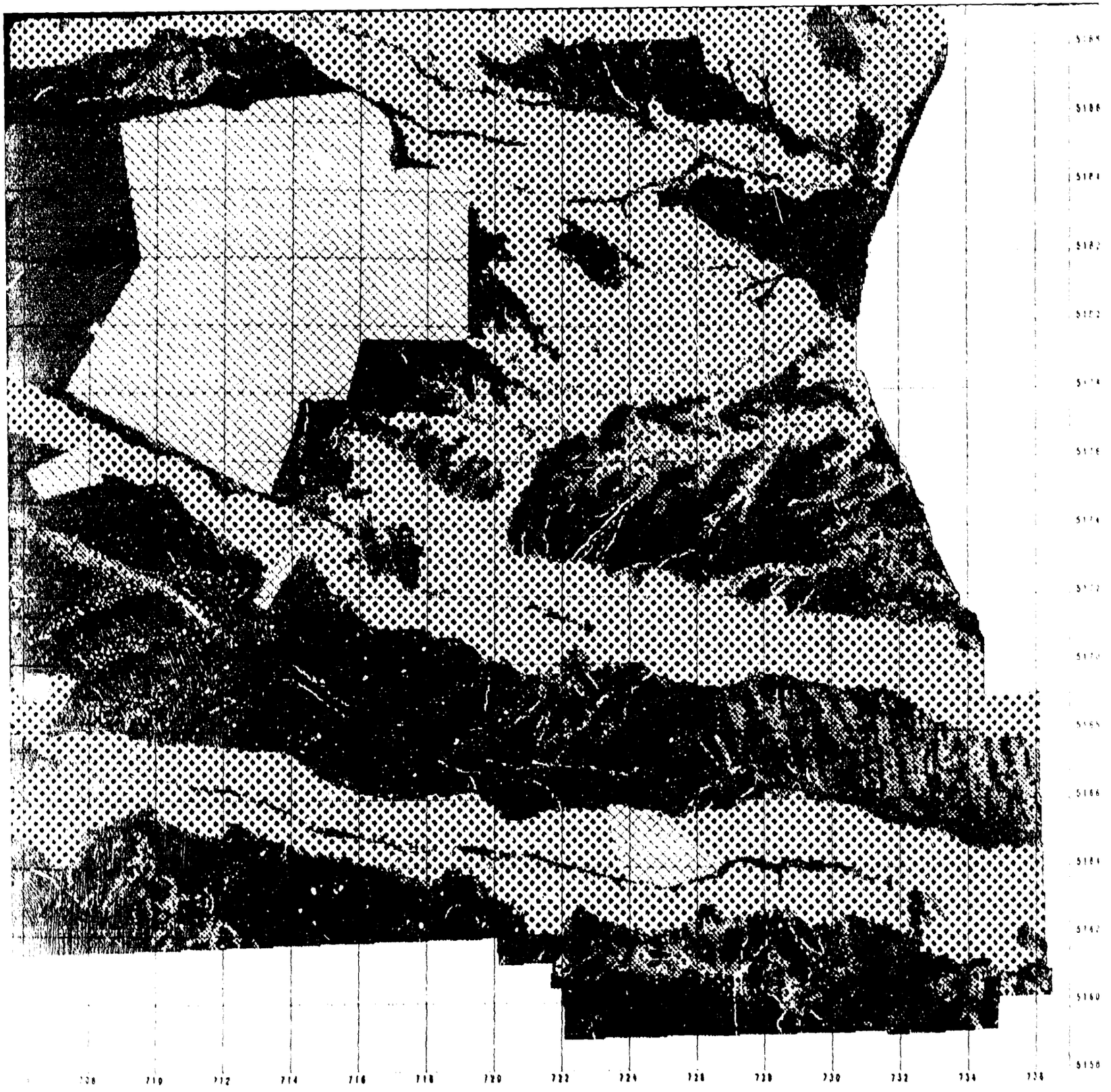
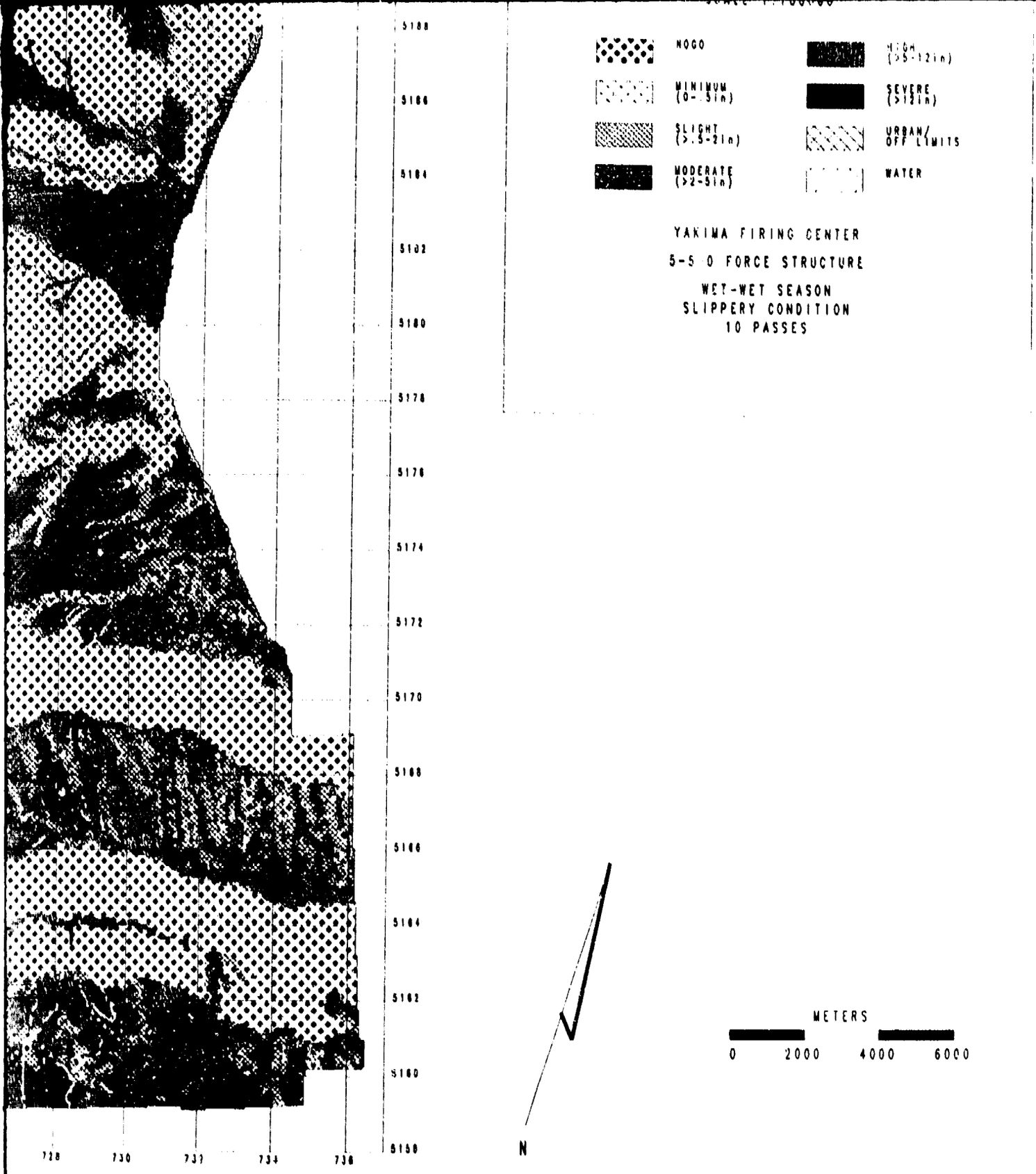
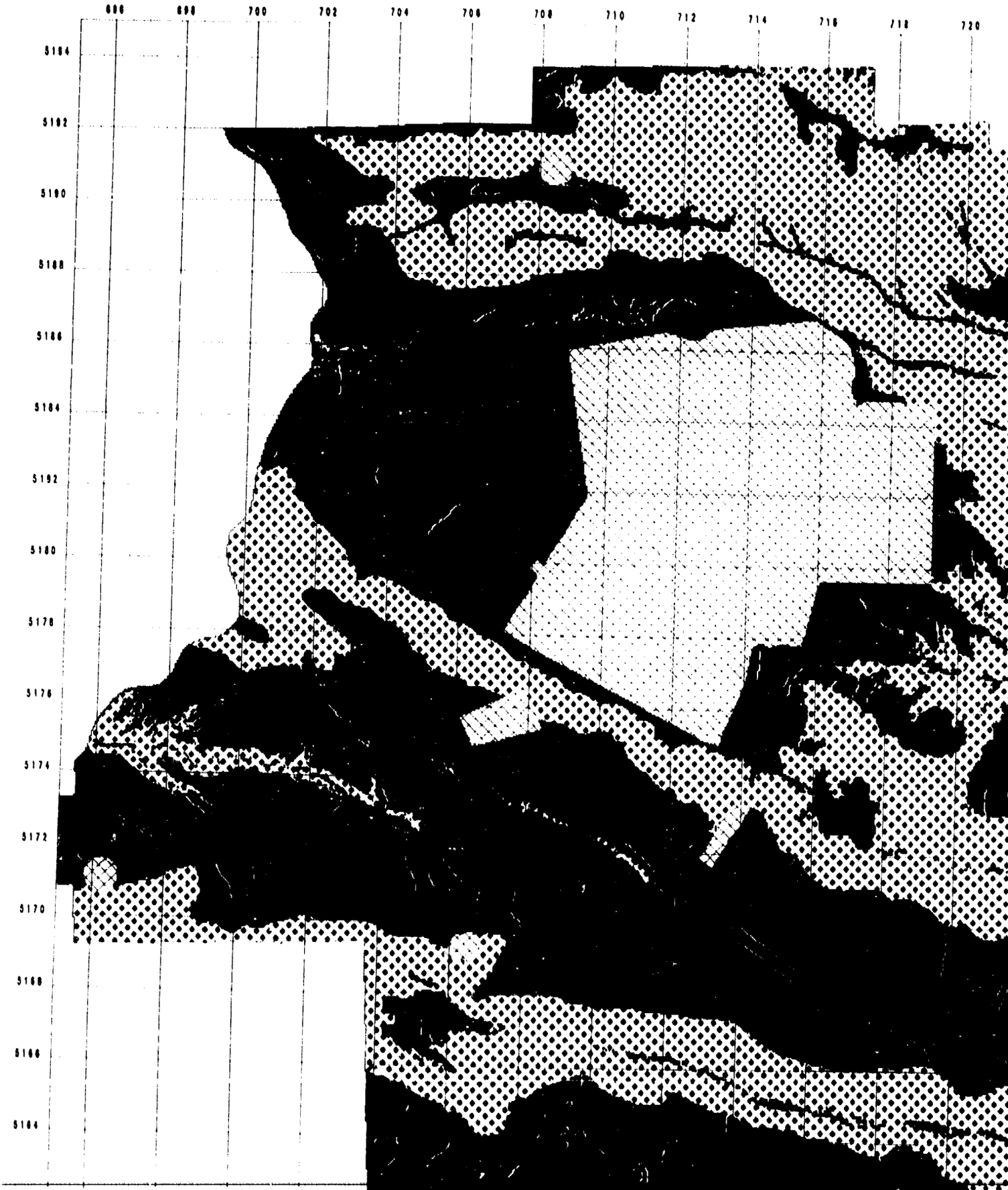
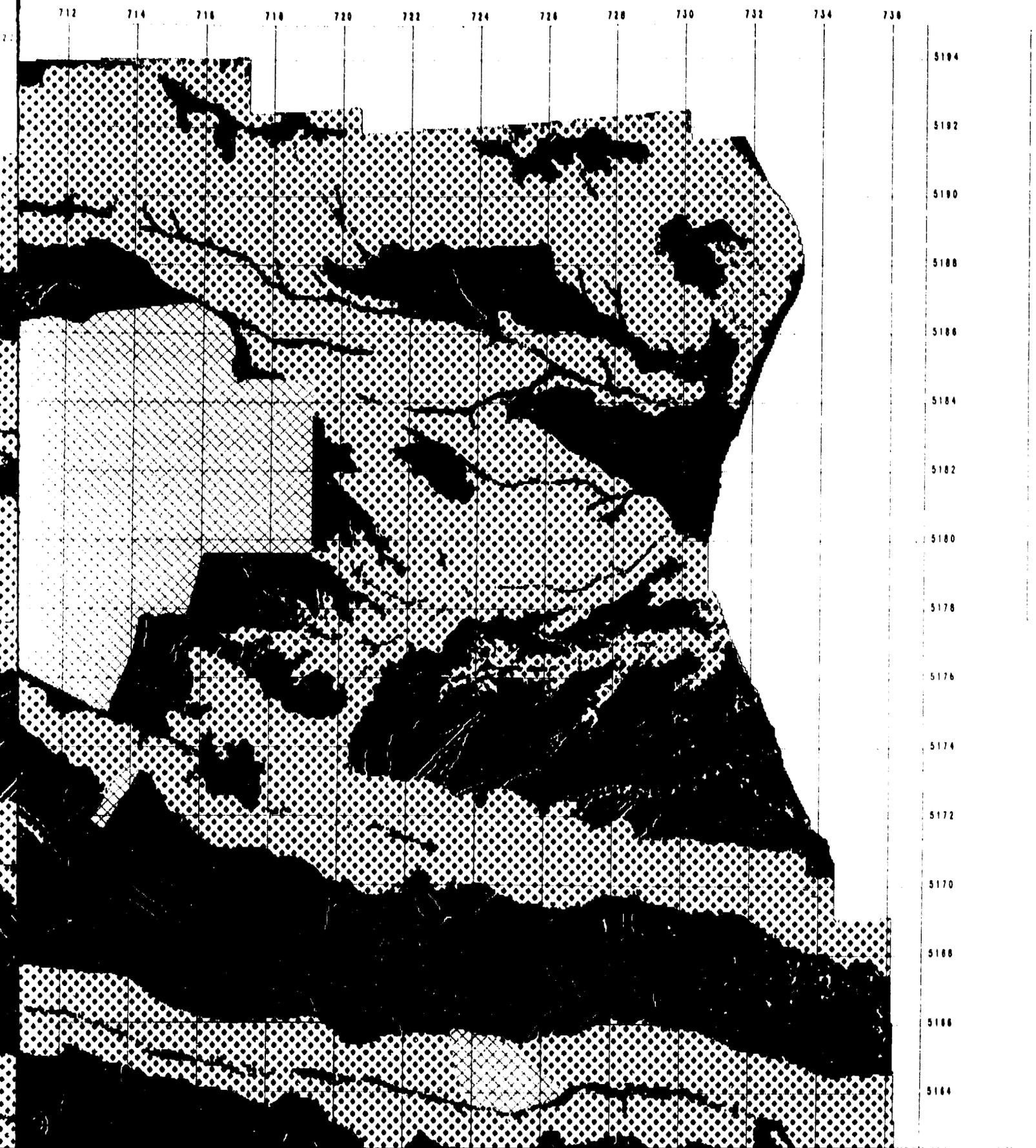


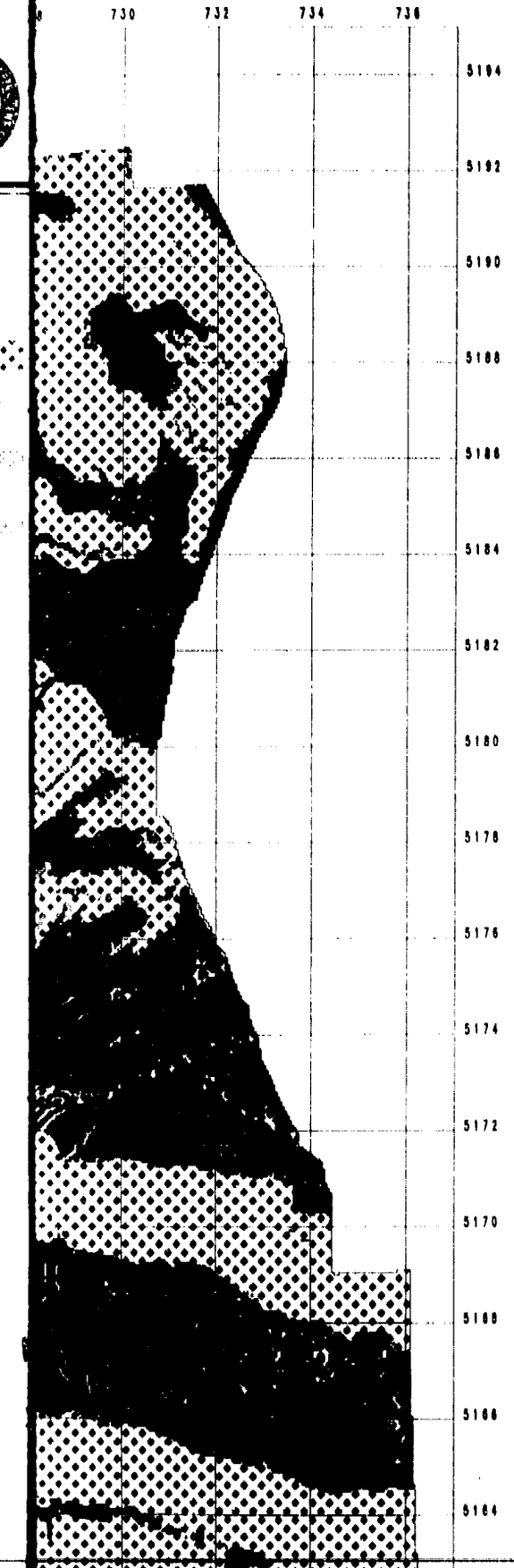
Plate 30. Ten pass soil disturbance level map for the 5-5-0 force structure in the wet-wet slippery surface



structure in the wet-wet slippery surface condition


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Waterways
Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
50 PASSES

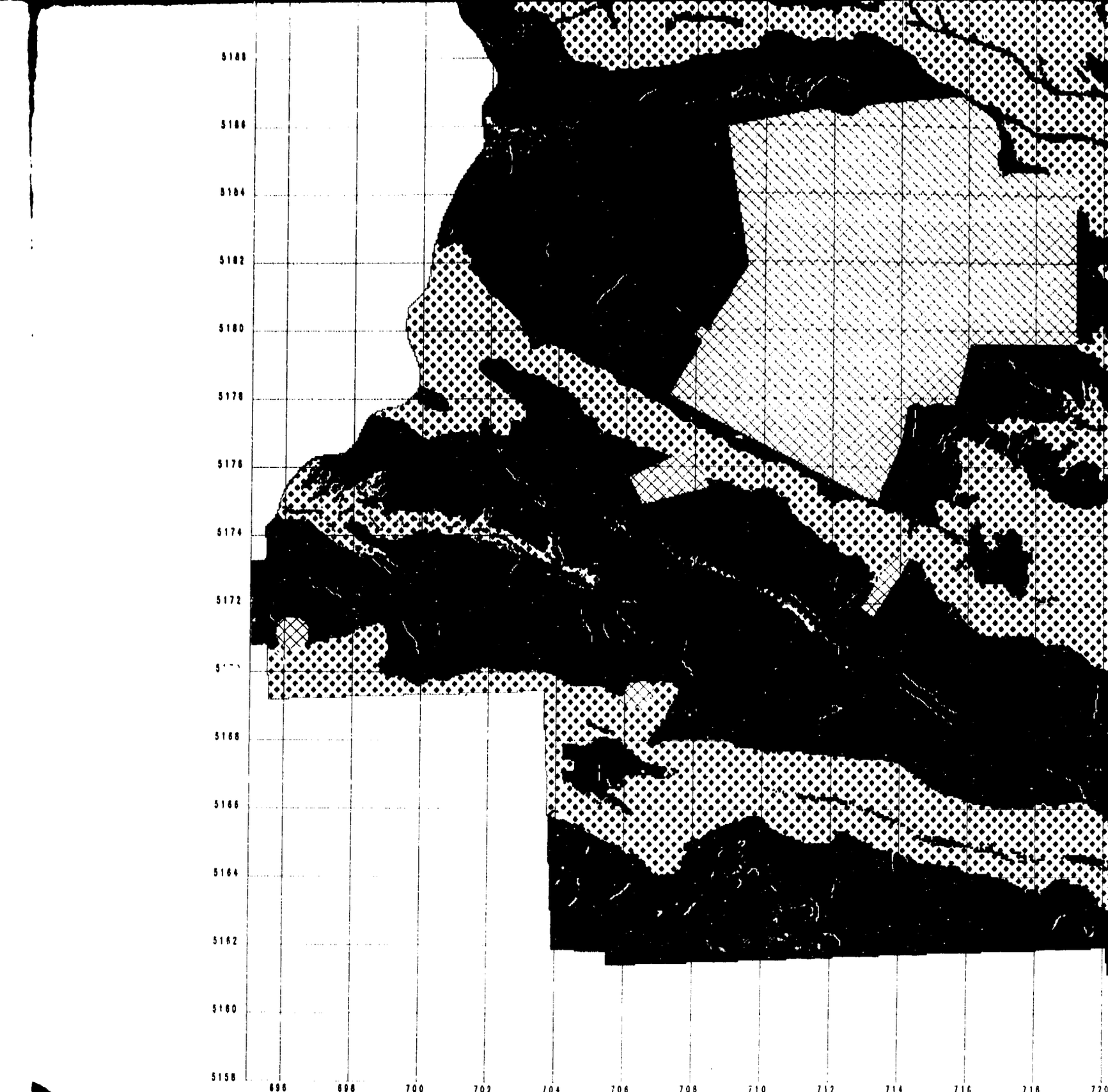


Plate 31. Fifty pass soil disturban

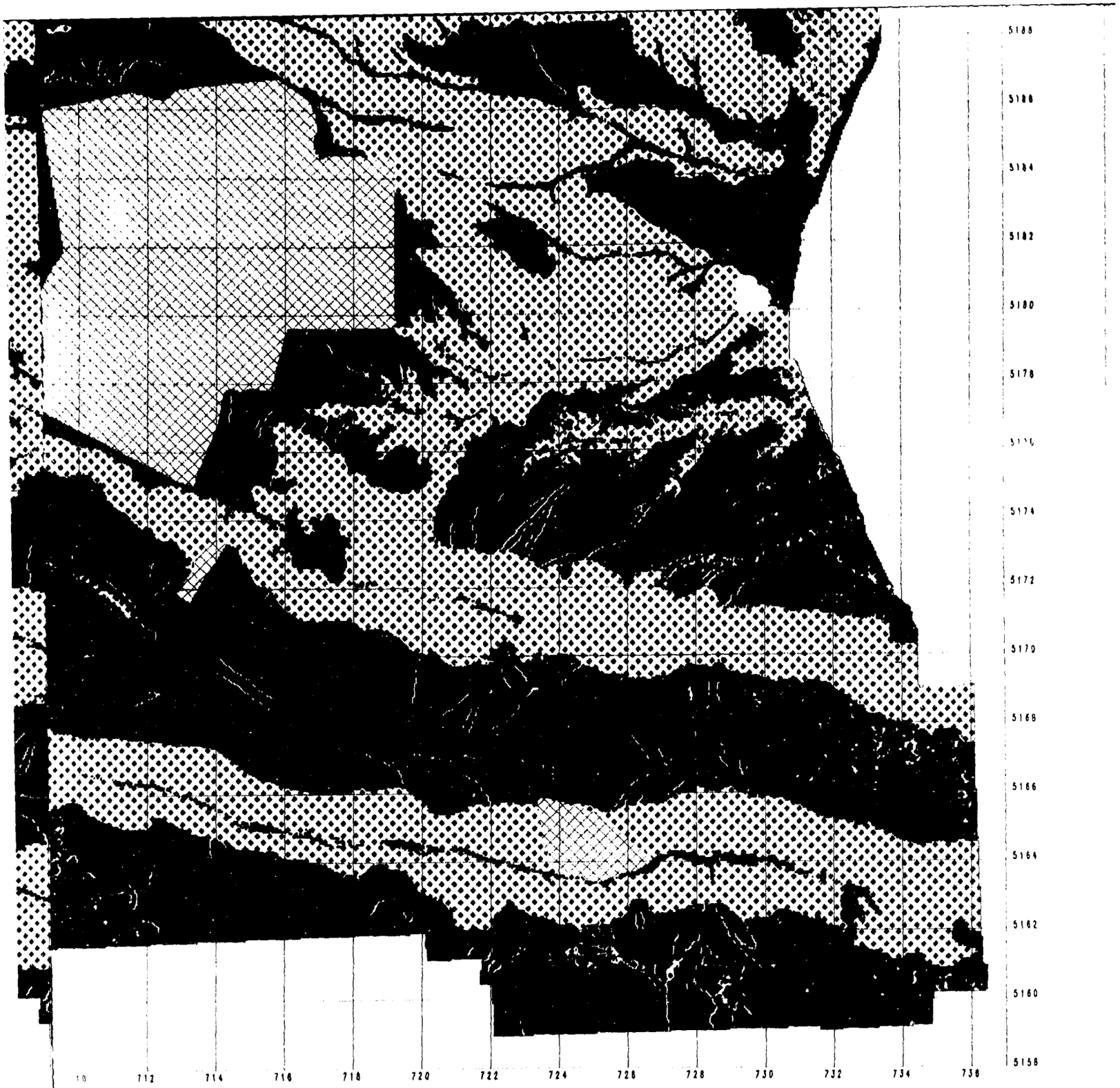
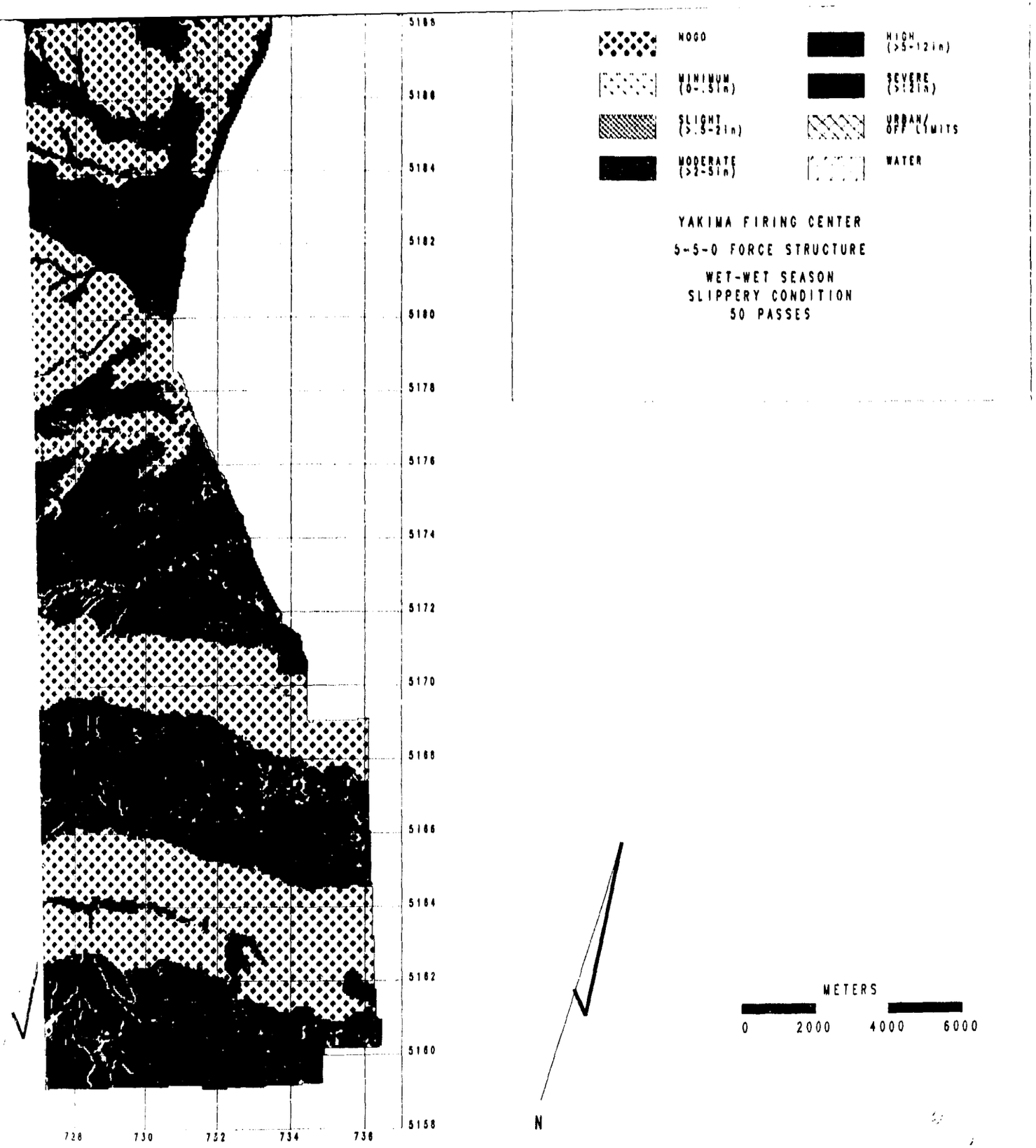
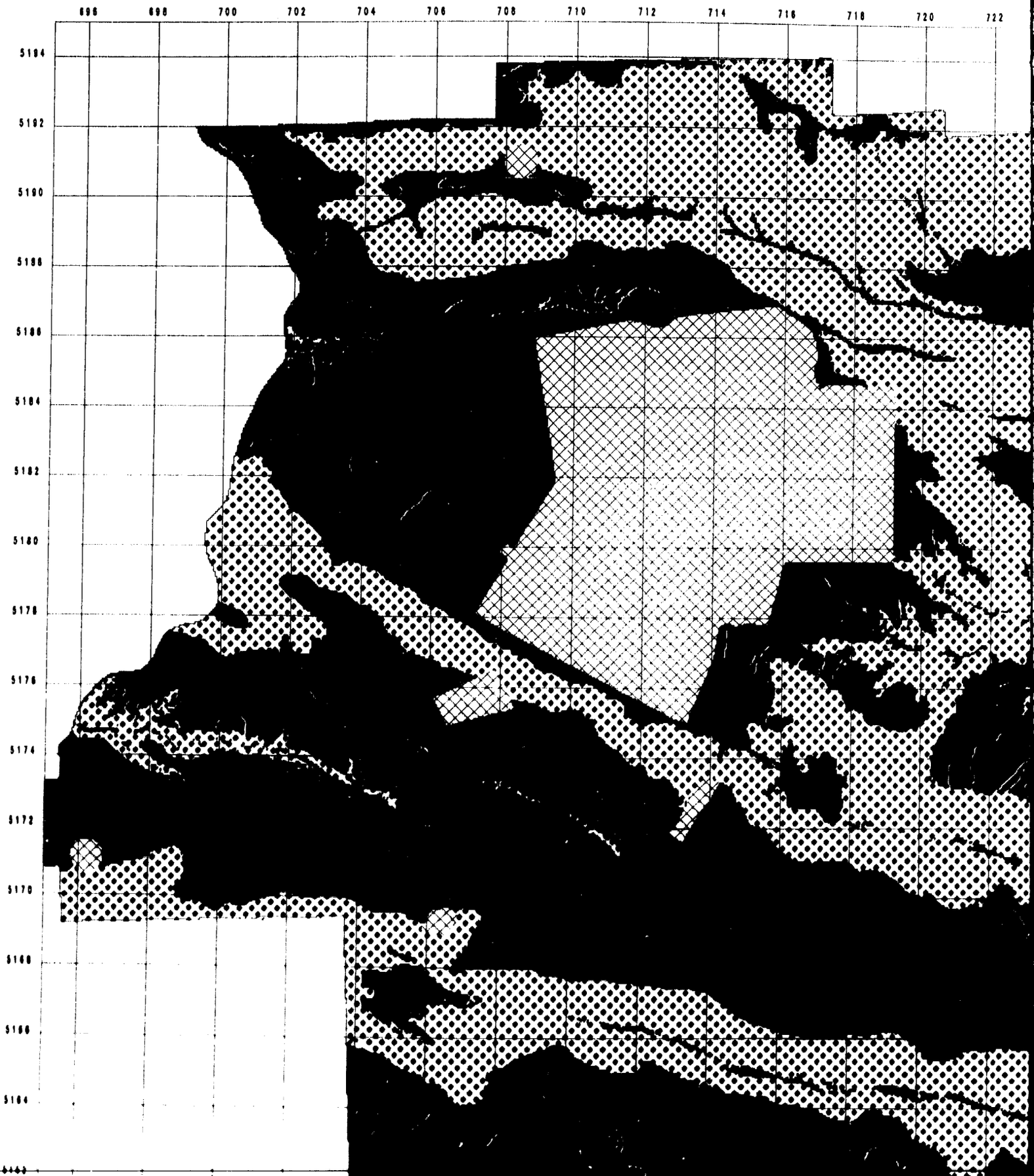
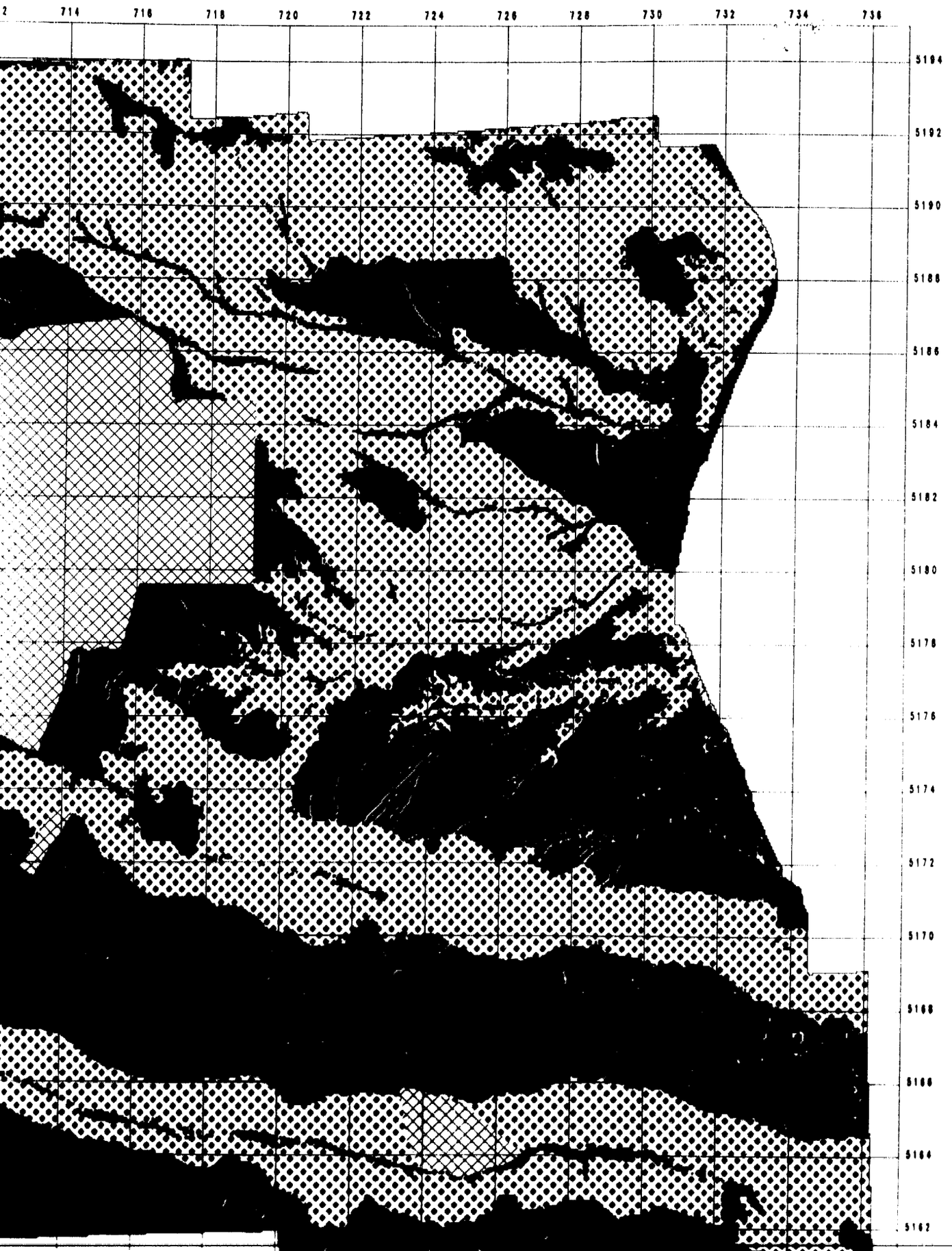


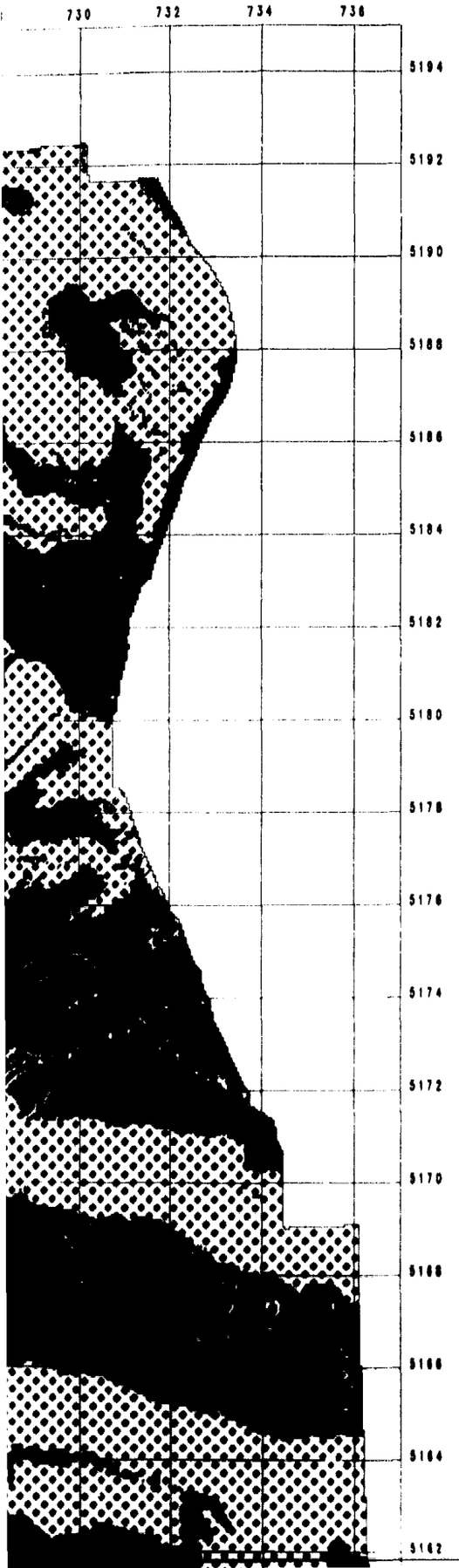
Plate 31. Fifty pass soil disturbance level map for the 5-5-0 force structure in the wet-wet slippery surface condi



force structure in the wet-wet slippery surface condition


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Experiment
Station

SOIL DISTURBANCE LEVELS

SCALE 1:100000

NOGO	HIGH (>5-12in)
MINIMUM (0-.5in)	SEVERE (>12in)
SLIGHT (>.5-2in)	URBAN/ OFF LIMITS
MODERATE (>2-5in)	WATER

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE

WET-WET SEASON
SLIPPERY CONDITION
1000 PASSES

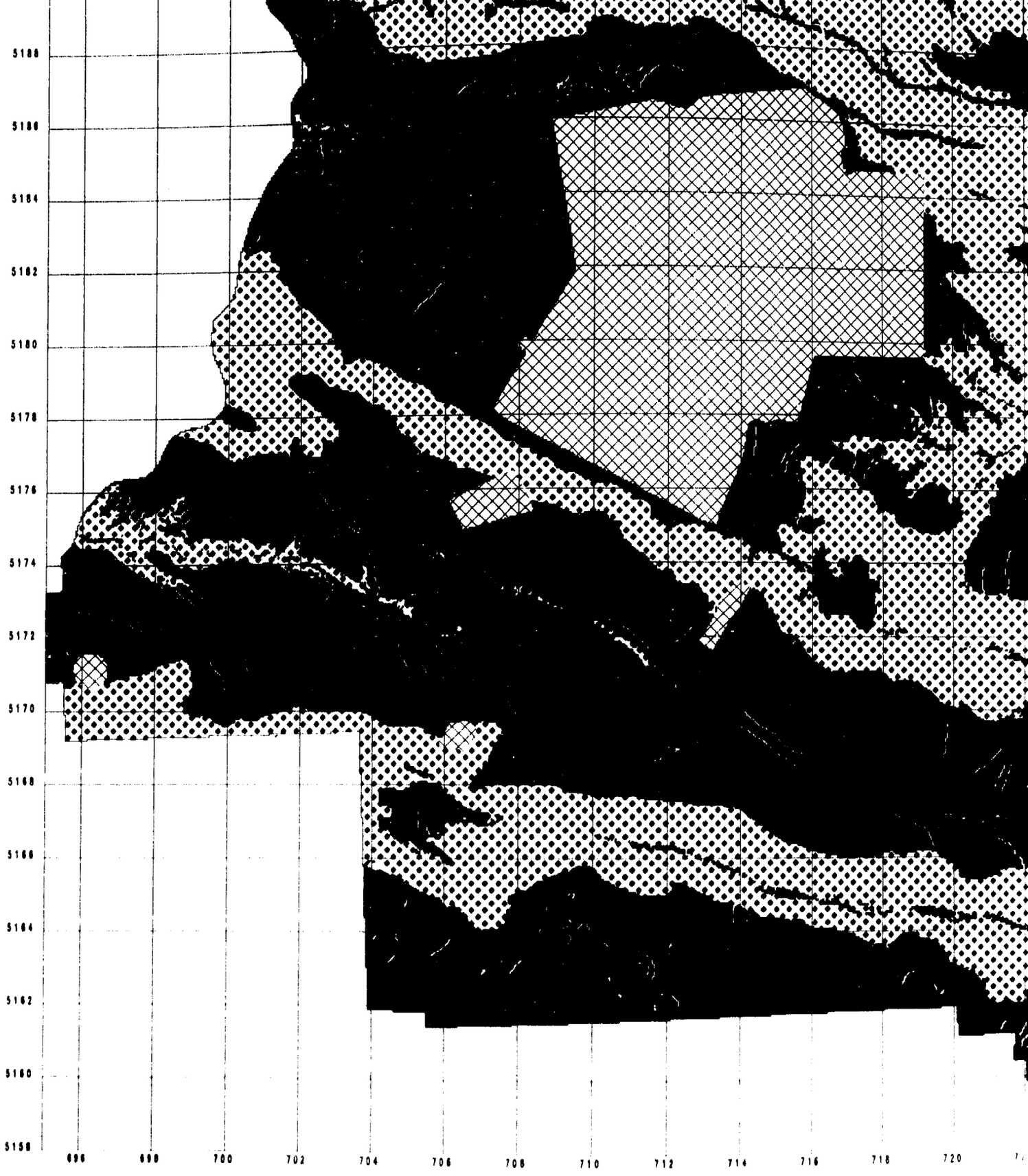


Plate 32. One thousand pass soil disturbance leve

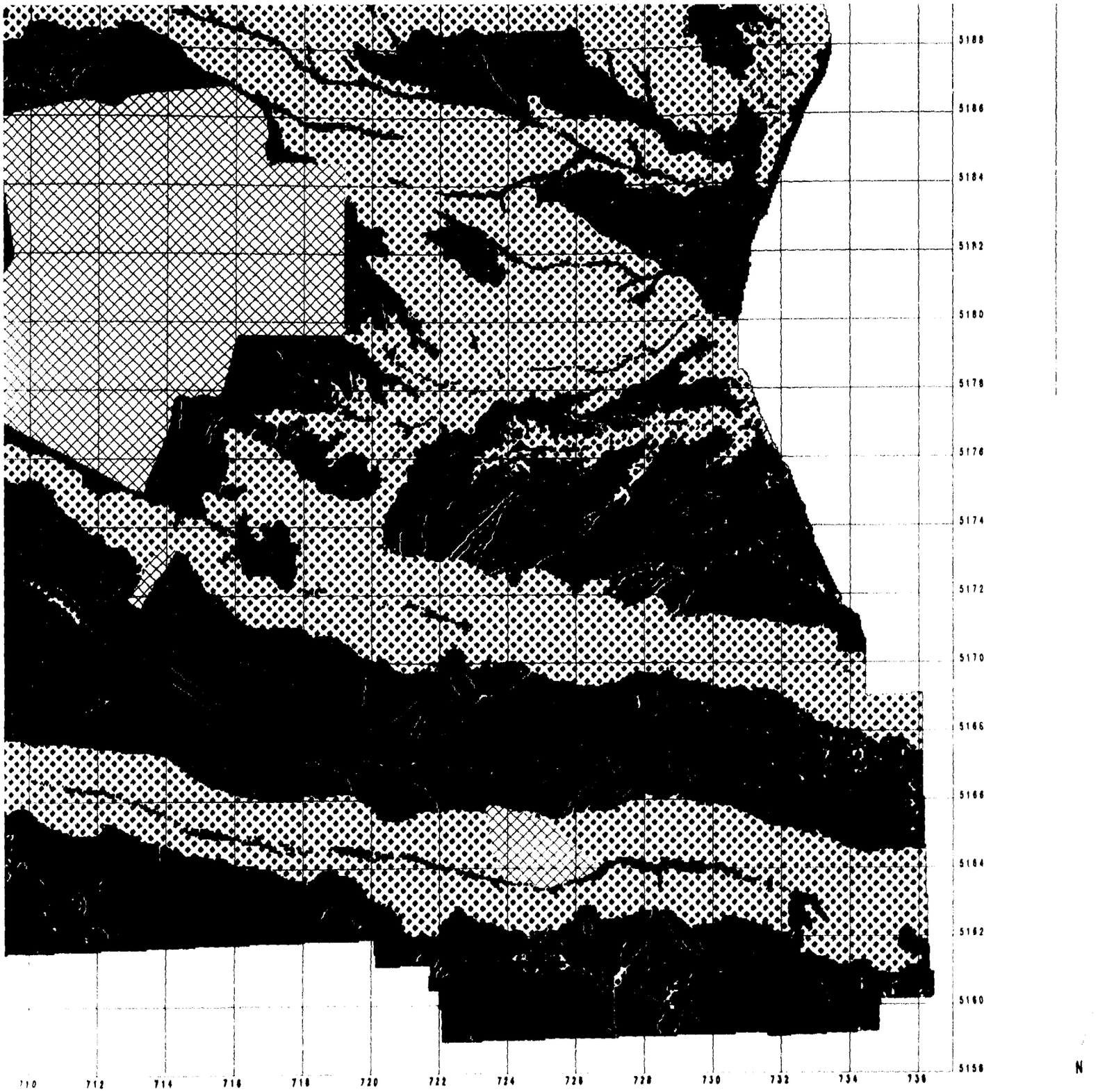
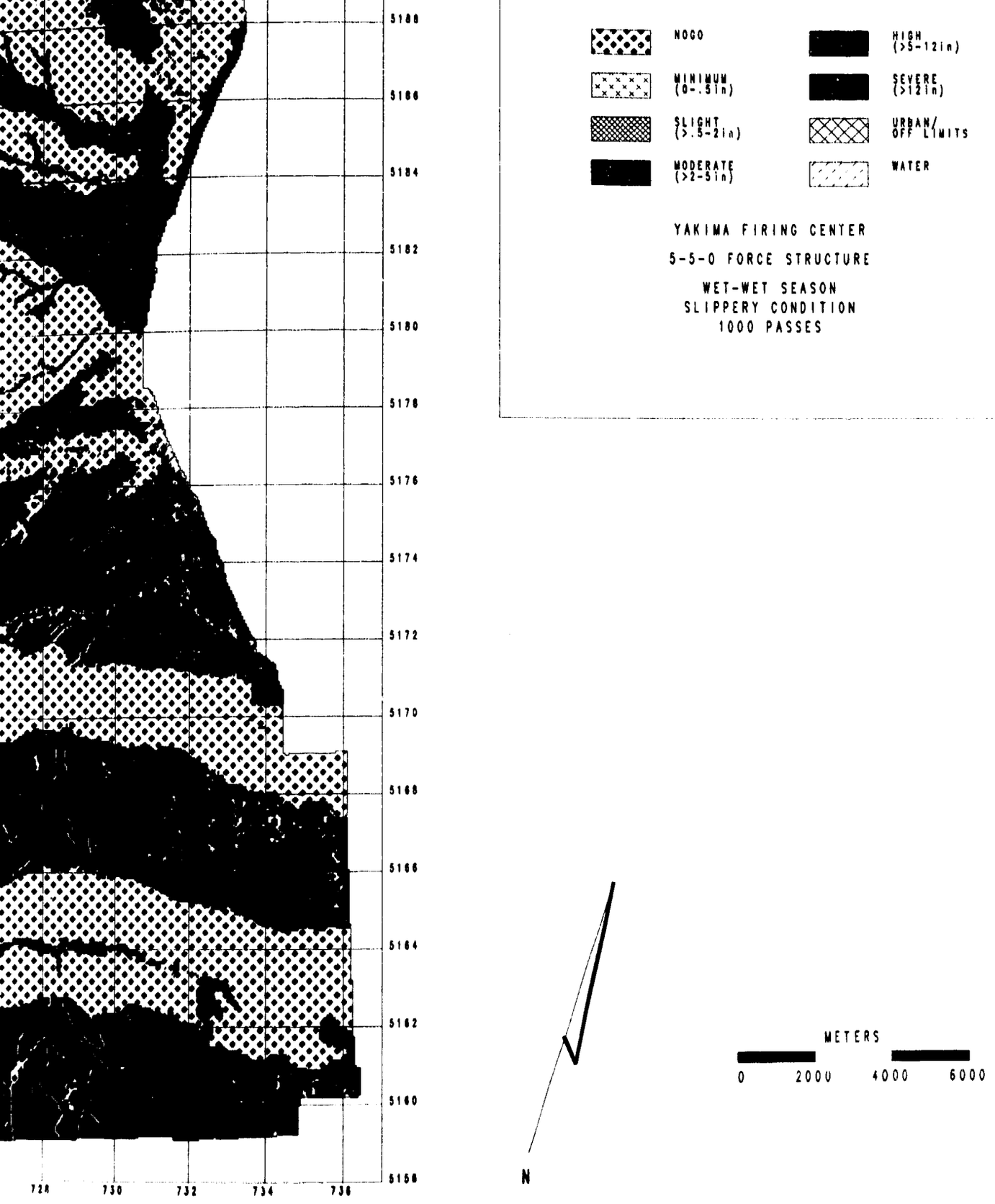
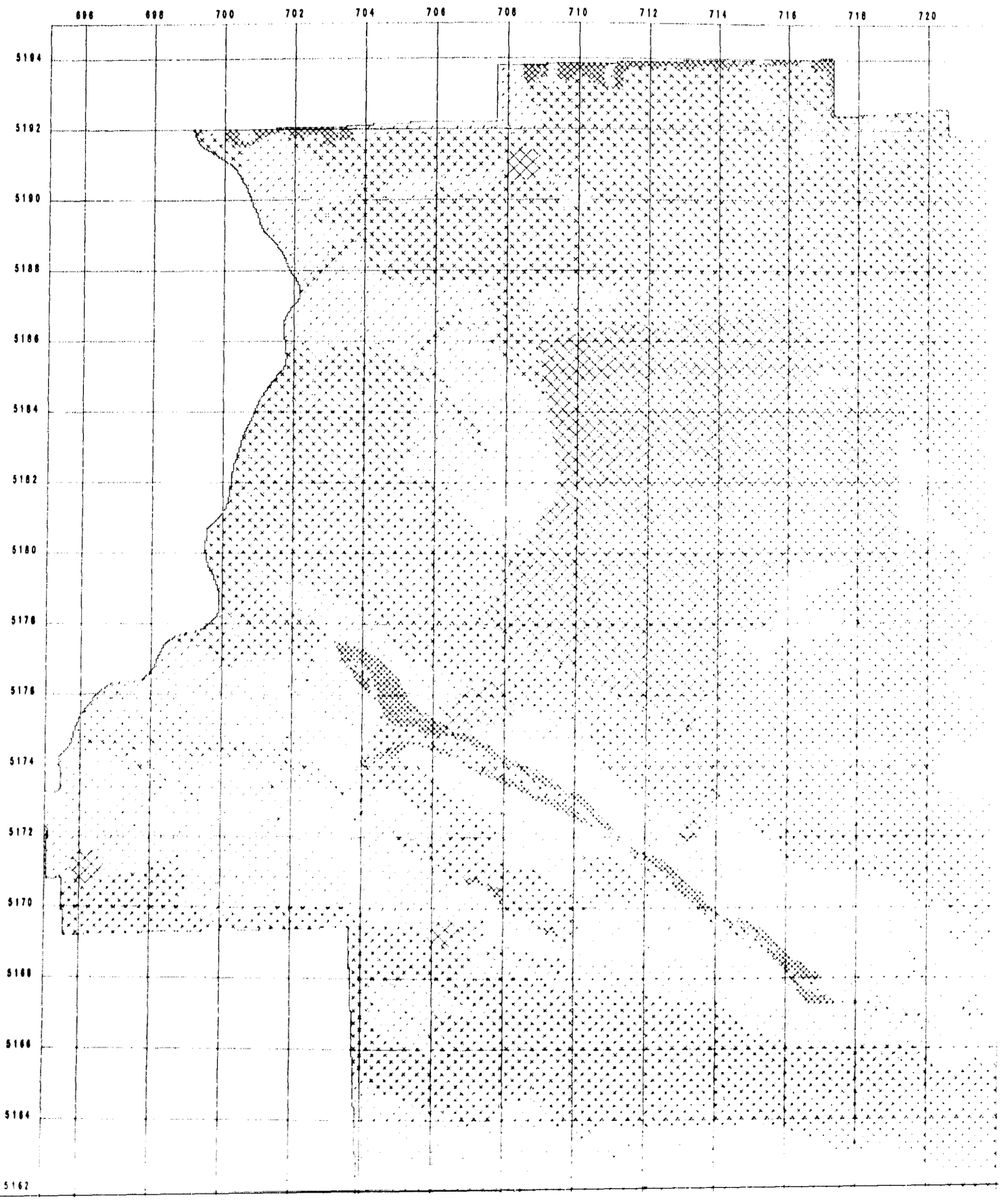
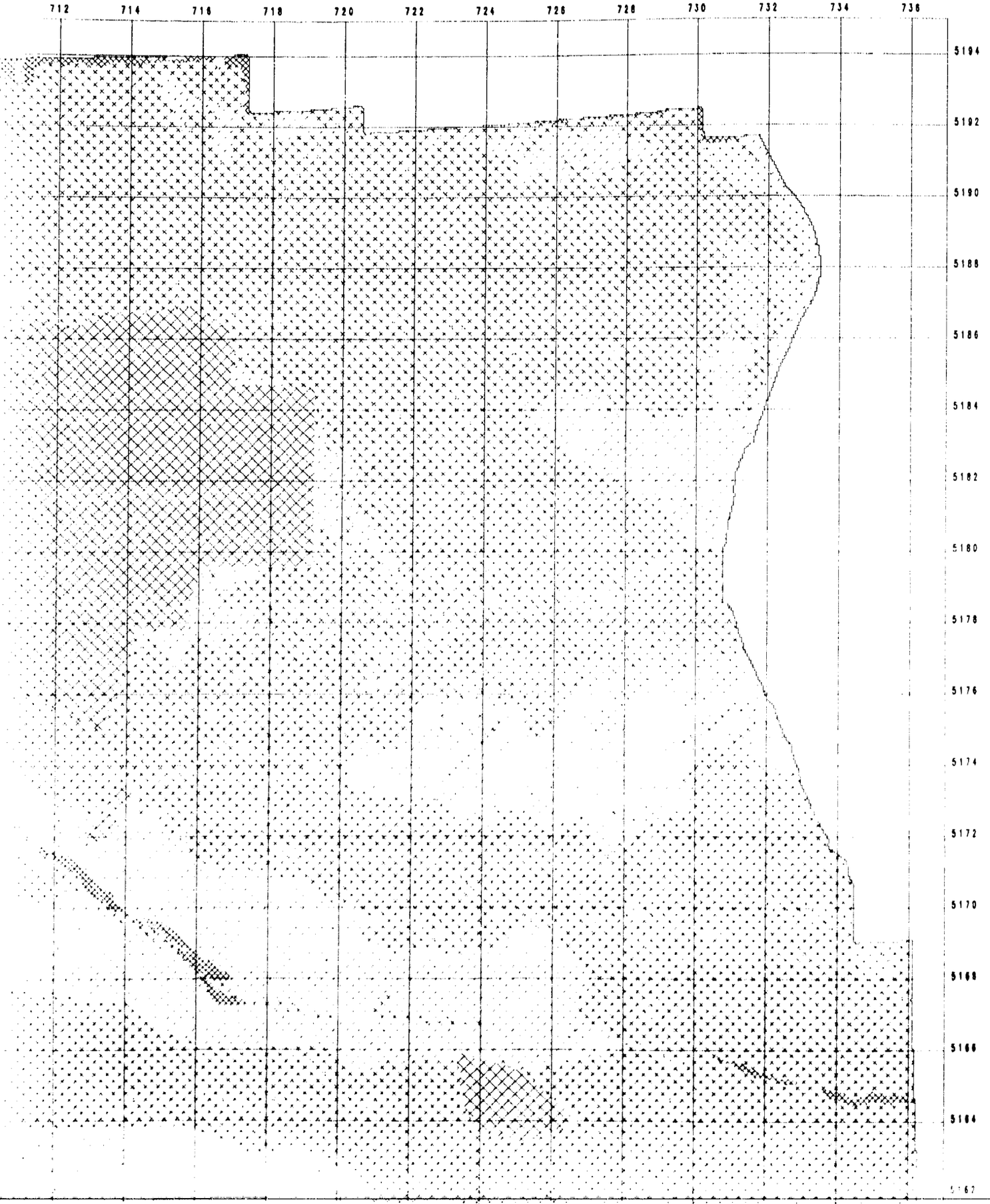


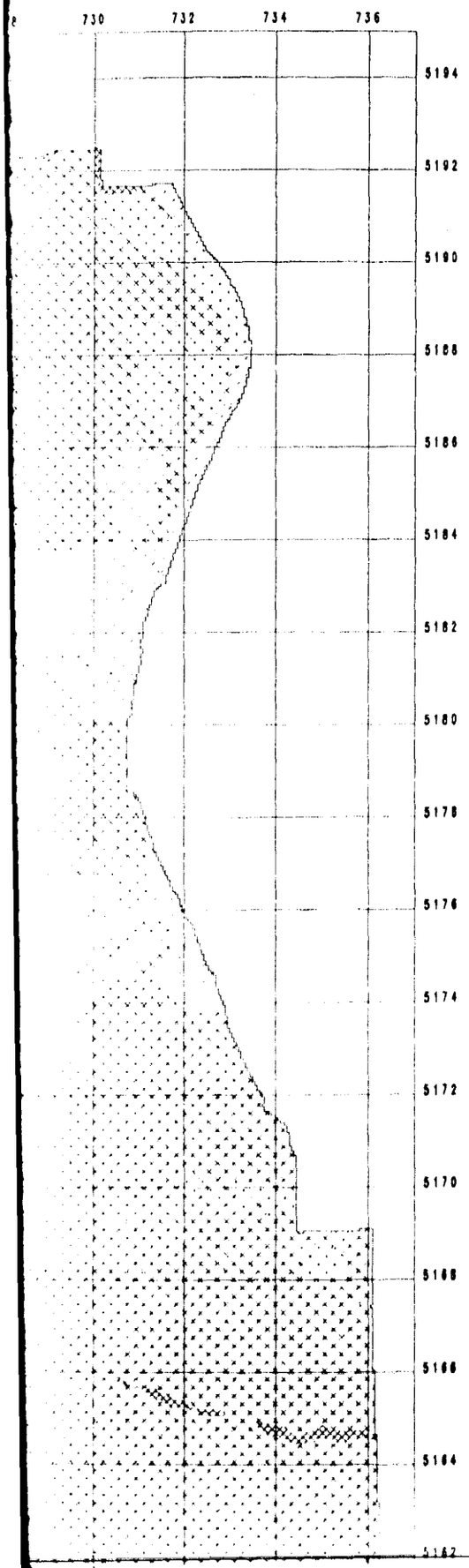
Plate 32. One thousand pass soil disturbance level map for the 5-5-0 force structure in the wet-wet slippery surface condition



) force structure in the wet-wet slippery surface condition


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
10 PASSES

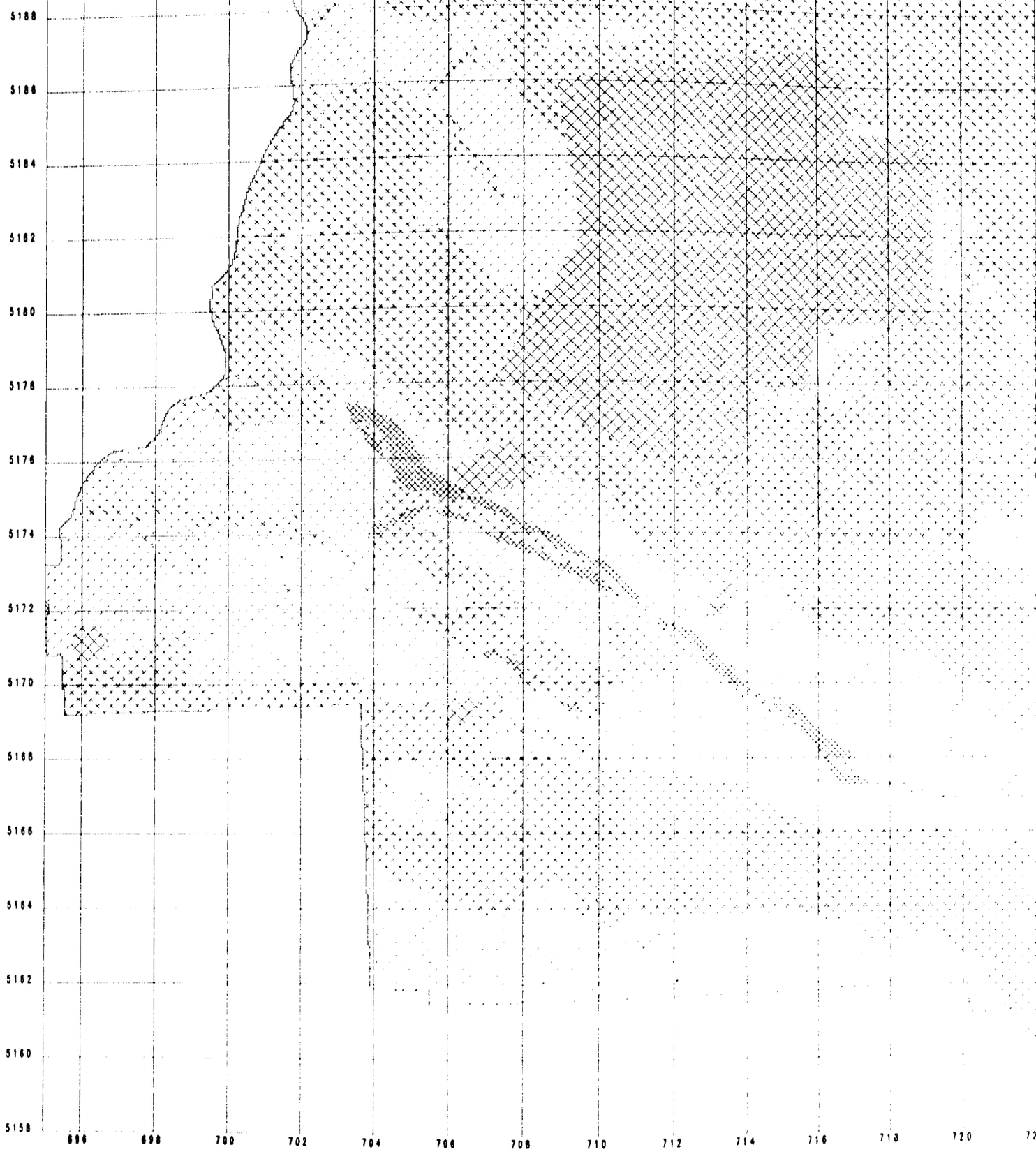


Plate 33. Rate of soil erosion for 3-3-5 a

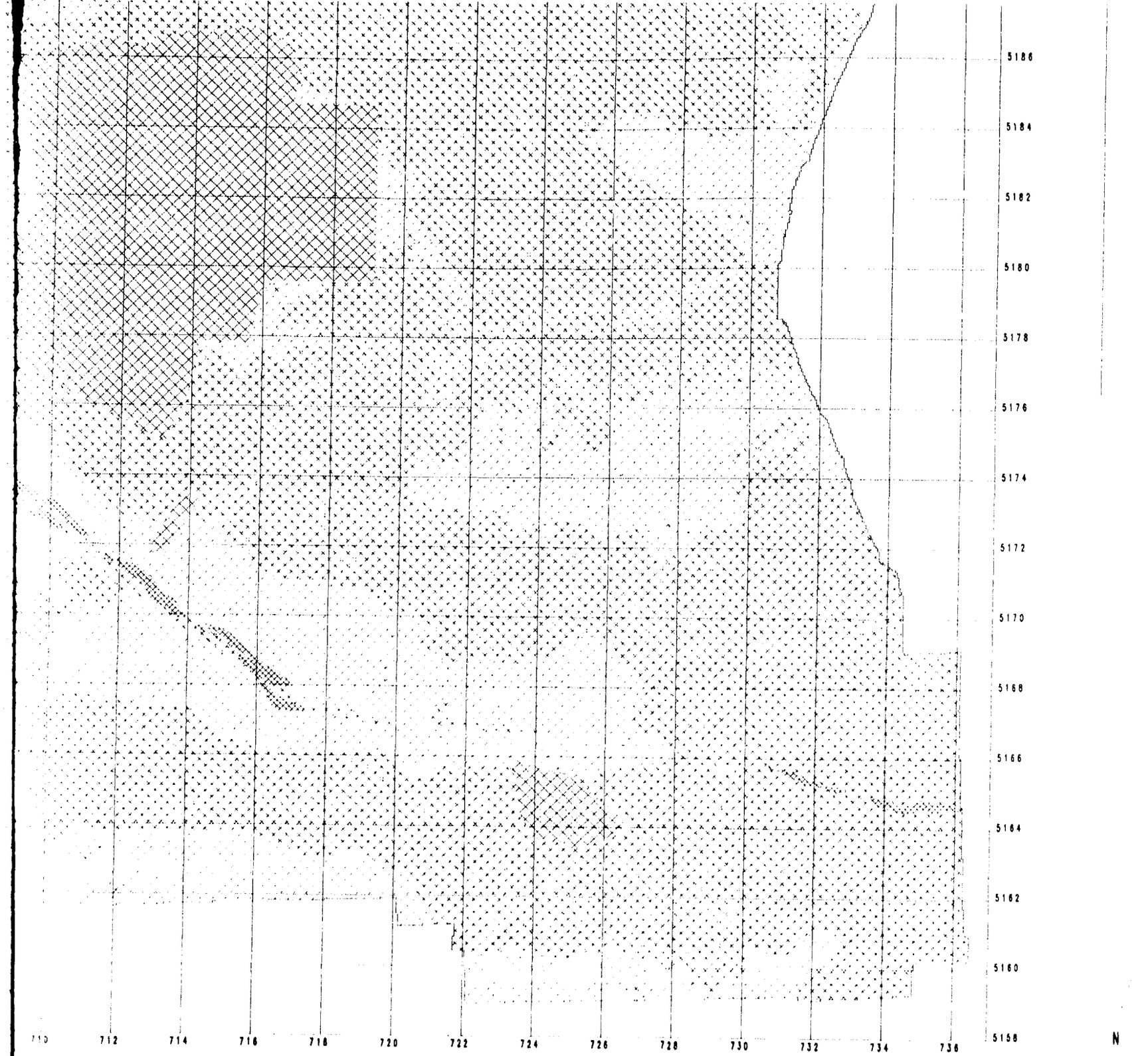
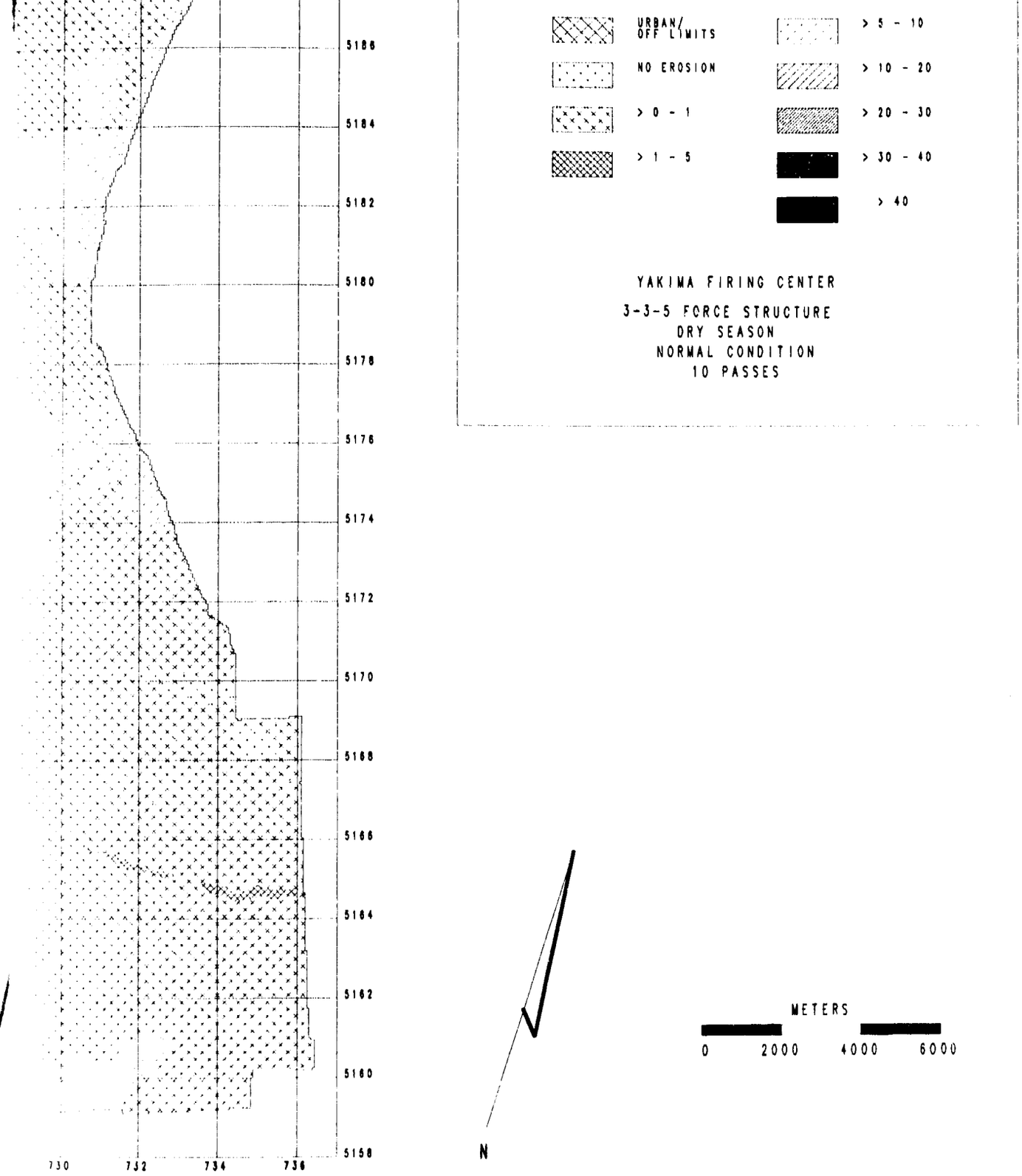
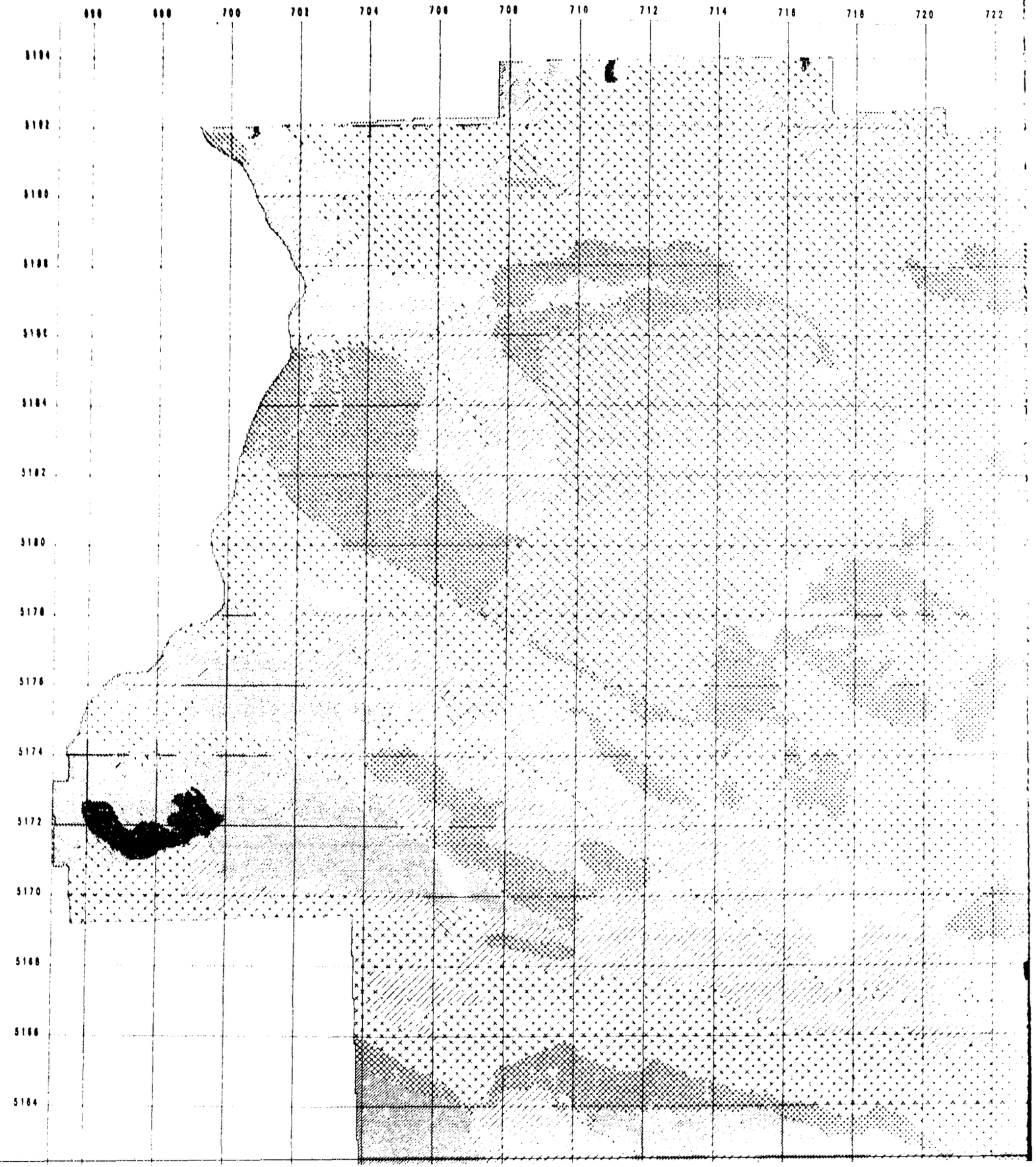
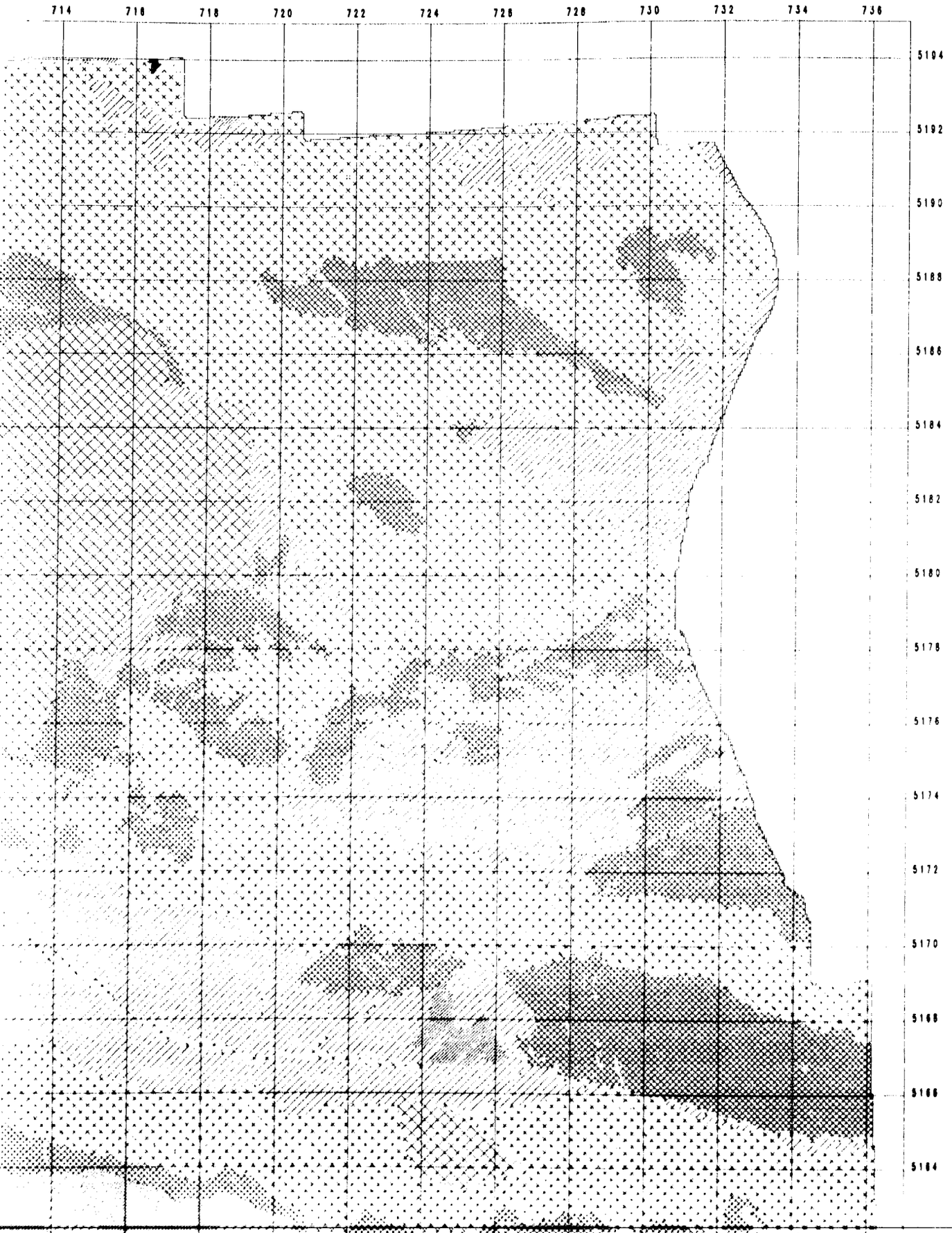


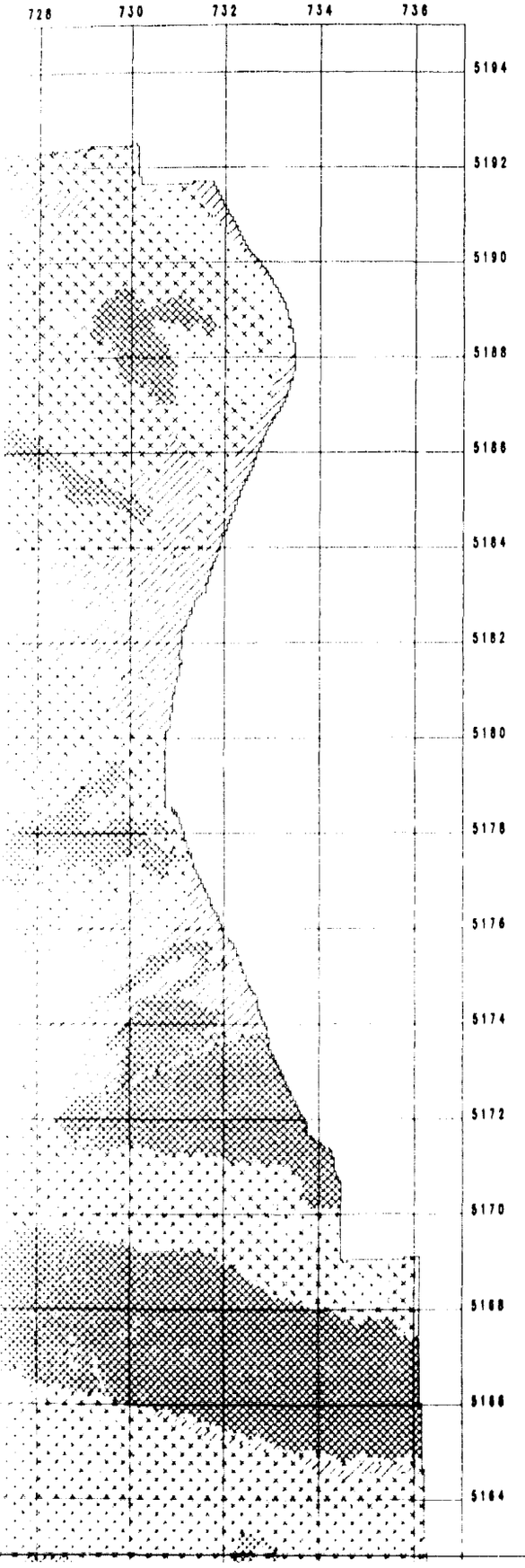
Plate 33. Rate of soil erosion for 3-3-5 and 4-3-3 (HMMWV) force structures in the dry normal surface condition for te



a ictures in the dry normal surface condition for ten passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
50 PASSES

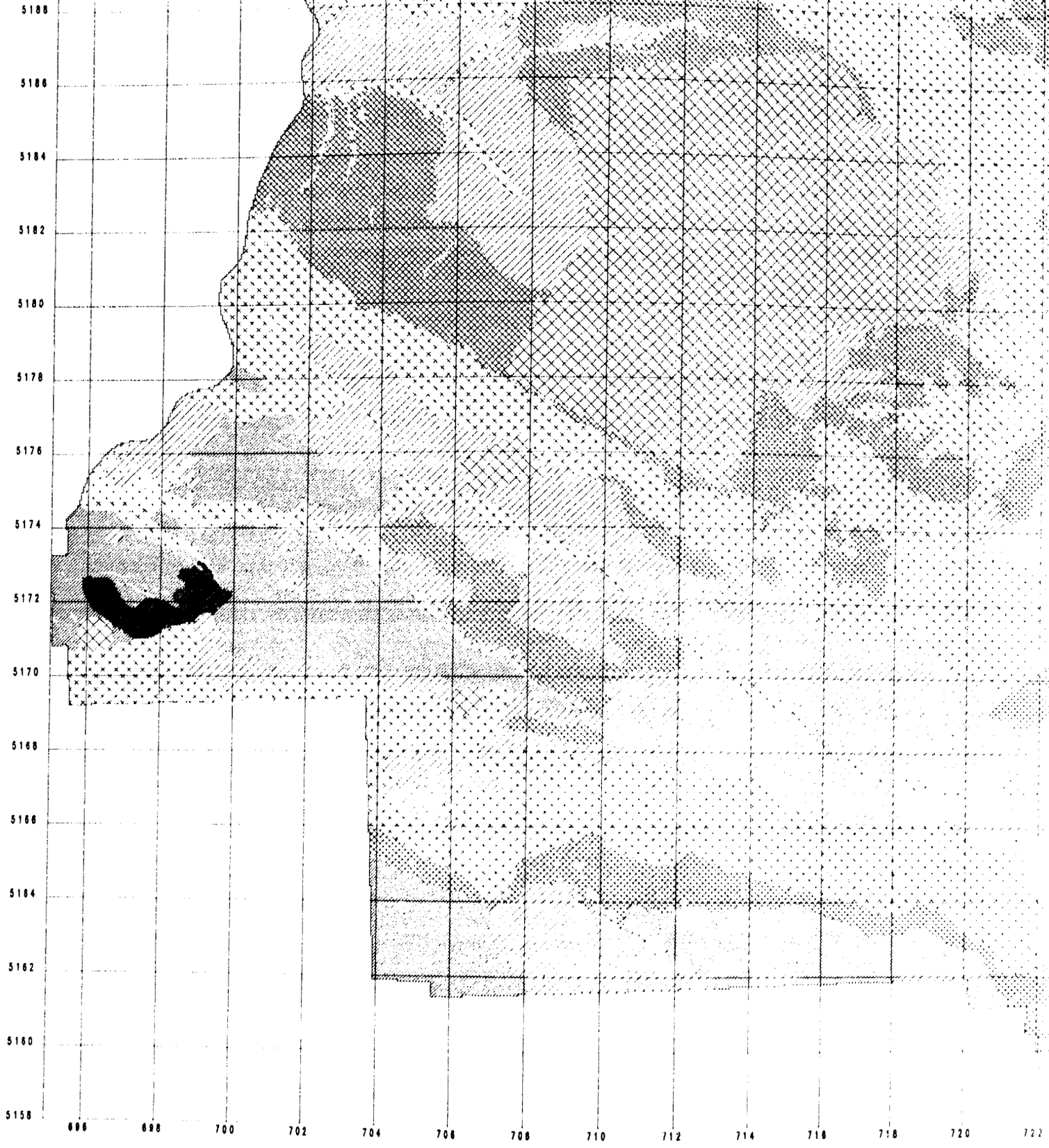


Plate 34. Rate of soil erosion for 3-3-5 and 4-3-3 (H

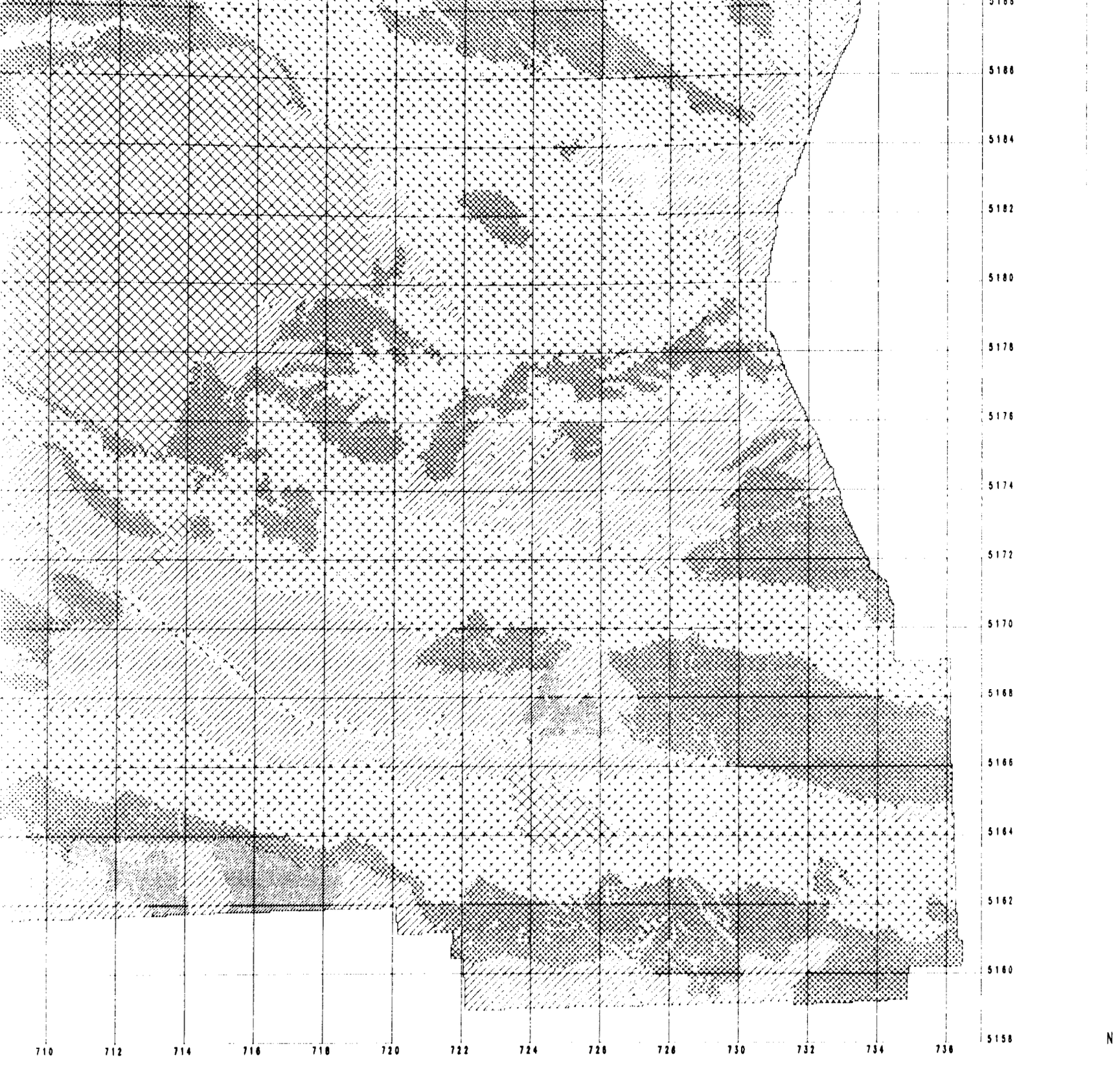
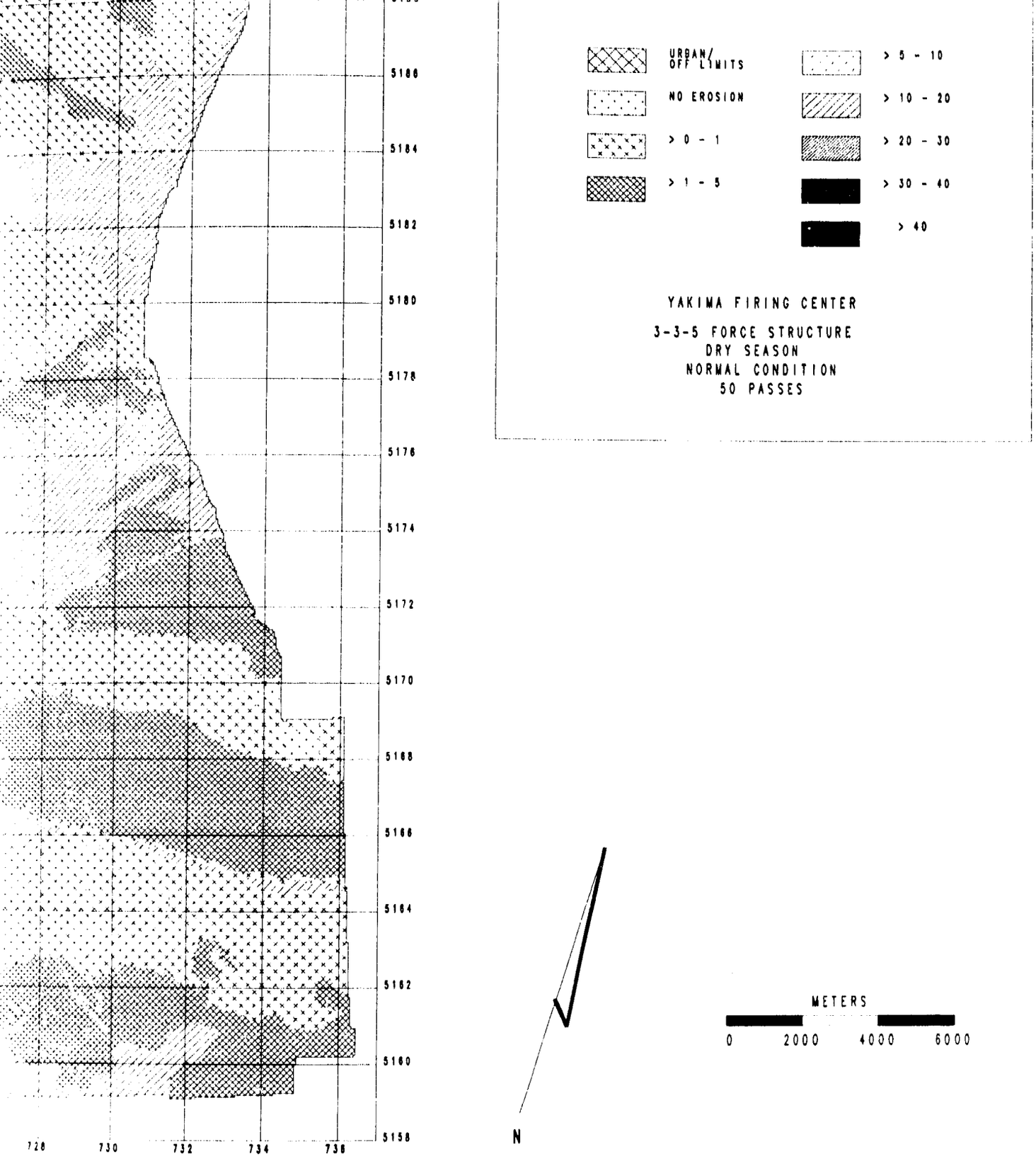
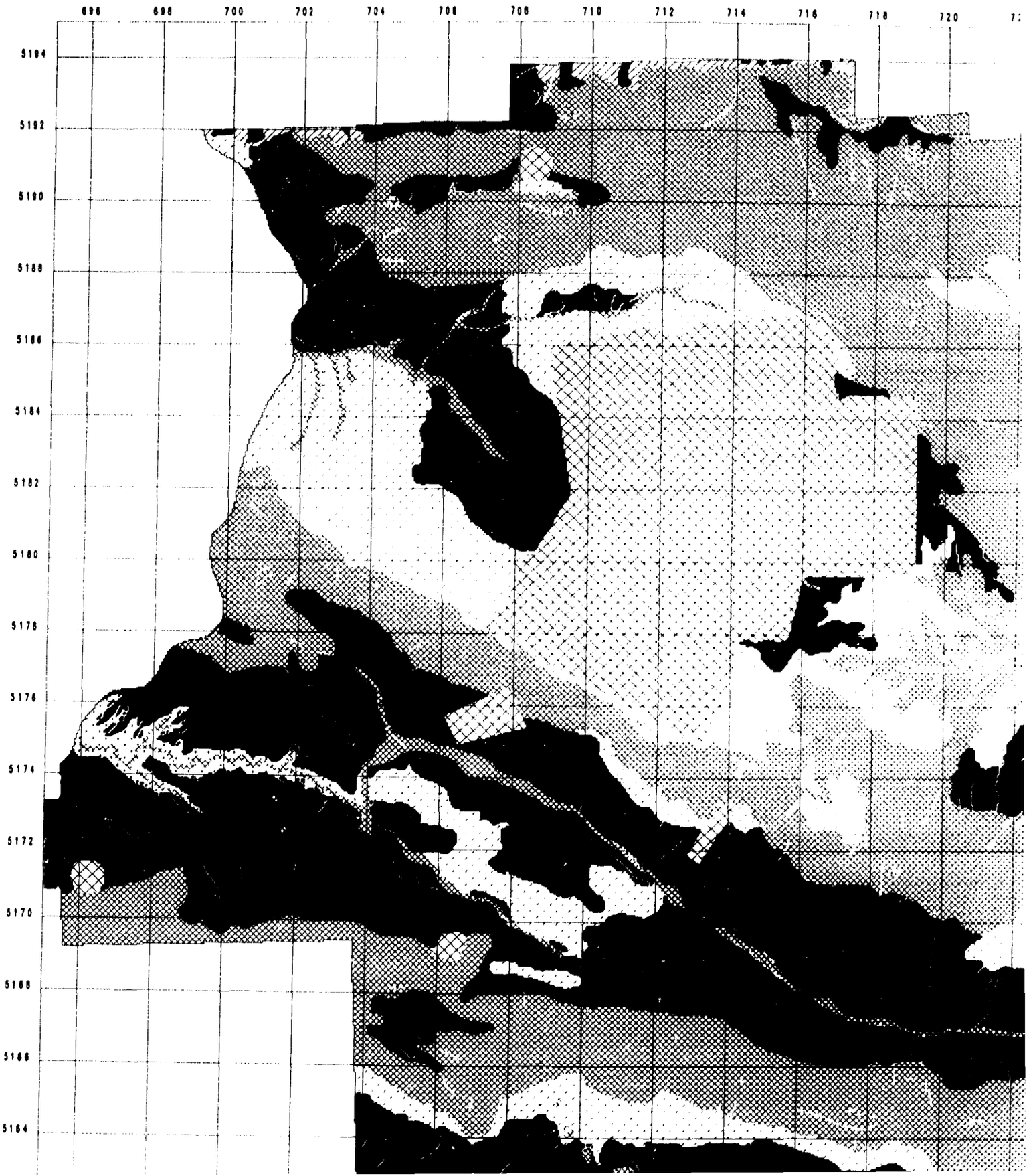
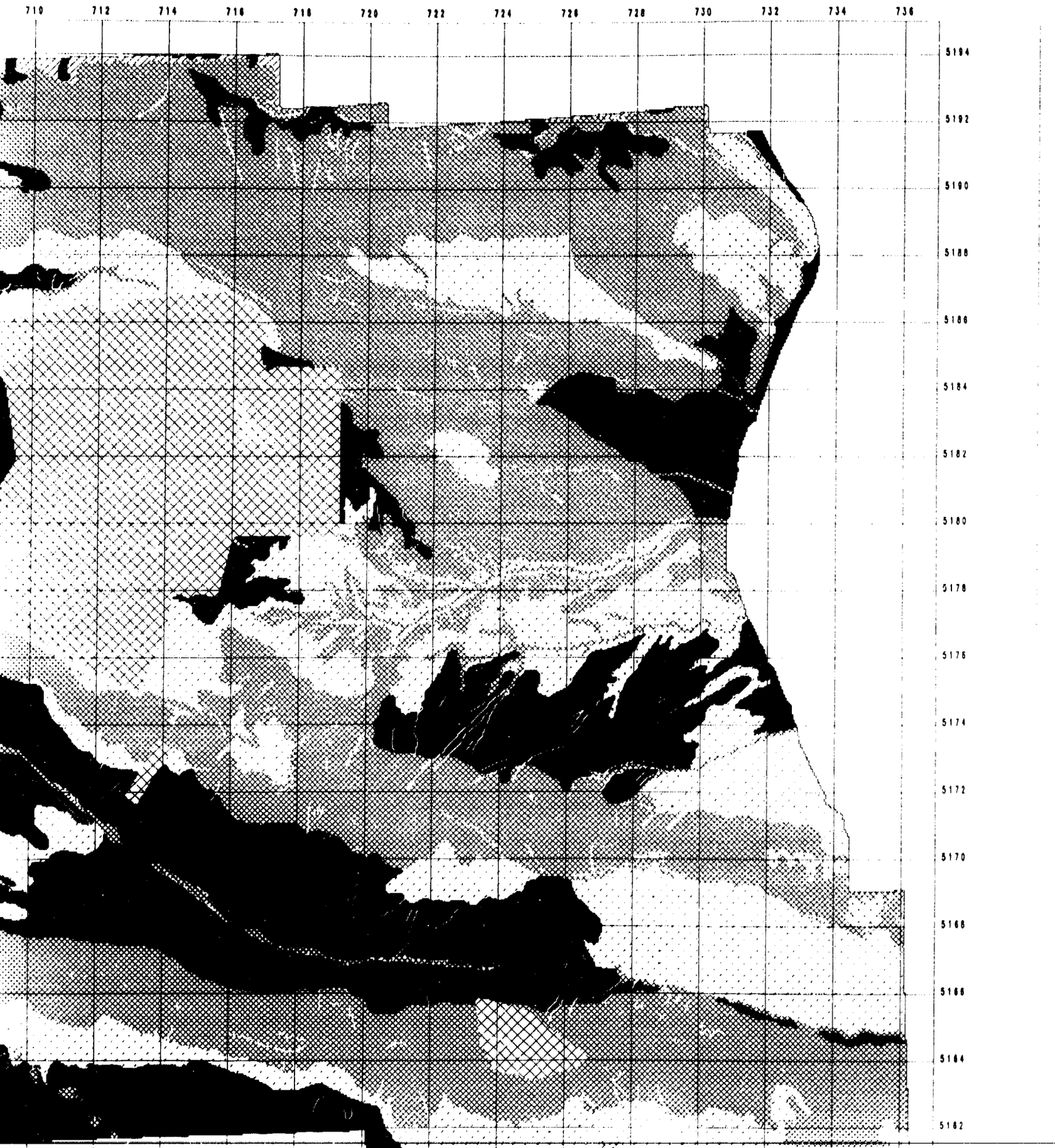


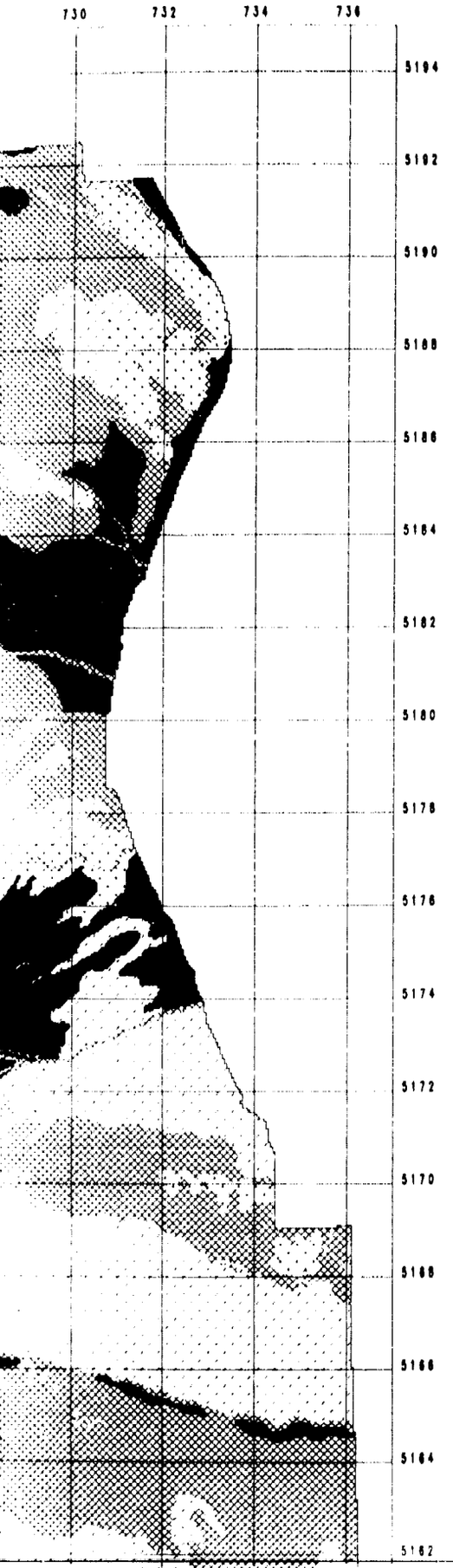
Plate 34. Rate of soil erosion for 3-3-5 and 4-3-3 (HMMWV) force structures in the dry normal surface condition for fifty pass



ures in the dry normal surface condition for fifty passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
1000 PASSES

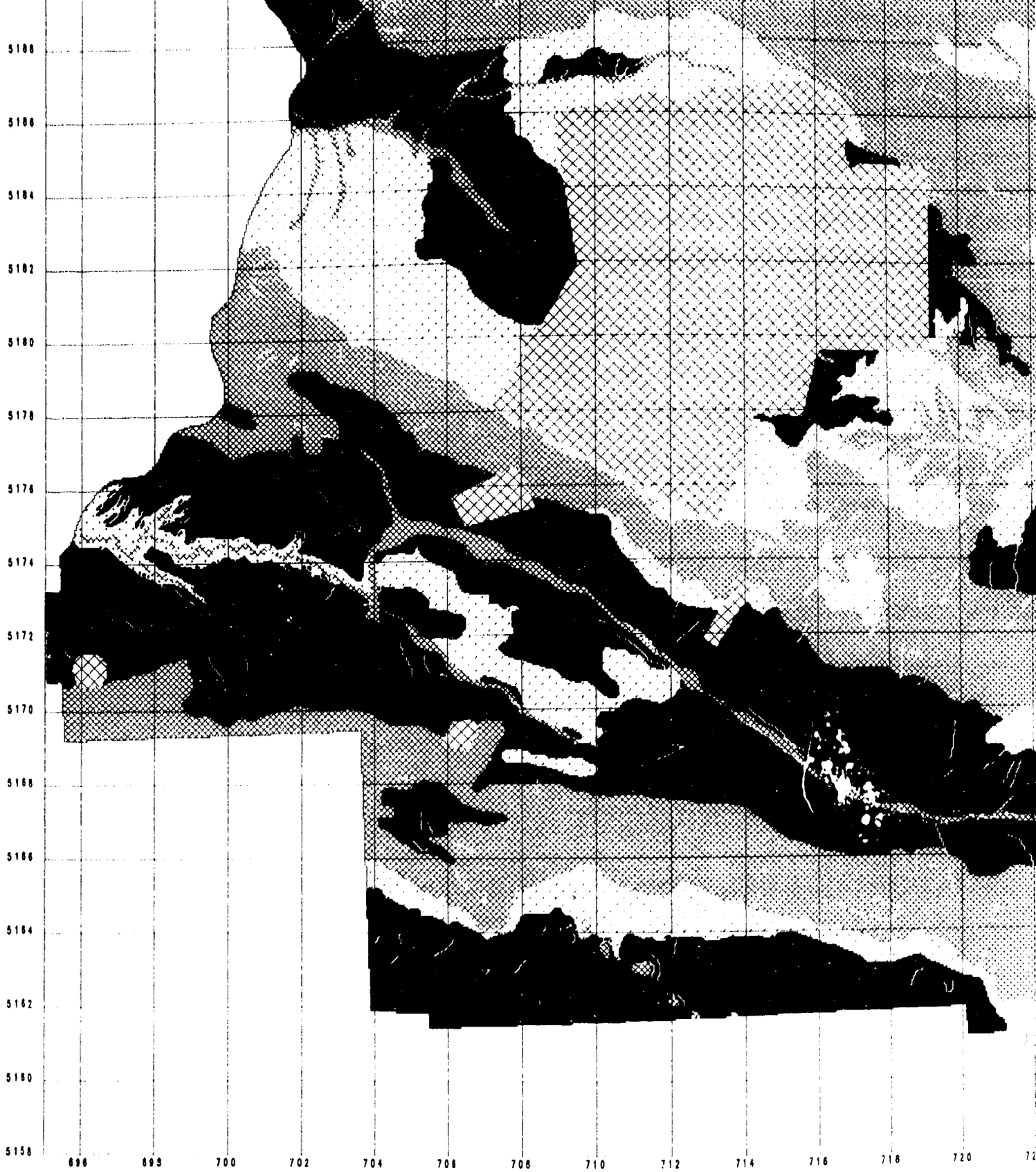
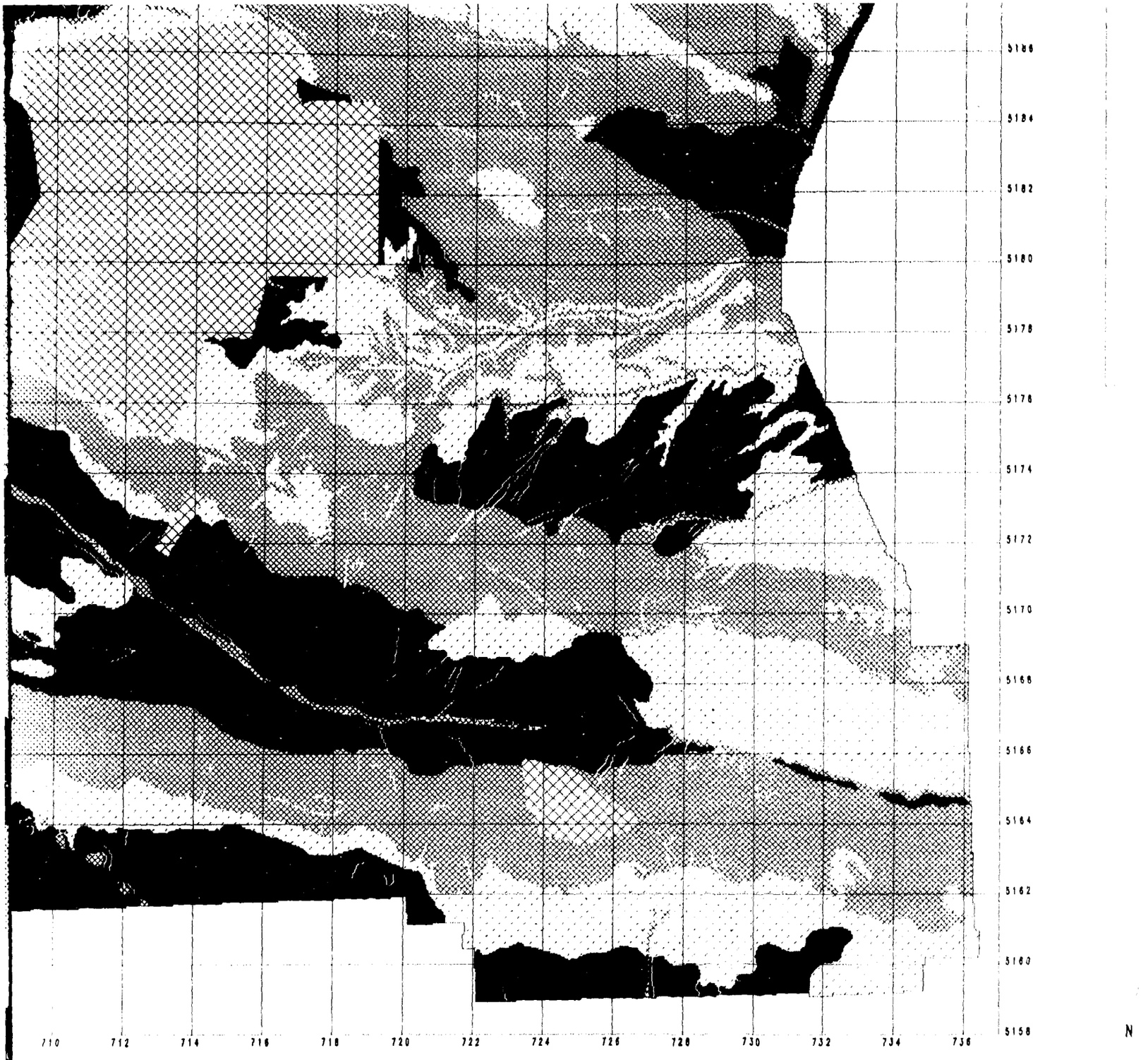
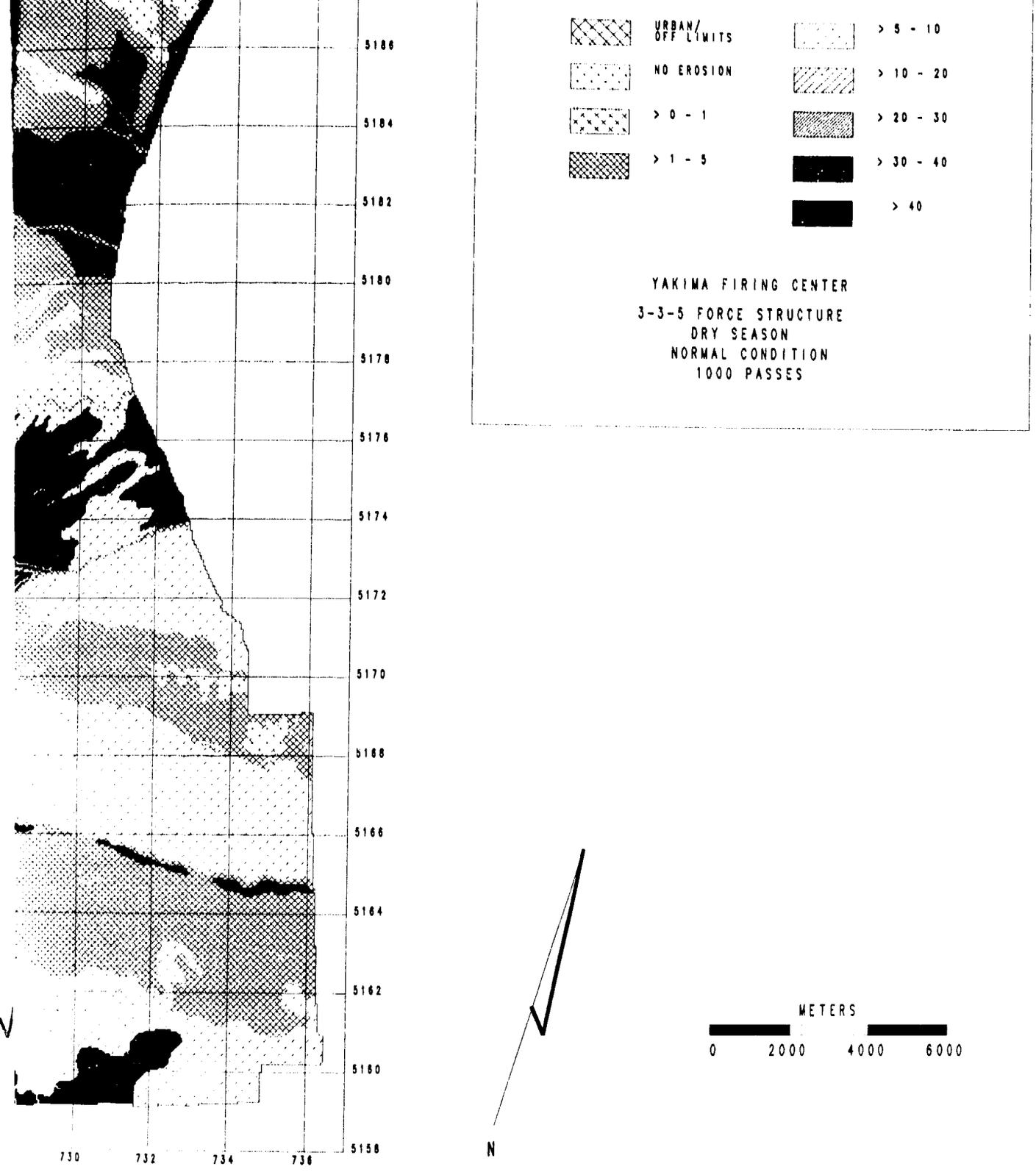


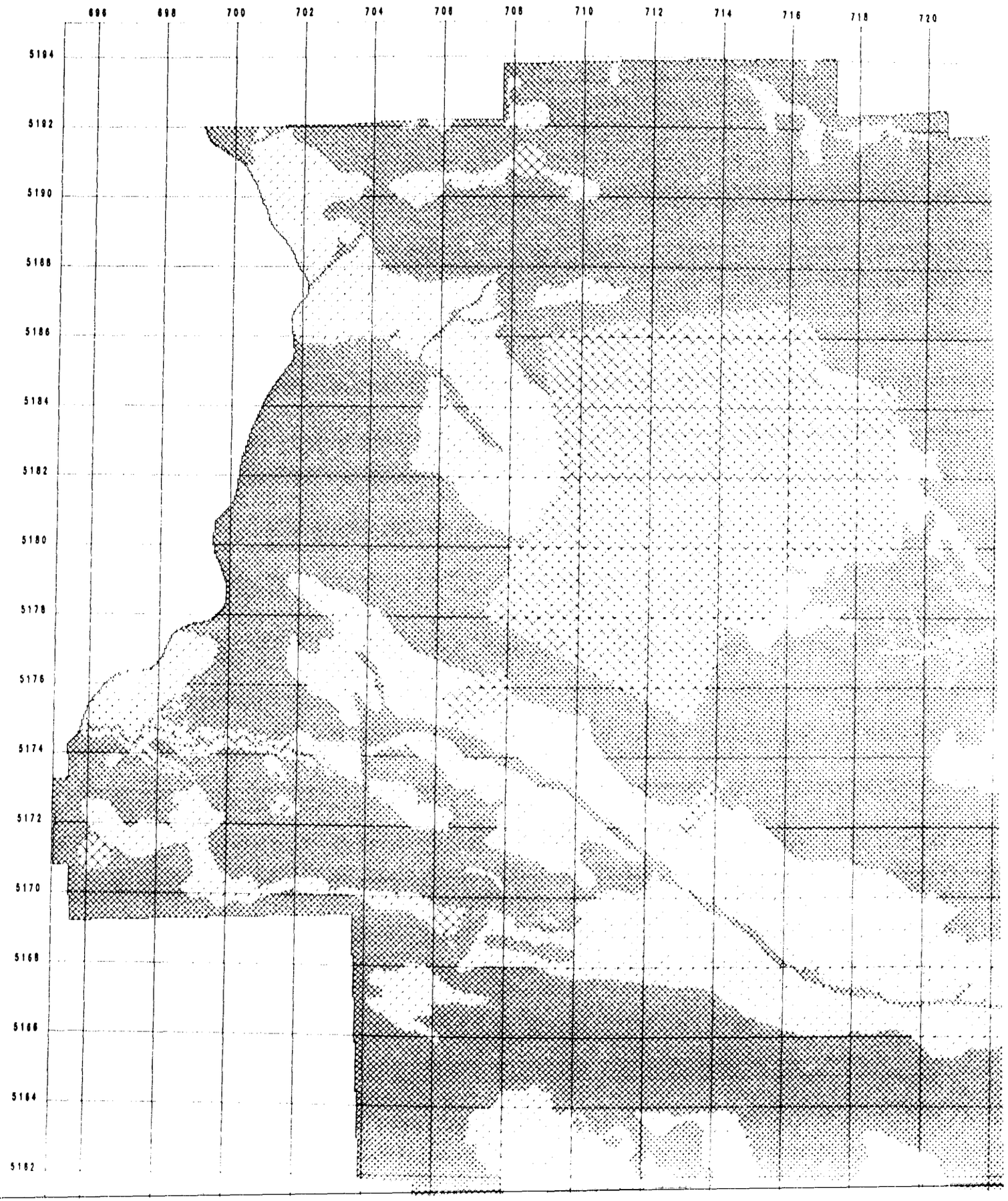
Plate 35. Rate of soil erosion for 3-3-5 and 4-3-3 (HM

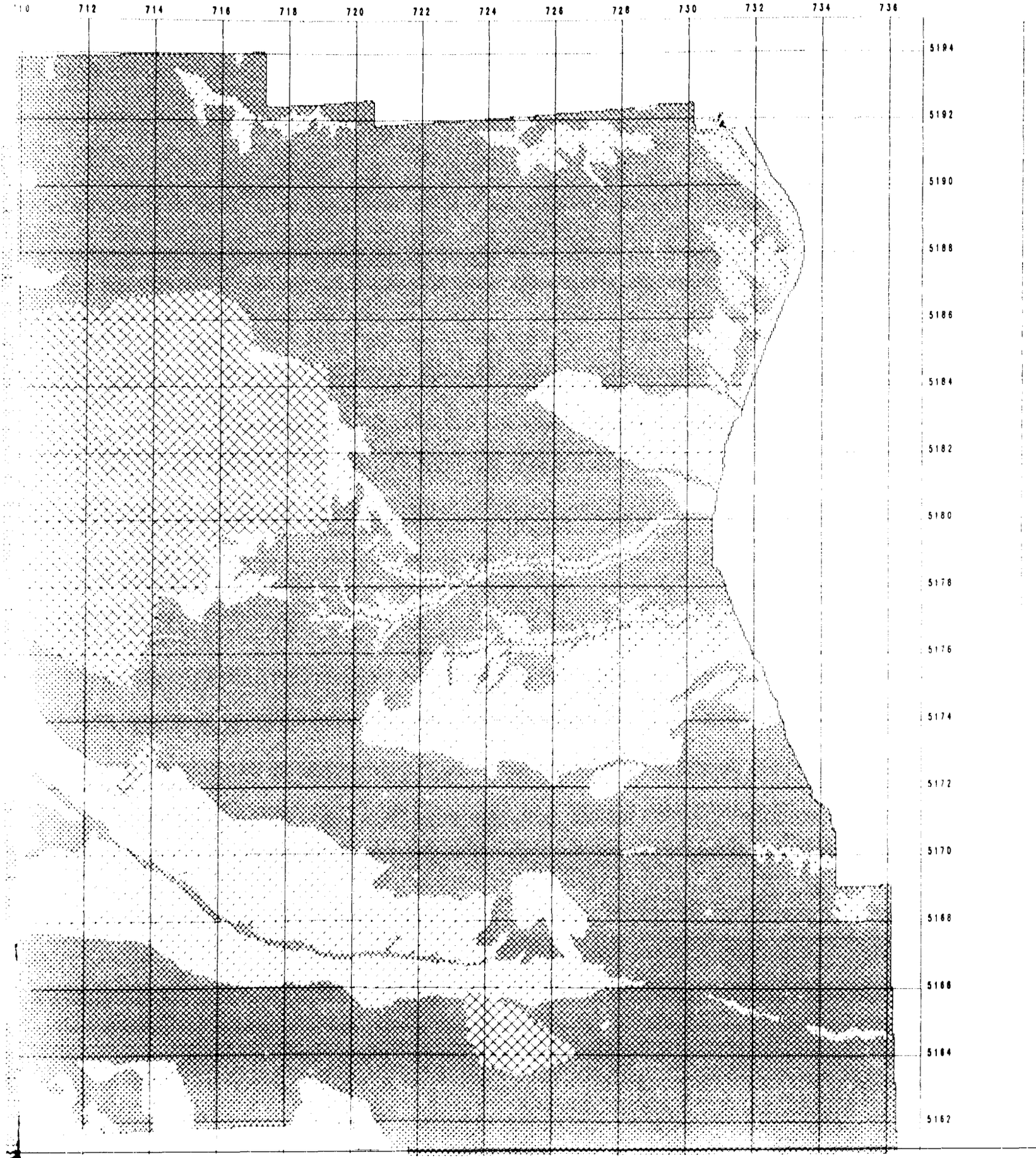


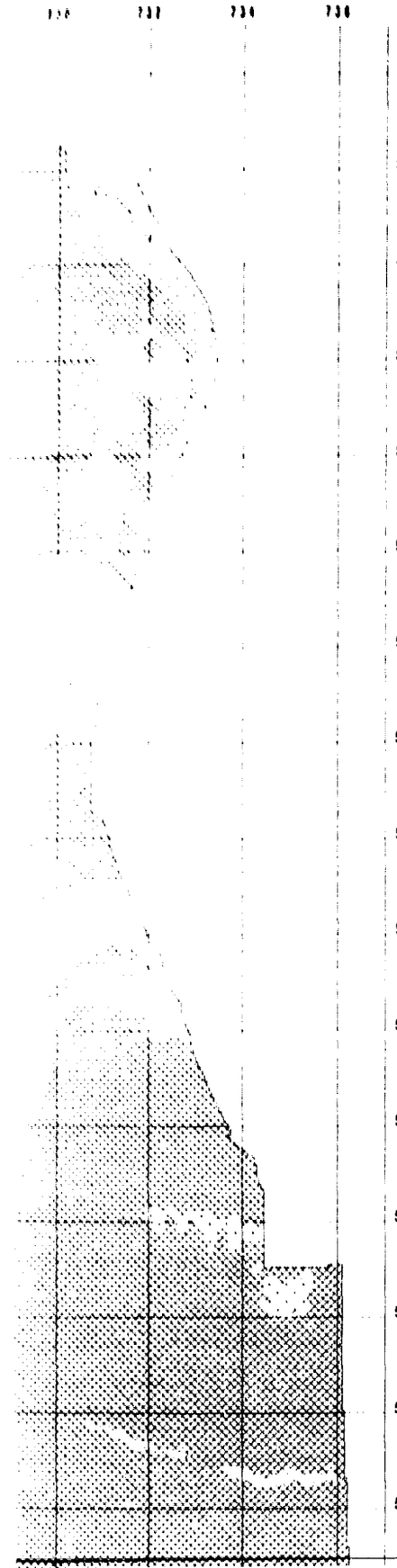
35. Rate of soil erosion for 3-3-5 and 4-3-3 (HMMWV) force structures in the dry normal surface condition for one thousand p



...e dry normal surface condition for one thousand passes


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U. S. Army Corps of Engineers
Waterways
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Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

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YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
10 PASSES

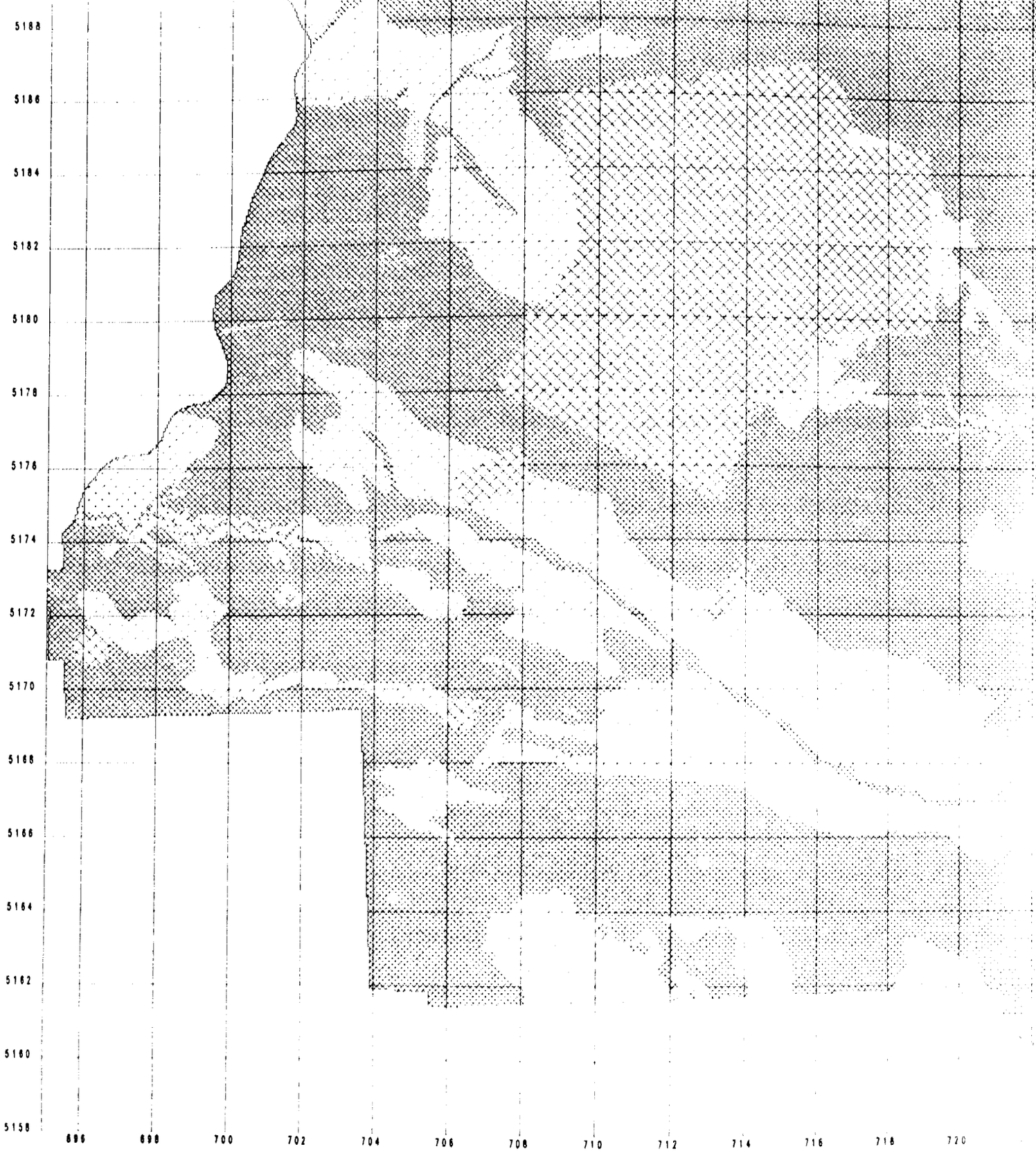
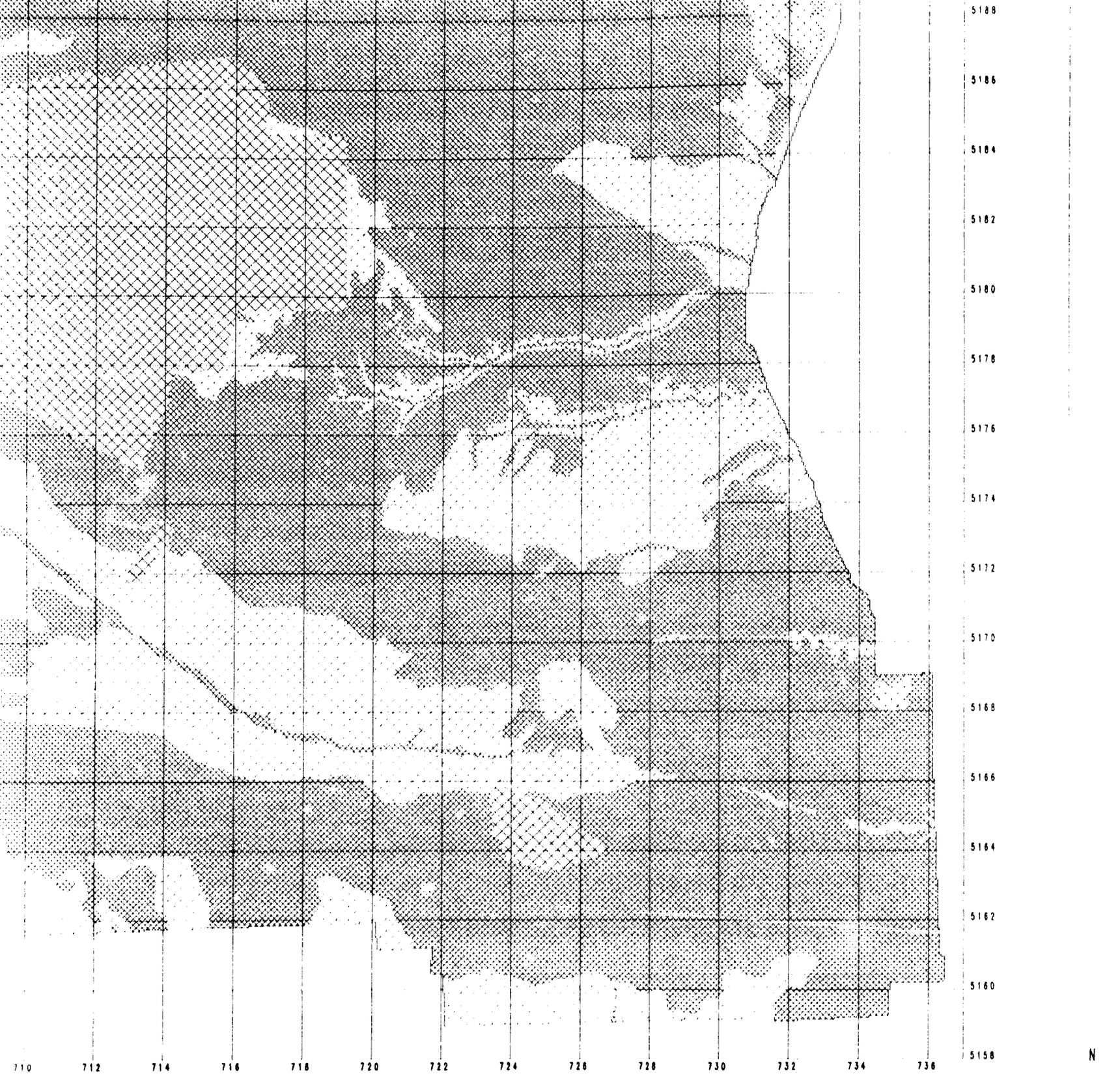
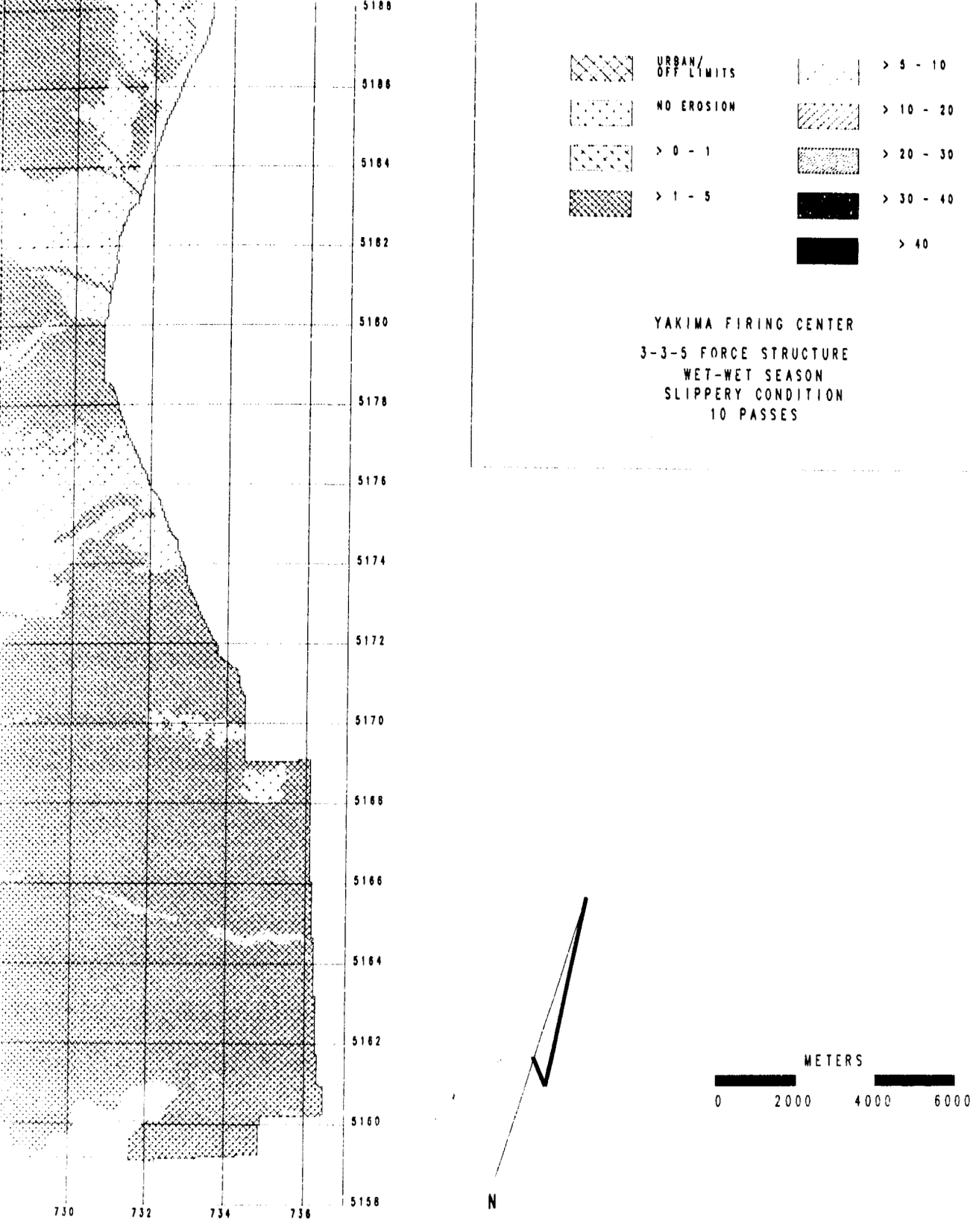


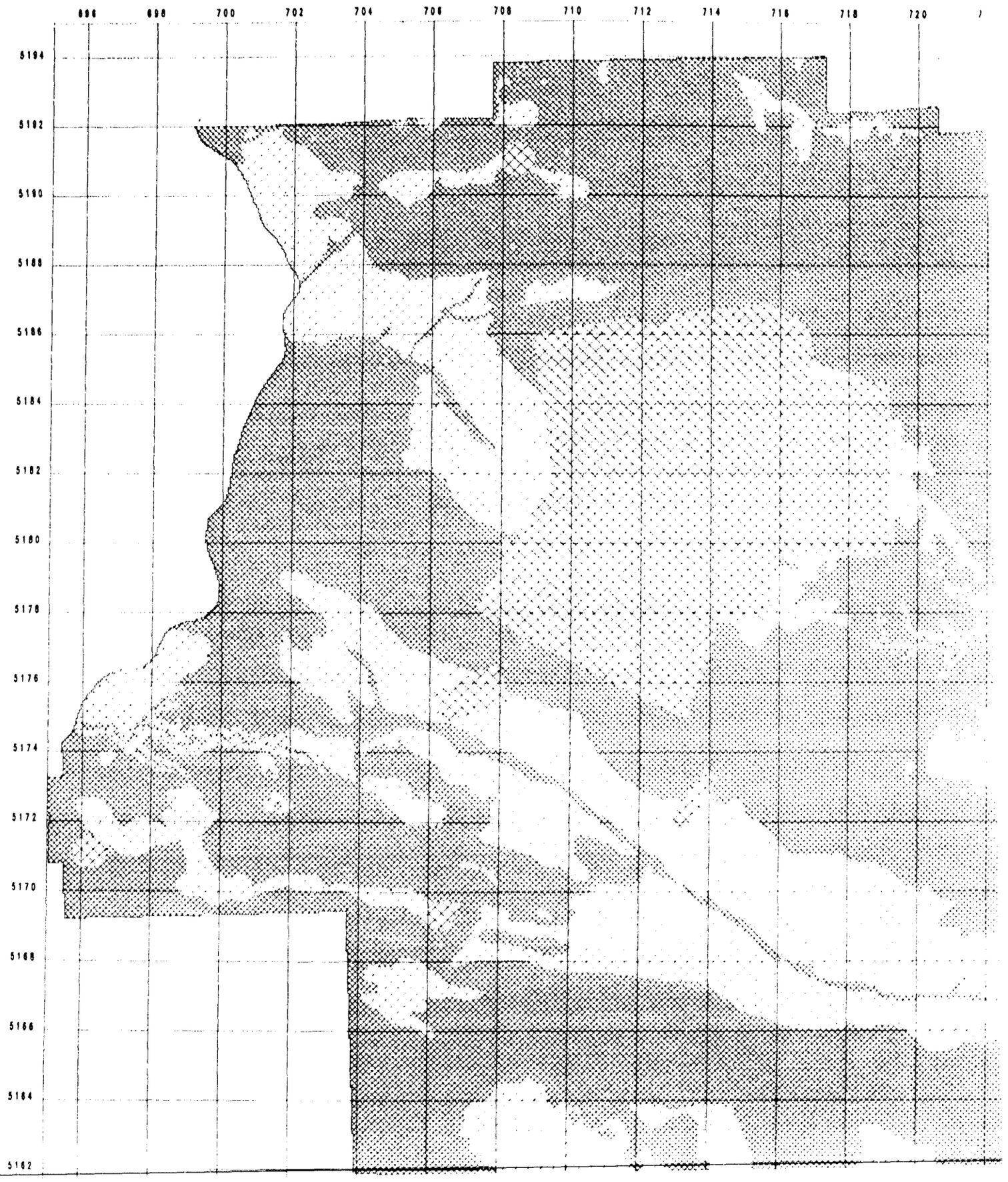
Plate 36. Rate of soil erosion for 3-3-5 and 4-3-3

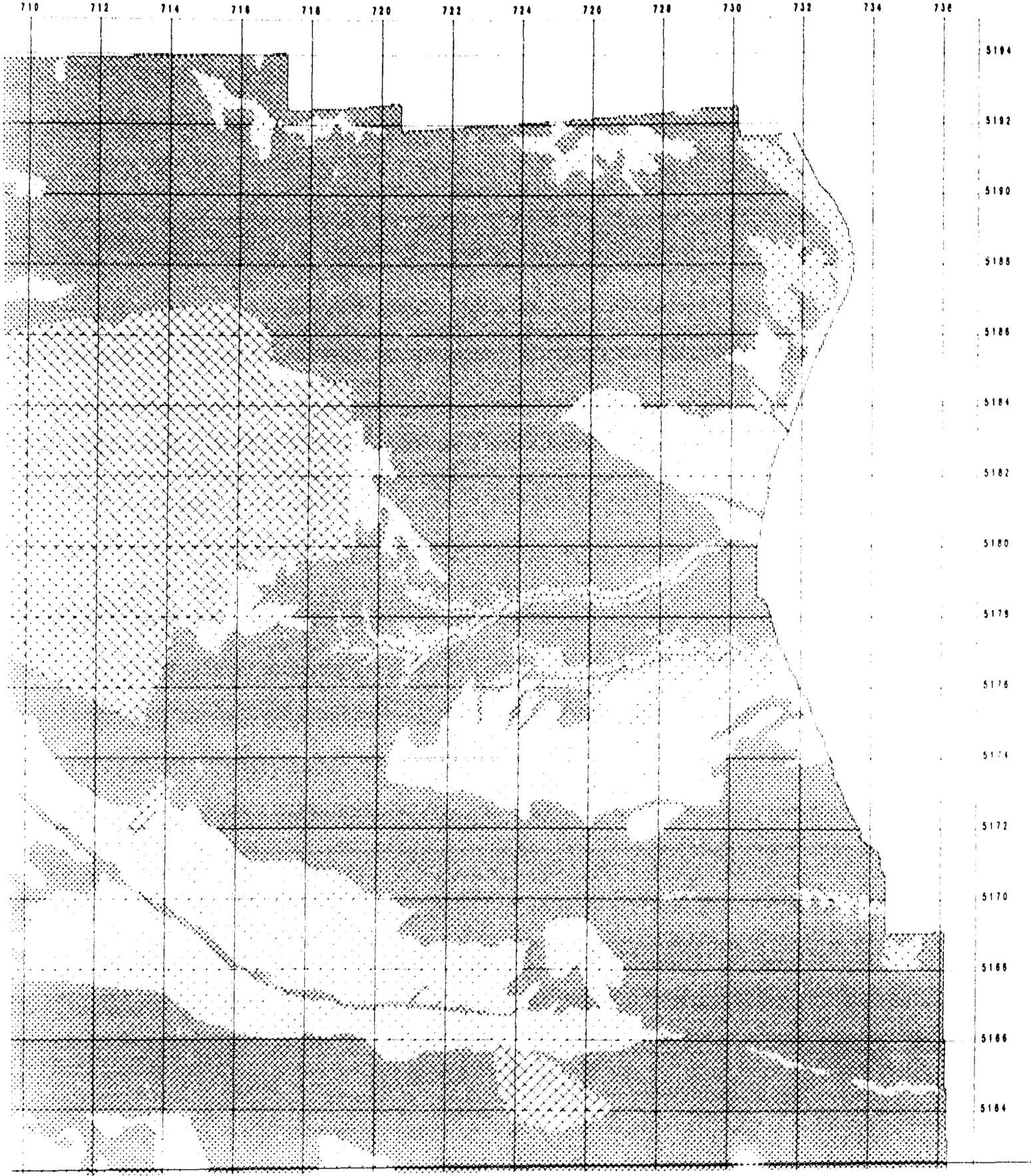


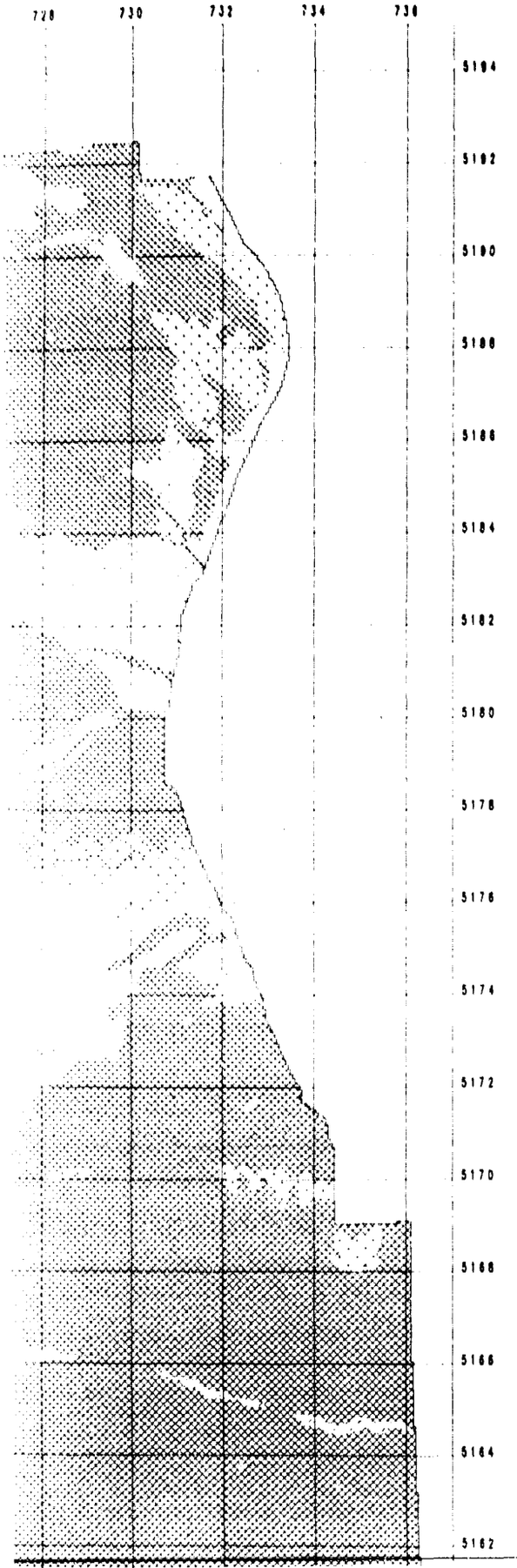
ate 36. Rate of soil erosion for 3-3-5 and 4-3-3 (HMMWV) force structures in the wet-wet slippery surface condition for ten pas



in the wet-wet slippery surface condition for ten passes


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U. S. Army Corps of Engineers
Waterways
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Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
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YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
50 PASSES

METERS

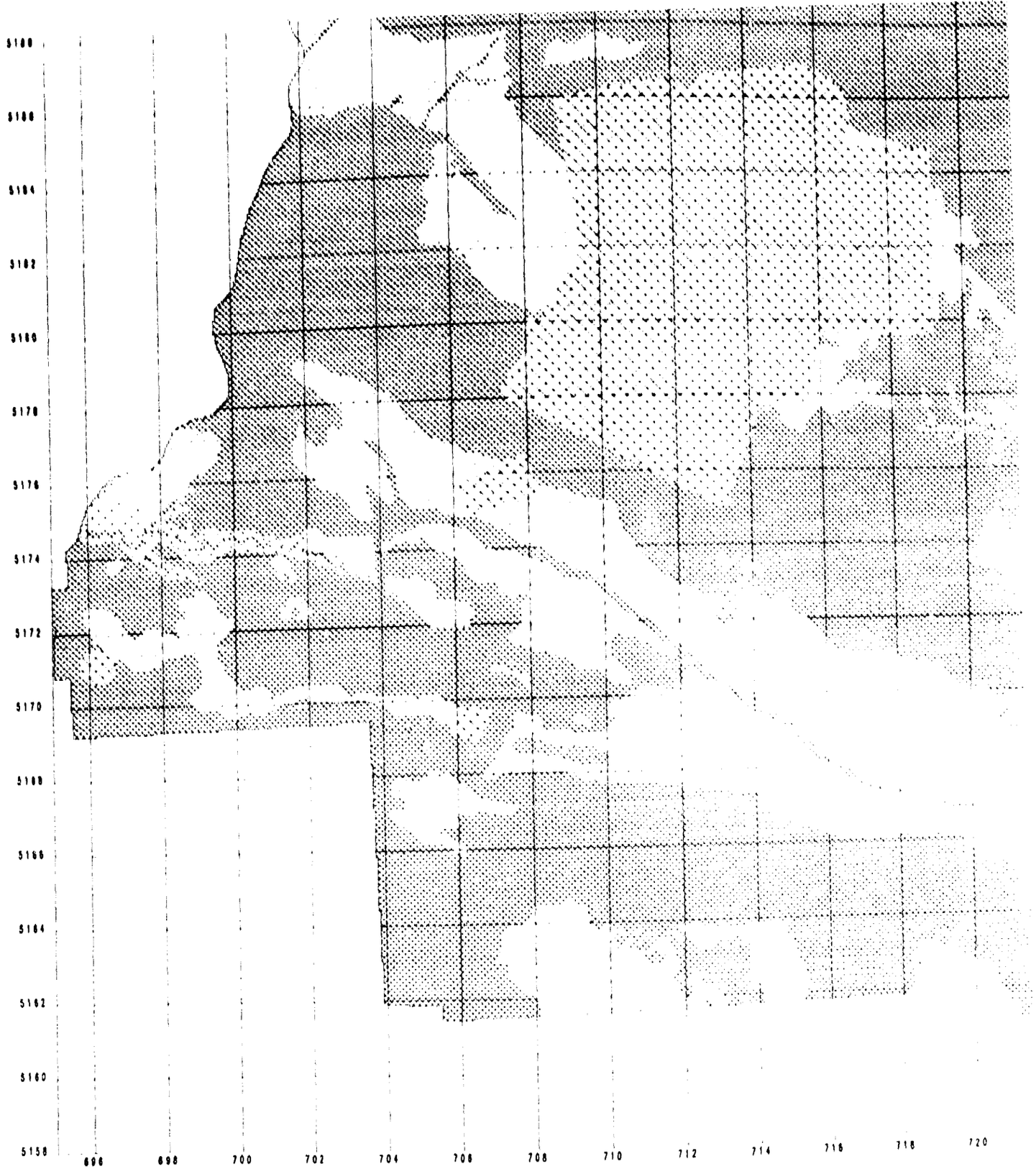


Plate 37. Rate of soil erosion for 3-3-5 and 4-3-3

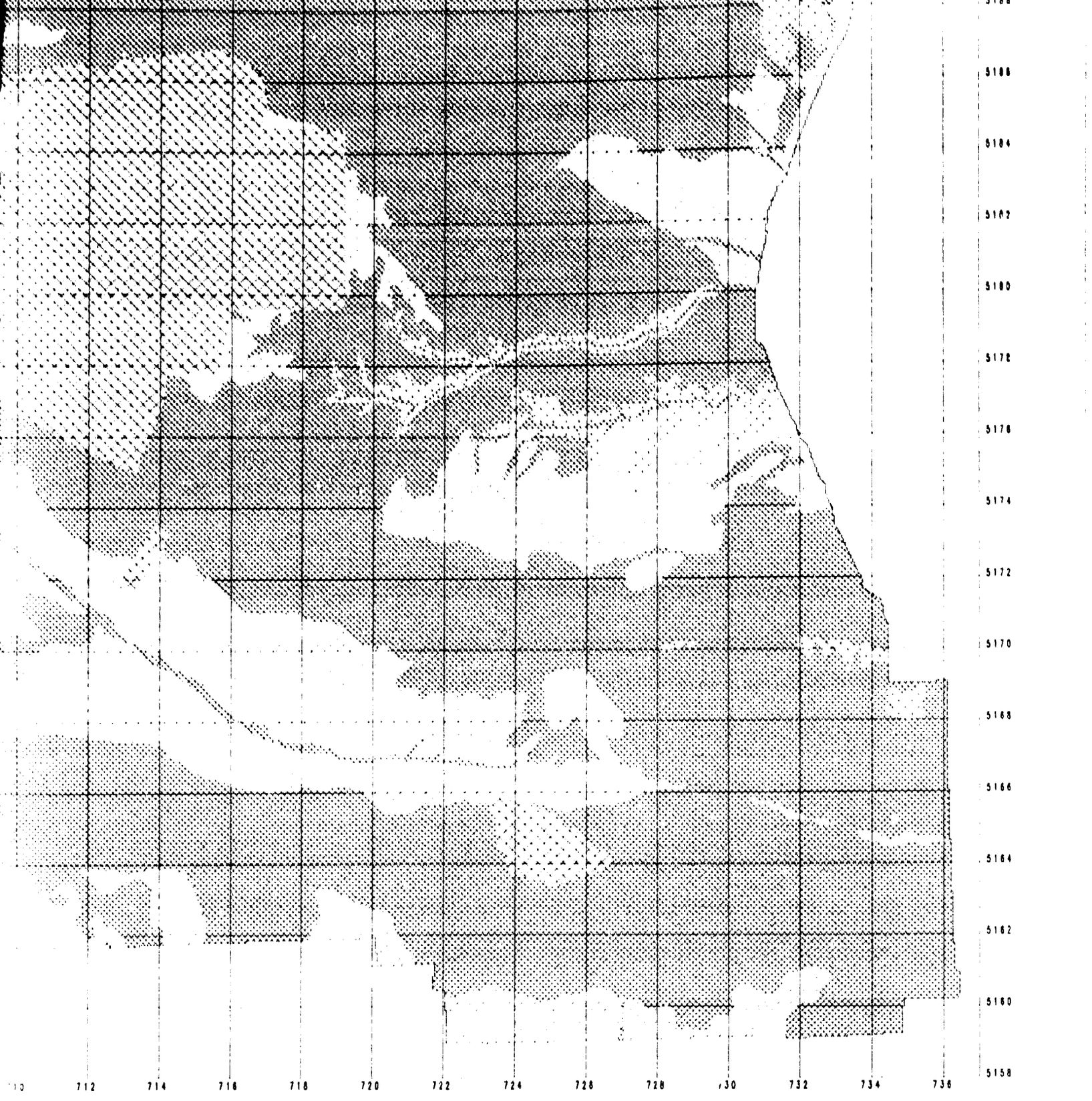
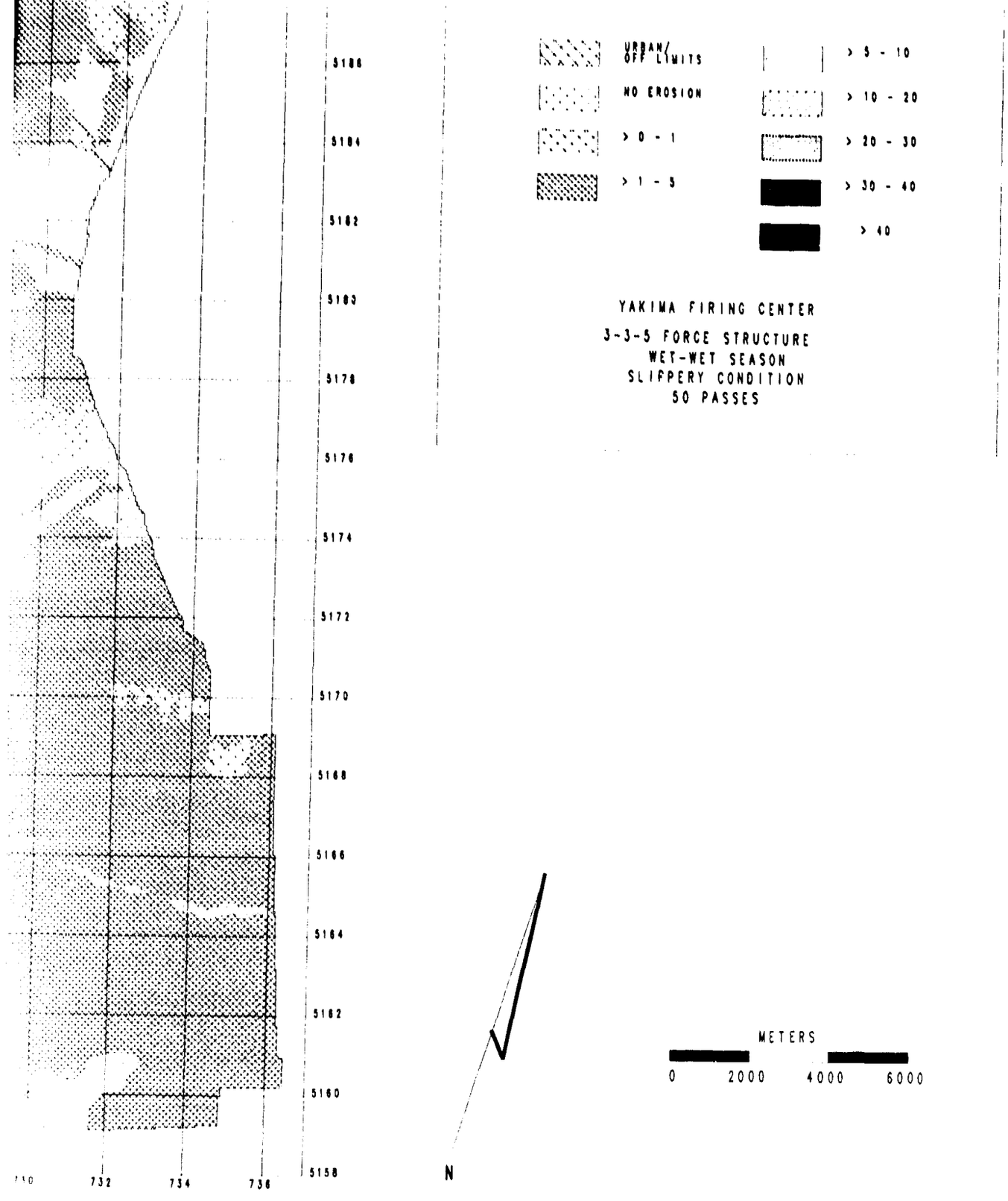
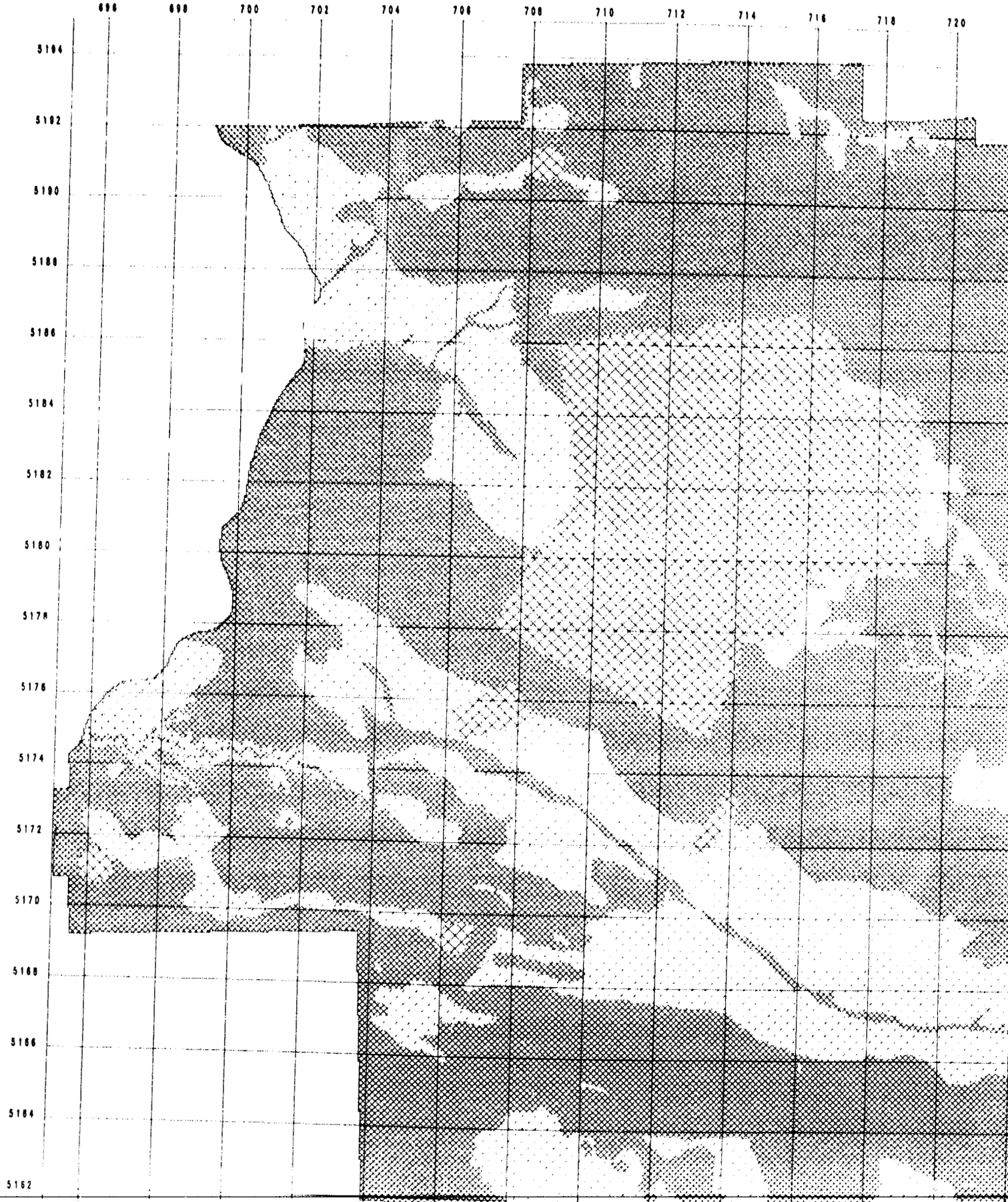
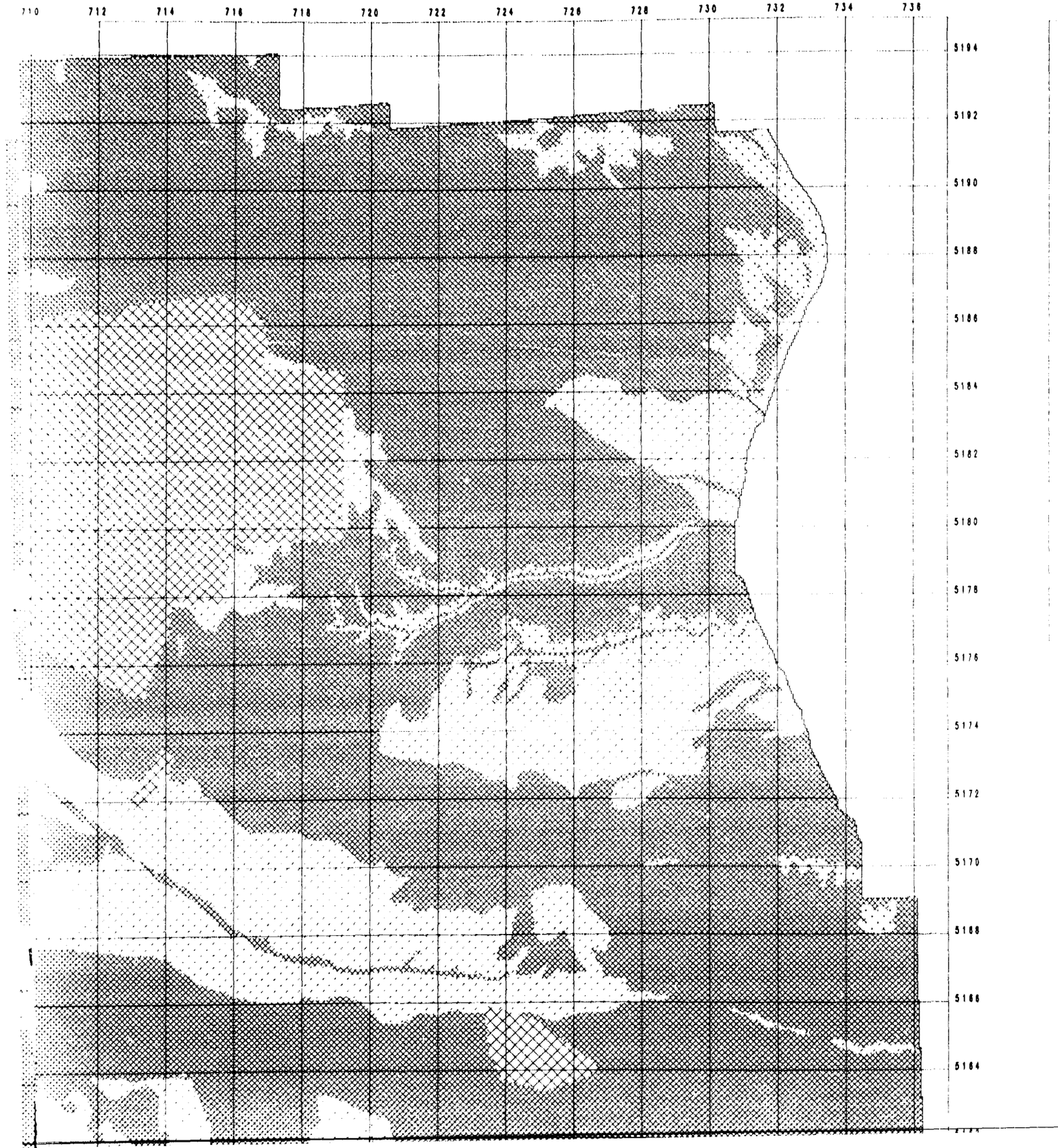


Figure 37. Rate of soil erosion for 3-3-5 and 4-3-3 (HMMWV) force structures in the wet-wet slippery surface condition for fifty pa



wet-wet slippery surface condition for fifty passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
1000 PASSES

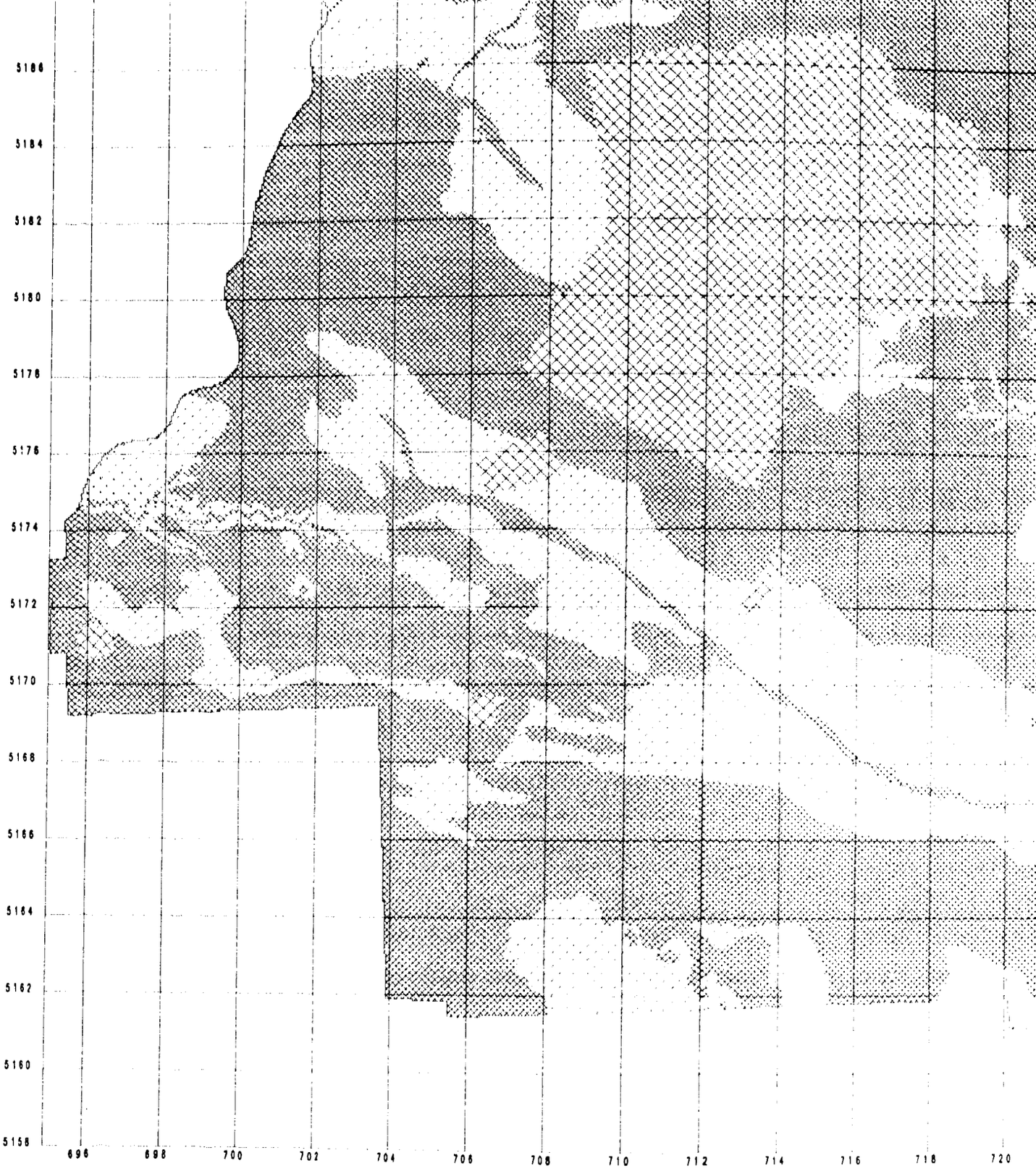
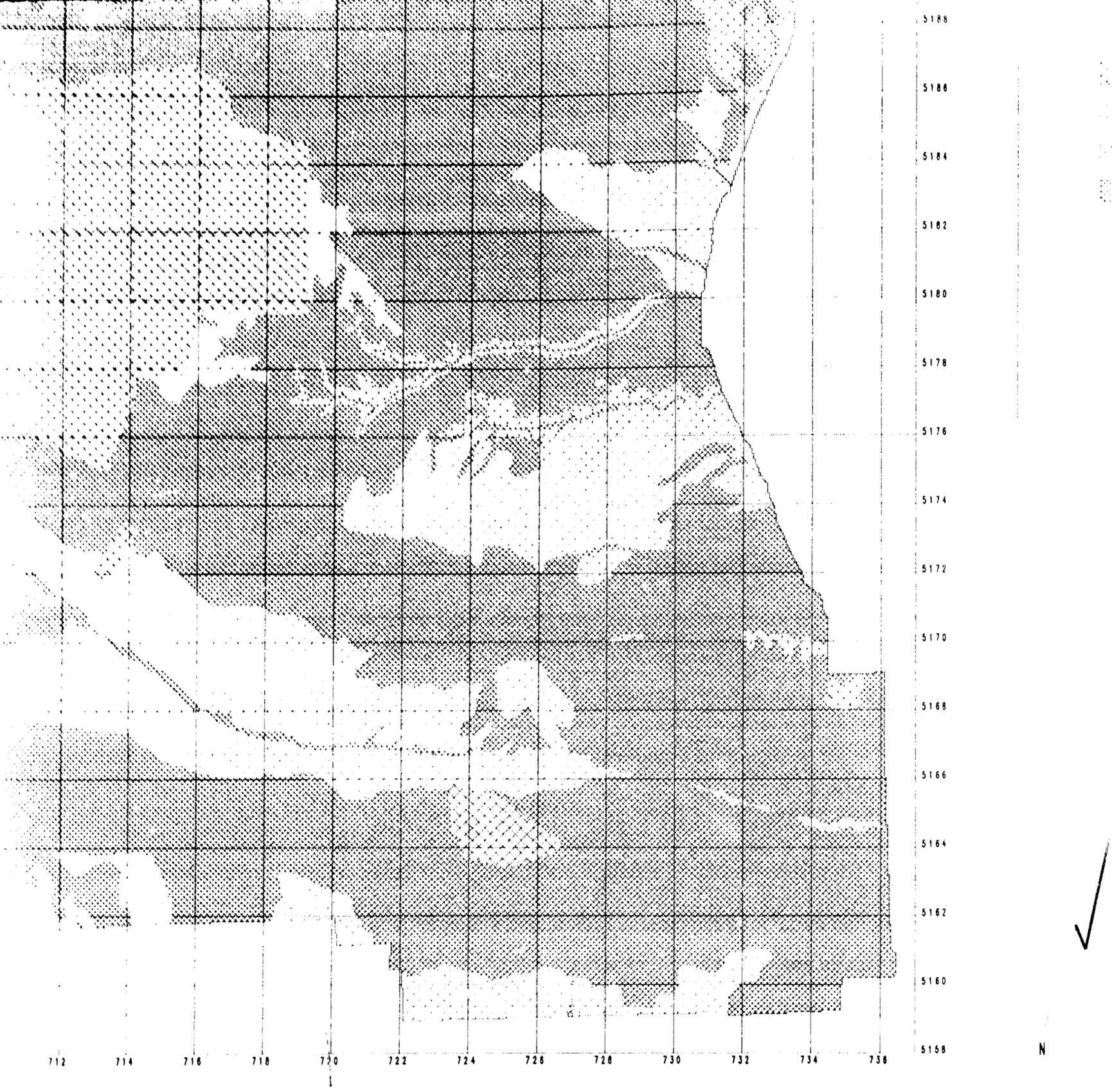
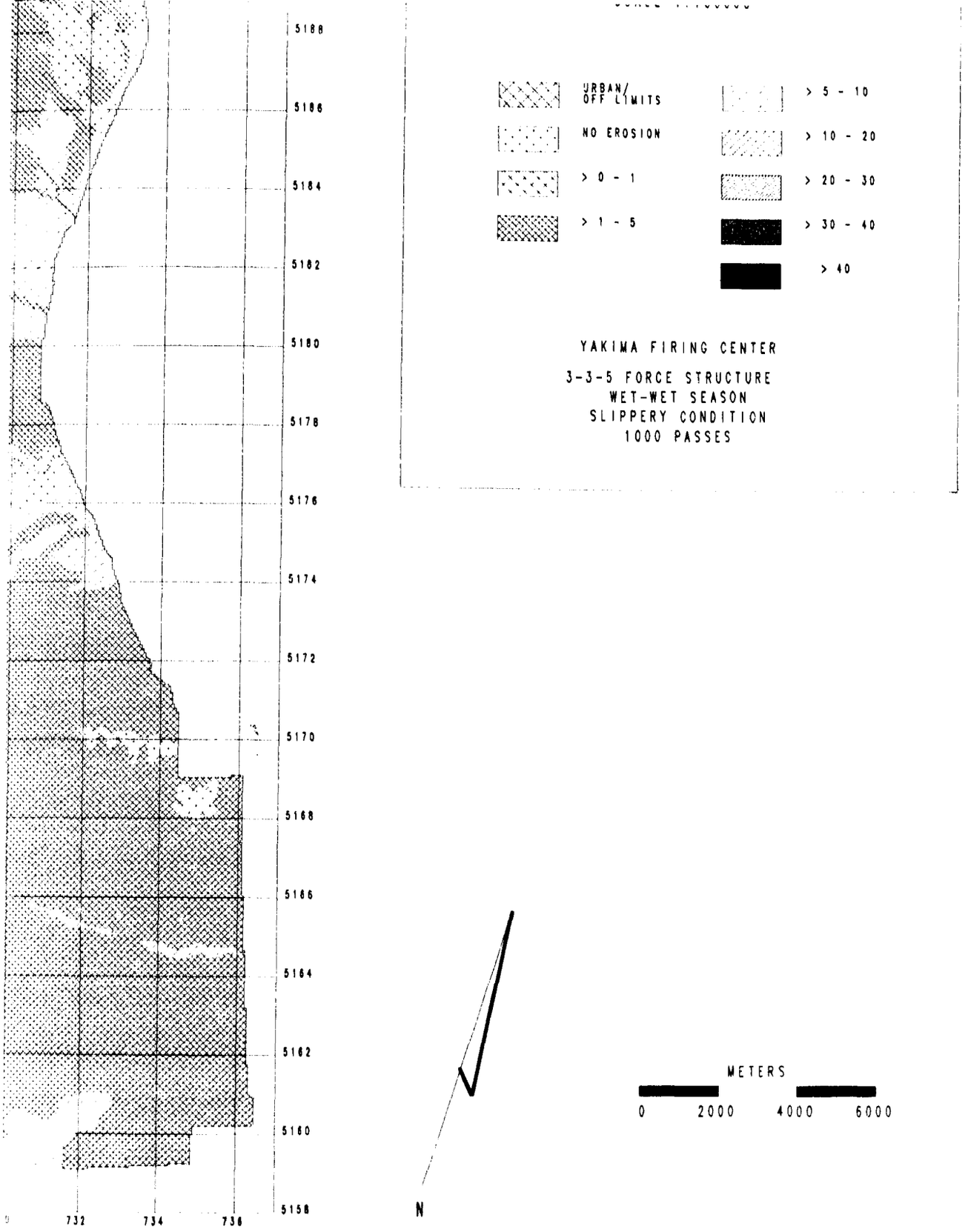


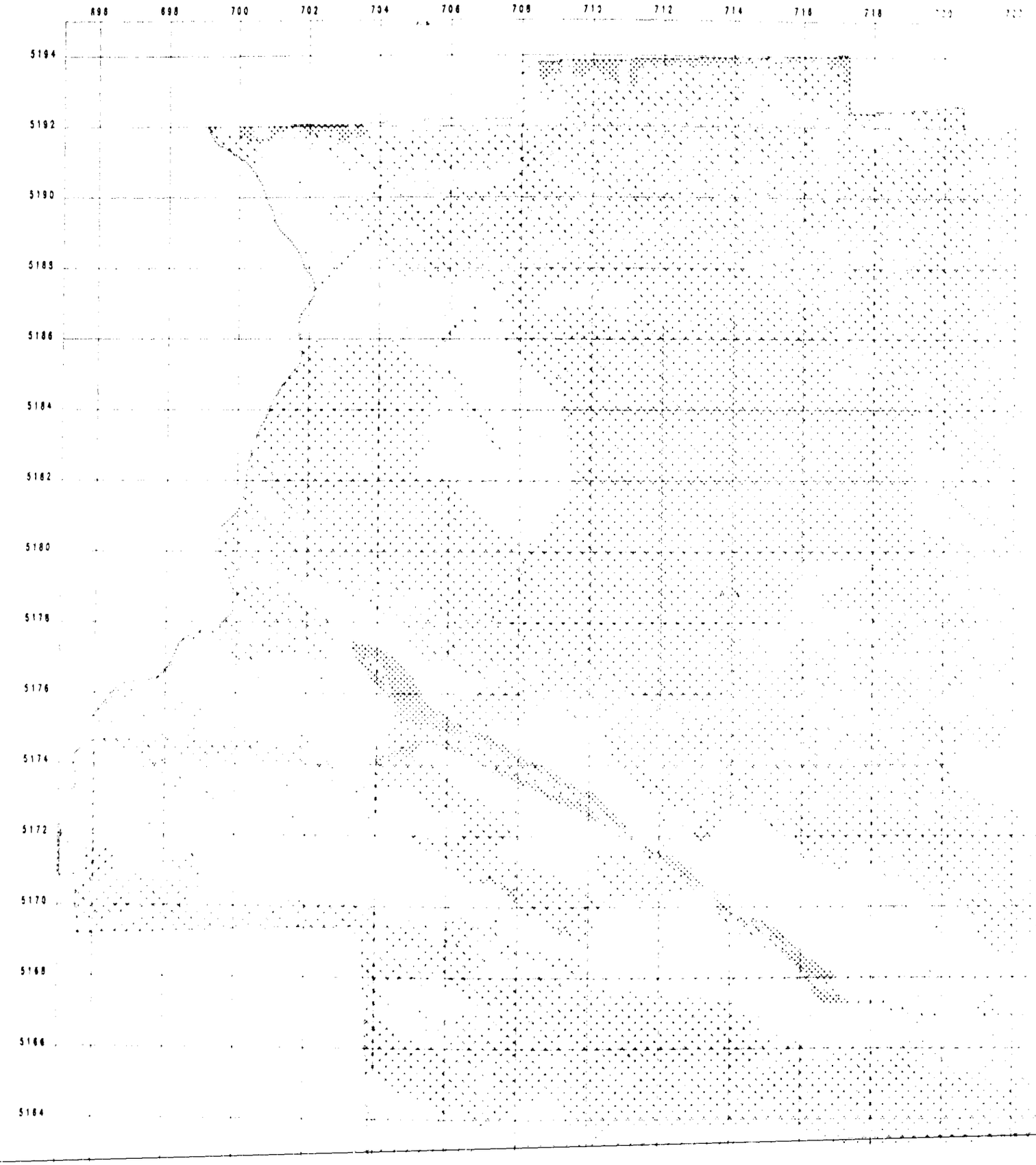
Plate 38. Rate of soil erosion for 3-3-5 and 4-3-3 (HMM

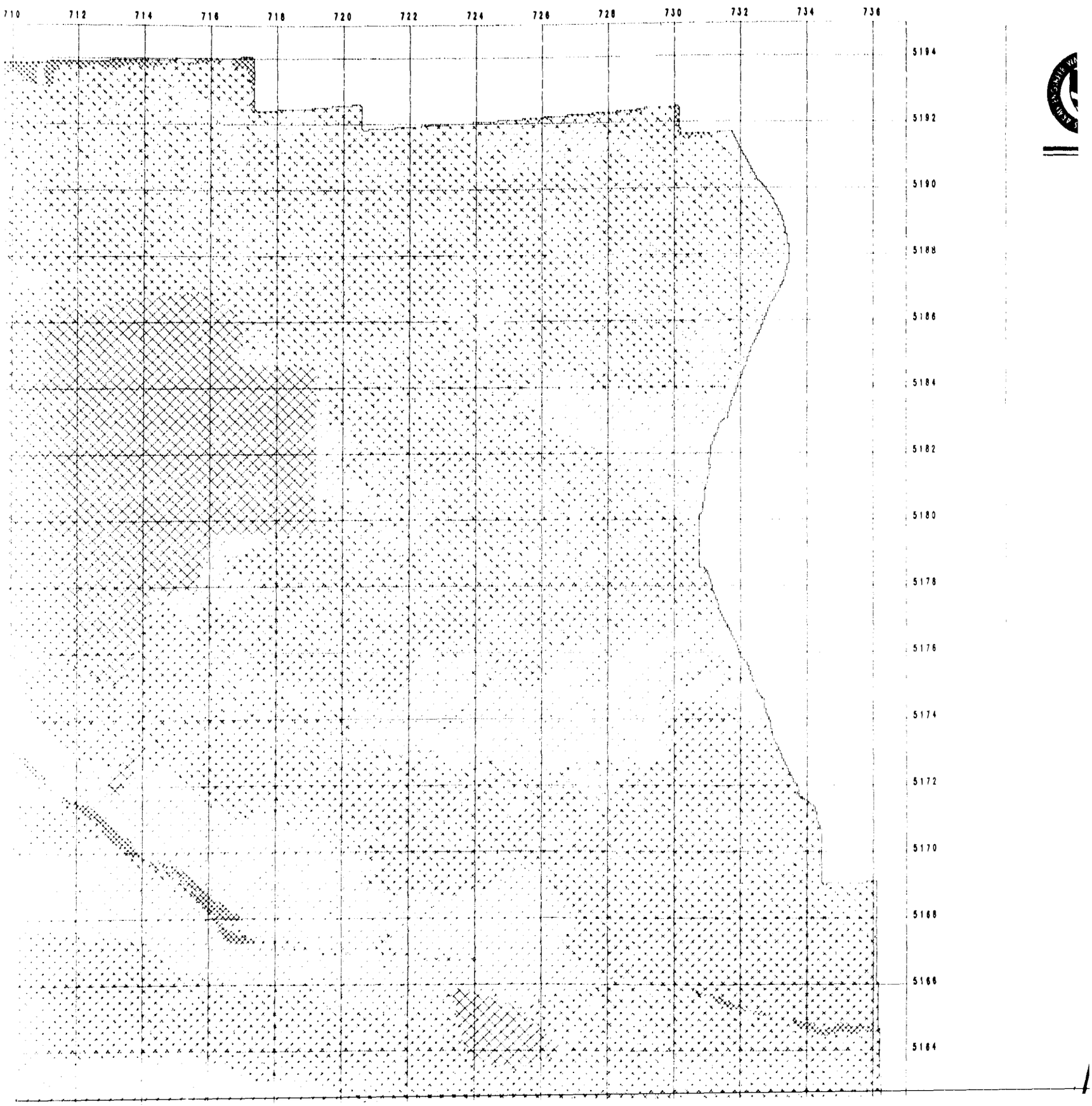


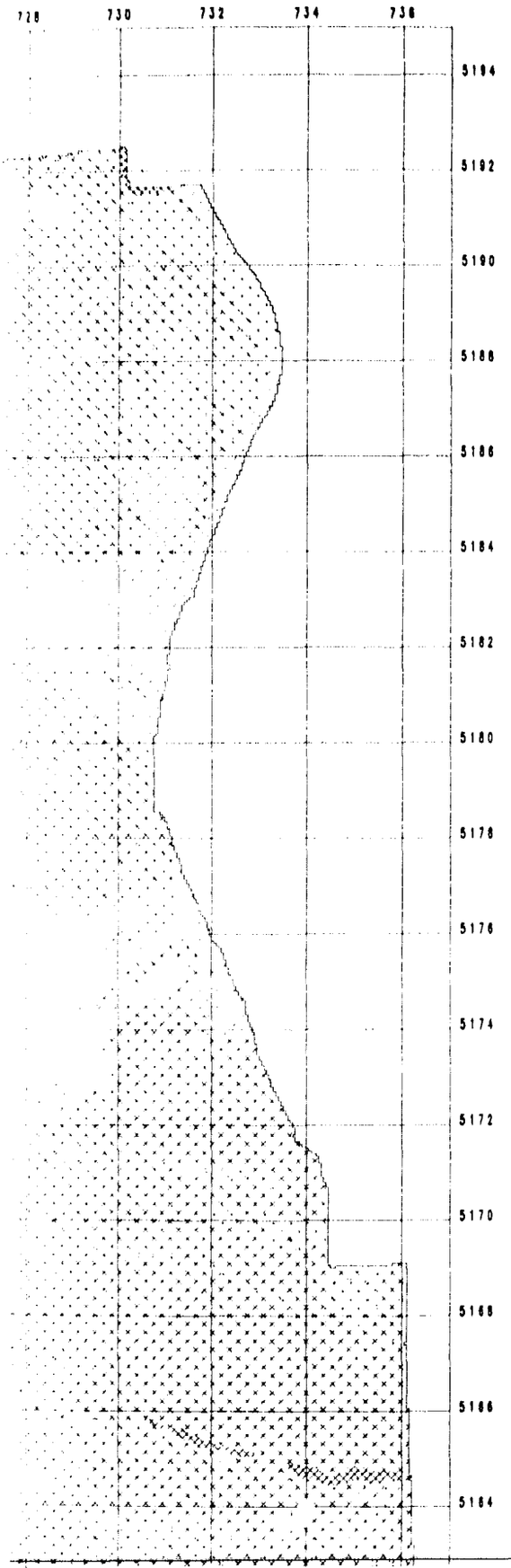
of soil erosion for 3-3-5 and 4-3-3 (HMMWV) force structures in the wet-wet slippery surface condition for one thousand passes



slippery surface condition for one thousand passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
10 PASSES

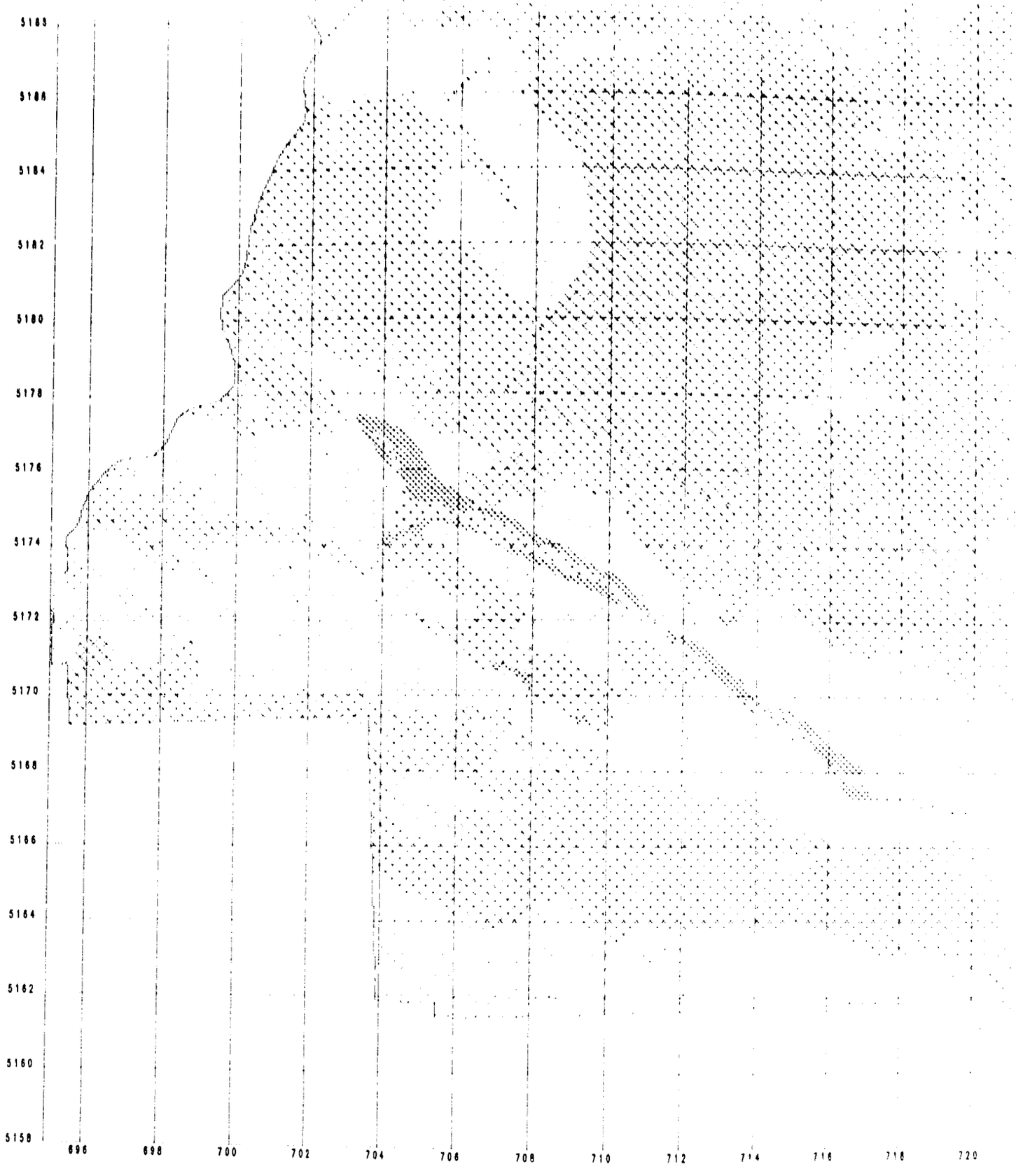


Plate 39. Rate of soil erosion for the 4-3-

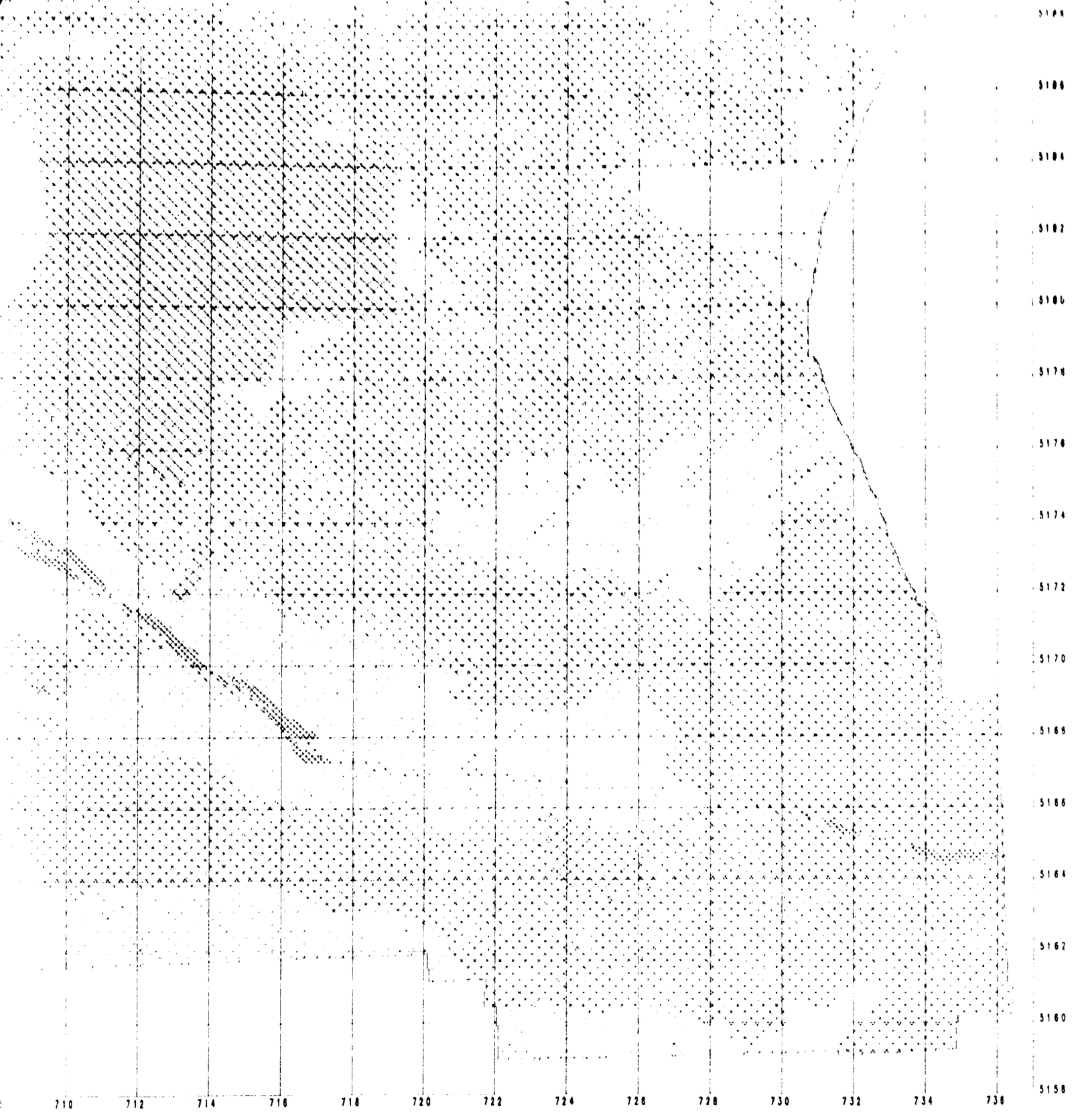
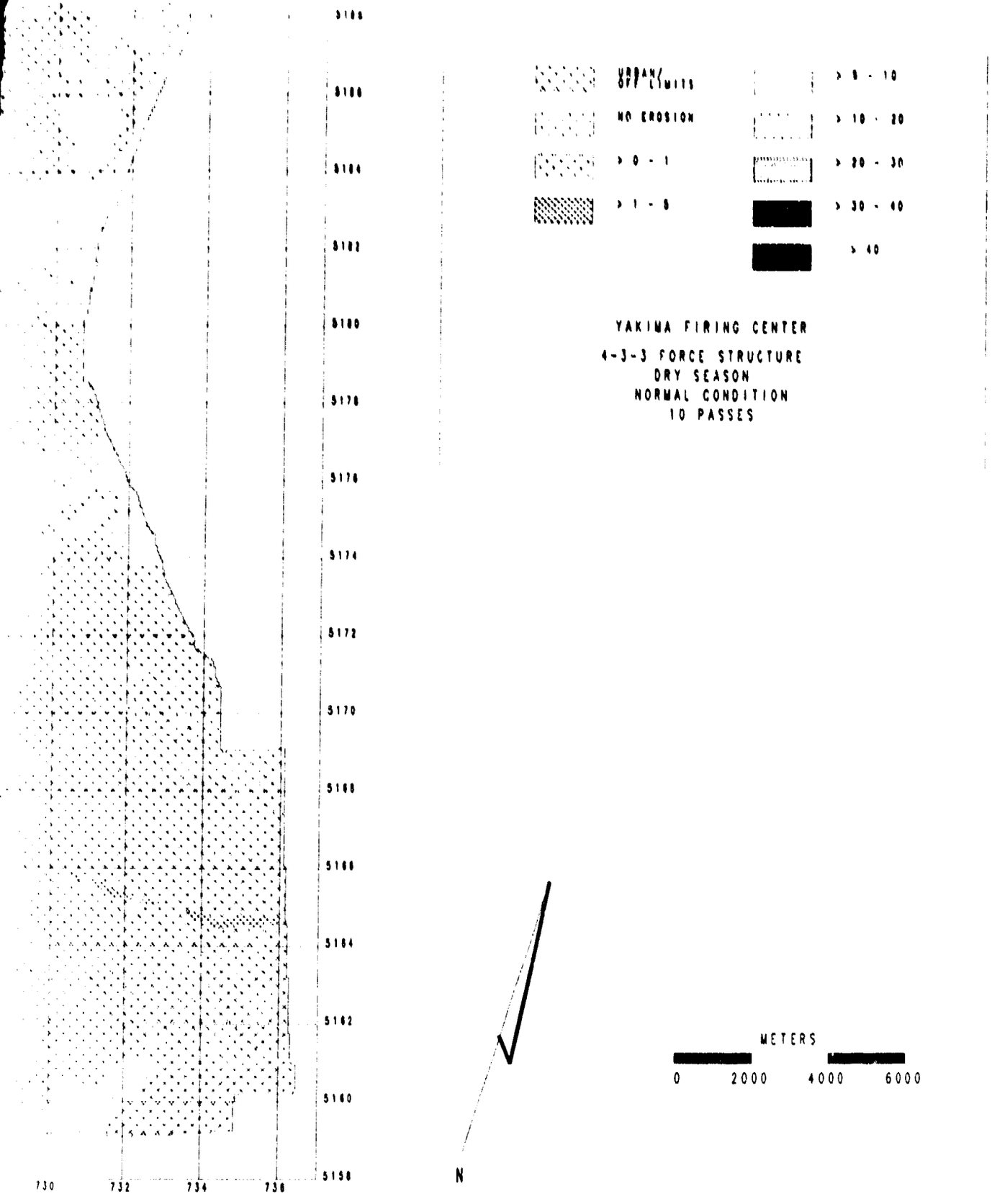
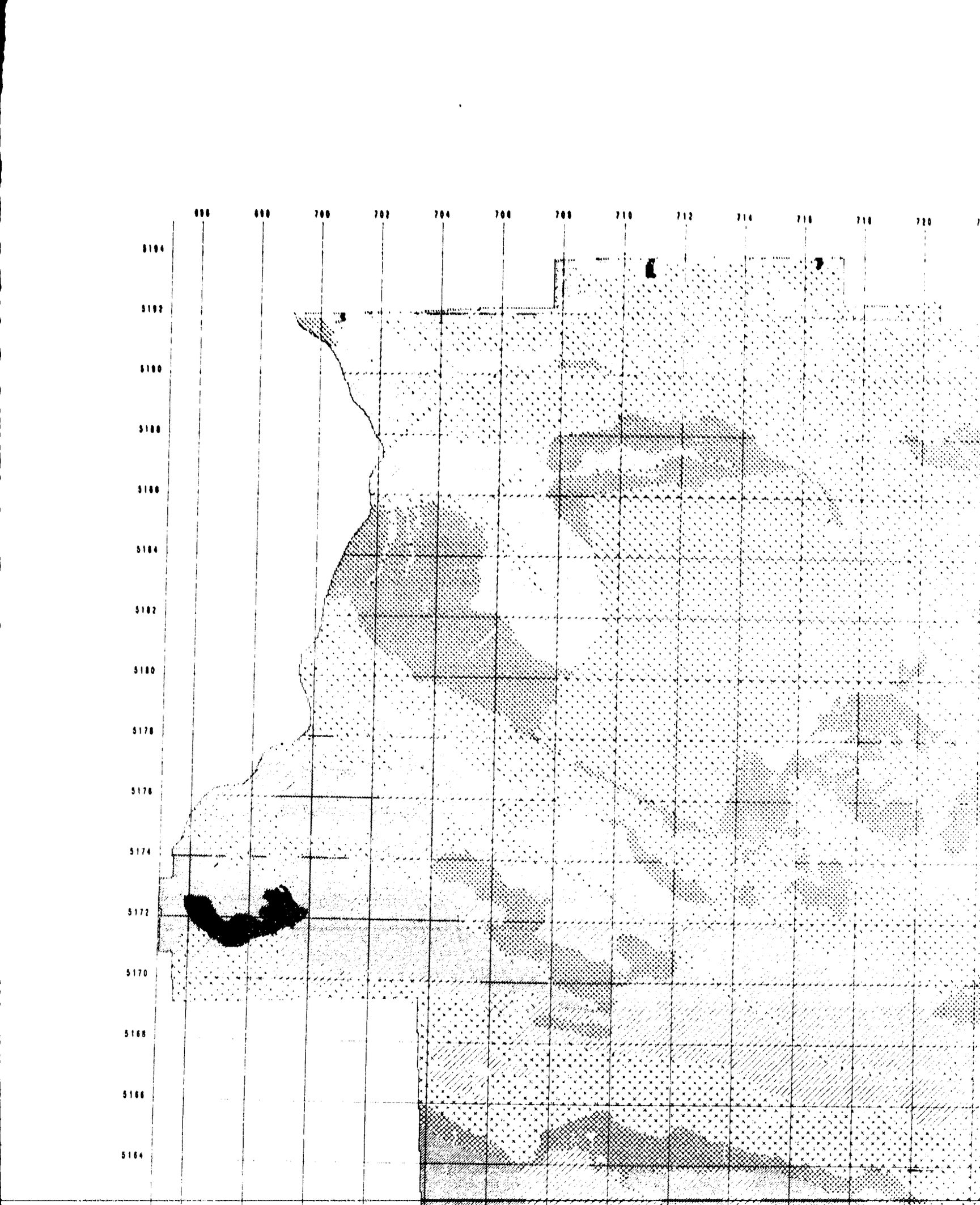


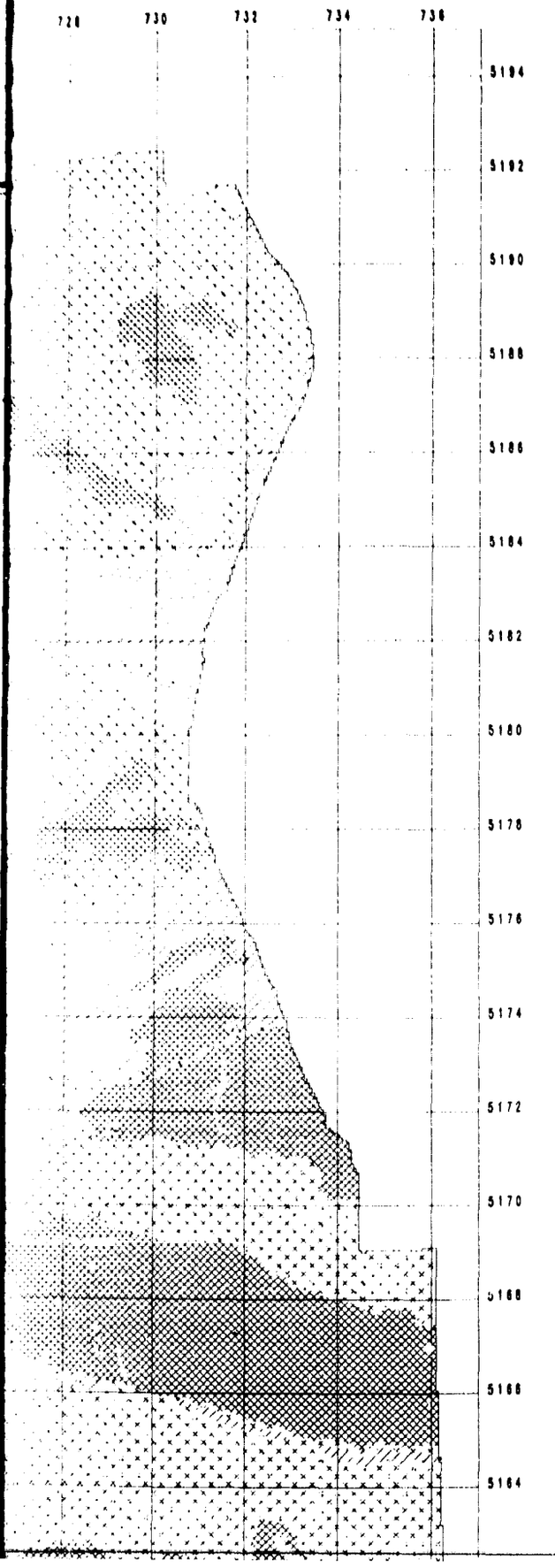
Plate 39. Rate of soil erosion for the 4-3-3 (8X8) force structure in the dry normal surface condition for ten passes



dry normal surface condition for ten passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
50 PASSES

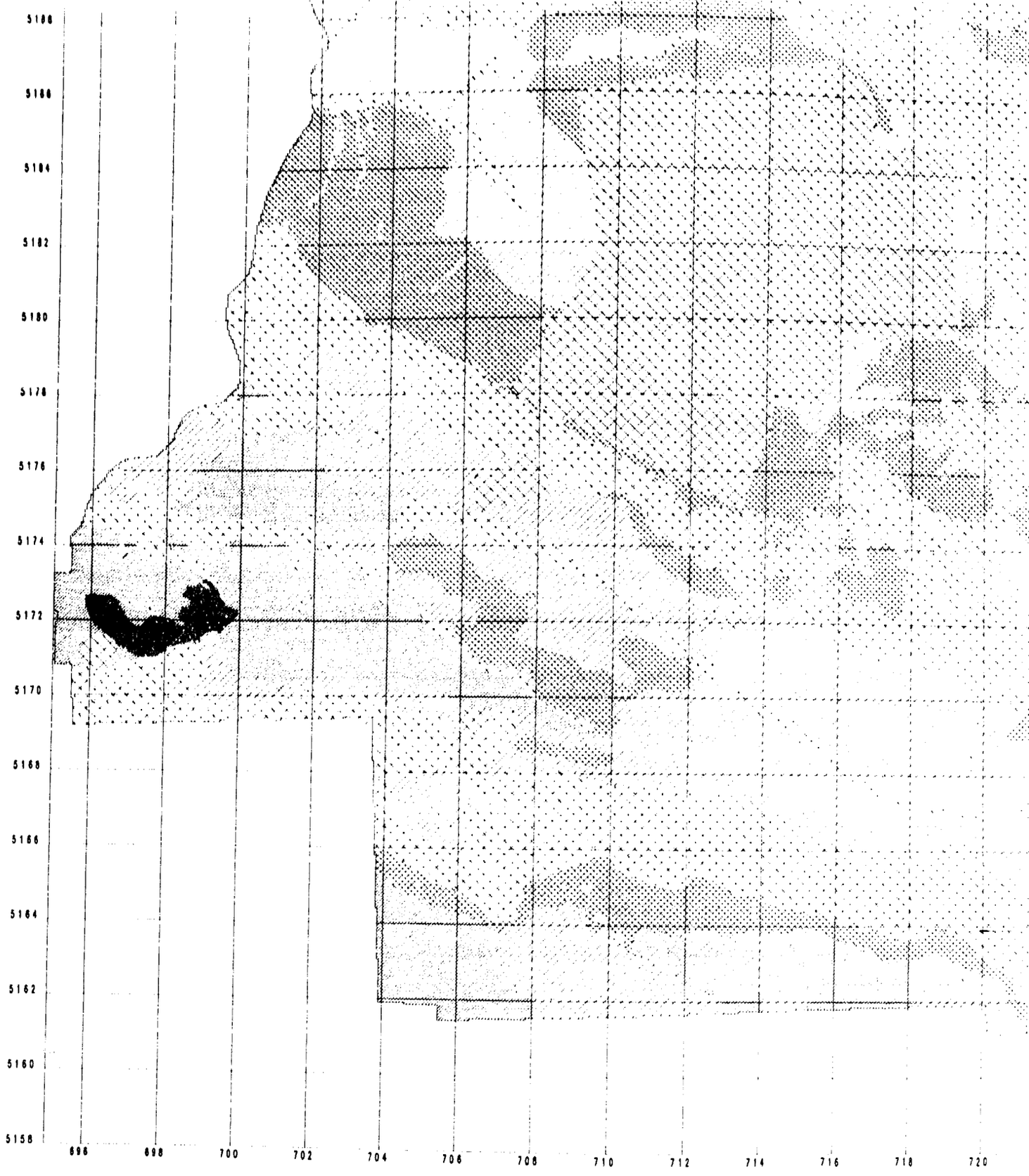


Plate 40. Rate of soil erosion for the 4-3-3

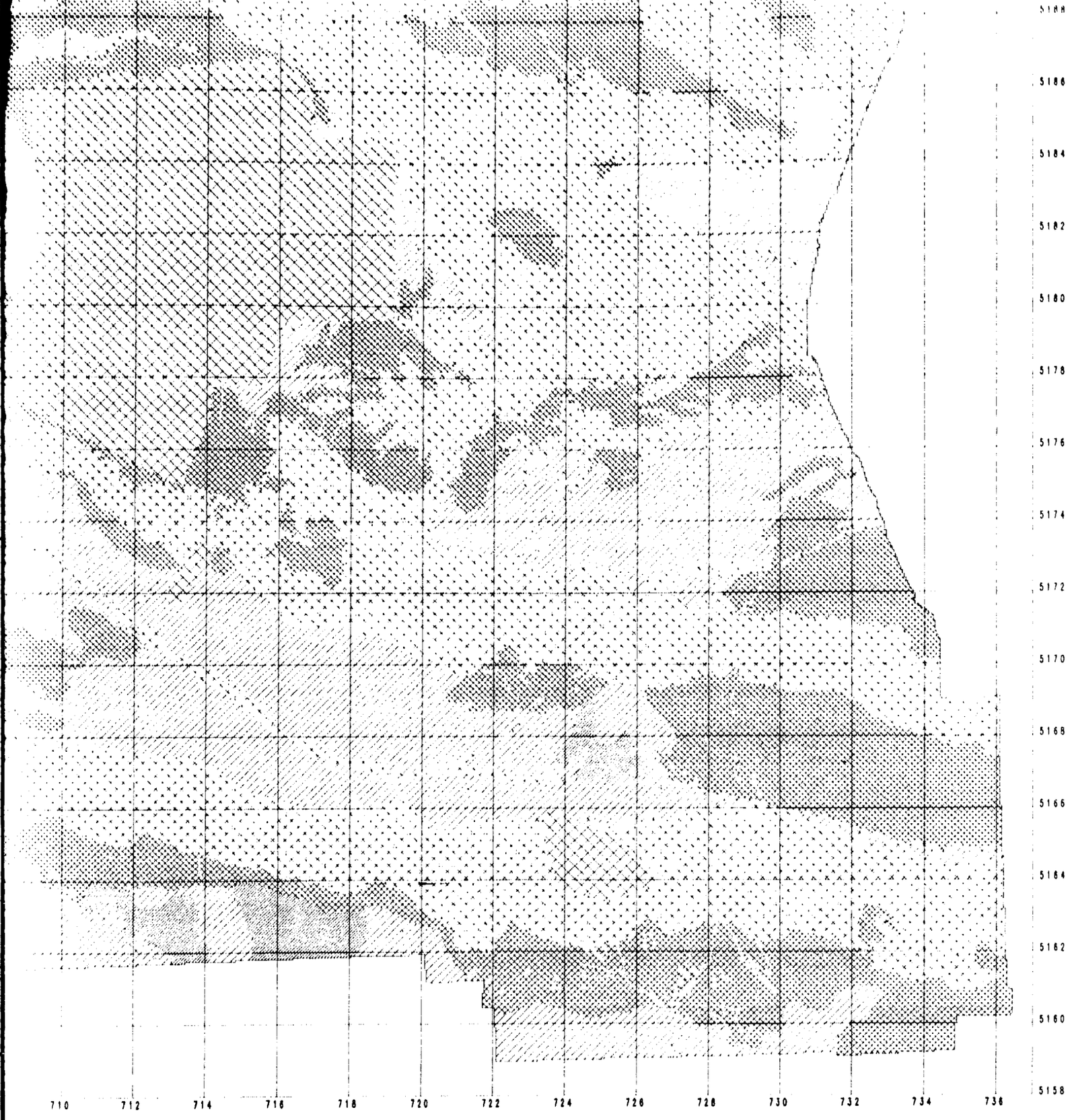
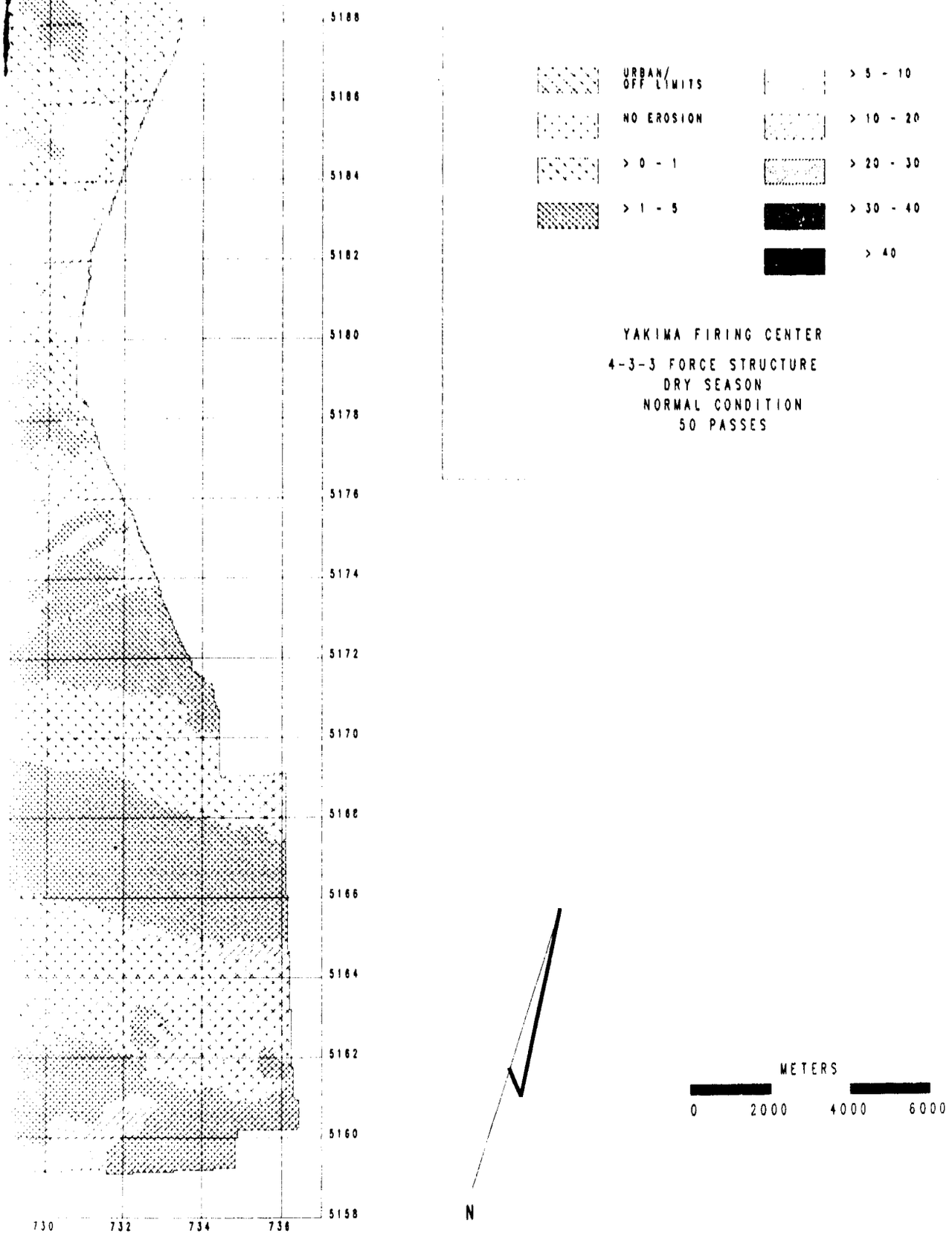
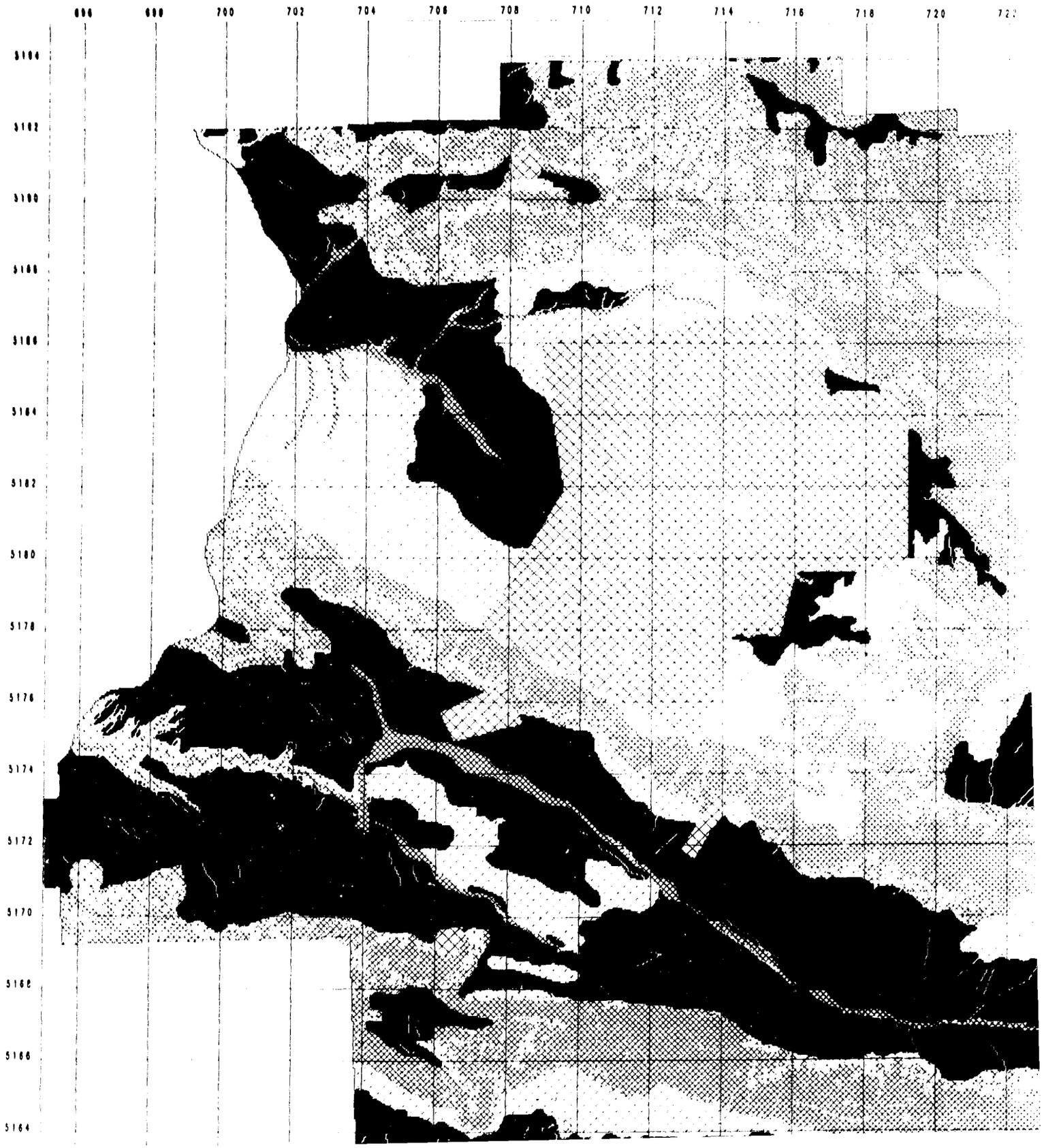
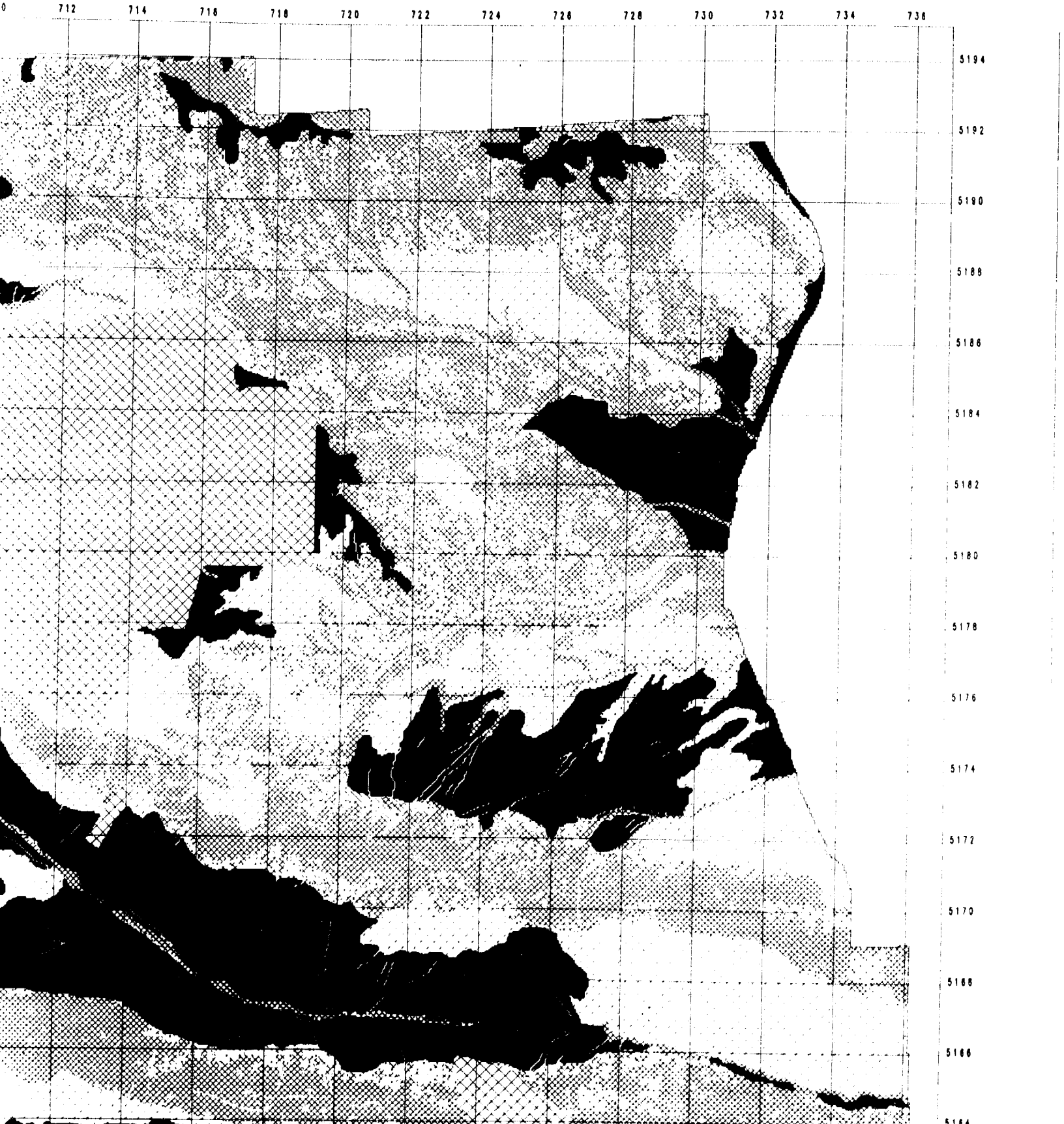


Plate 40. Rate of soil erosion for the 4-3-3 (8X8) force structure in the dry normal surface condition for fifty passes



ry normal surface condition for fifty passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
1000 PASSES

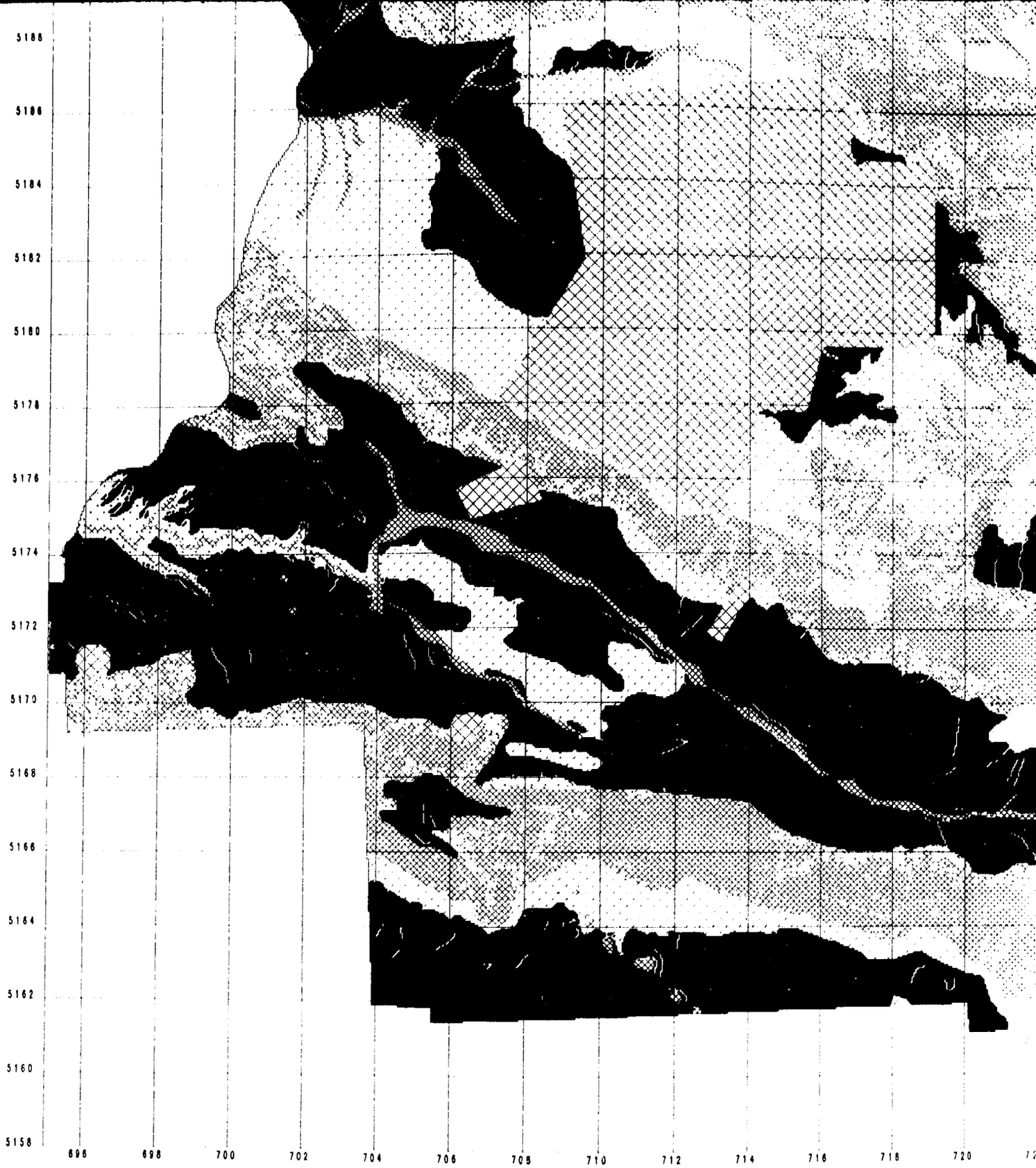
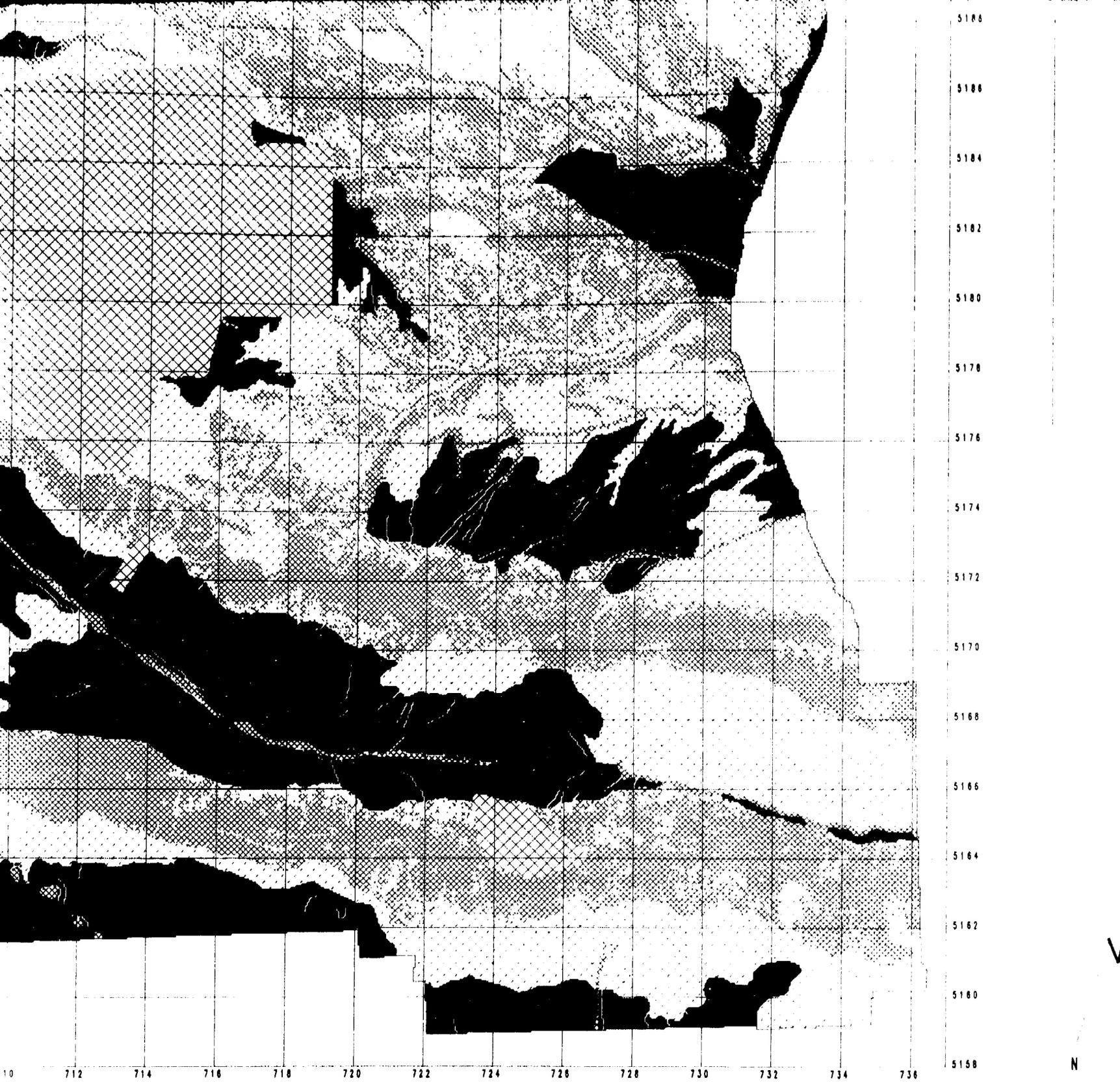
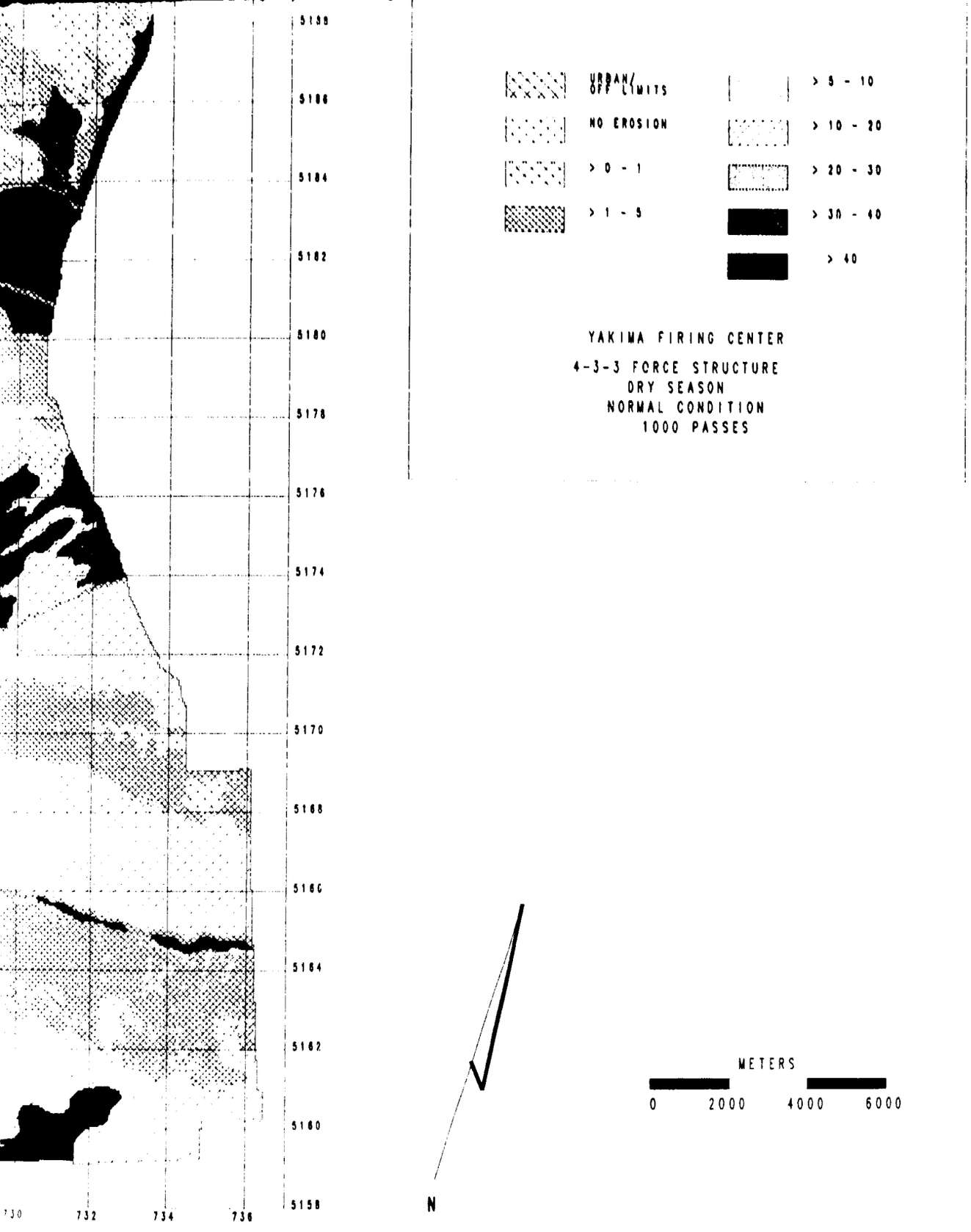


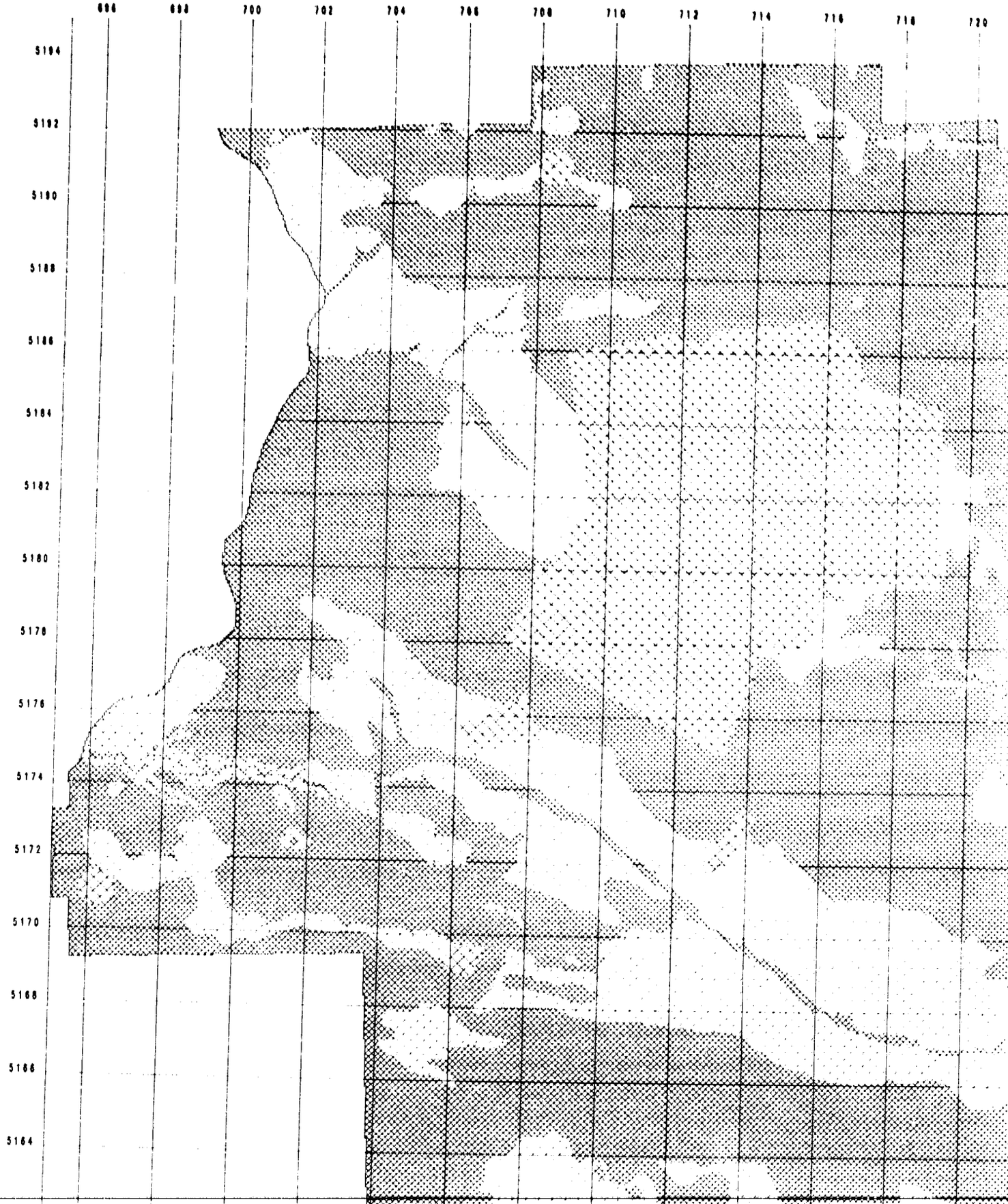
Plate 41. Rate of soil erosion for the 4-3-3 (8X

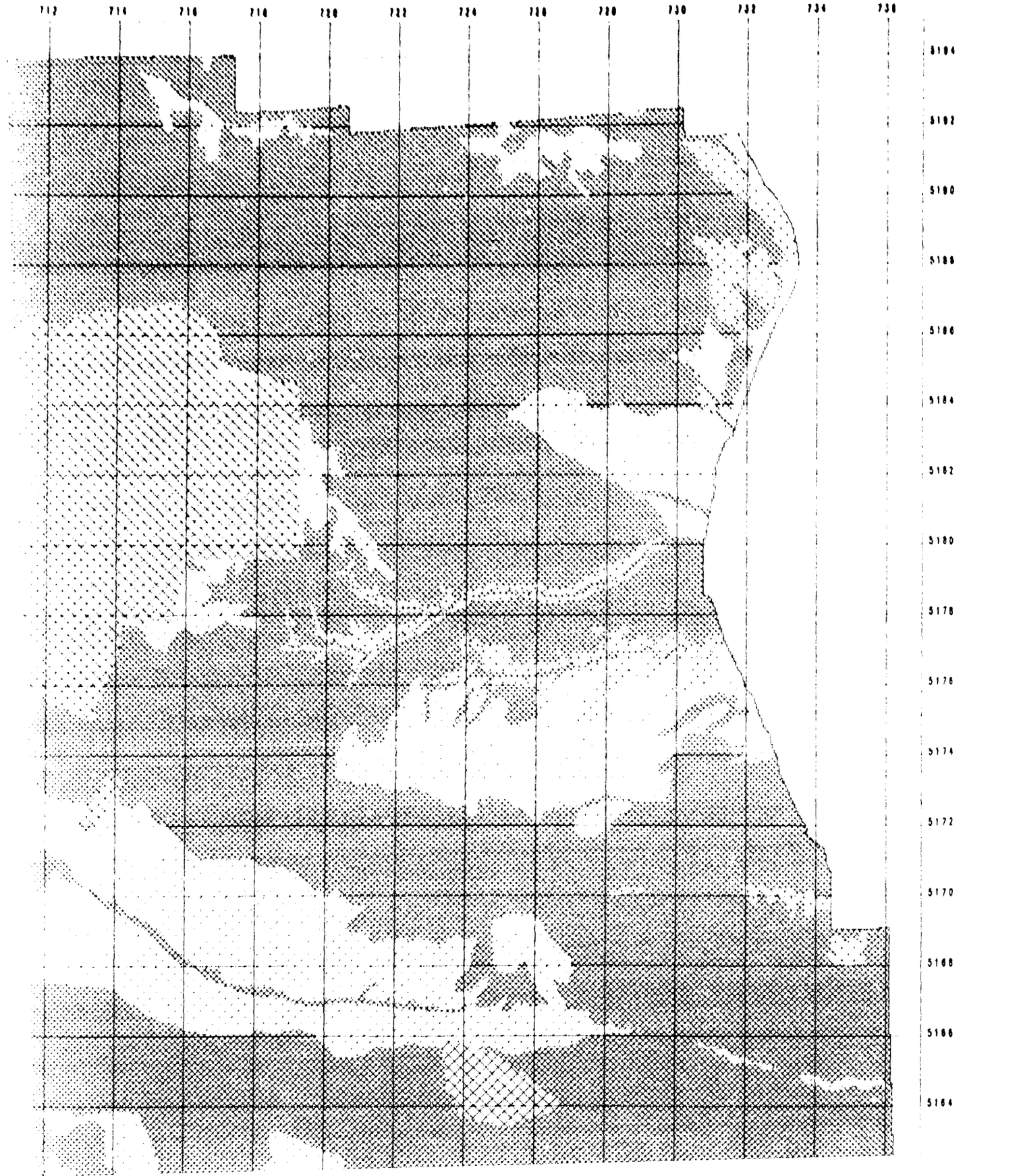


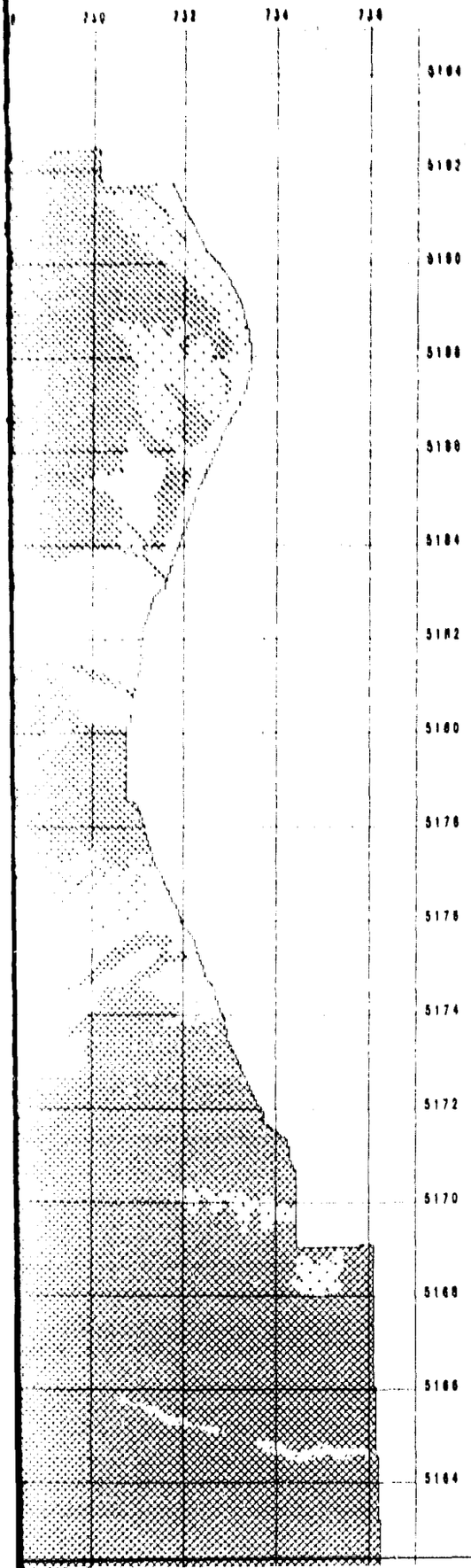
late 41. Rate of soil erosion for the 4-3-3 (8X8) force structure in the dry normal surface condition for one thousand passes



normal surface condition for one thousand passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
10 PASSES

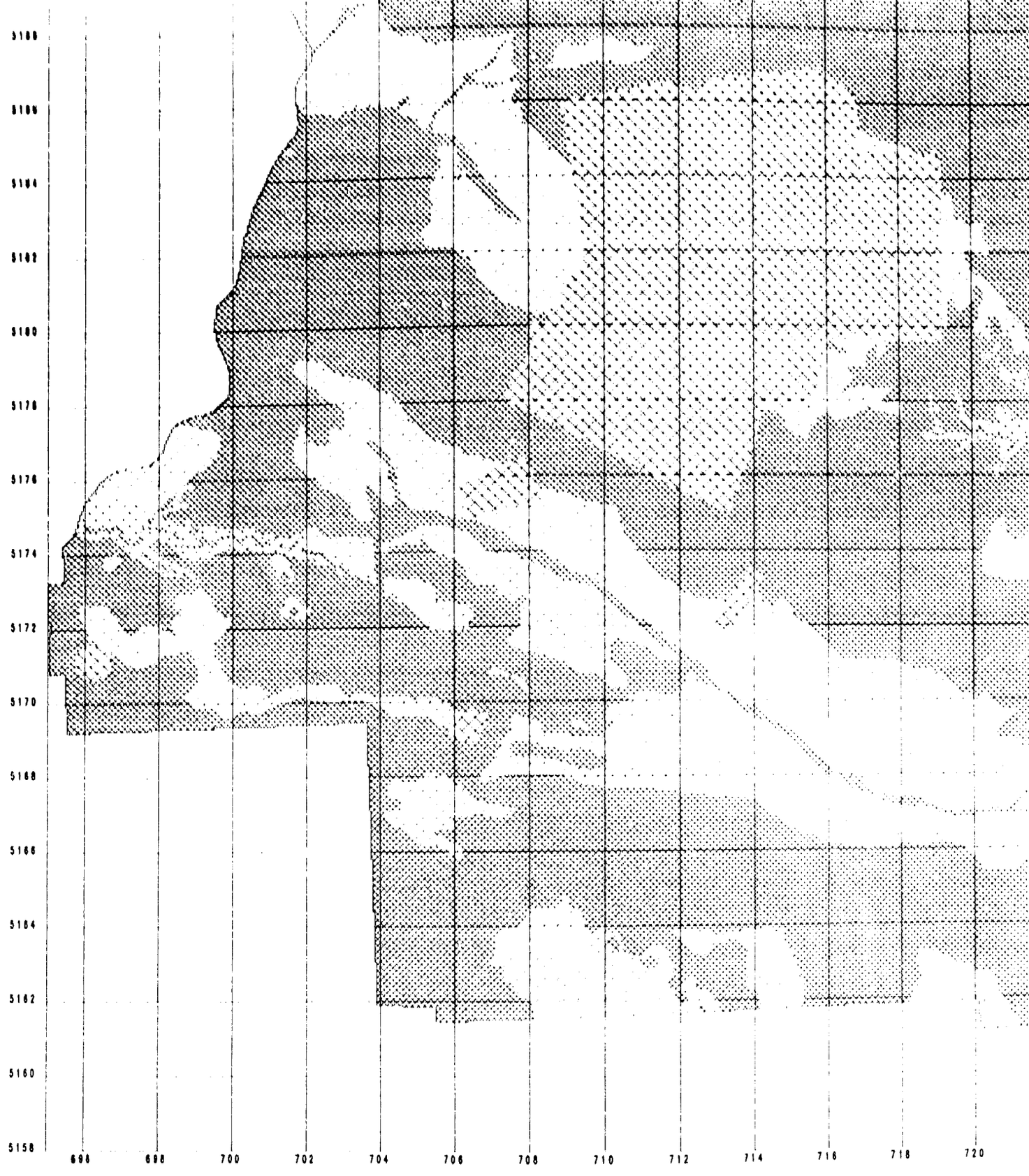
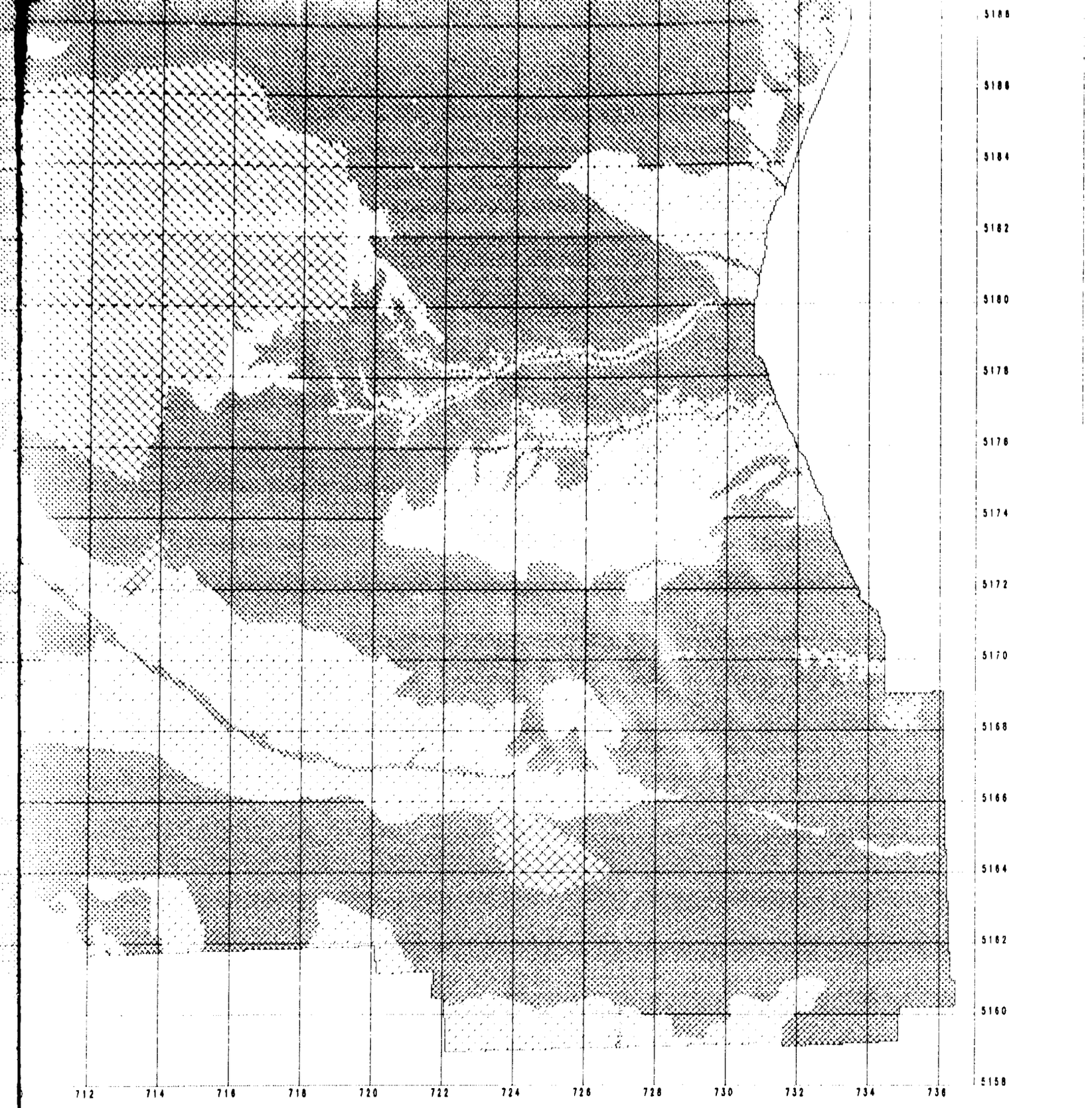
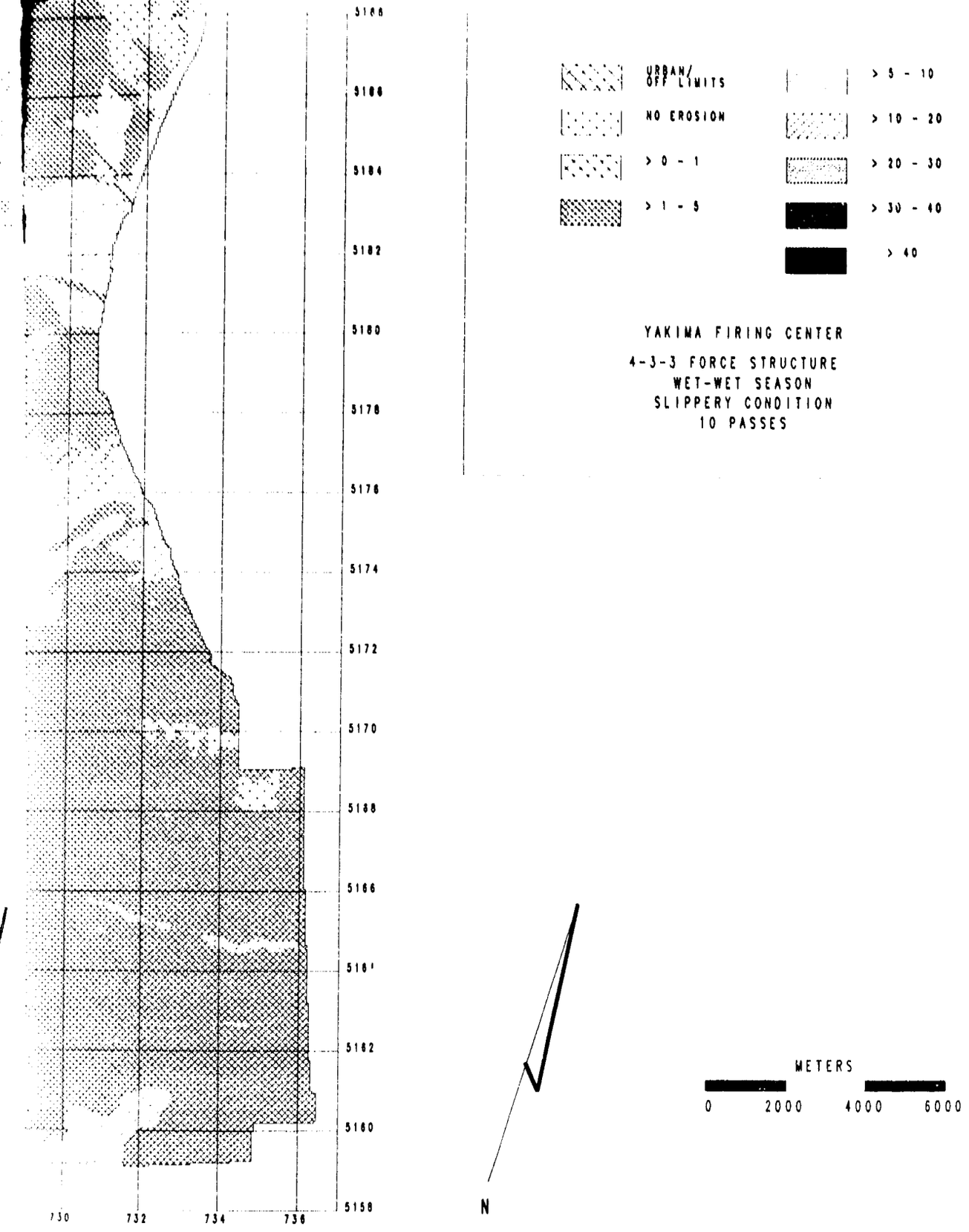


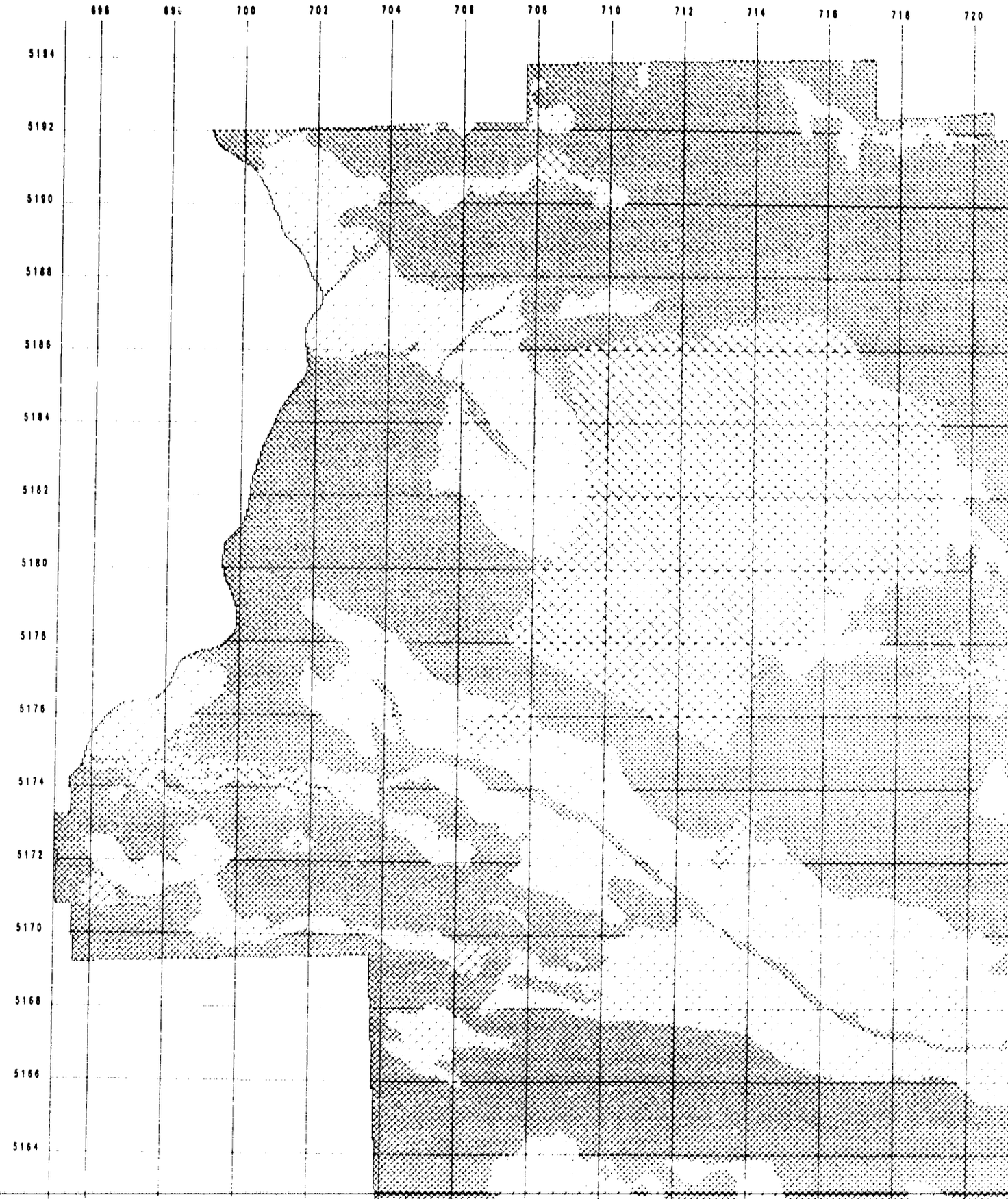
Plate 42. Rate of soil erosion for the 4-3-3 (8X8) fo

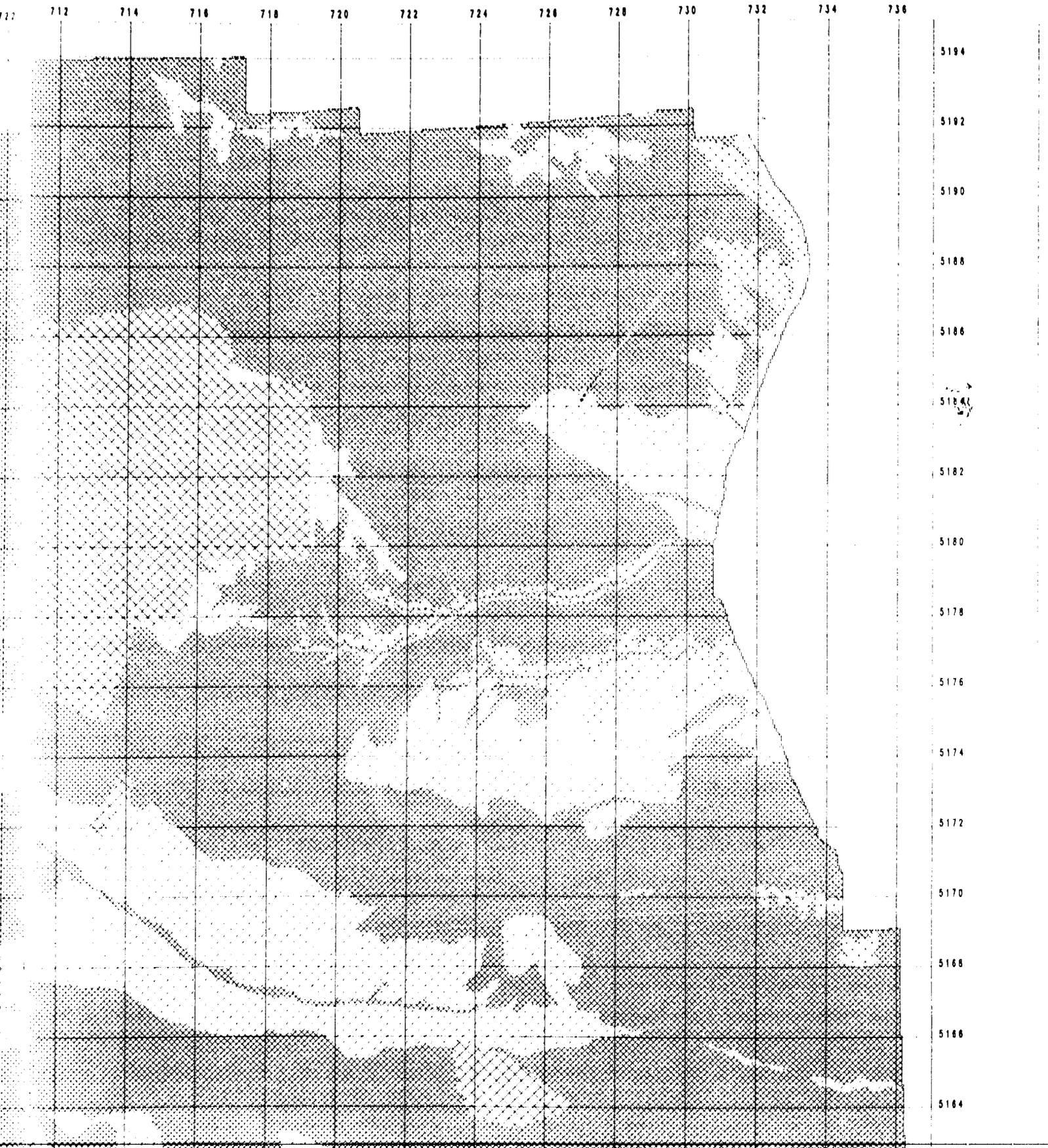


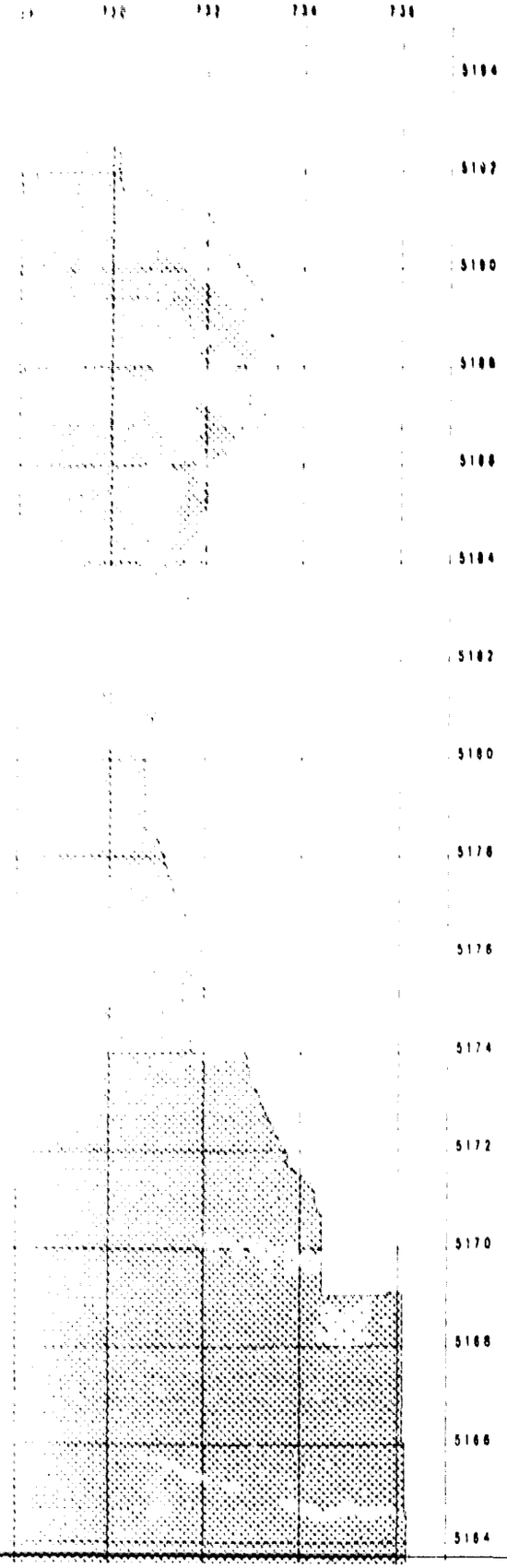
Rate of soil erosion for the 4-3-3 (8X8) force structure in the wet-wet slippery surface condition for ten passes



lippery surface condition for ten passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
50 PASSES

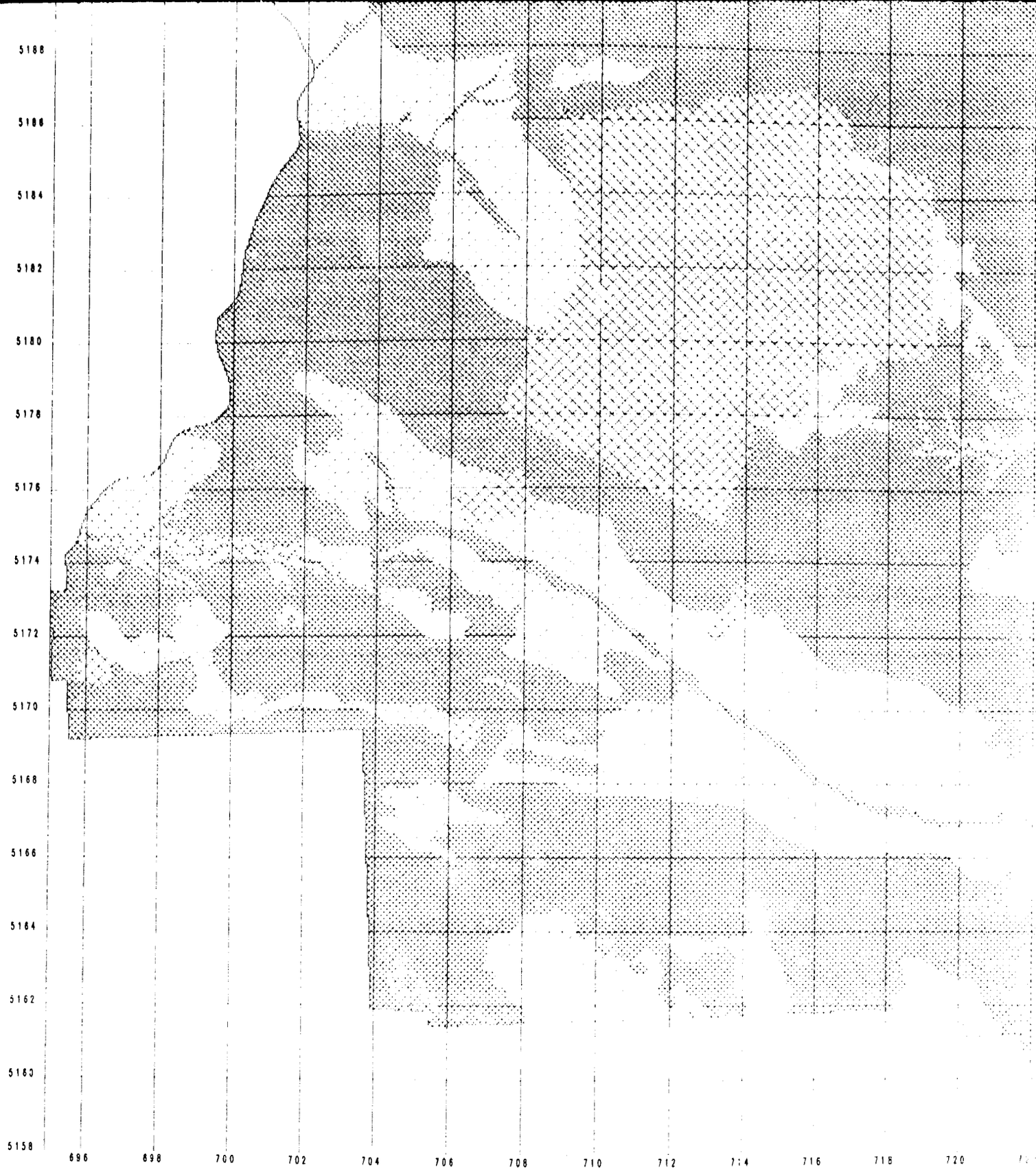
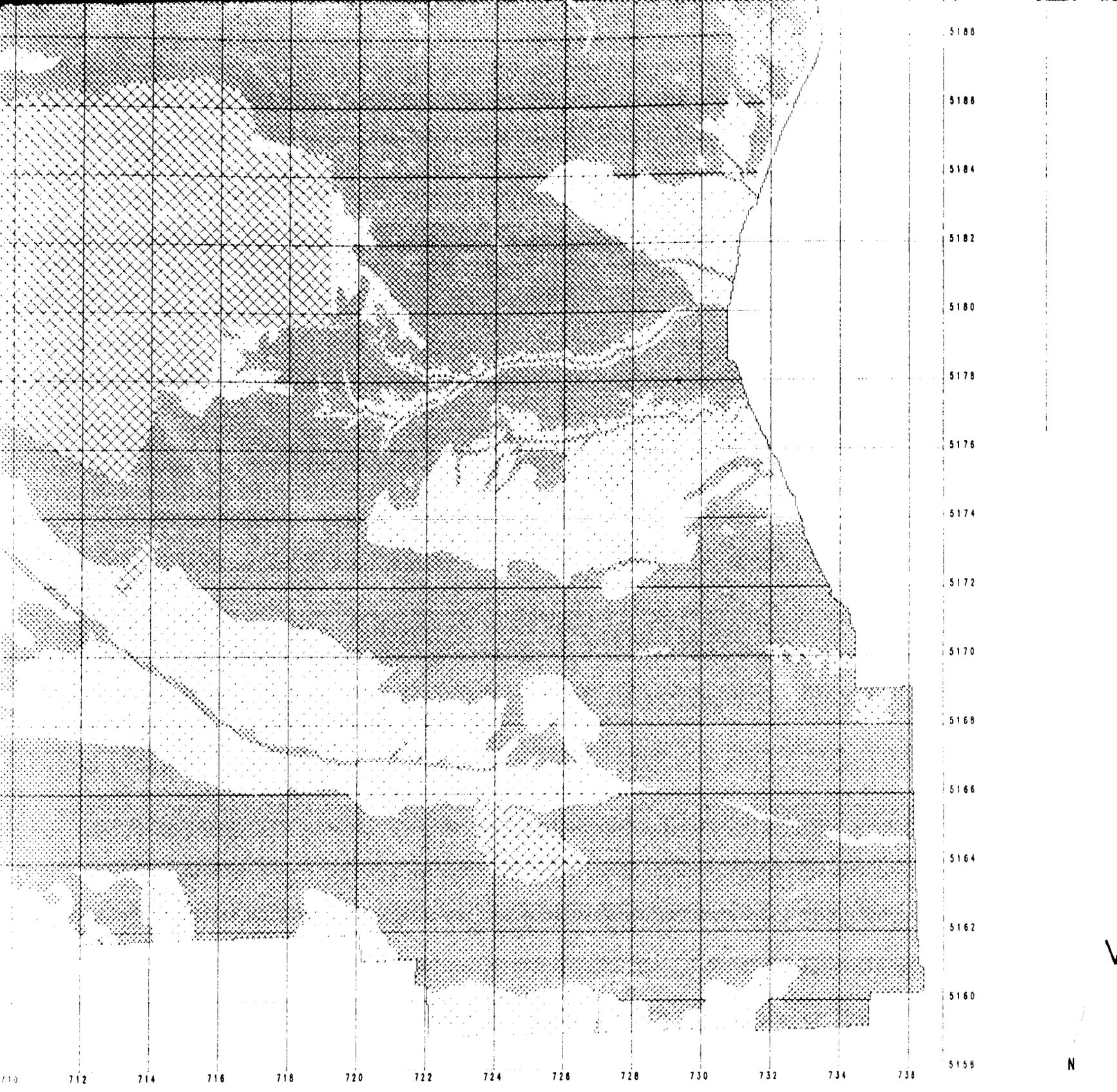
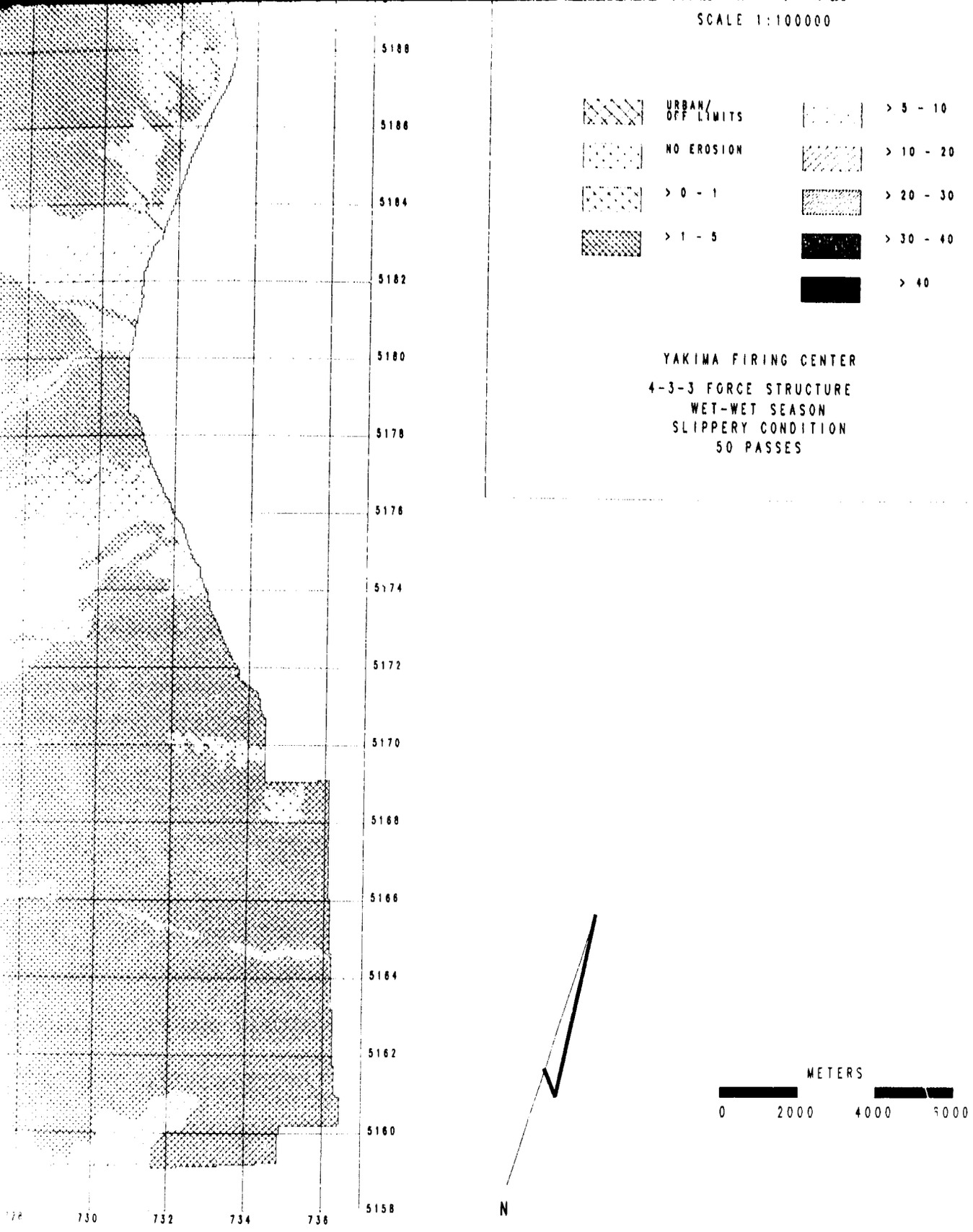


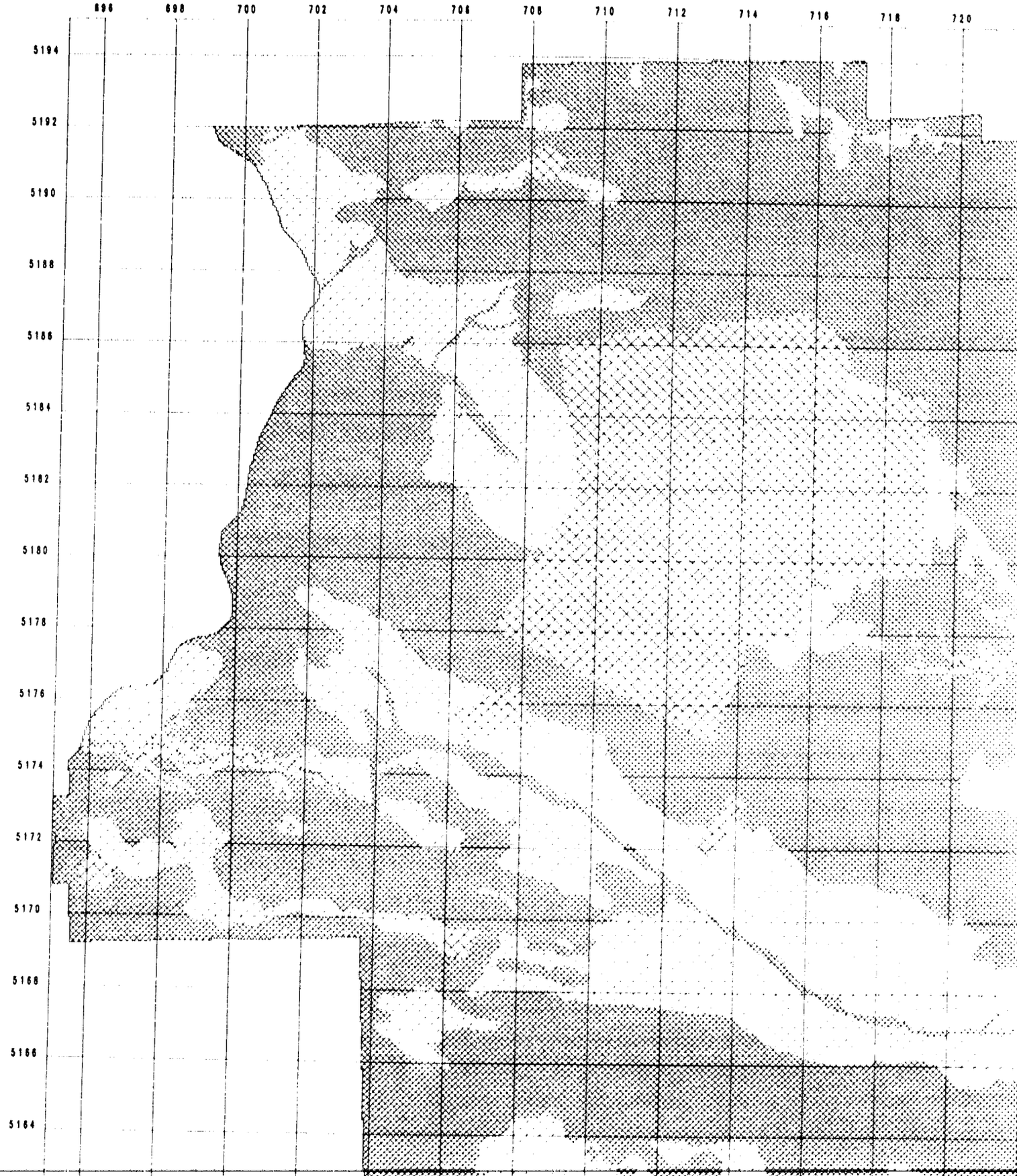
Plate 43. Rate of soil erosion for the 4-3-3 (8X8) forc

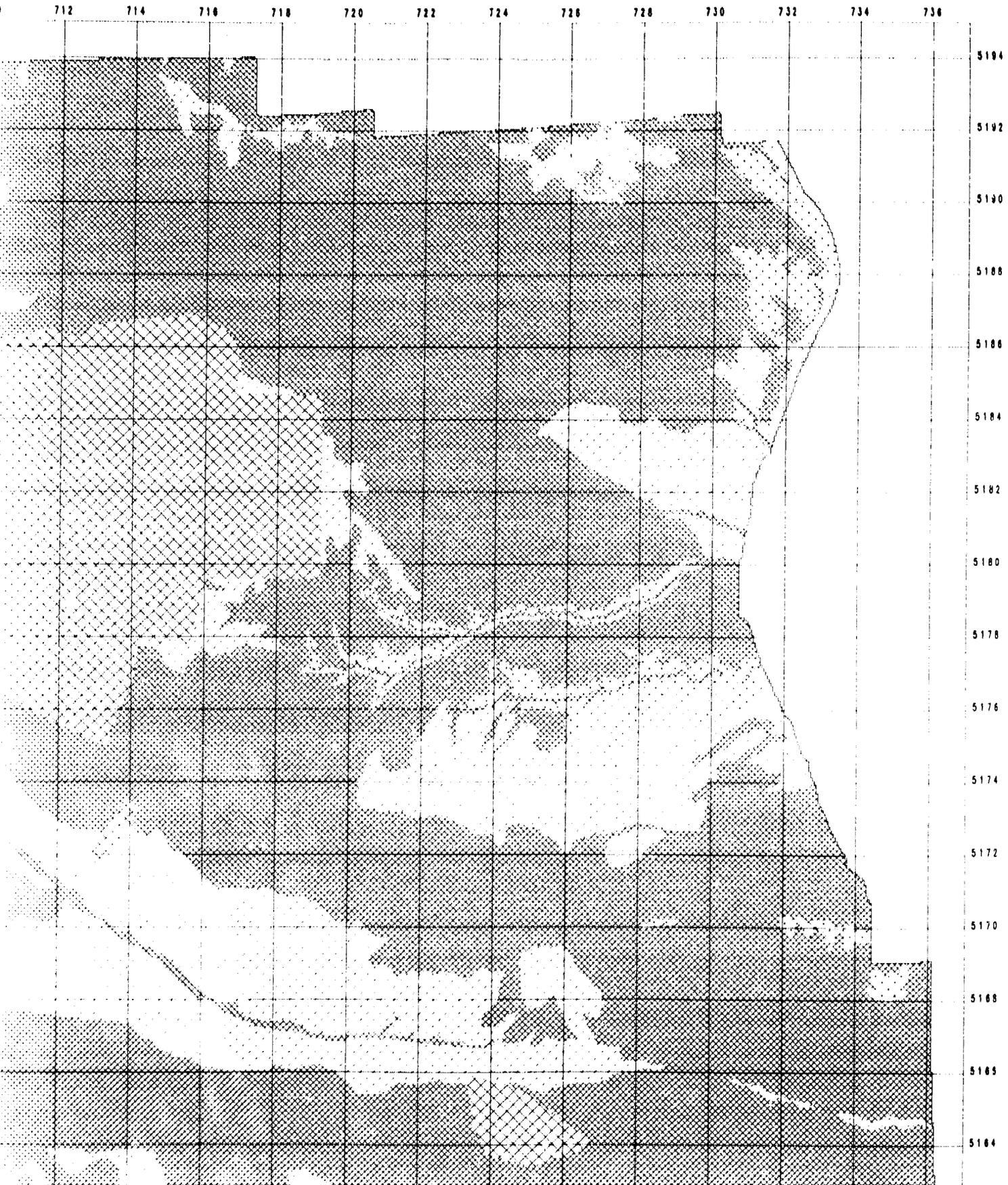


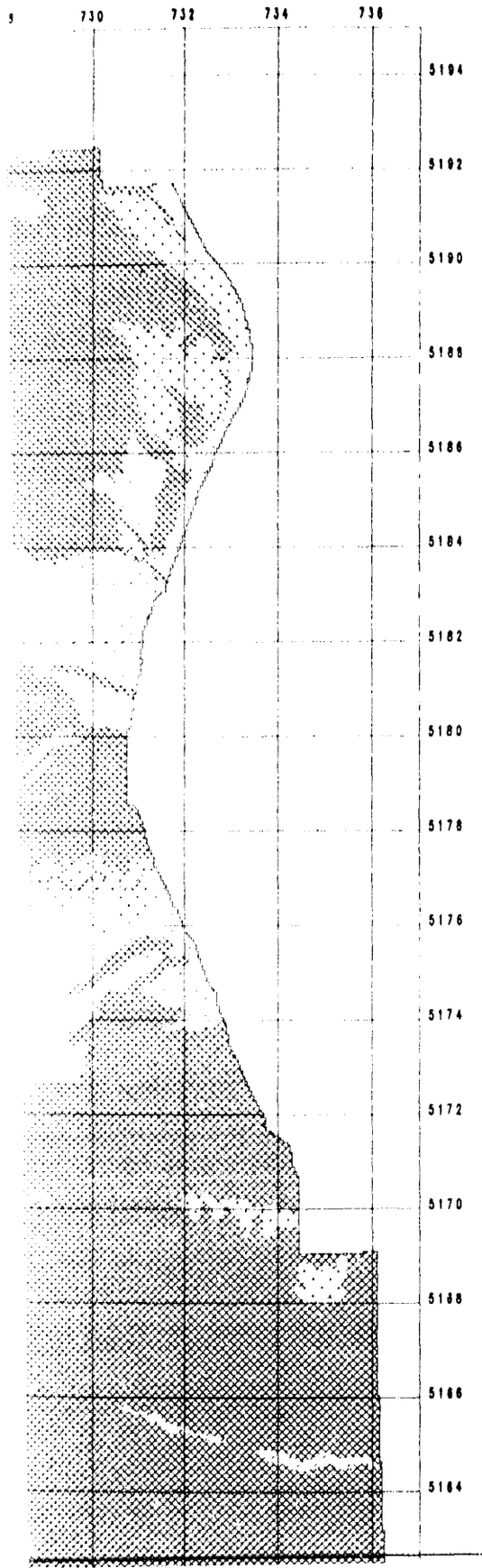
. Rate of soil erosion for the 4-3-3 (8X8) force structure in the wet-wet slippery surface condition for fifty passes



-wet slippery surface condition for fifty passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
1000 PASSES

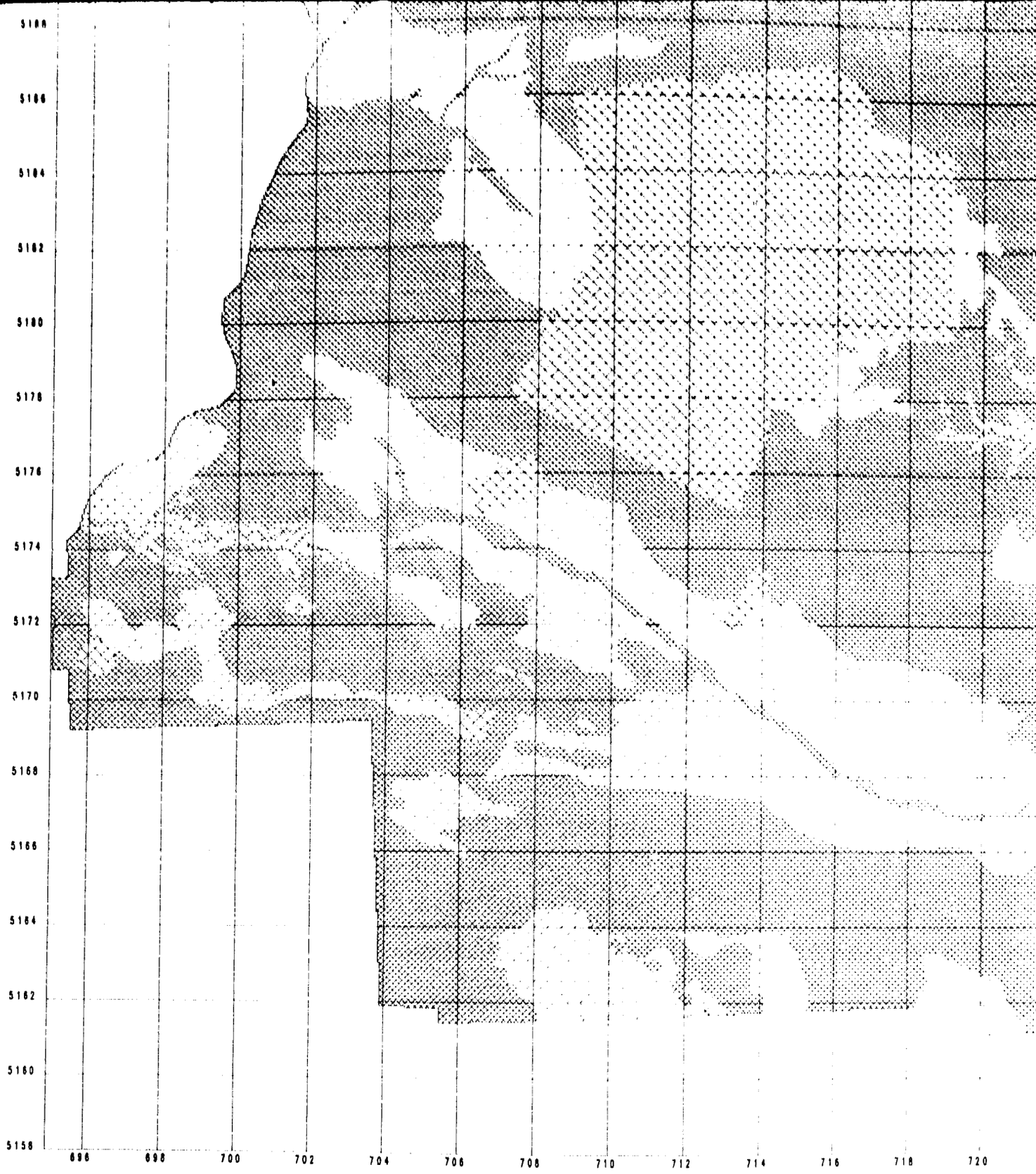
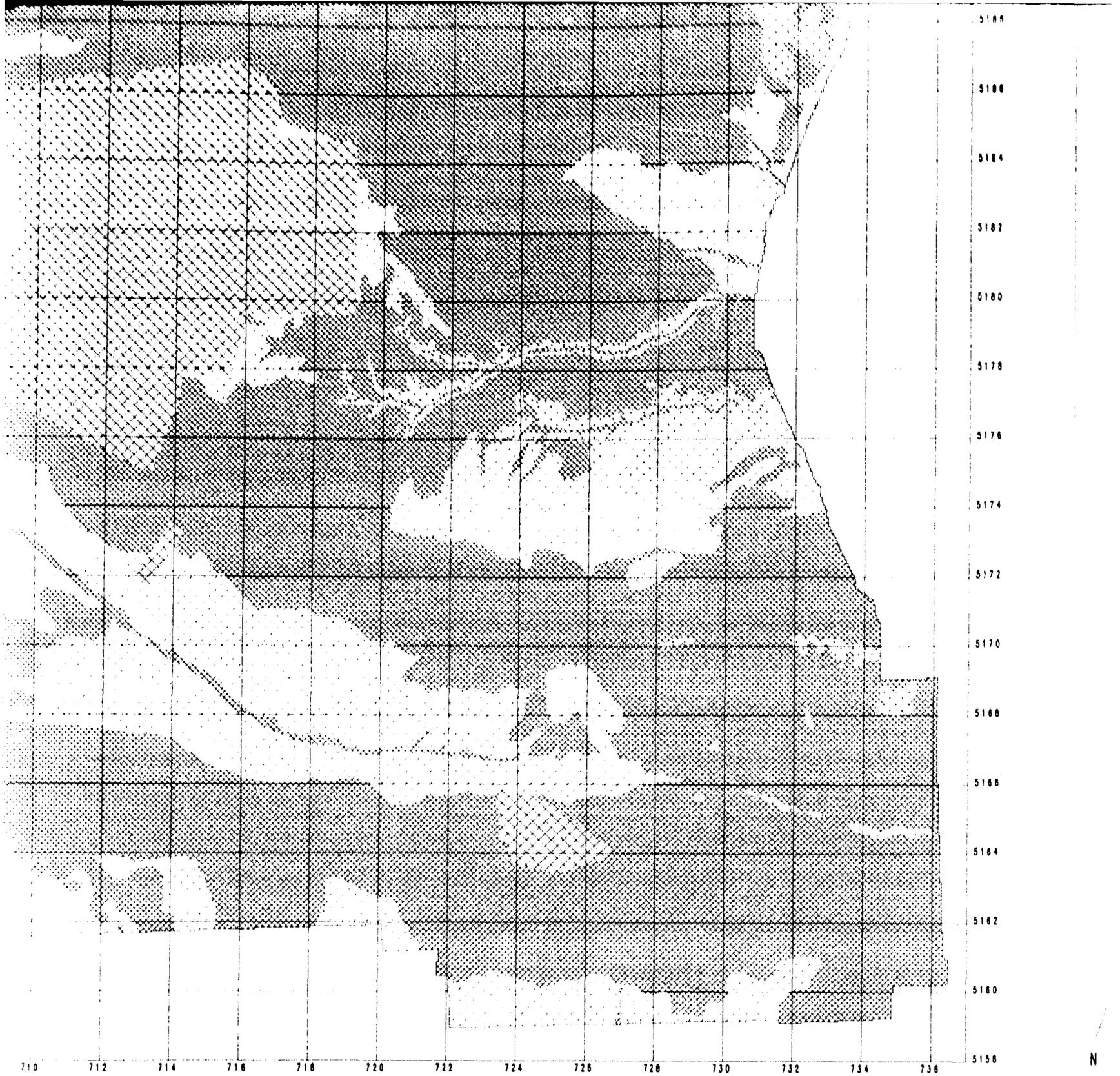
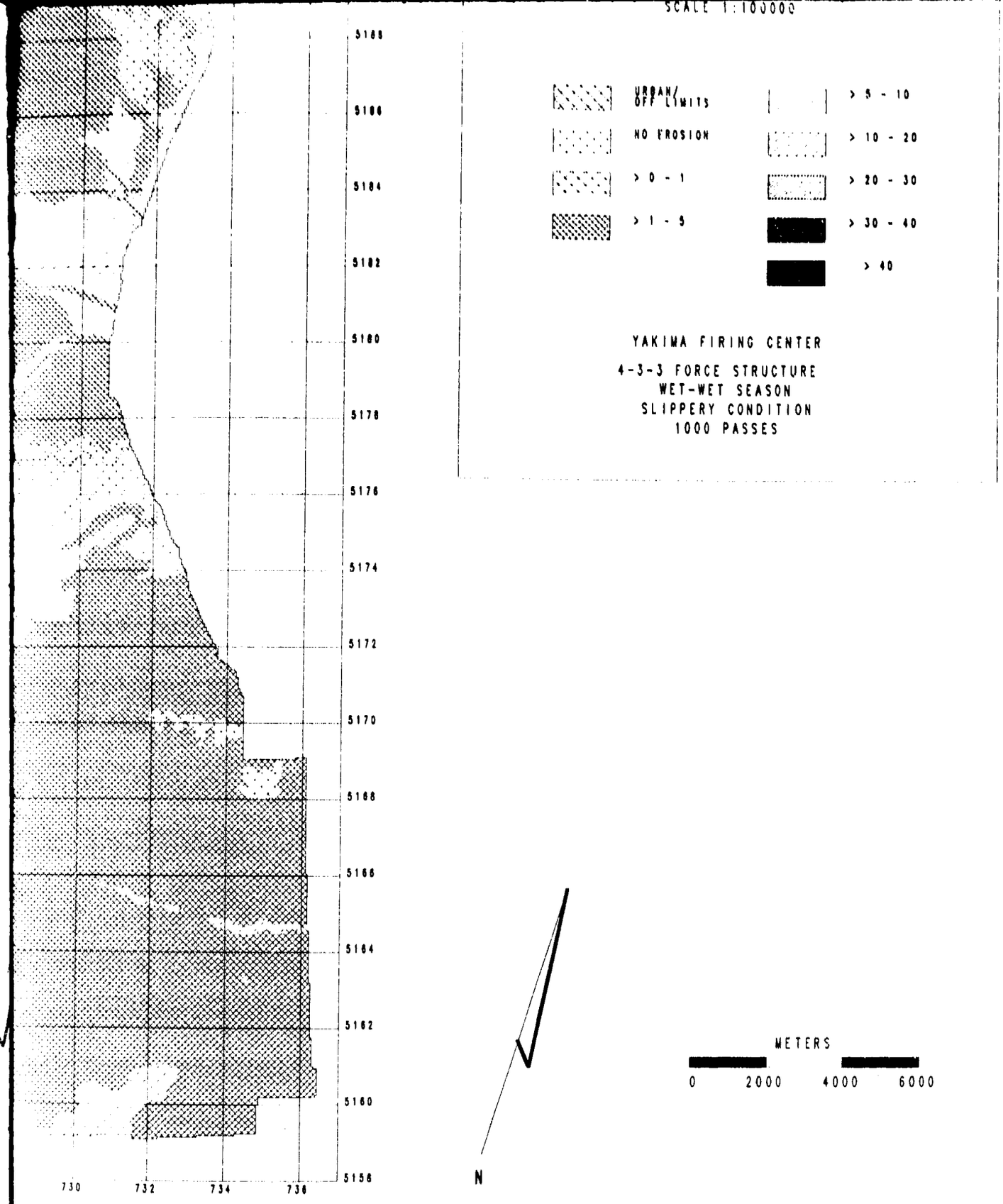


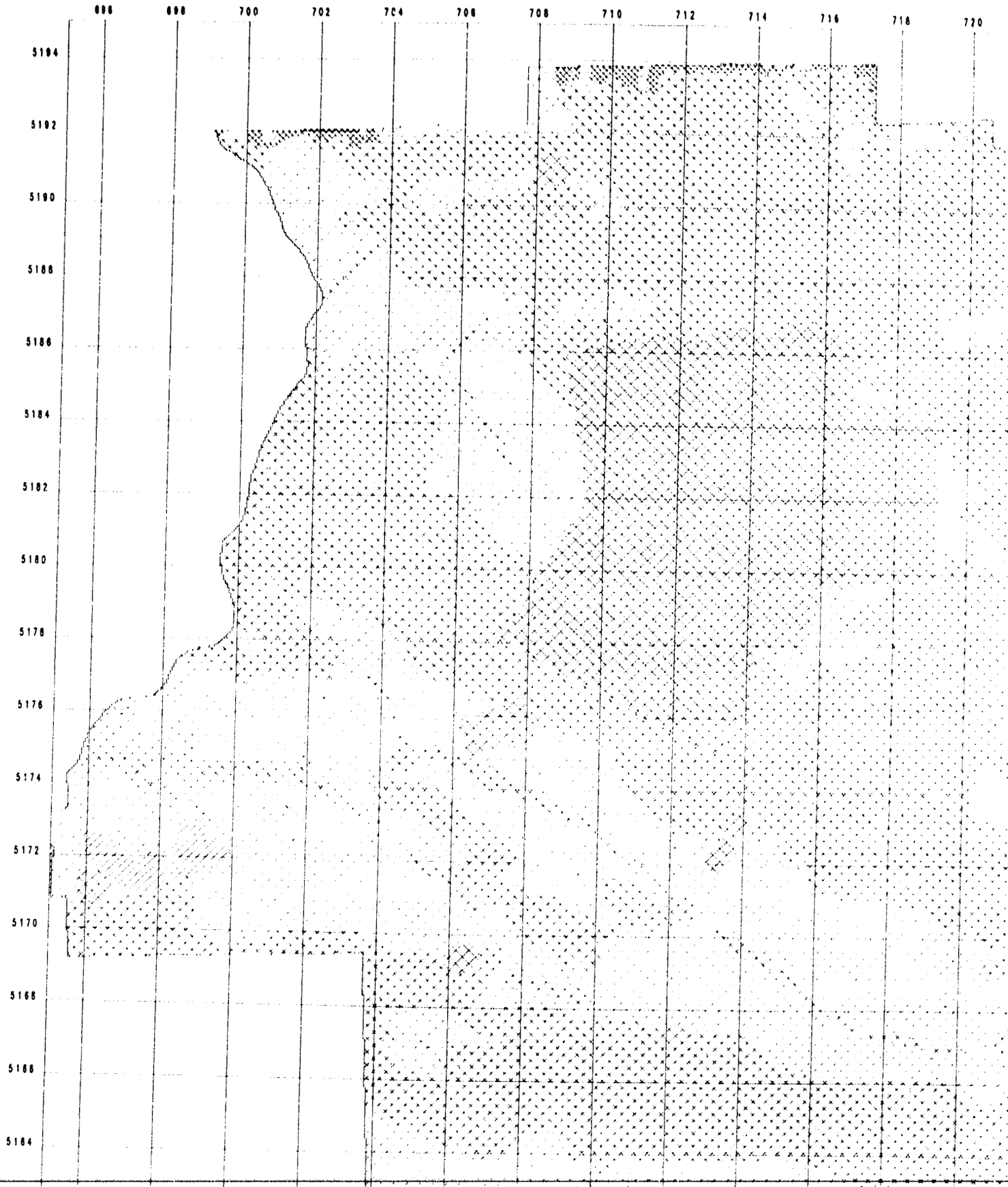
Plate 44. Rate of soil erosion for the 4-3-3 (8X8) forc

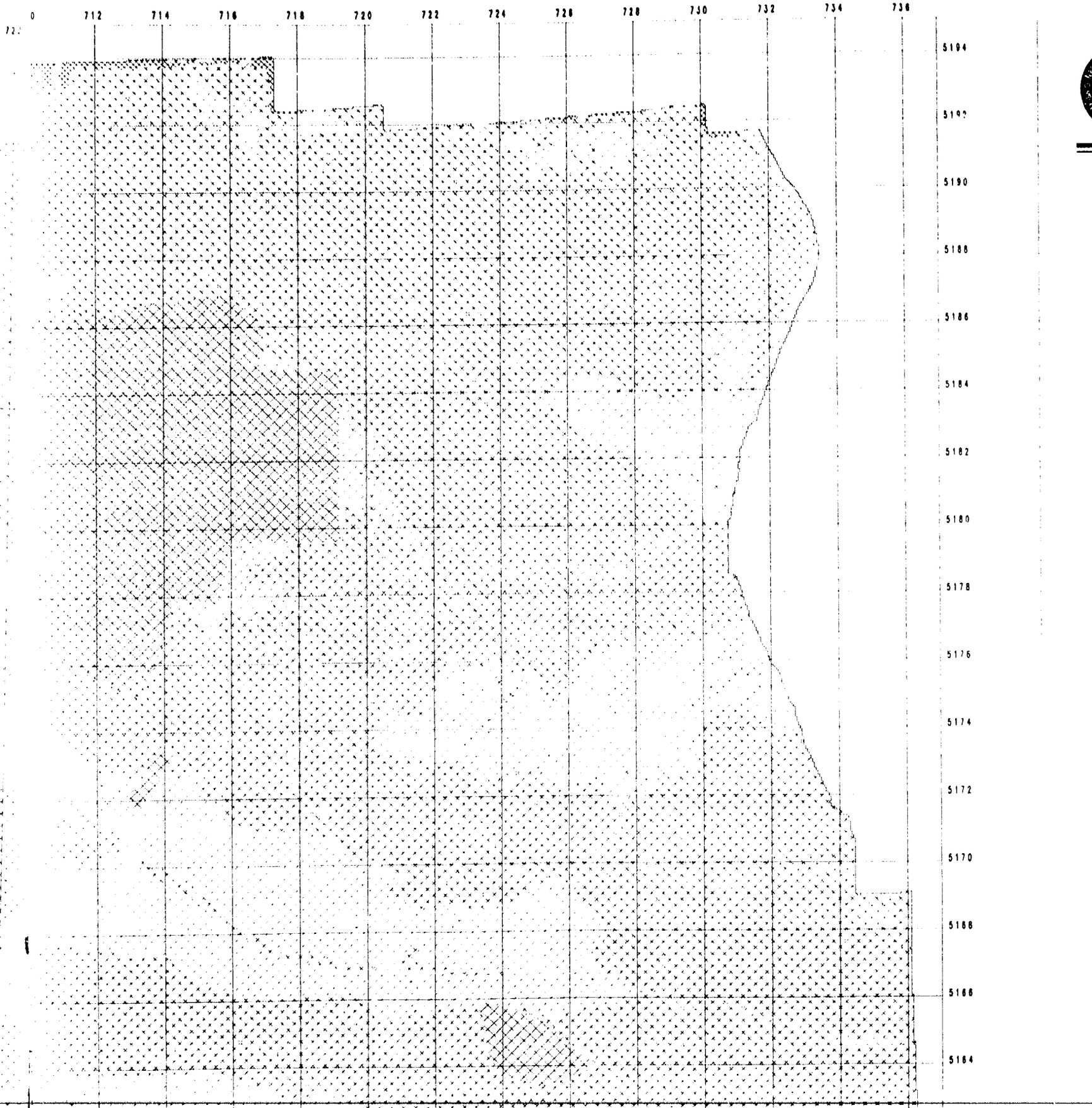


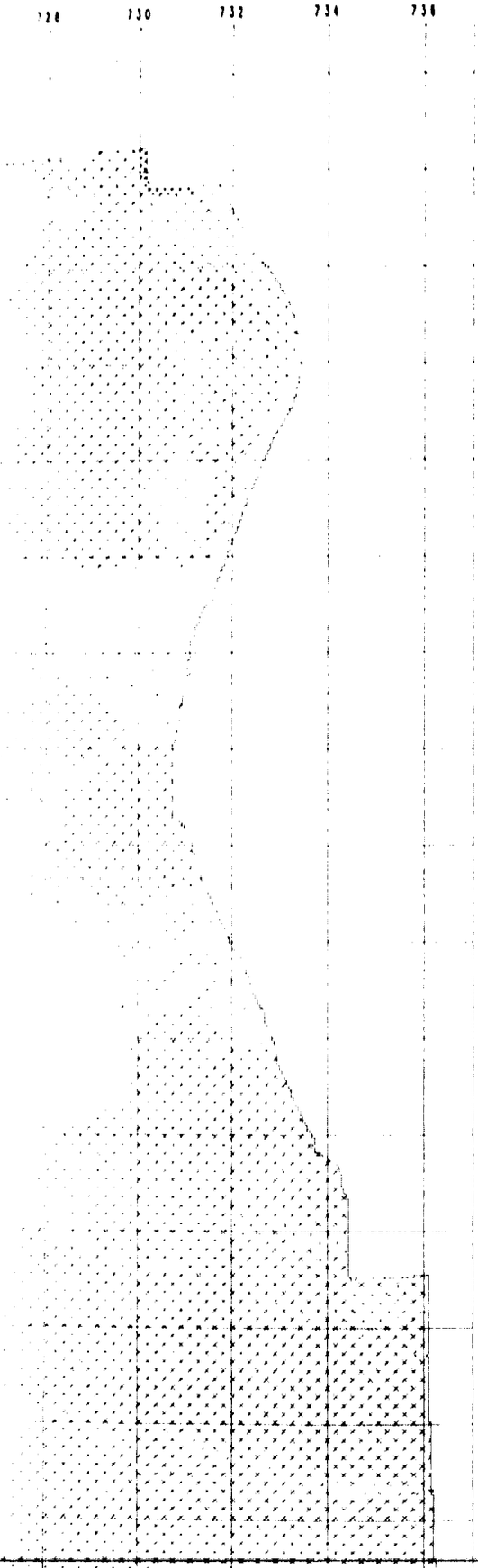
4. Rate of soil erosion for the 4-3-3 (8X8) force structure in the wet-wet slippery surface condition for one thousand passes



Slippery surface condition for one thousand passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
10 PASSES

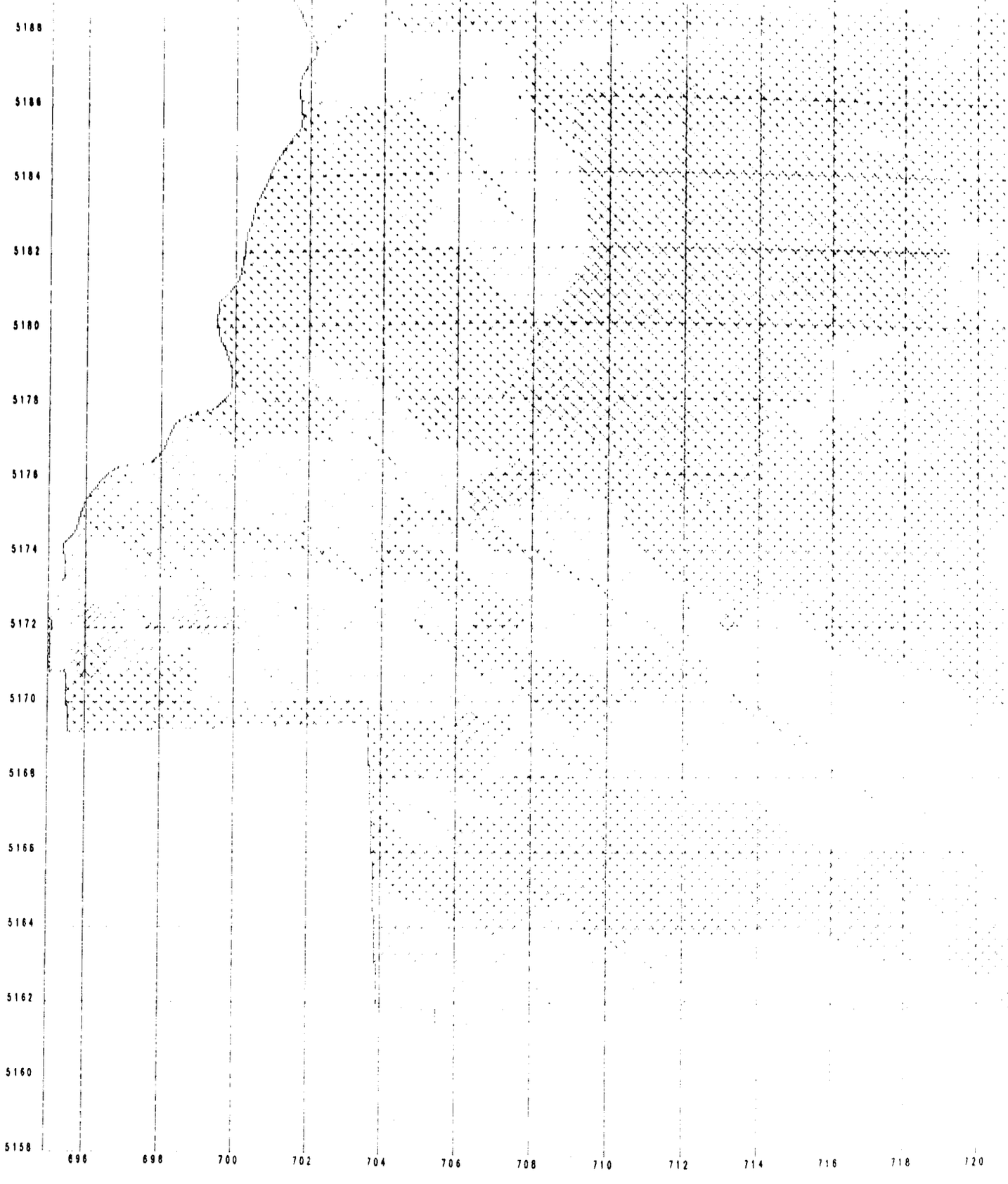
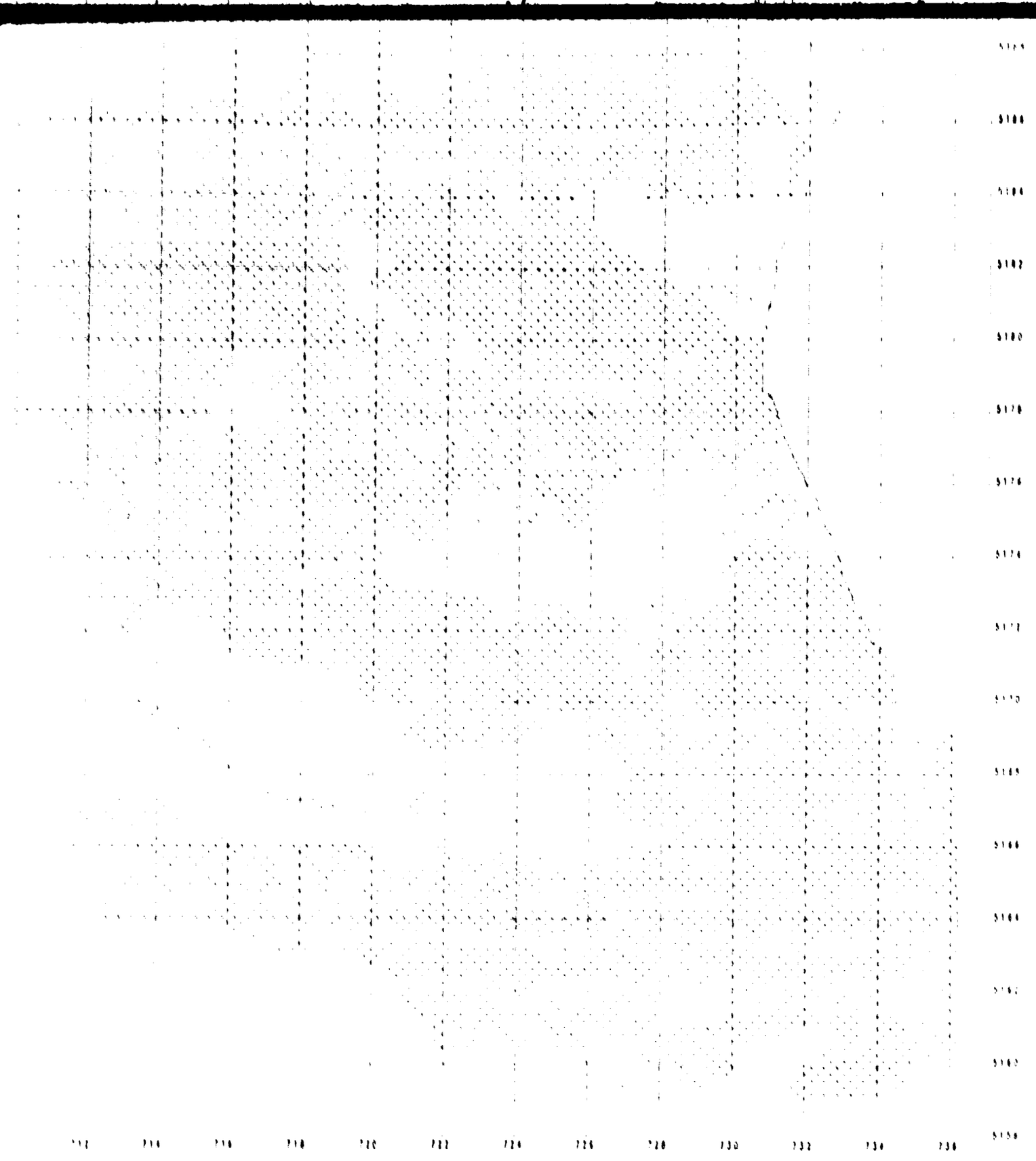
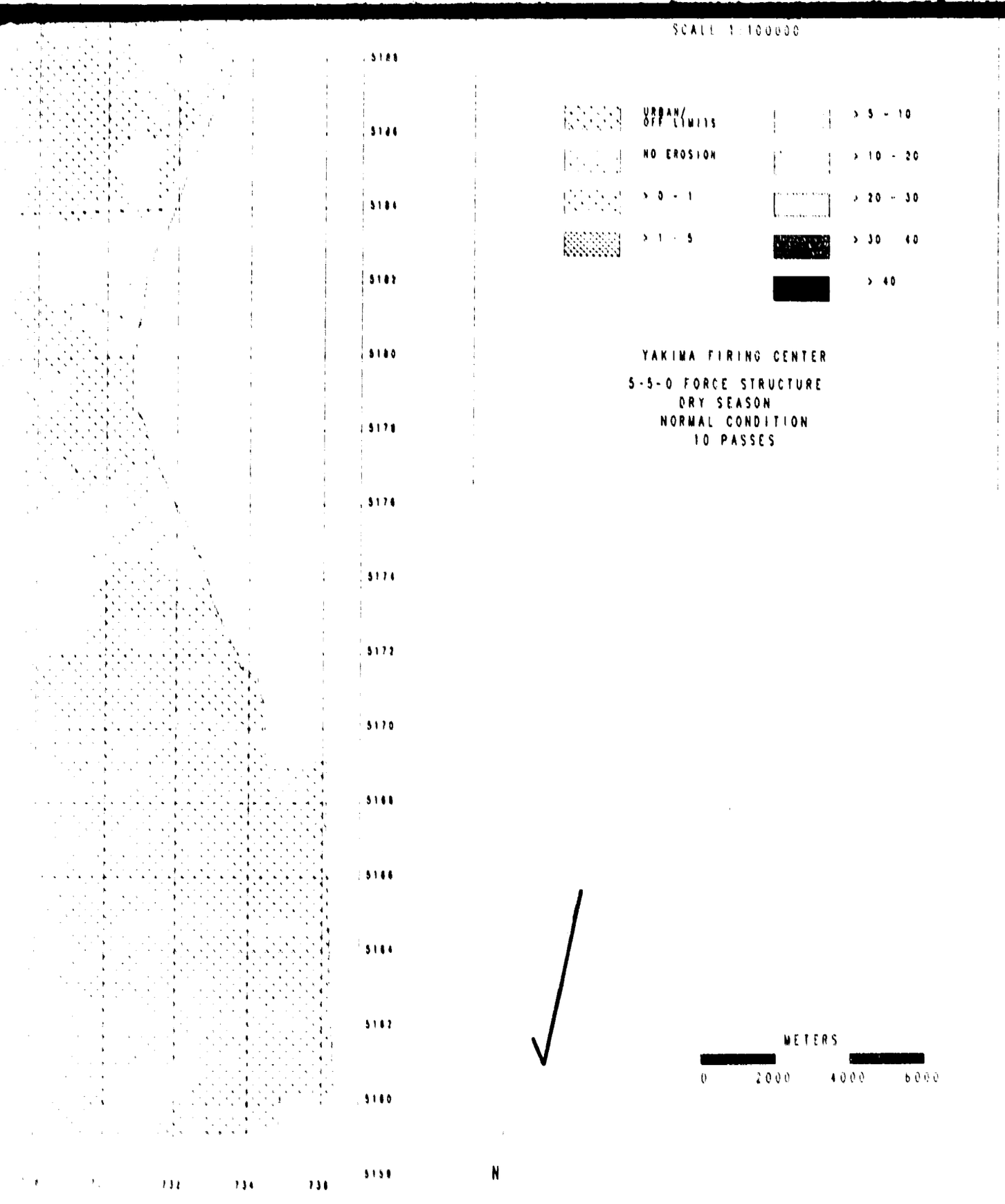


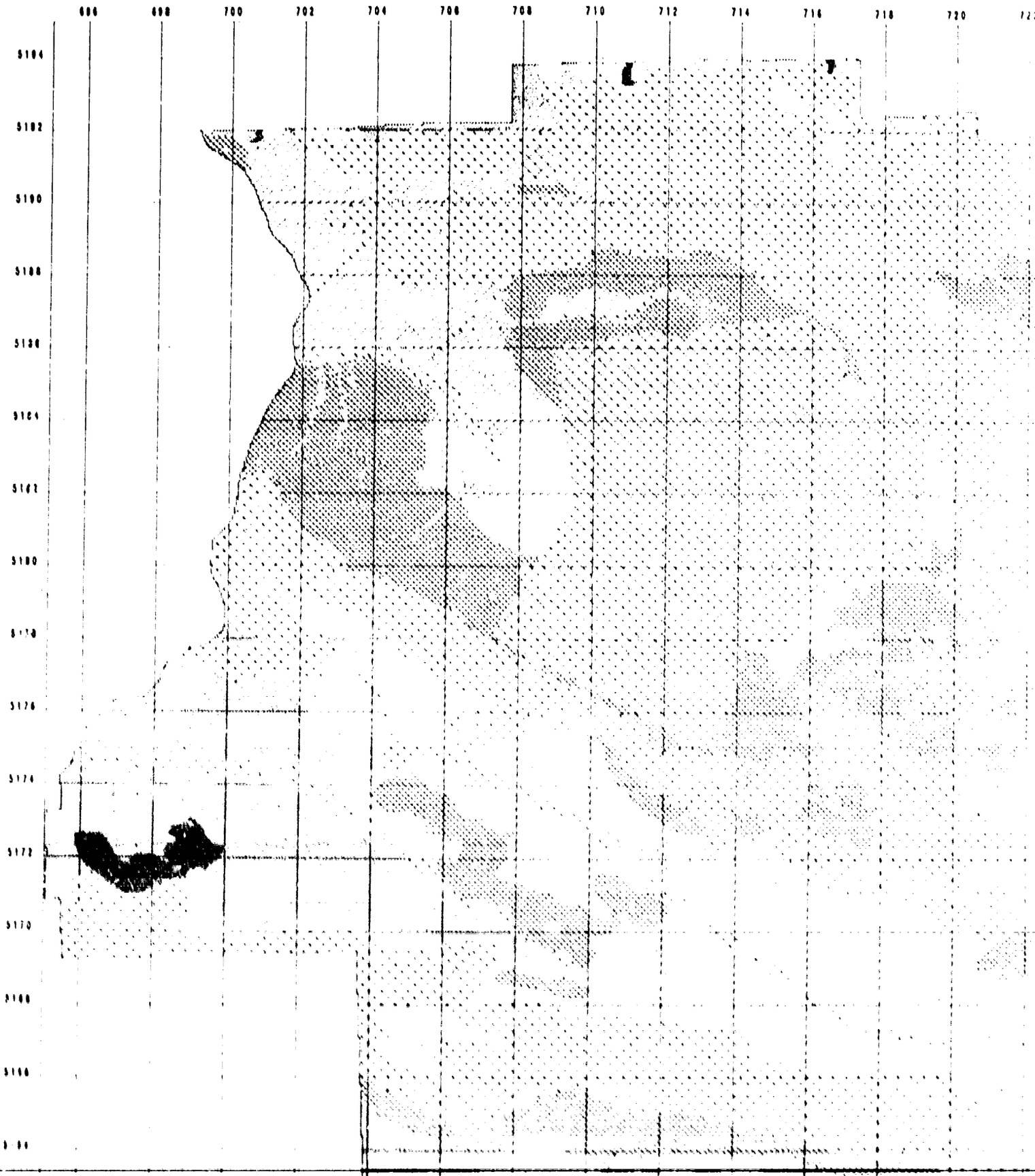
Plate 45. Rate of soil erosion for the 5-5-0

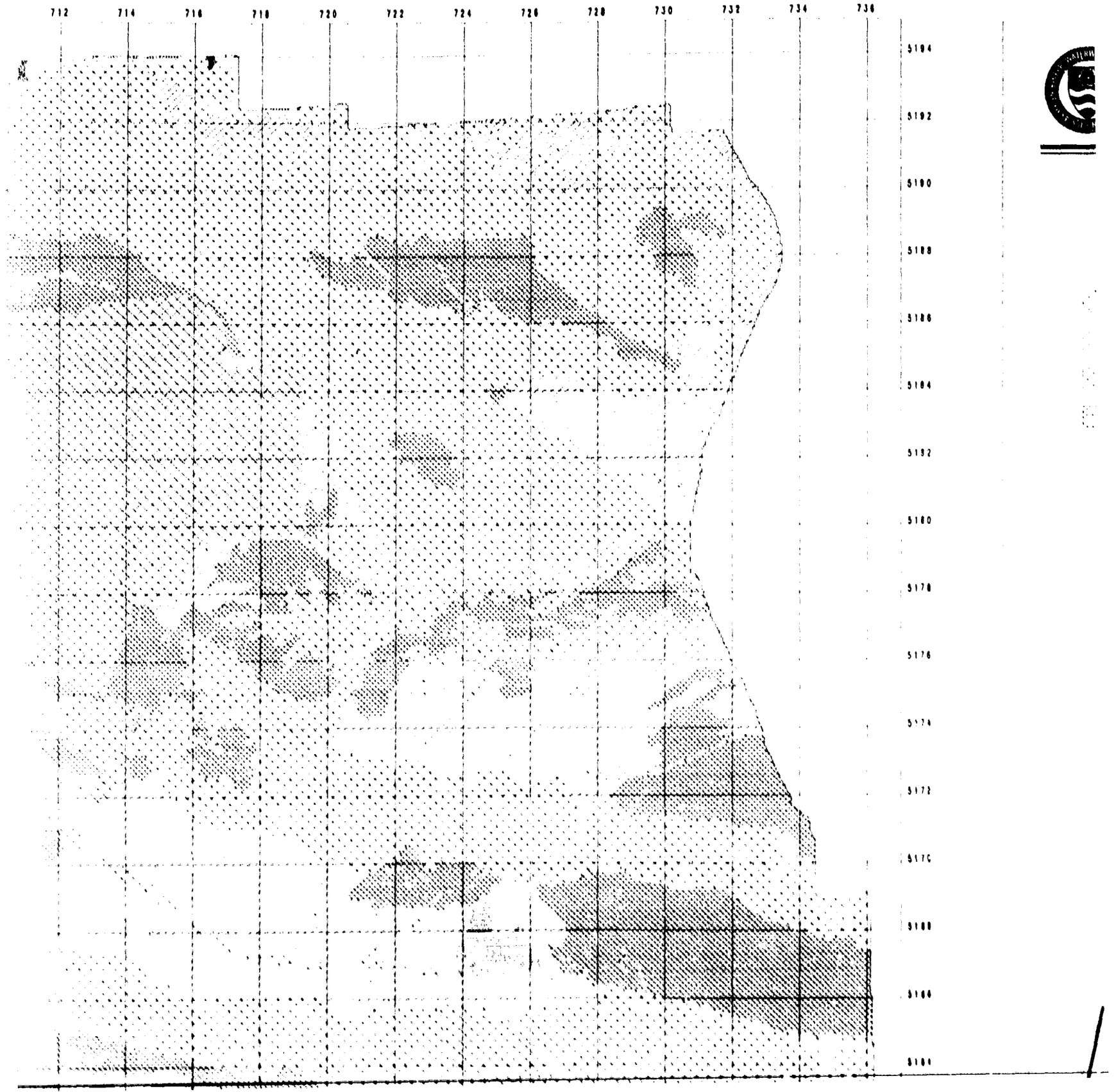


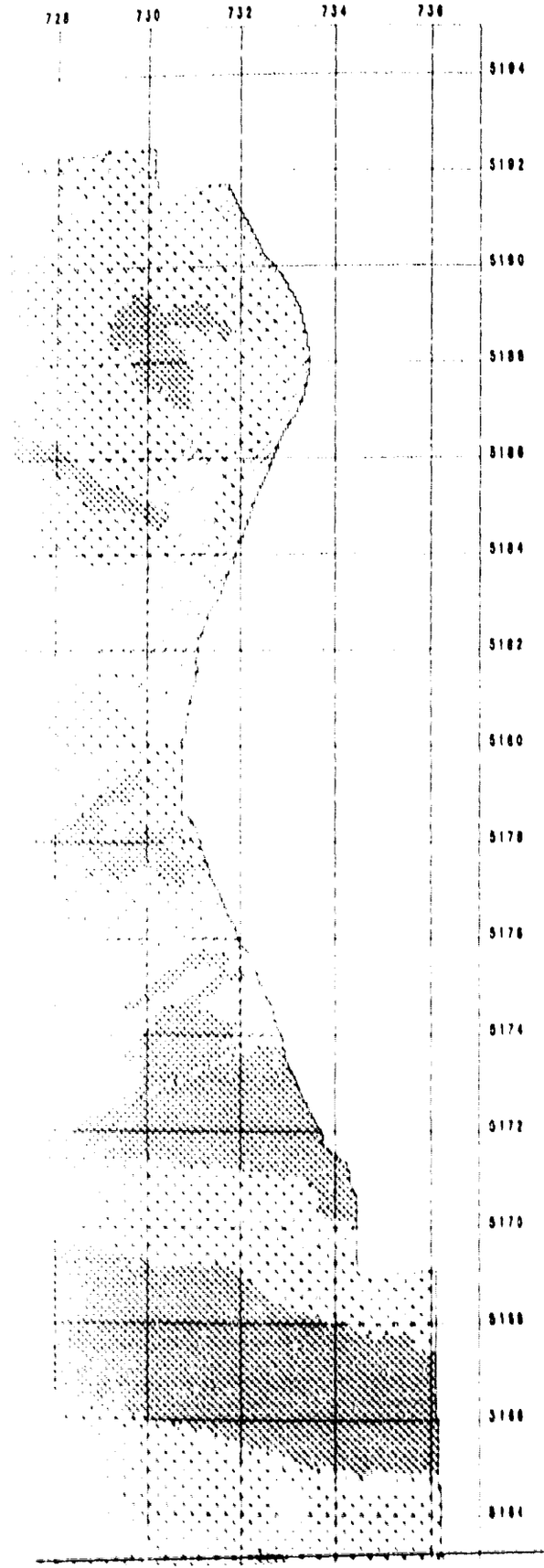
ure 45. Rate of soil erosion for the 5-5-0 force structure in the dry normal surface condition for ten passes



ry normal surface condition for ten passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
50 PASSES

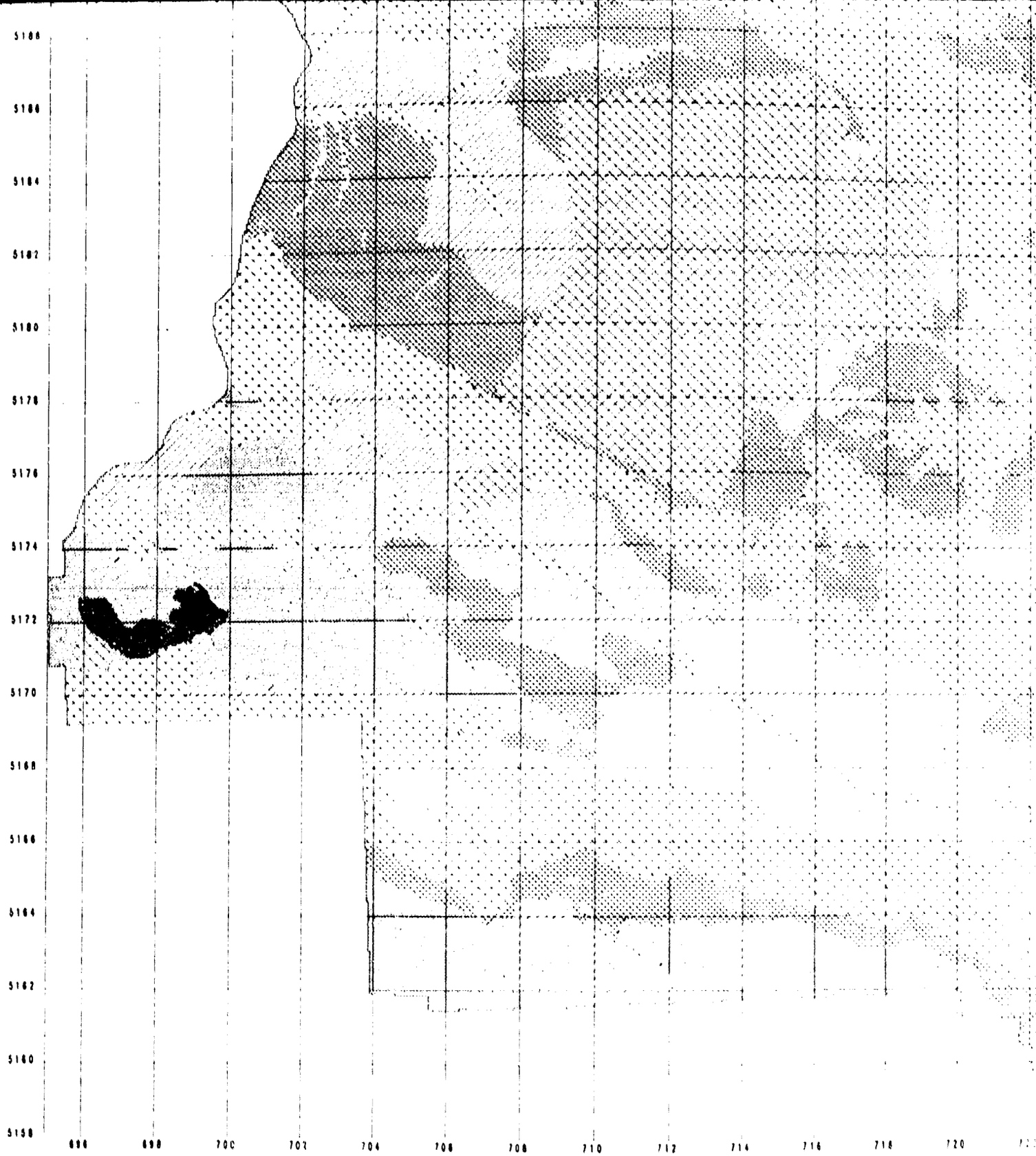


Plate 46. Rate of soil erosion for the 5-5-0 for

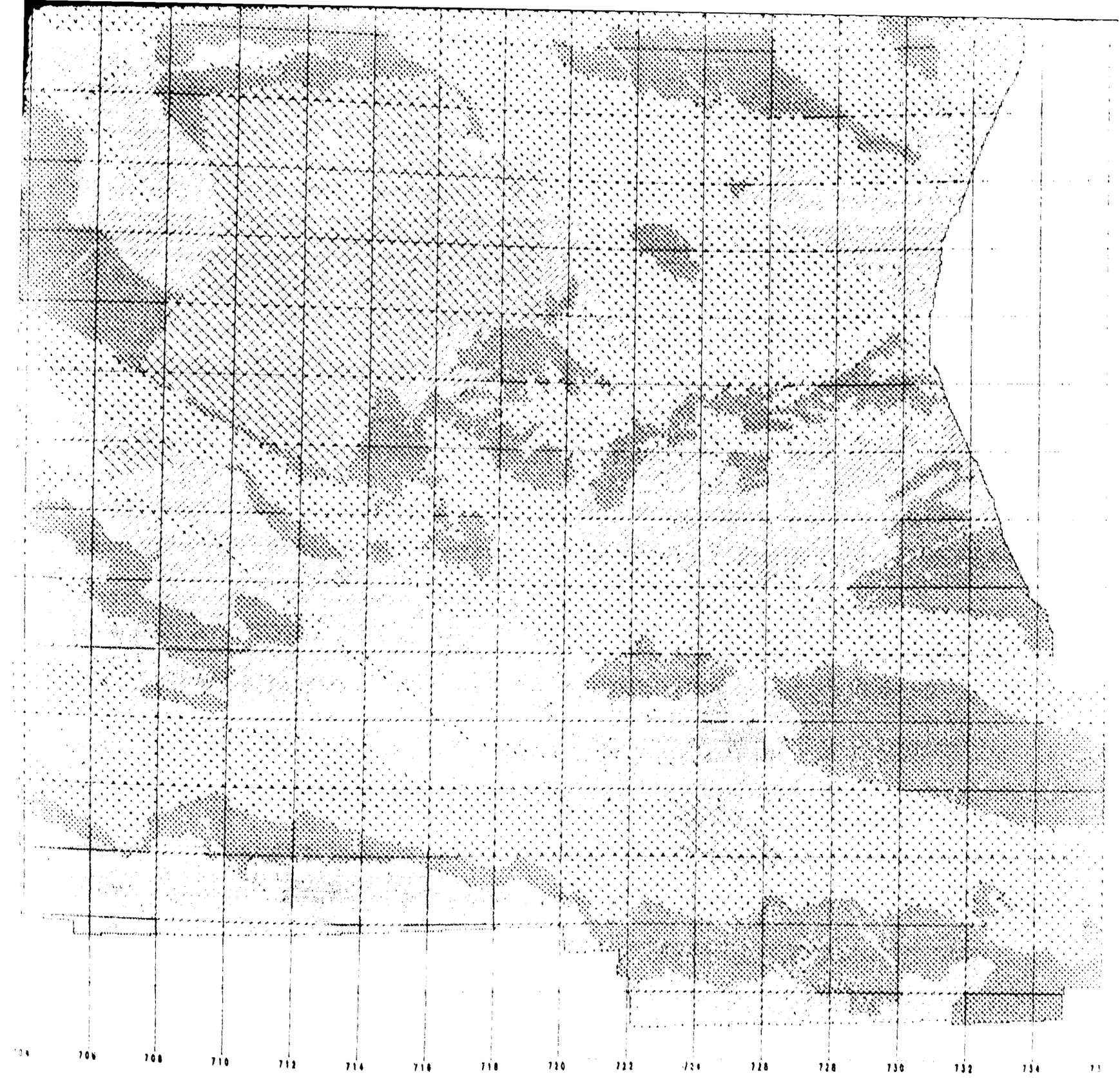
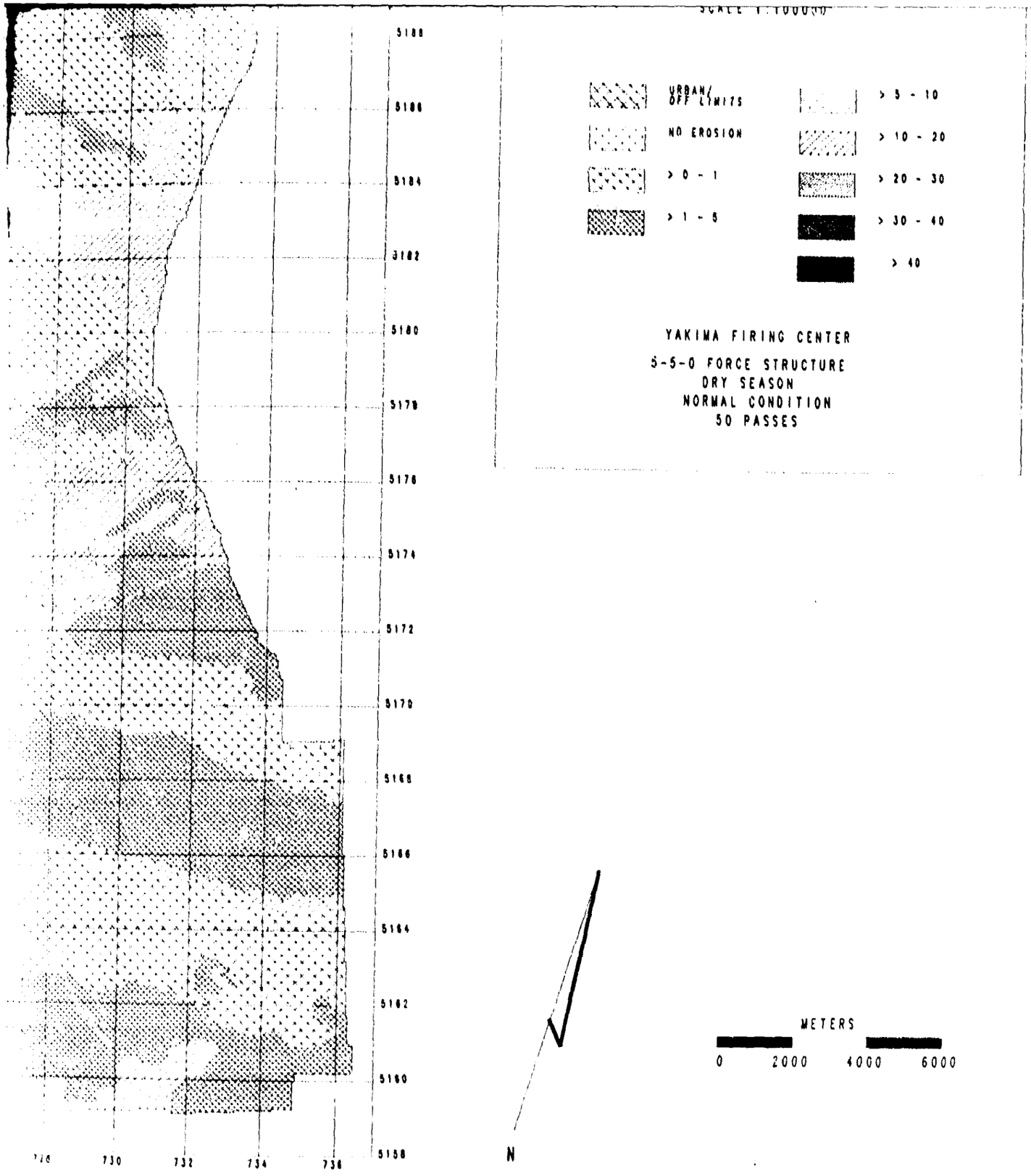
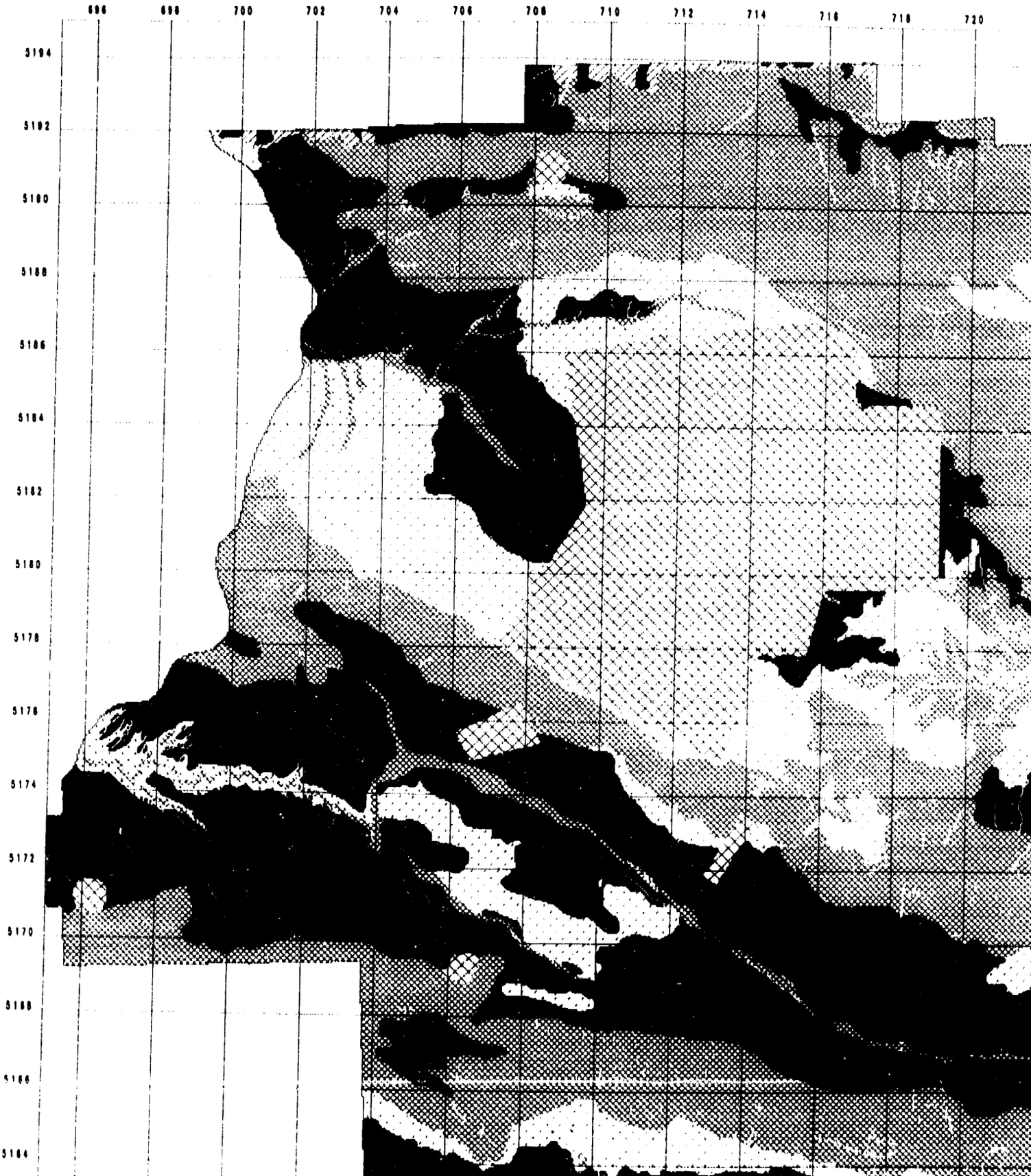
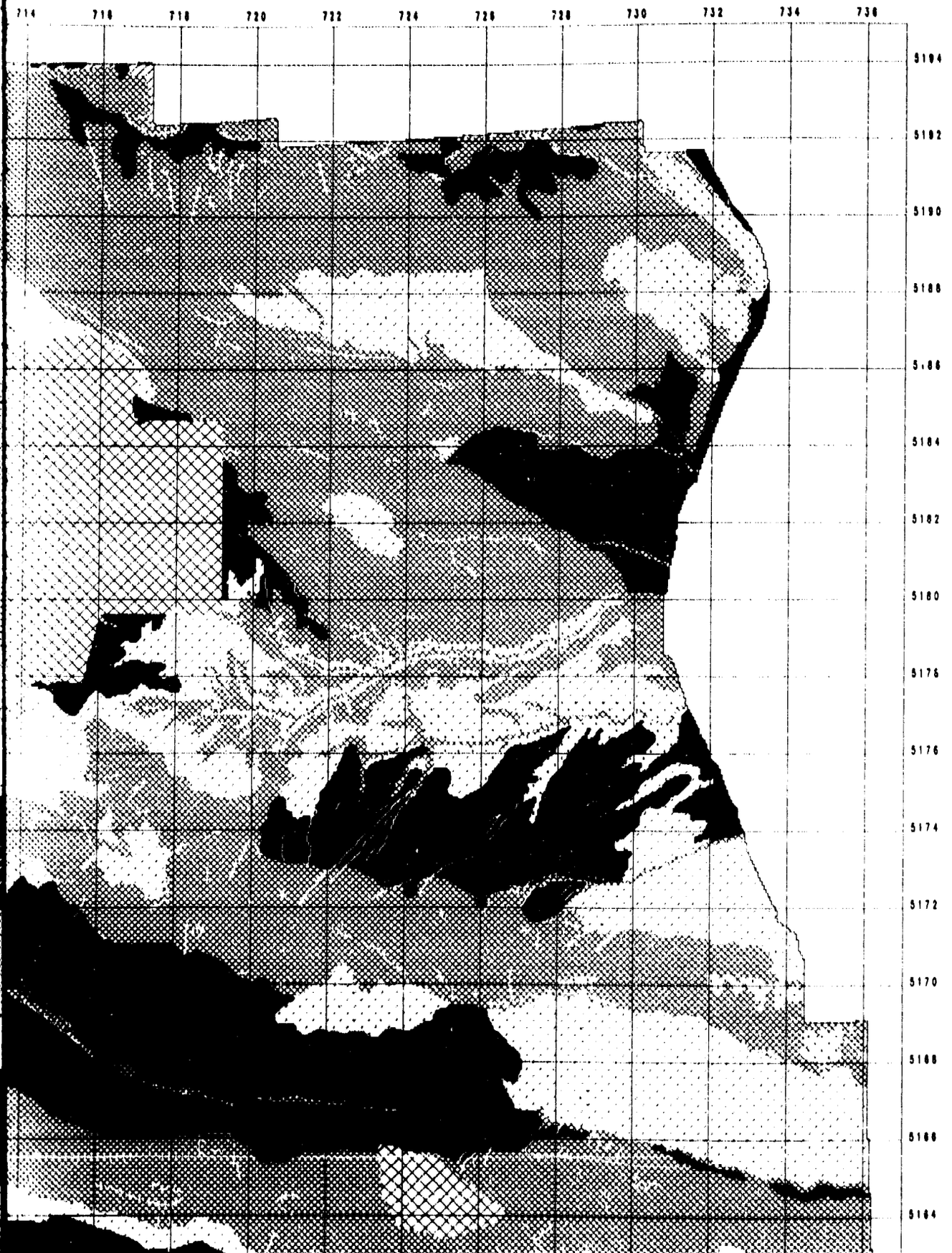


Plate 46. Rate of soil erosion for the 5-5-0 force structure in the dry normal surface condition for f



dry normal surface condition for fifty passes


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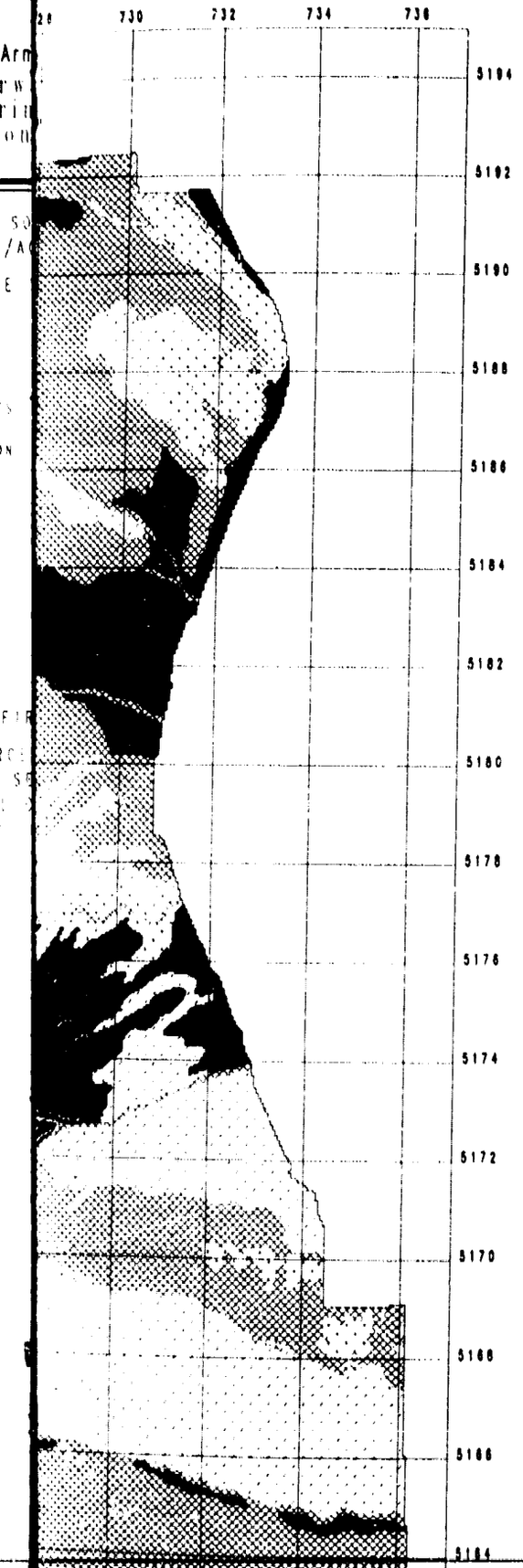
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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
DRY SEASON
NORMAL CONDITION
1000 PASSES

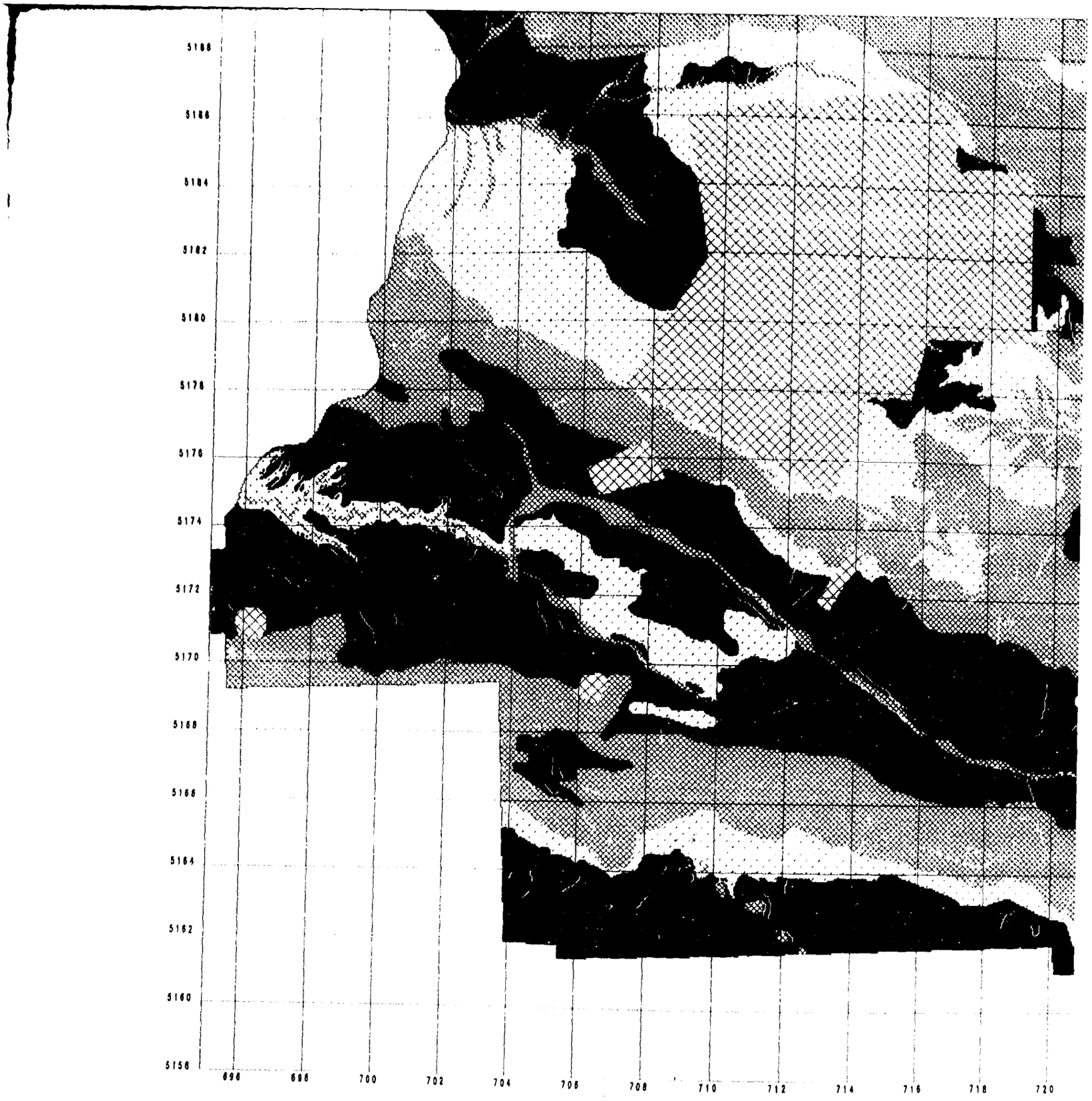


Plate 47. Rate of soil erosion for the 5-5-0 force s

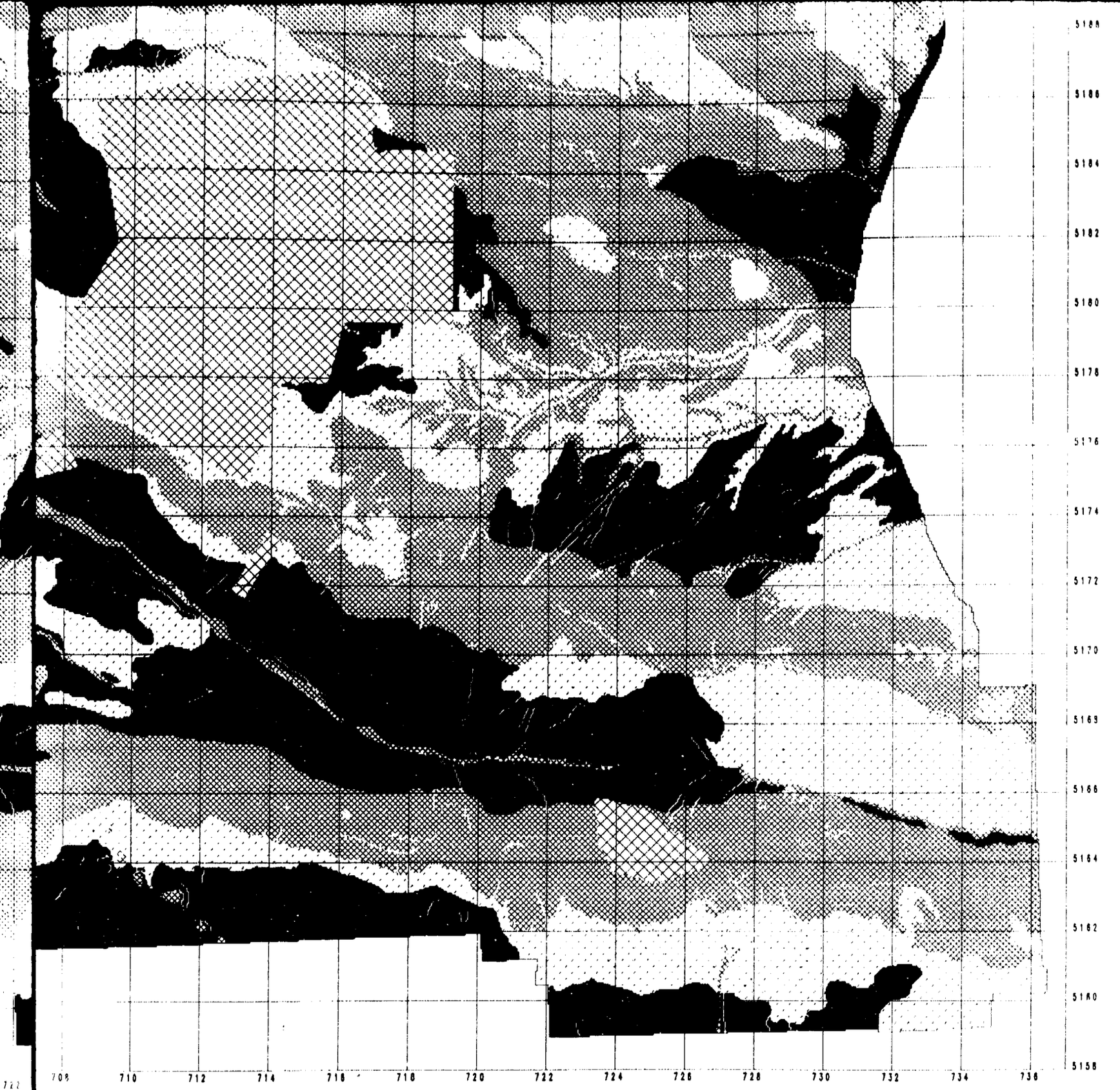
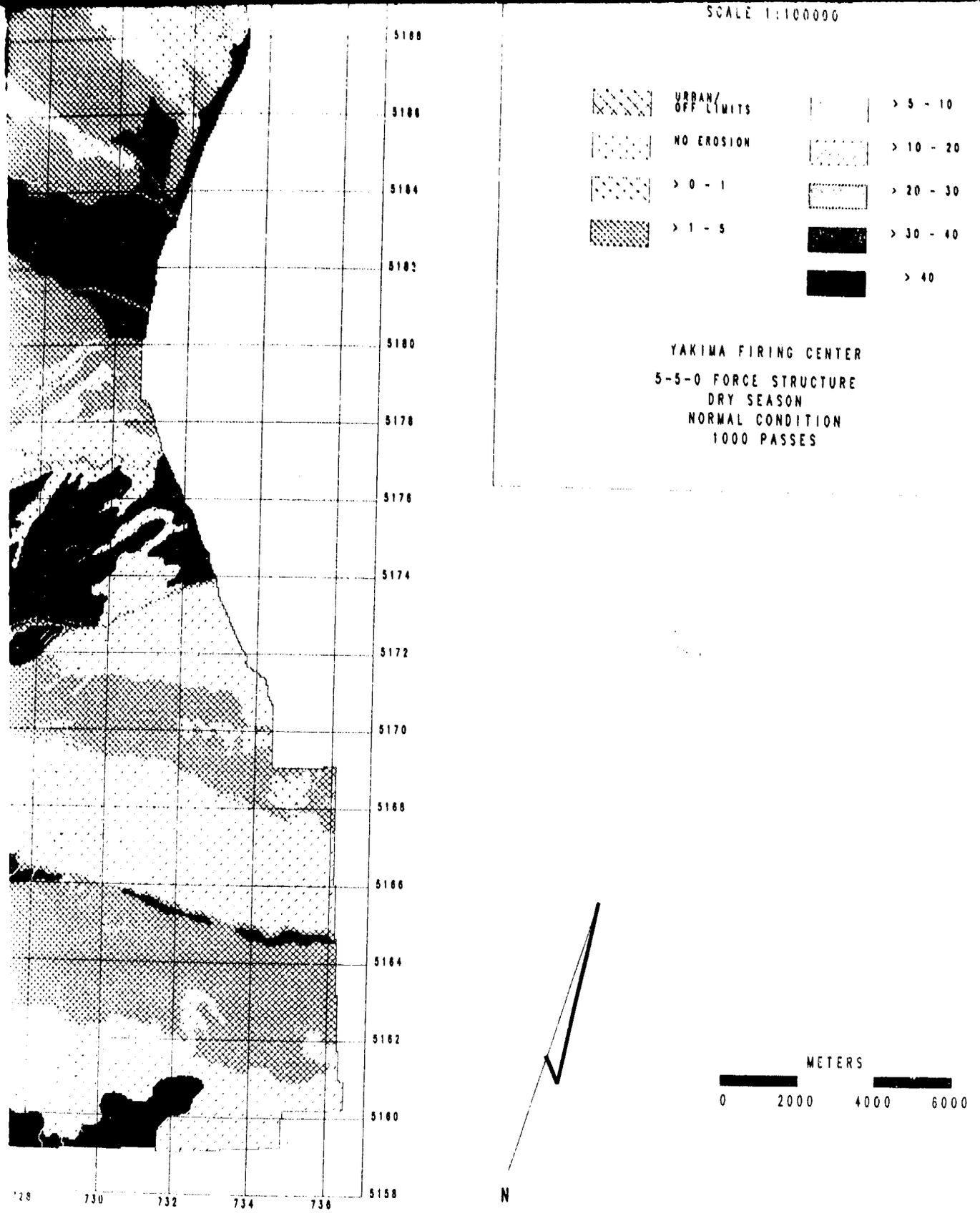
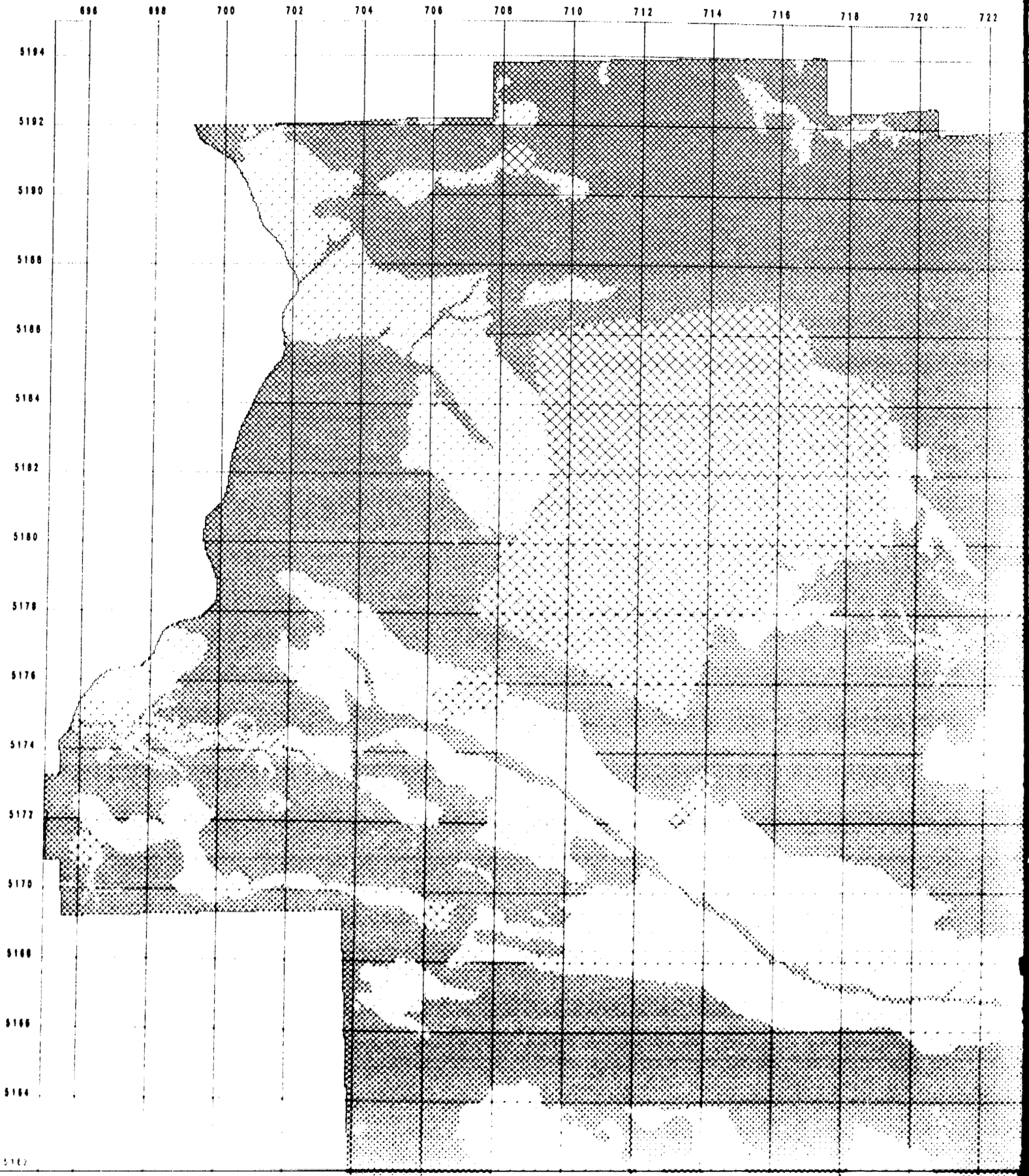
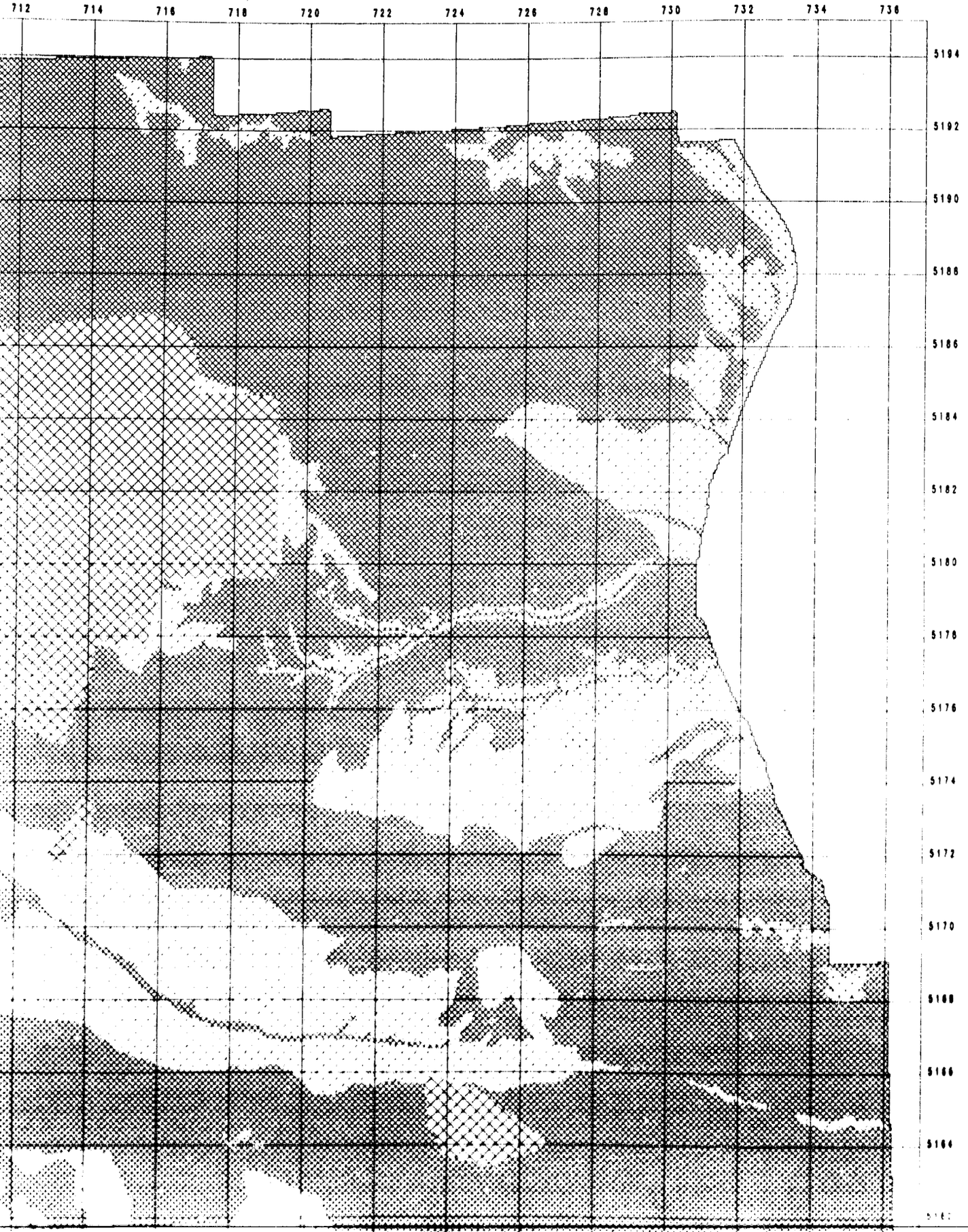


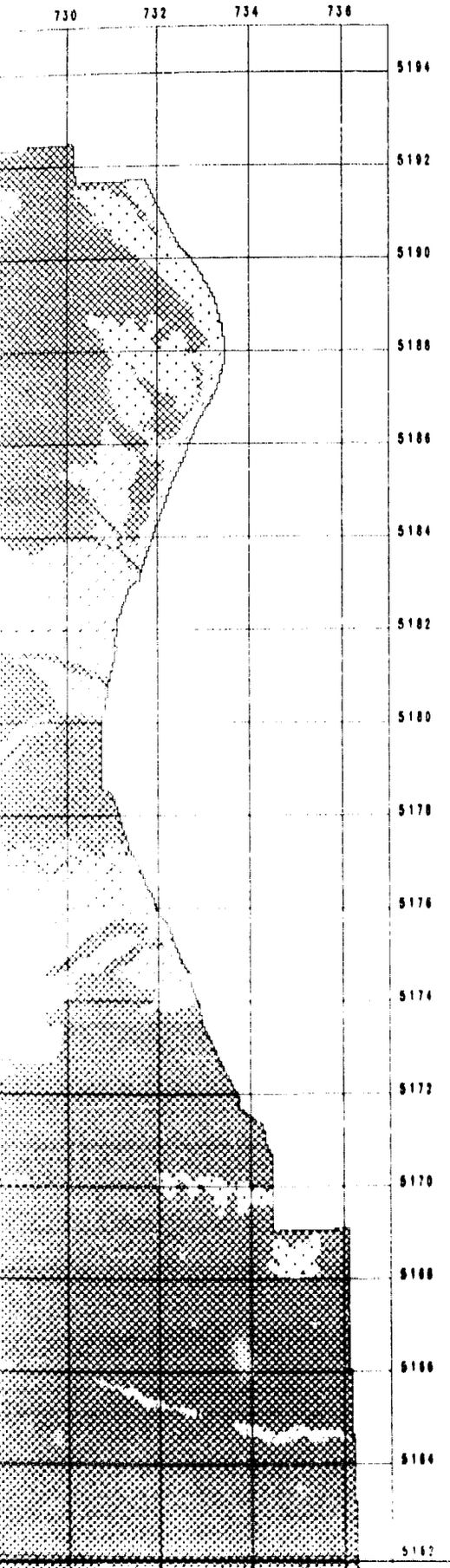
Plate 47. Rate of soil erosion for the 5-5-0 force structure in the dry normal surface condition for one thousand passes



surface condition for one thousand passes


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RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
10 PASSES

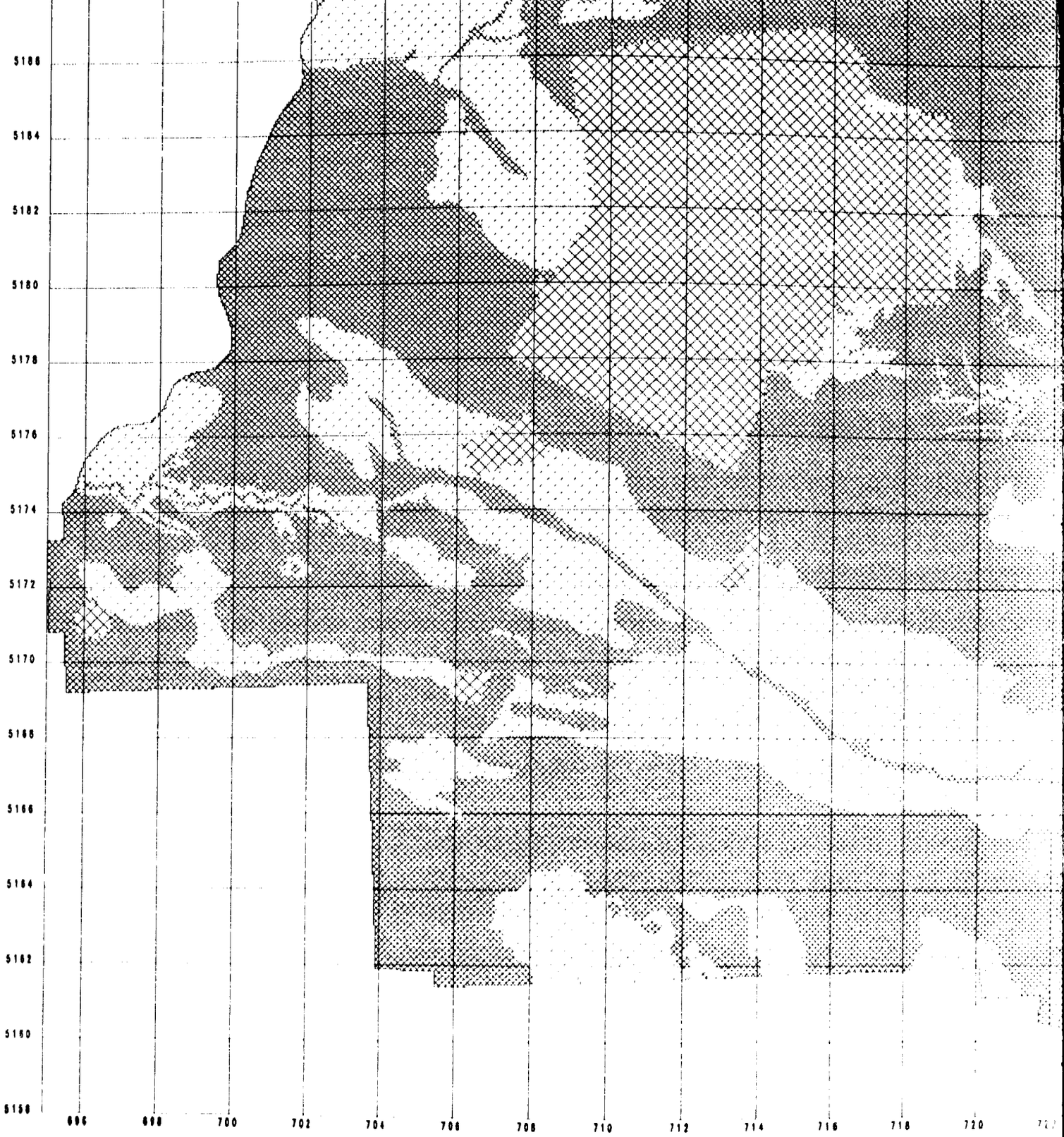
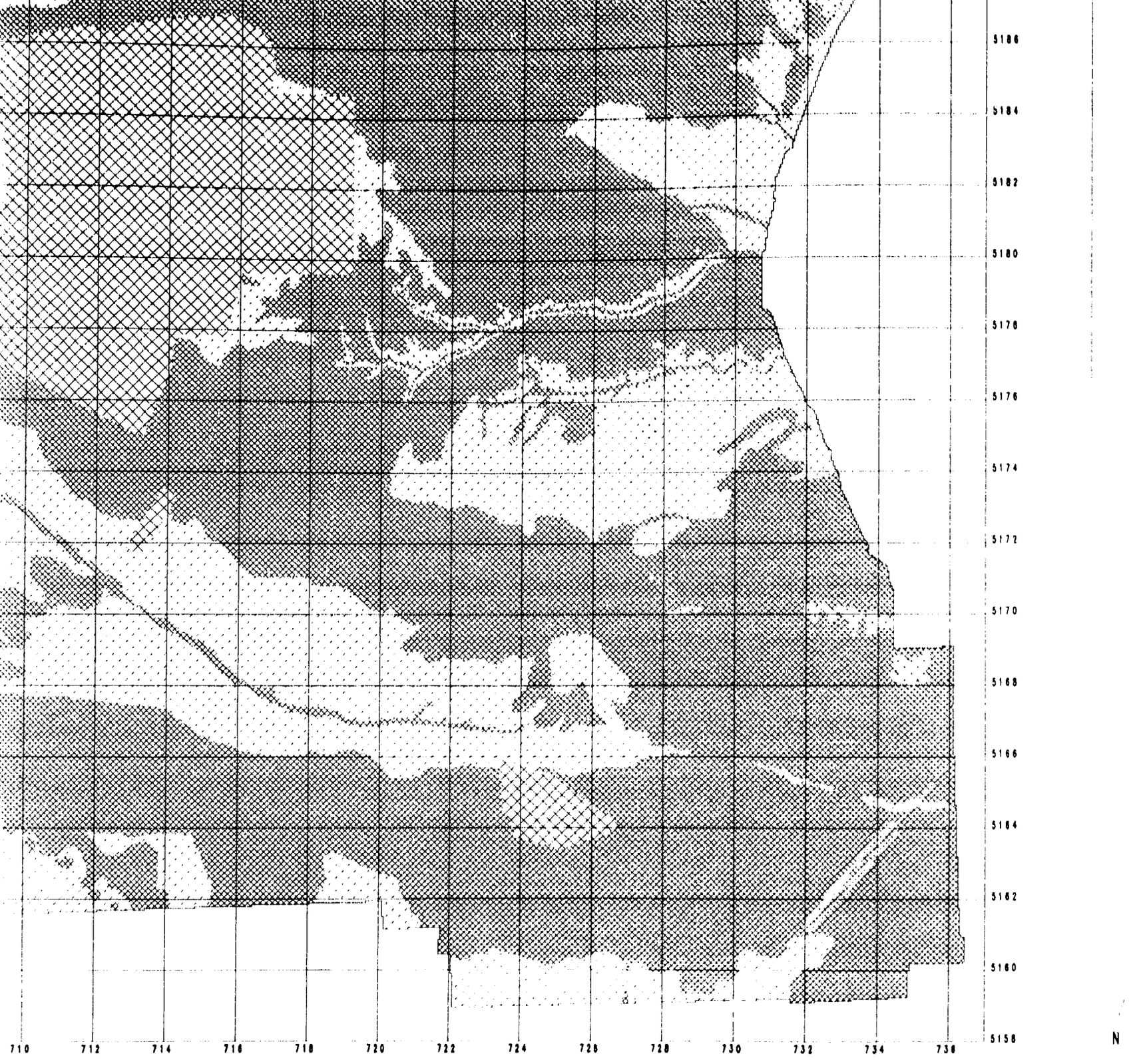
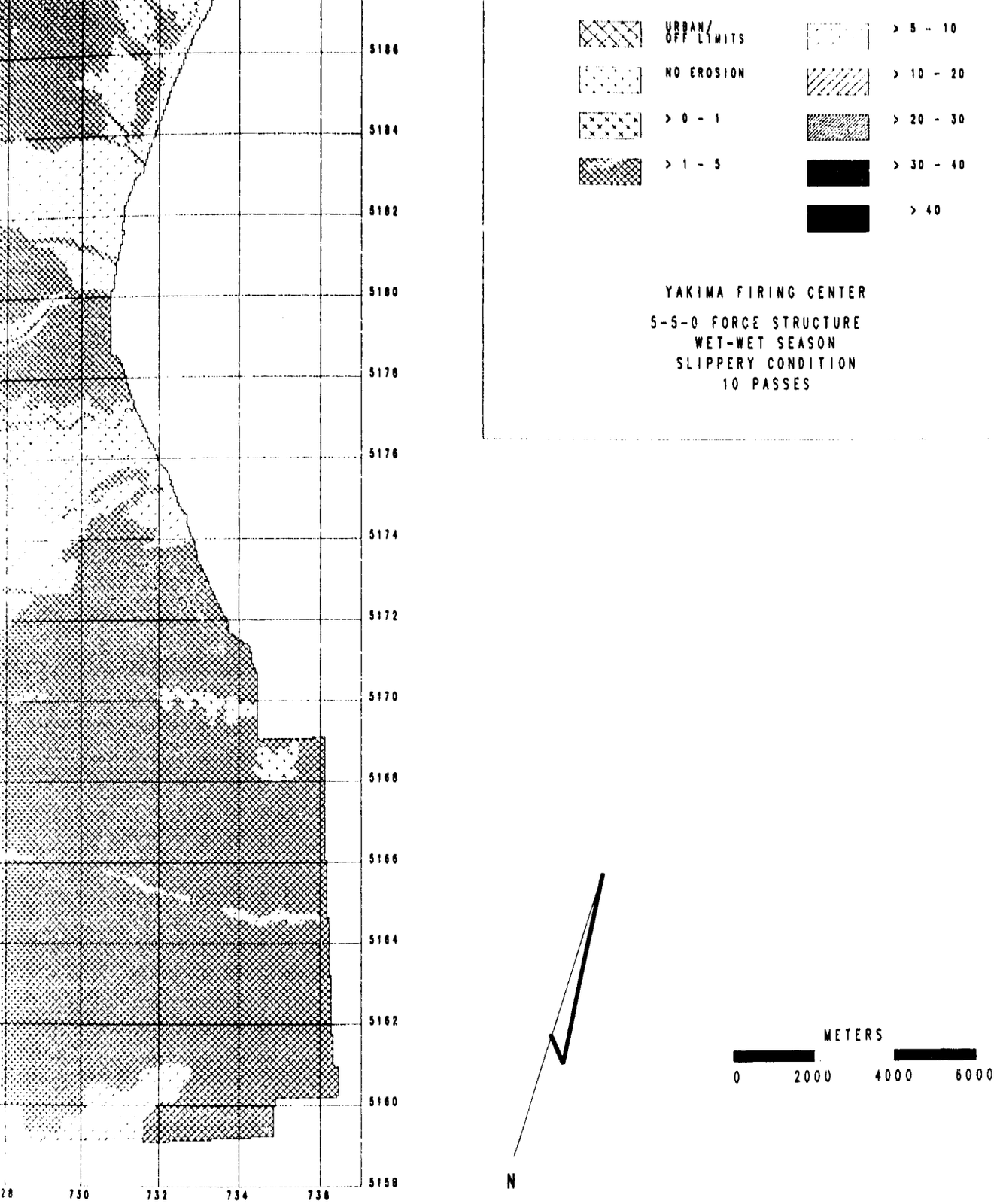


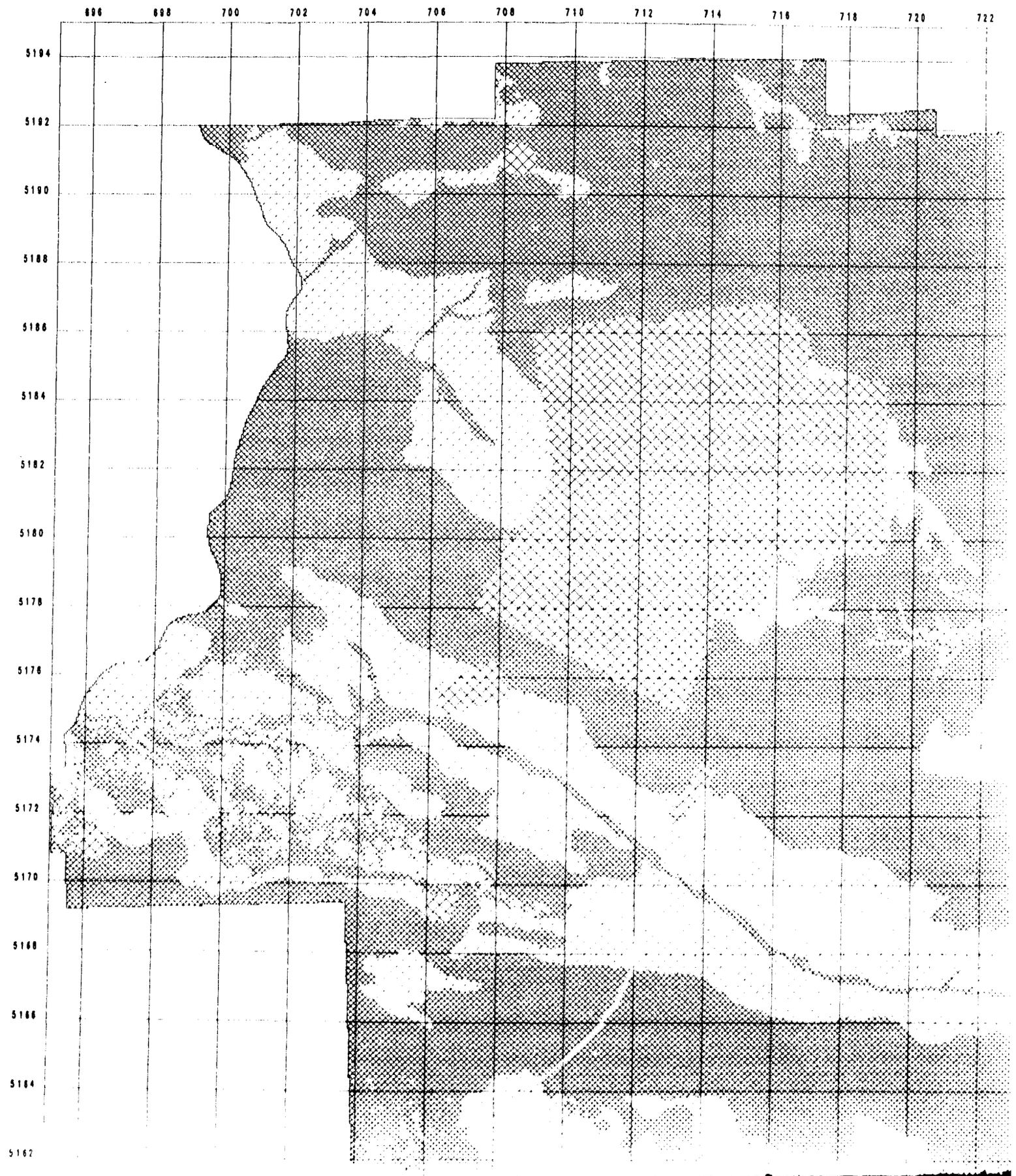
Plate 48. Rate of soil erosion for the 5-5-0 force st

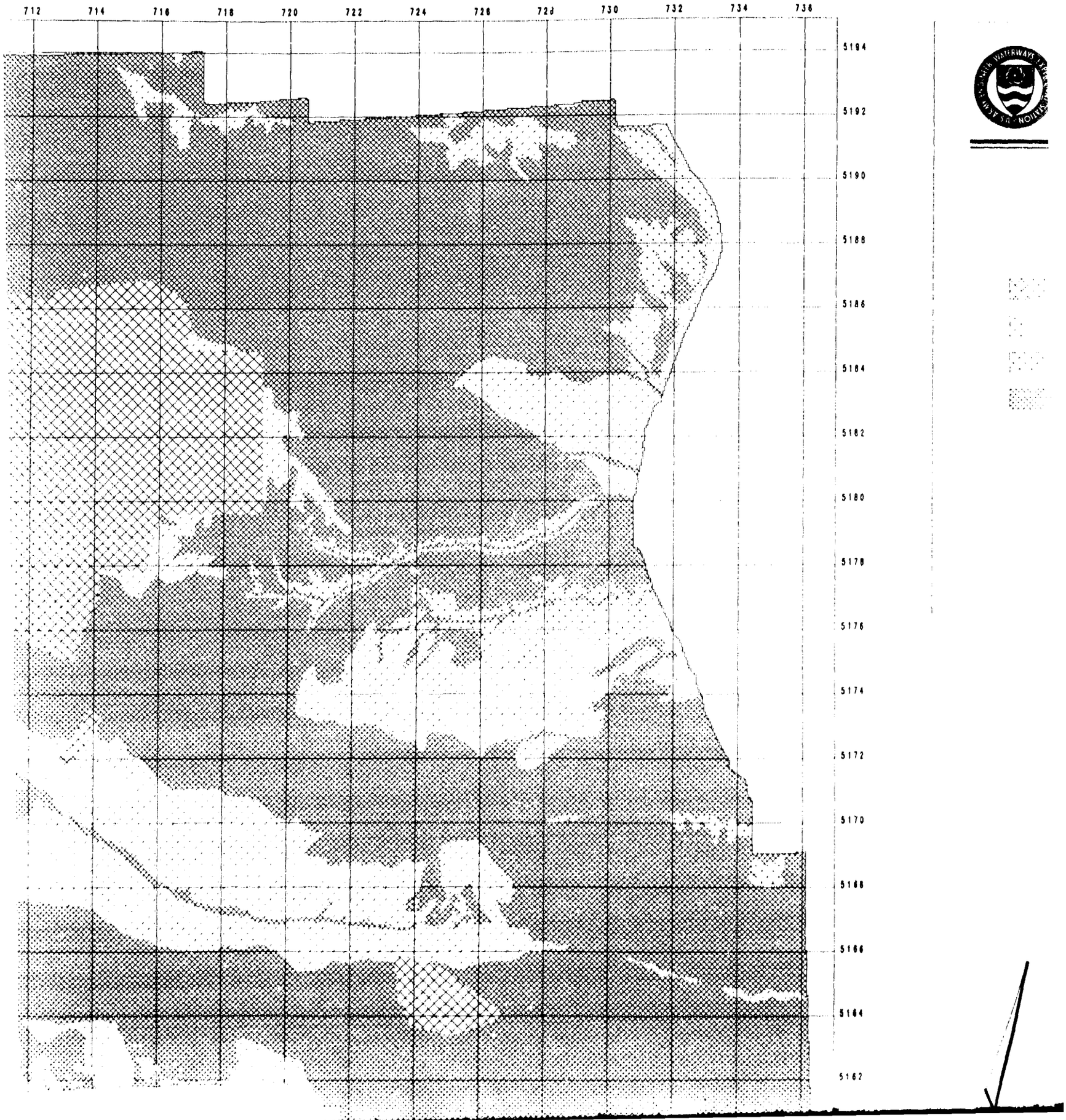


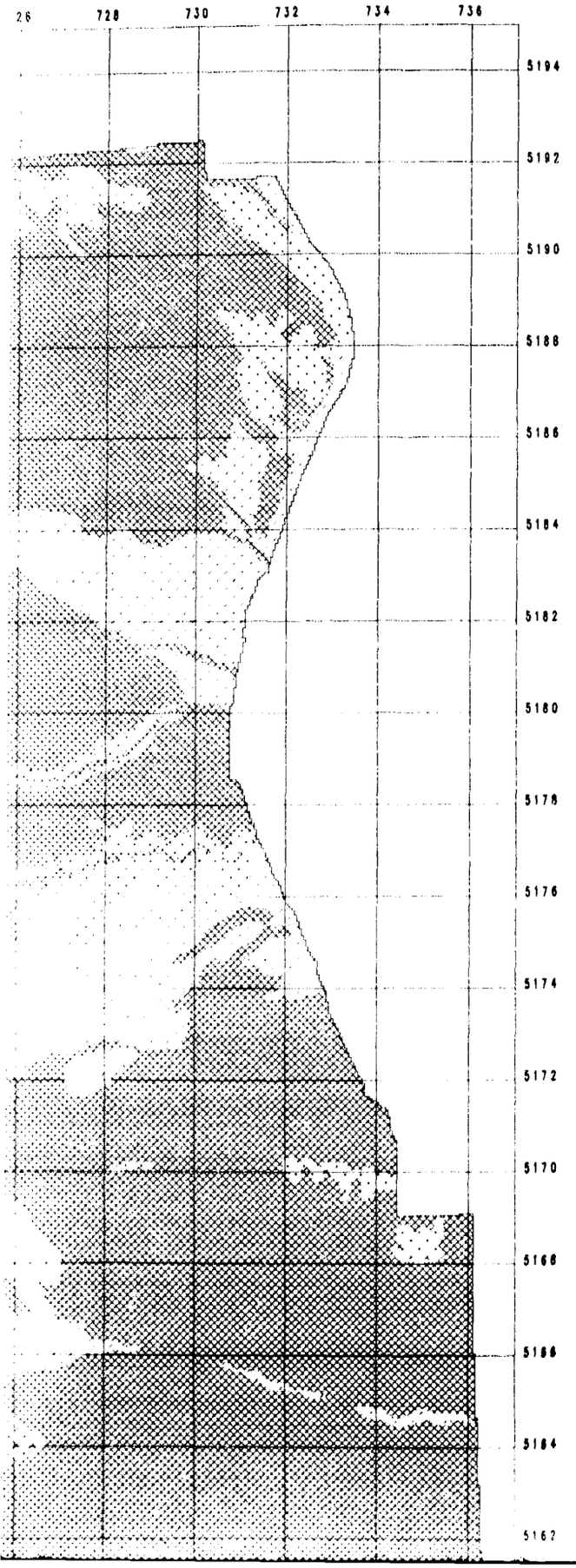
ate 48. Rate of soil erosion for the 5-5-0 force structure in the wet-wet slippery surface condition for ten passes



slippery surface condition for ten passes


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U. S. Army Corps of Engineers
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Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
50 PASSES

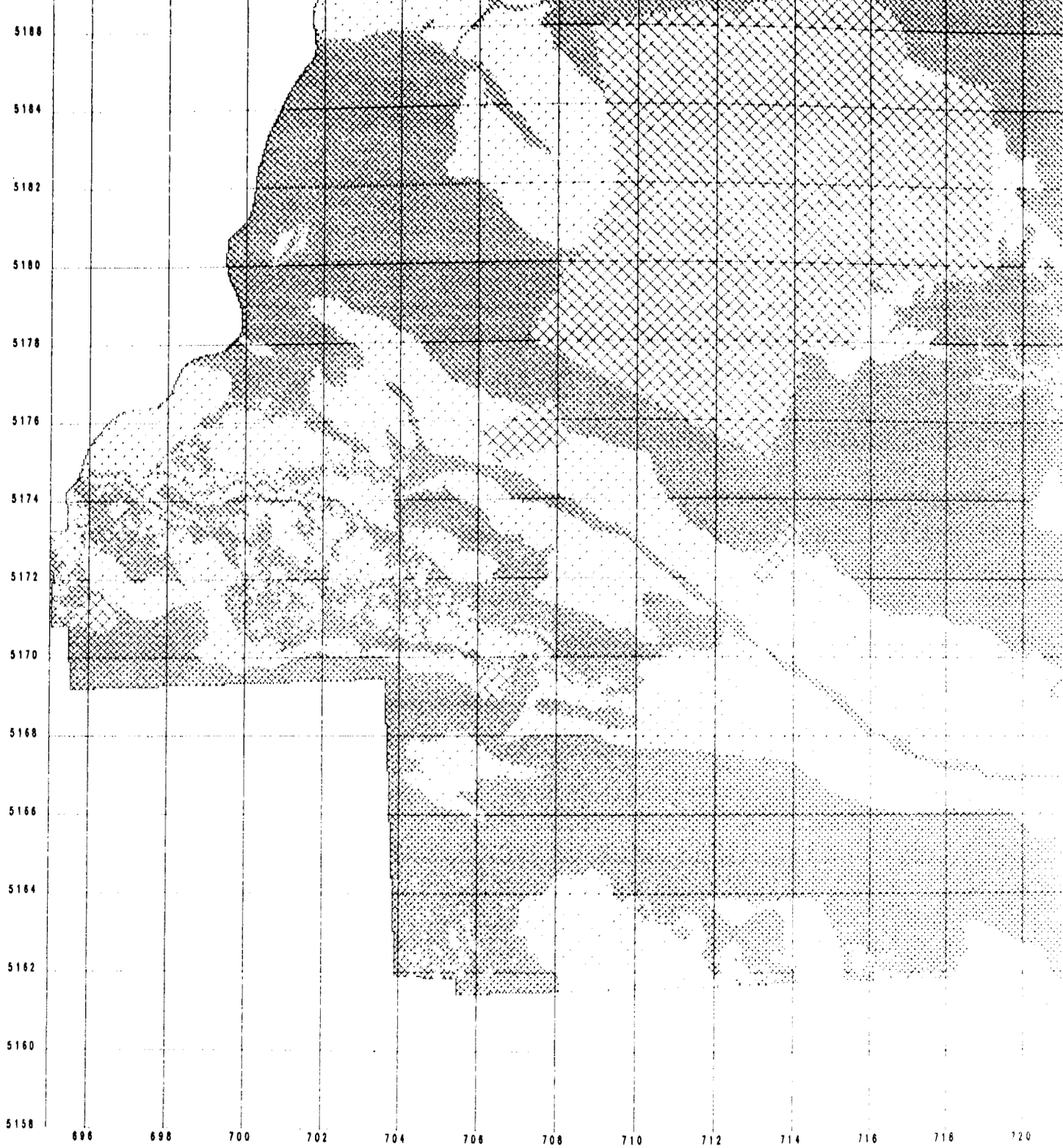


Plate 49. Rate of soil erosion for the 5-5-0 force st

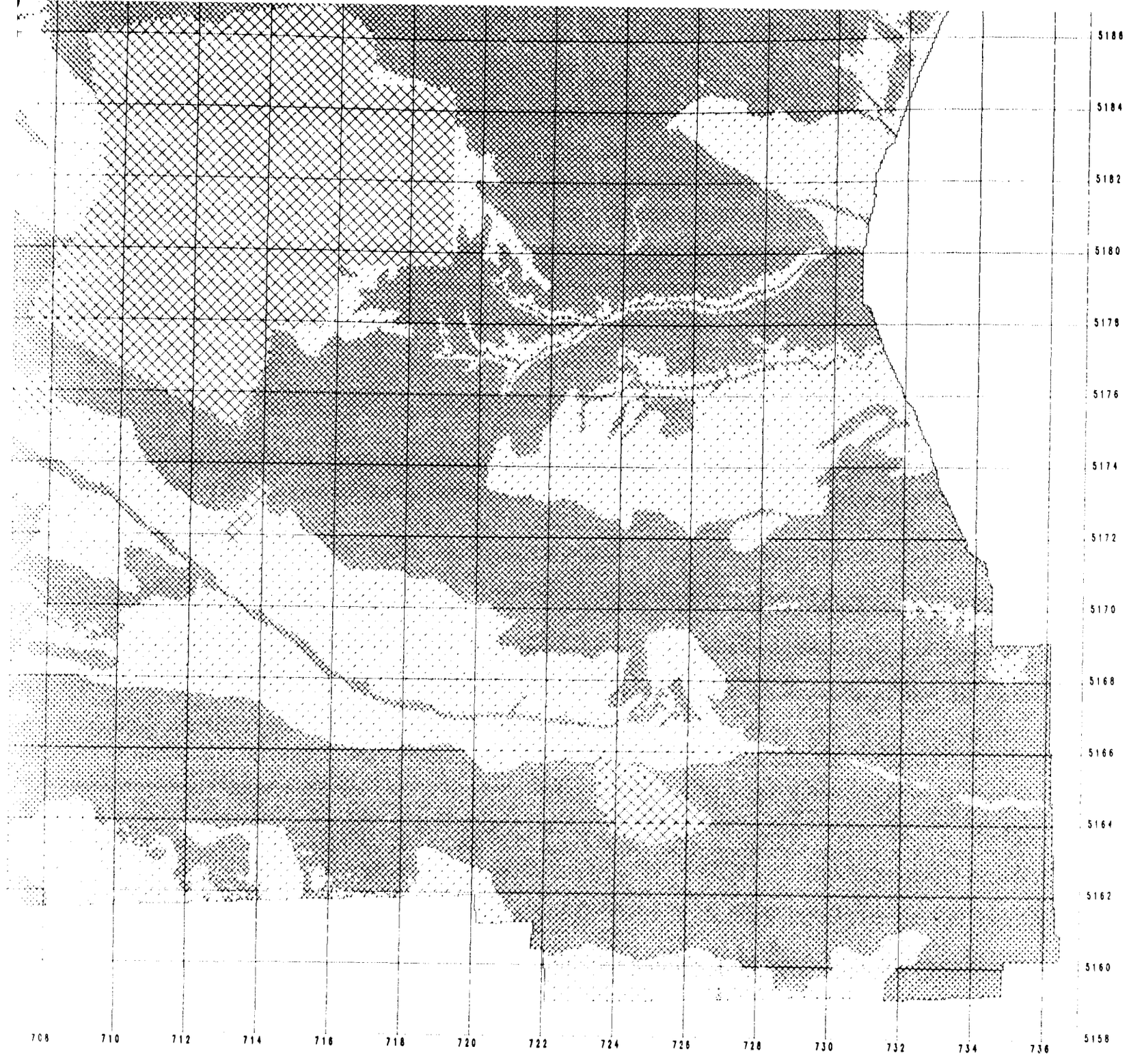
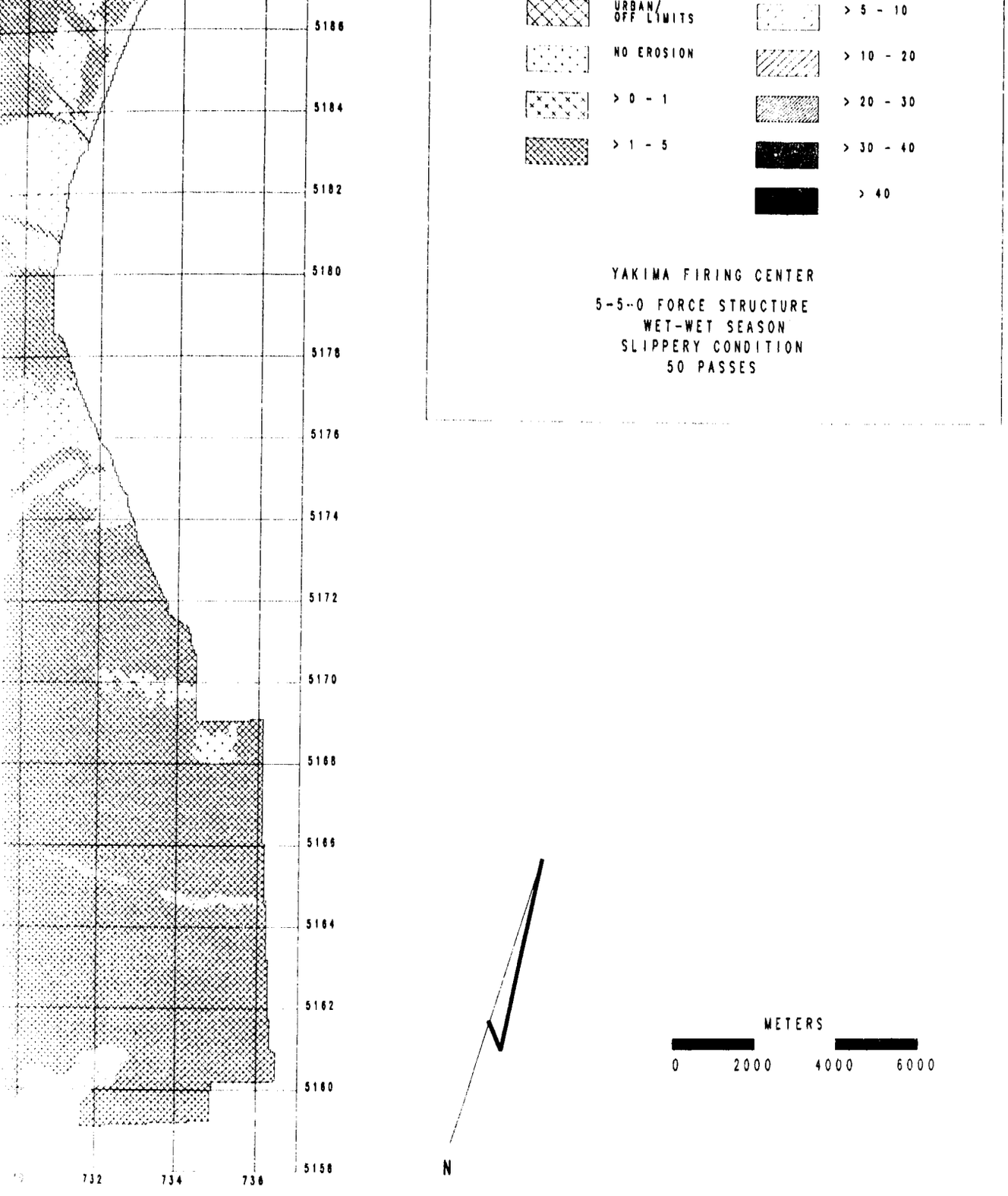
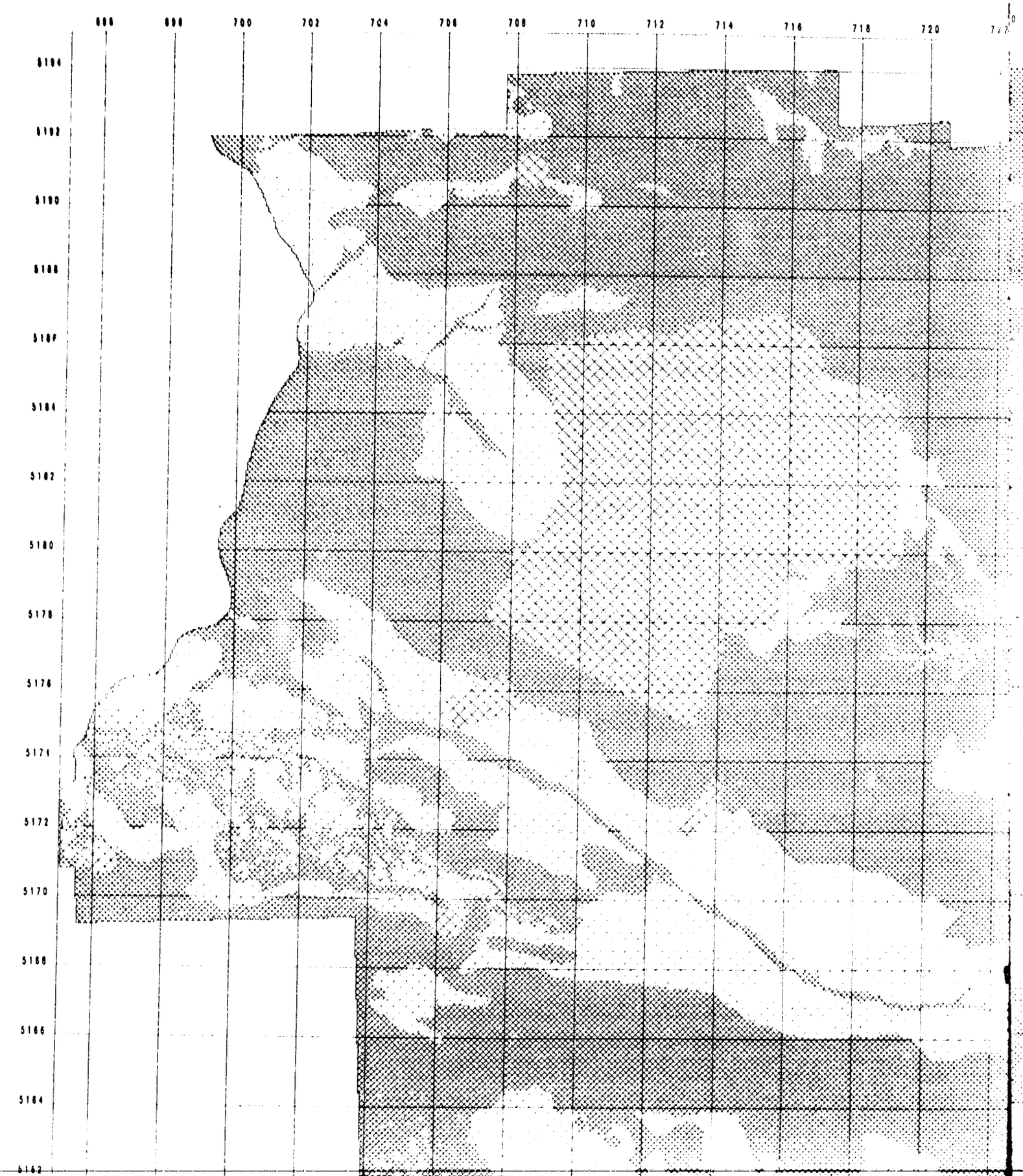
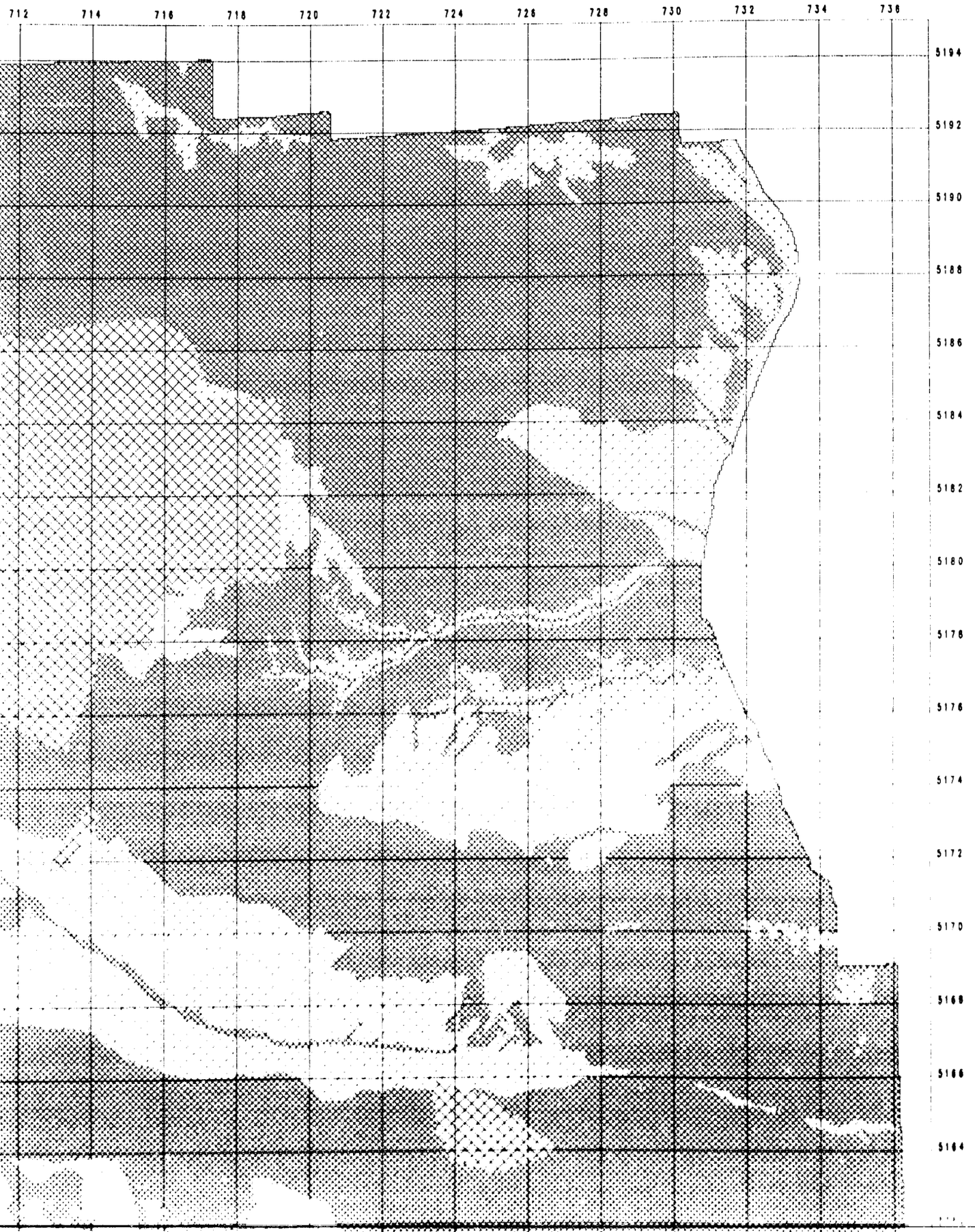


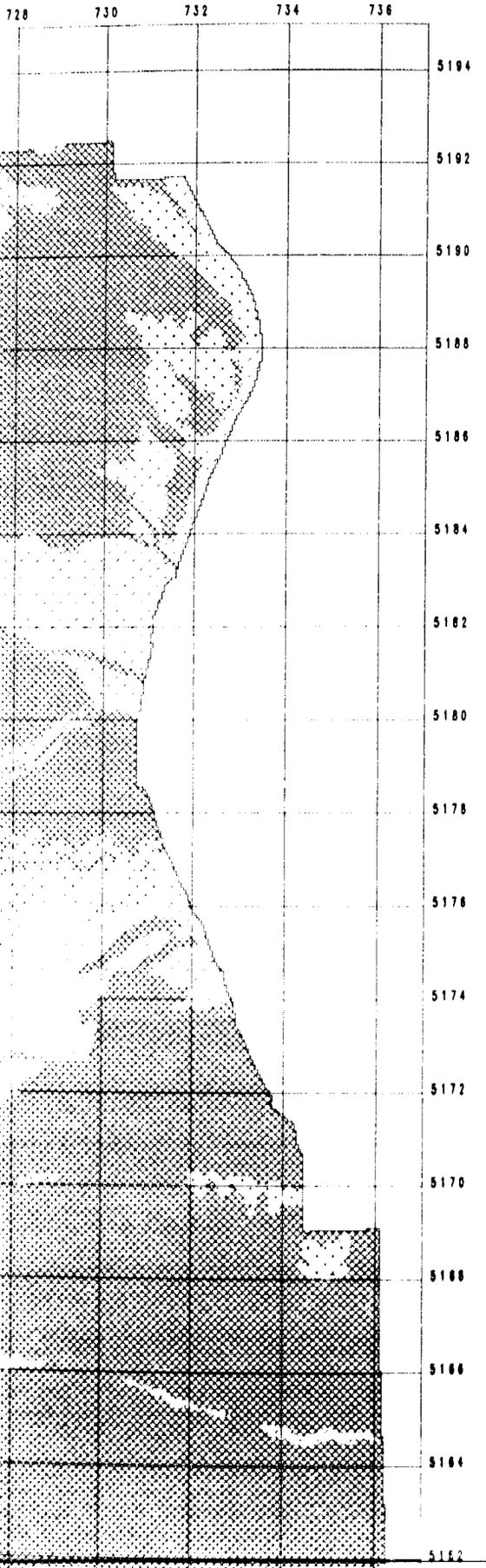
Plate 49. Rate of soil erosion for the 5-5-0 force structure in the wet-wet slippery surface condition for fifty passes



face condition for fifty passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

RATE OF SOIL EROSION
(TONS/ACRE/YEAR)

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
WET-WET SEASON
SLIPPERY CONDITION
1000 PASSES

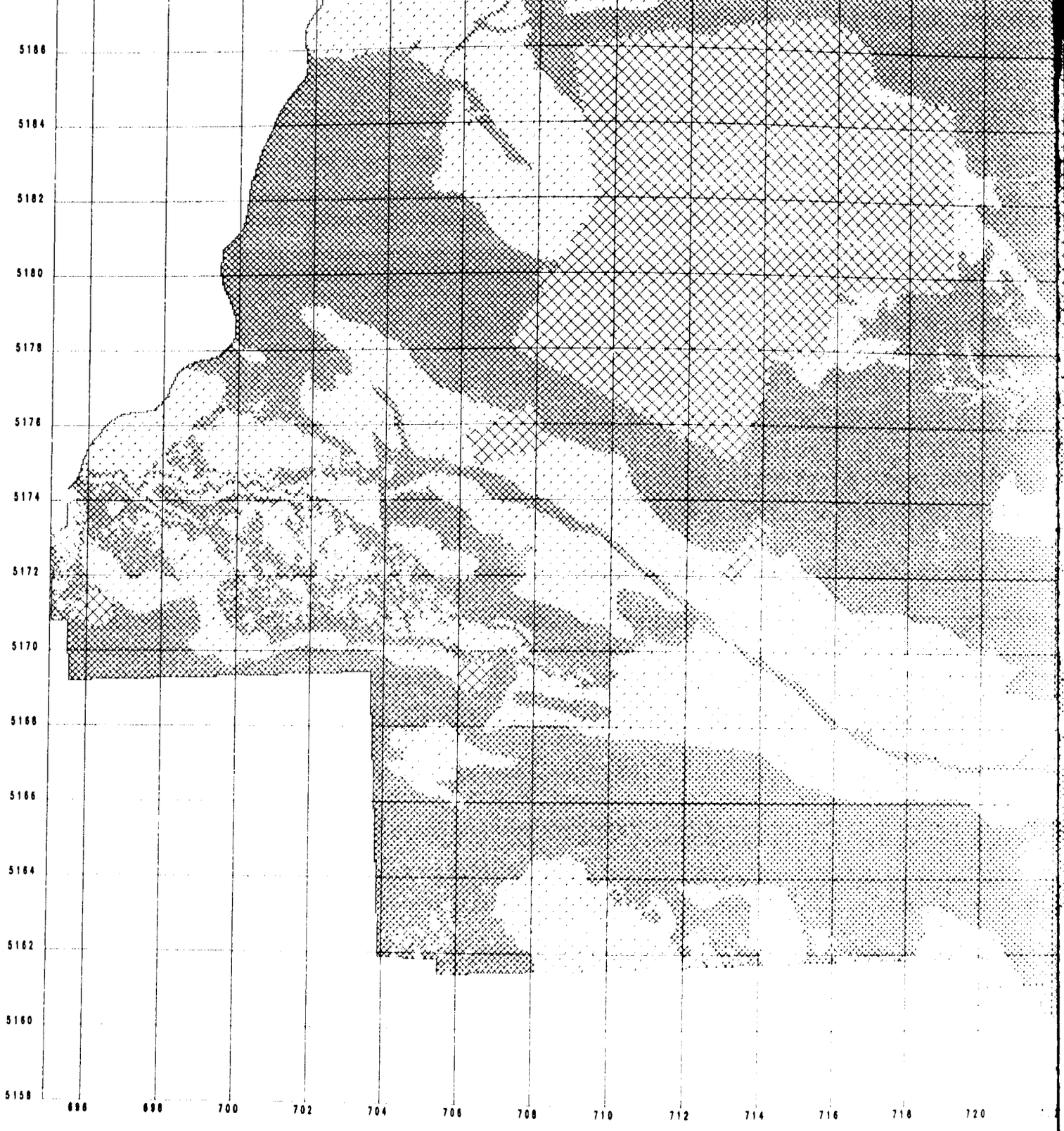
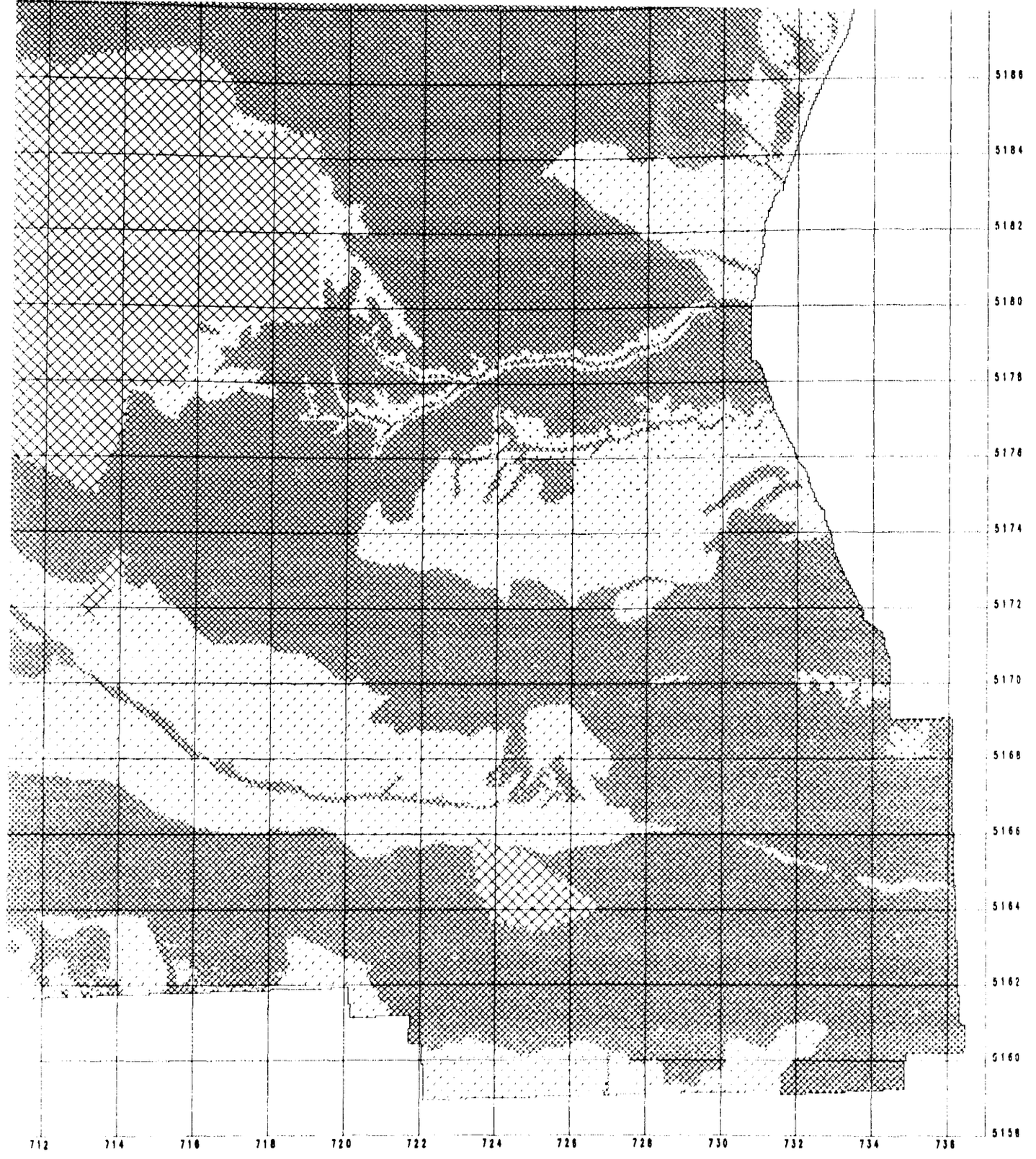
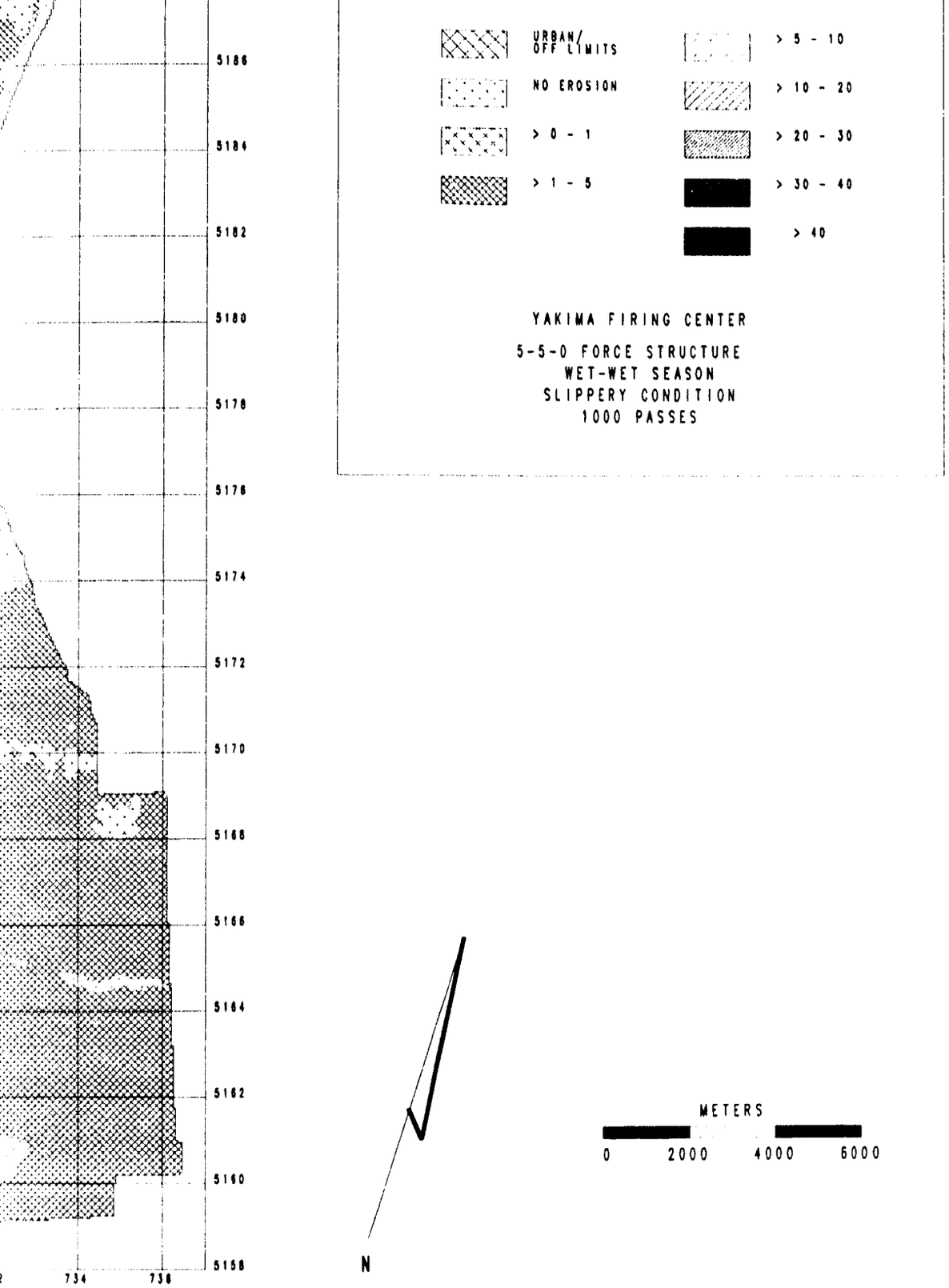


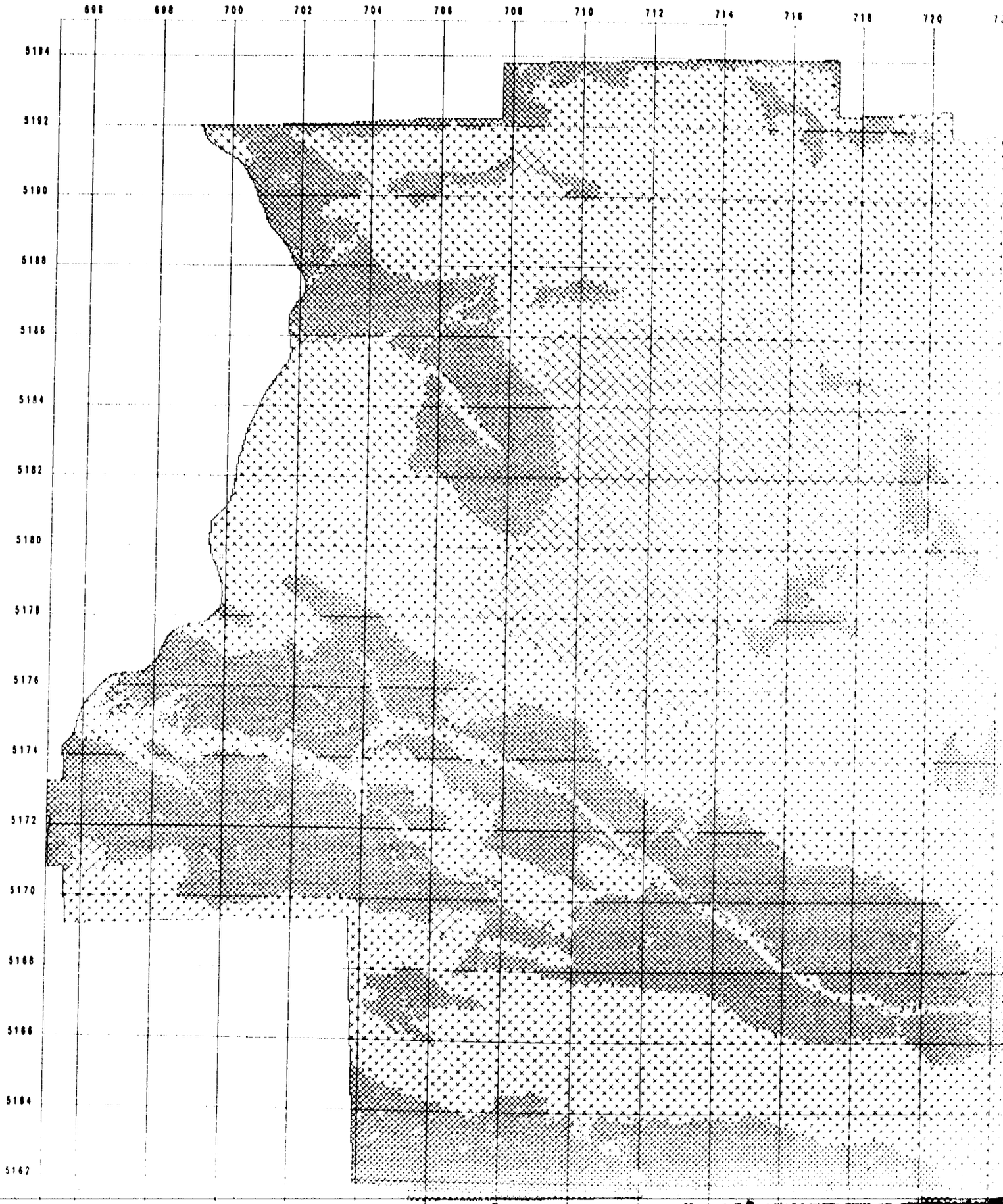
Plate 50. Rate of soil erosion for the 5-5-0 force structure in



soil erosion for the 5-5-0 force structure in the wet-wet slippery surface condition for one thousand passes

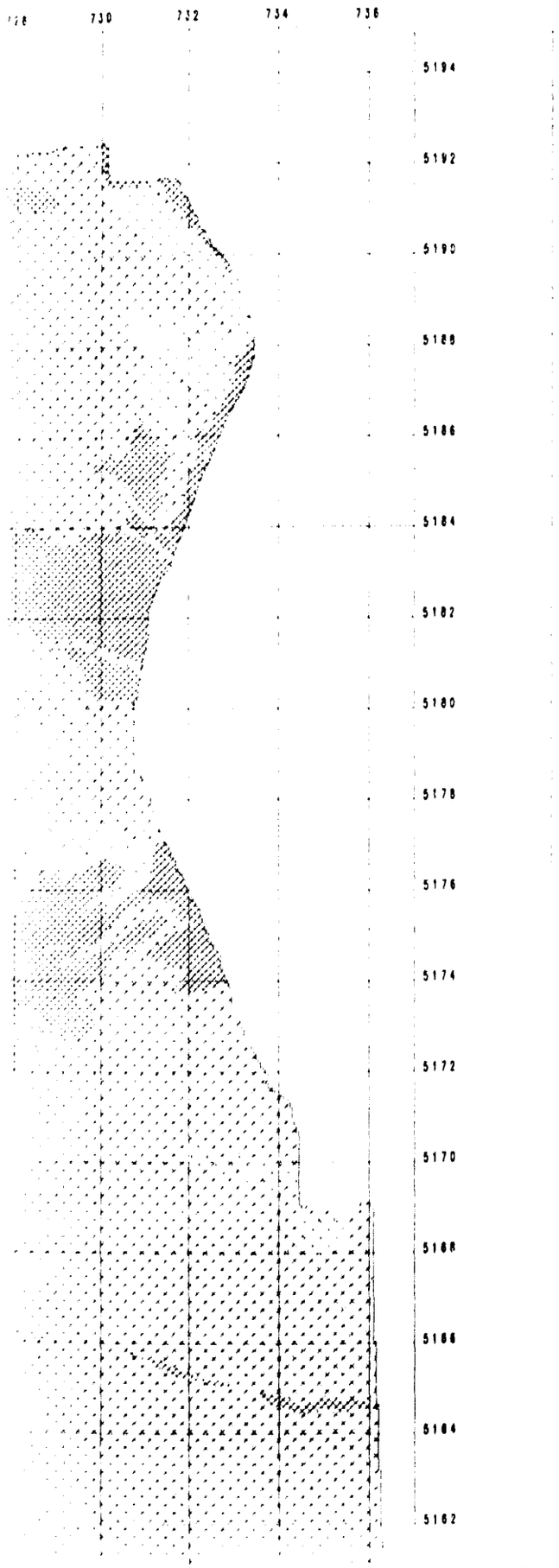


for one thousand passes


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TOTAL POSSIB.



U. S. Army Corps of Engineers
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SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
10 PASSES

METERS

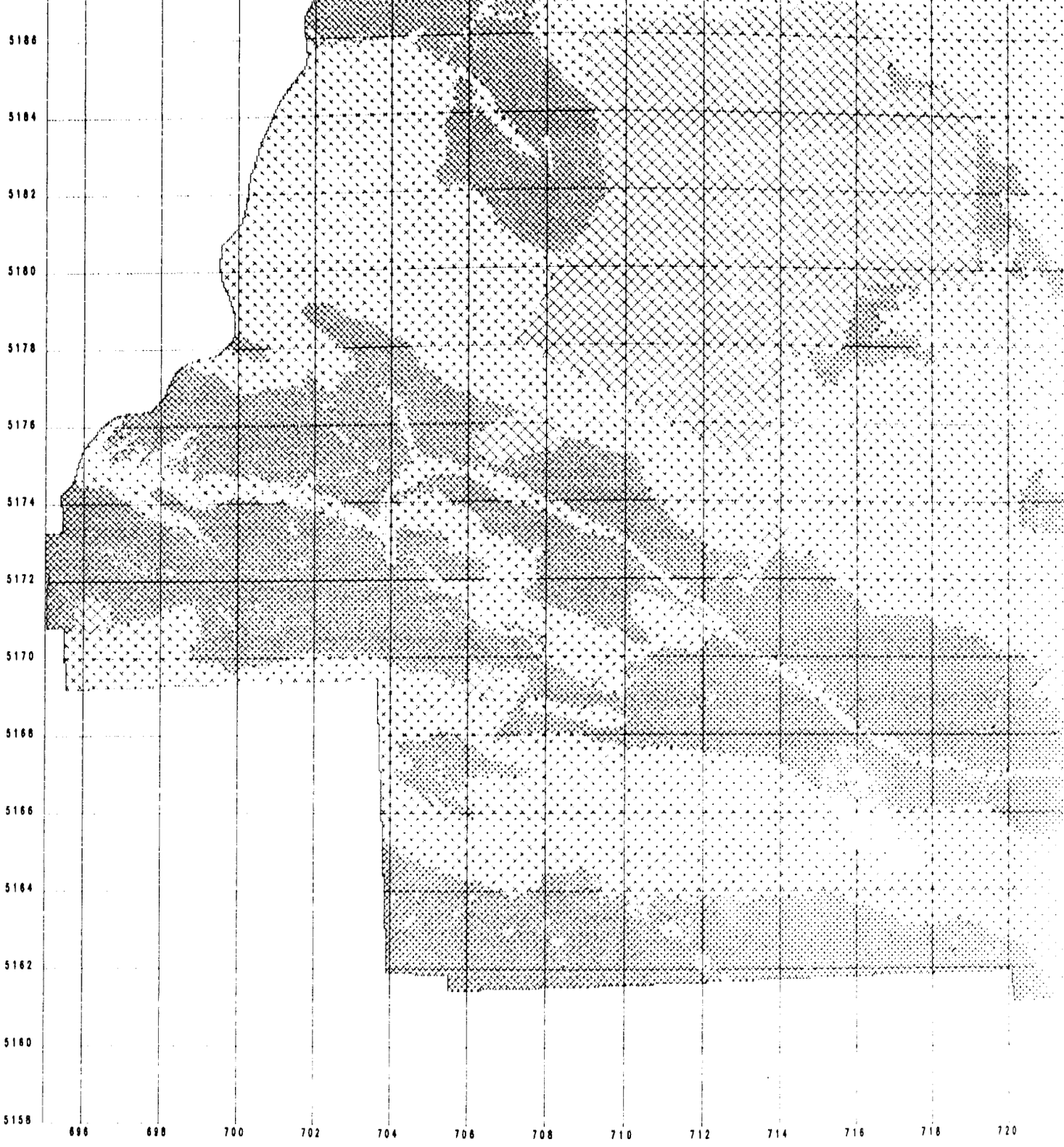


Plate 51. Soil erosion severity for 3-3-

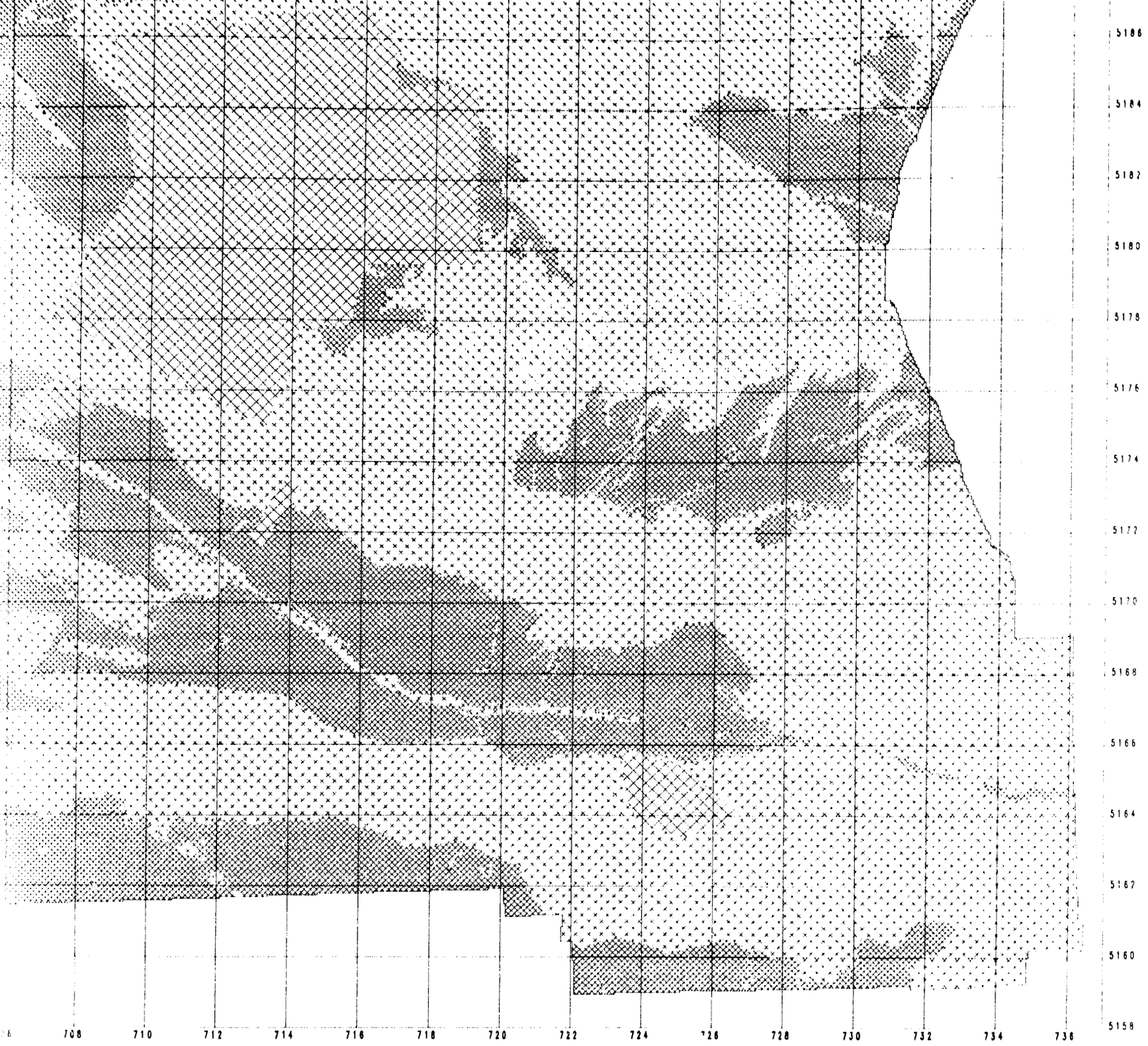
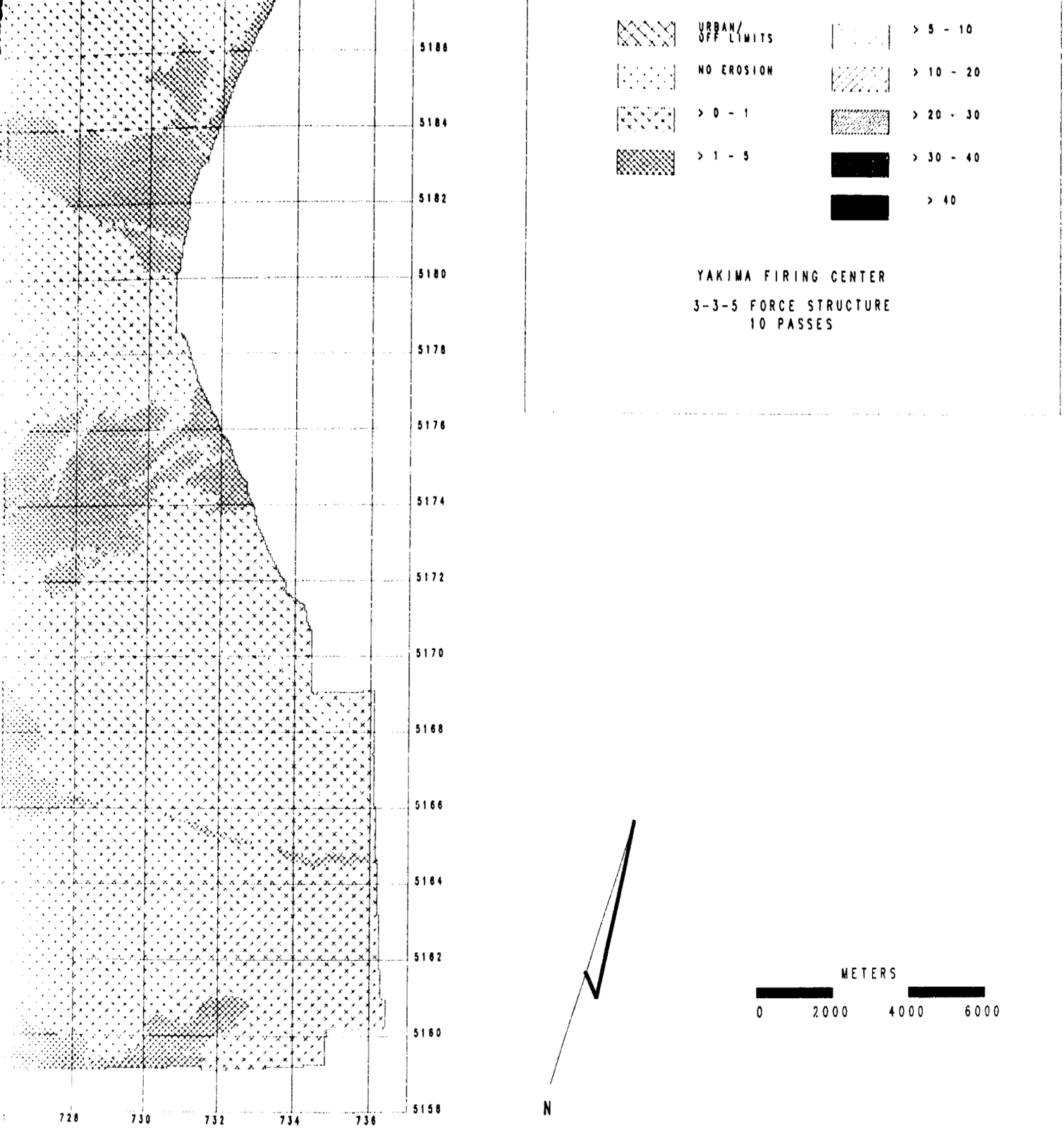
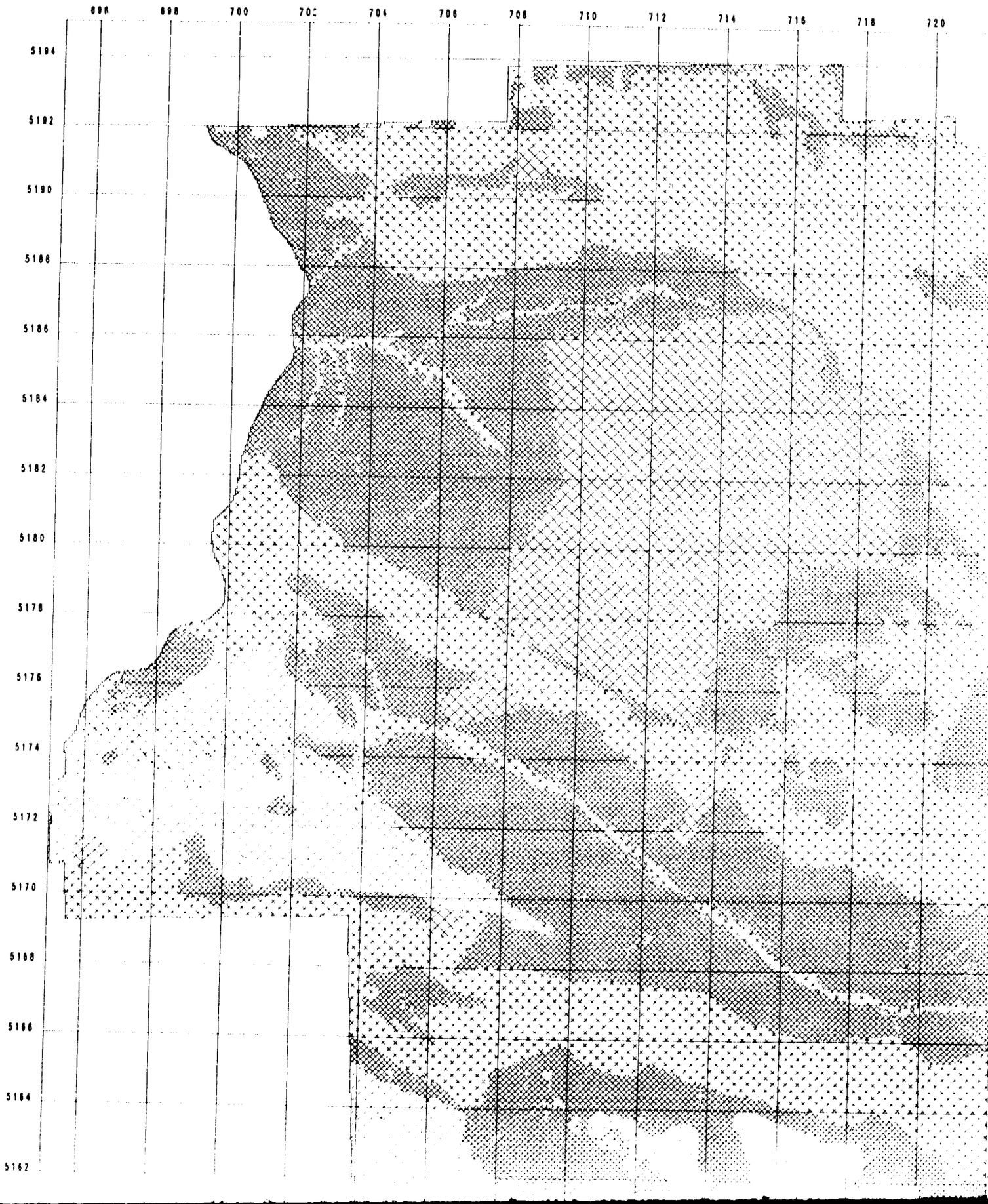
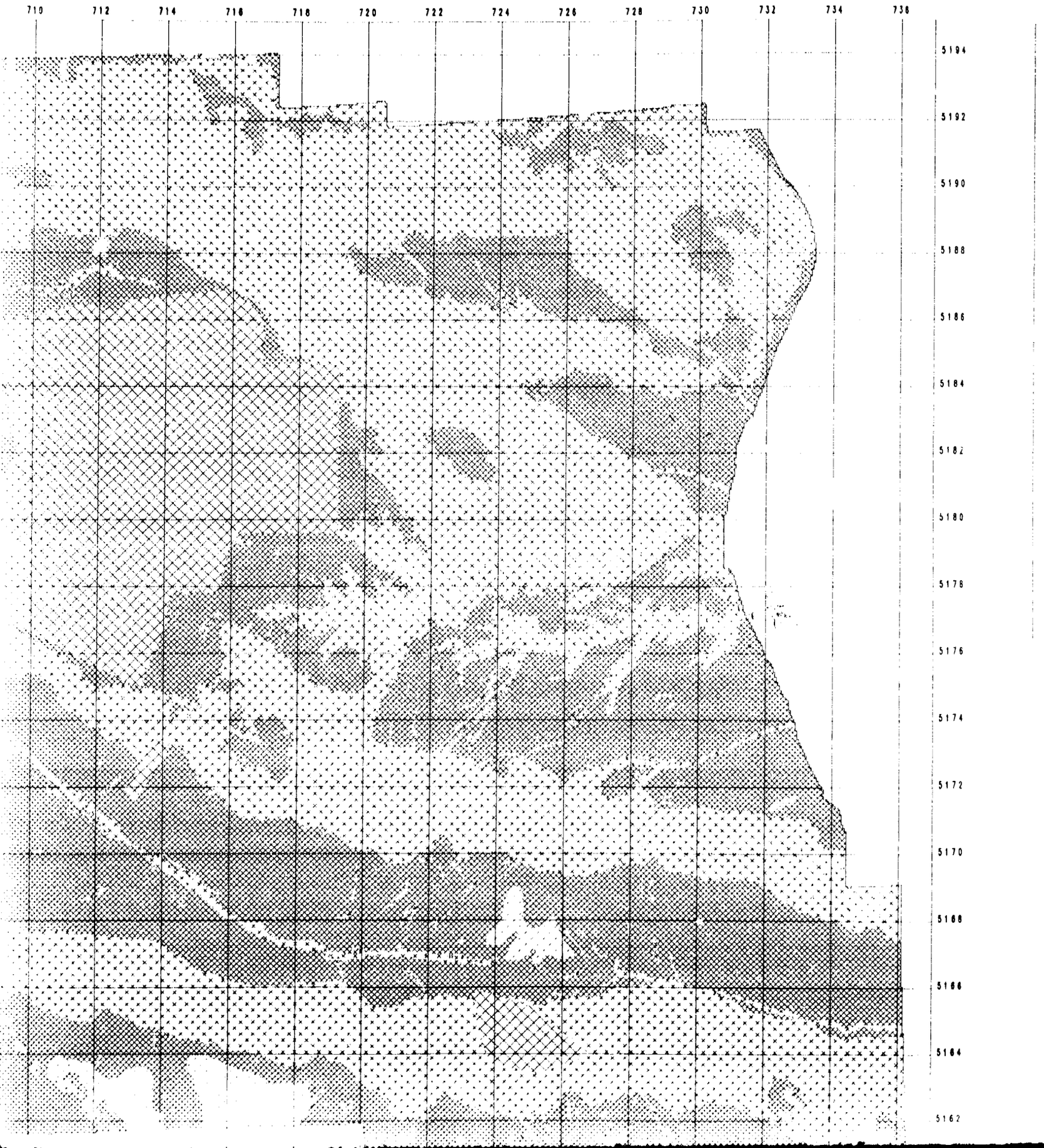


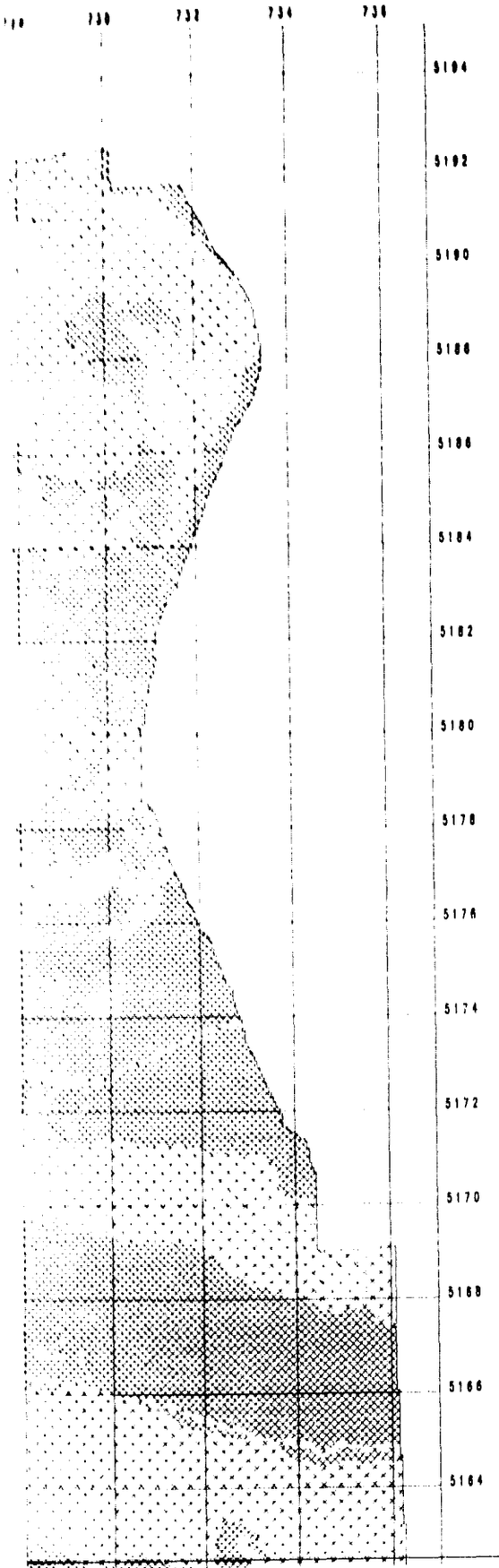
Plate 51. Soil erosion severity for 3-3-5 and 4-3-3 (HMMWV) force structures for ten passes



') force structures for ten passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

- URBAN/ OFF LIMITS
- NO EROSION
- > 0 - 1
- > 1 - 5
- > 5 - 10
- > 10 - 20
- > 20 - 30
- > 30 - 40
- > 40

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
50 PASSES

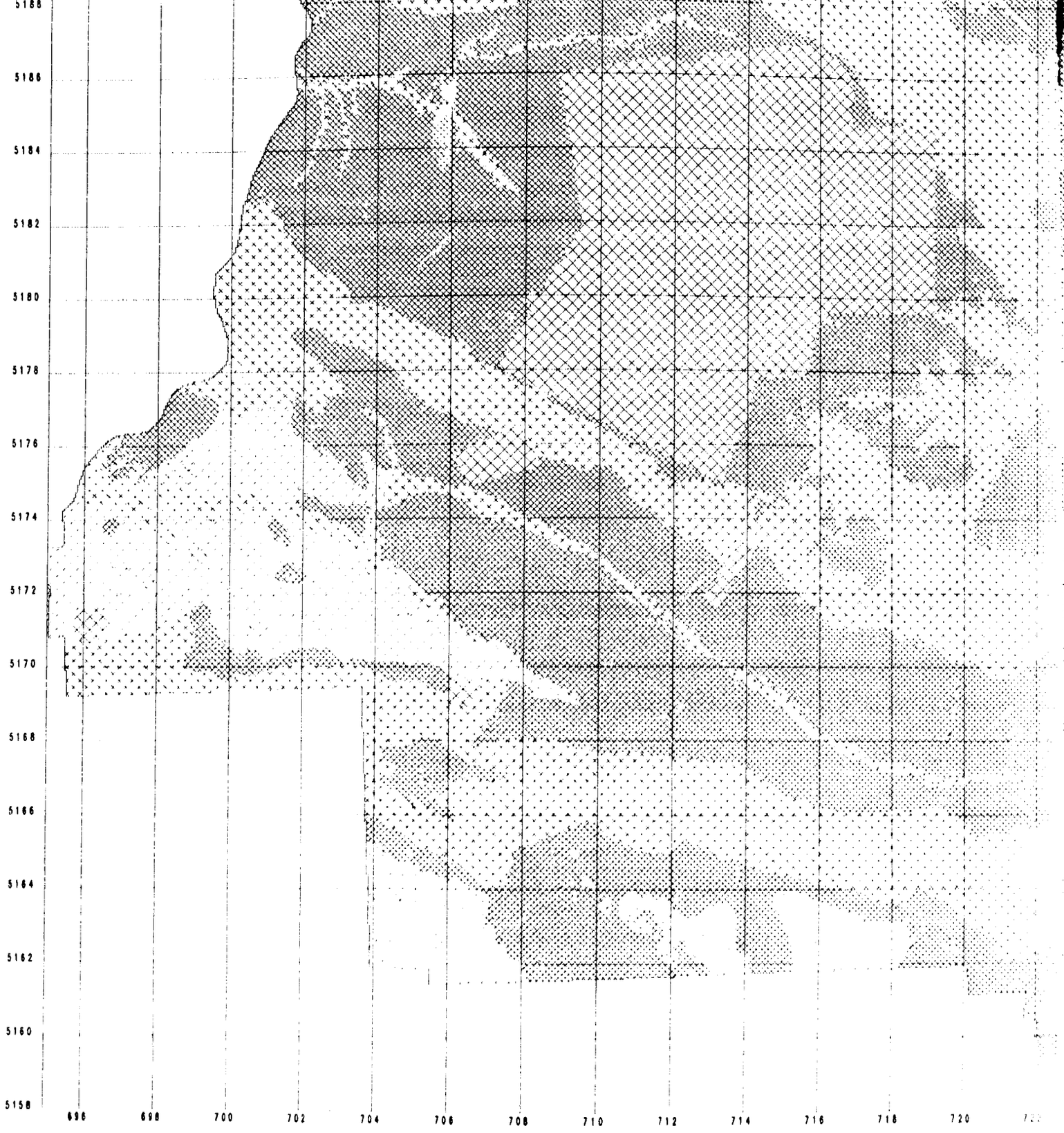


Plate 52. Soil erosion severity for 3-3-5

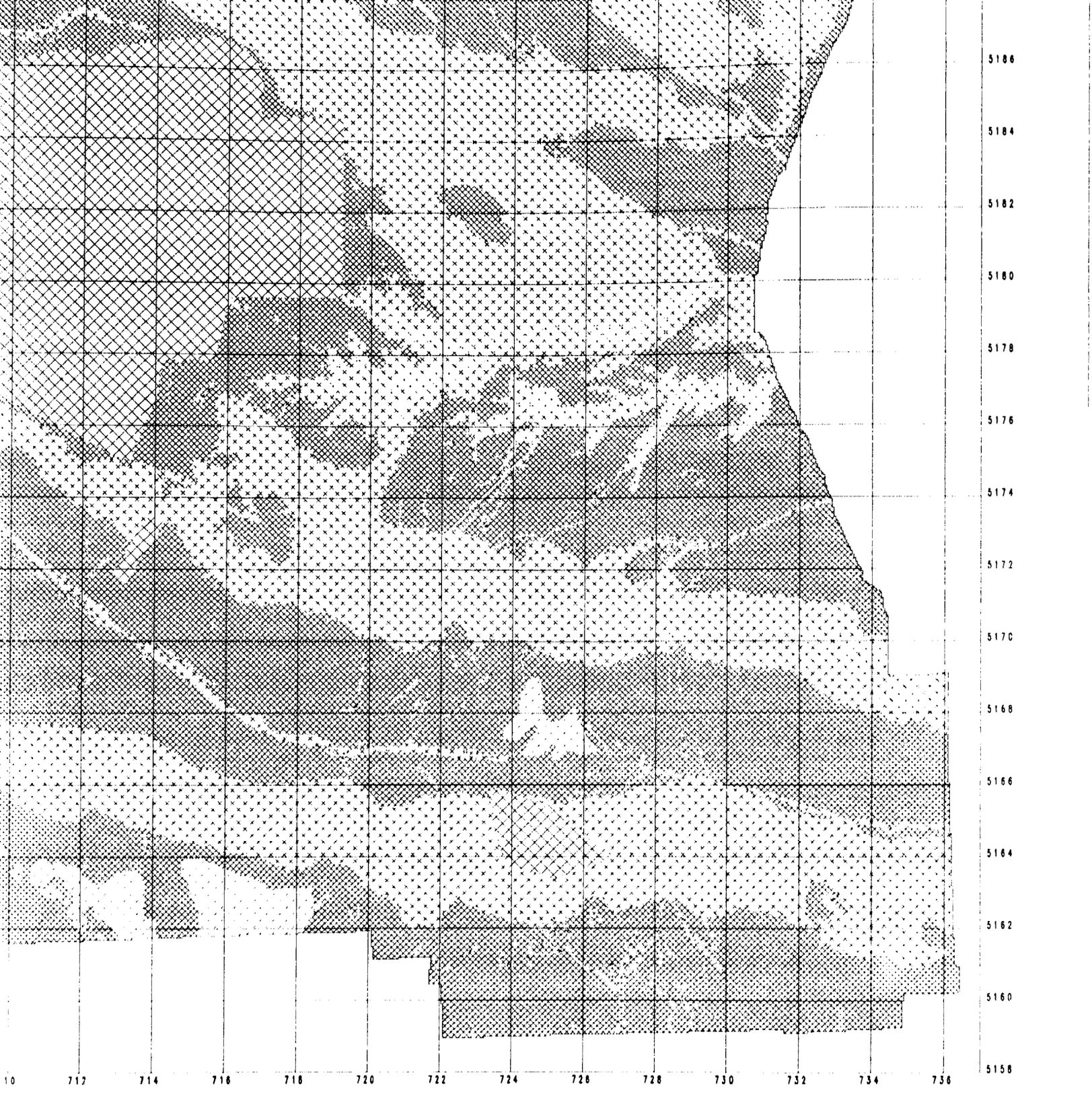
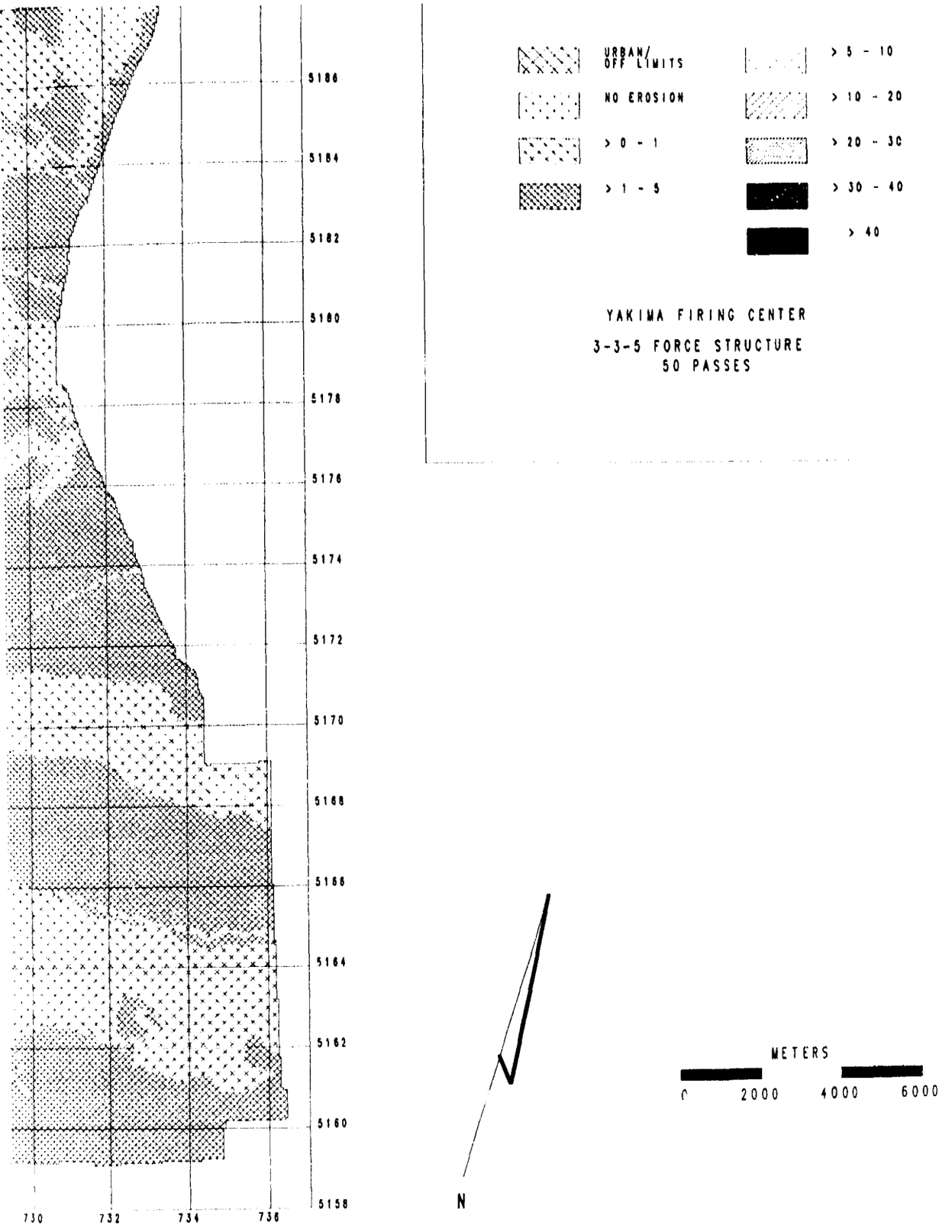
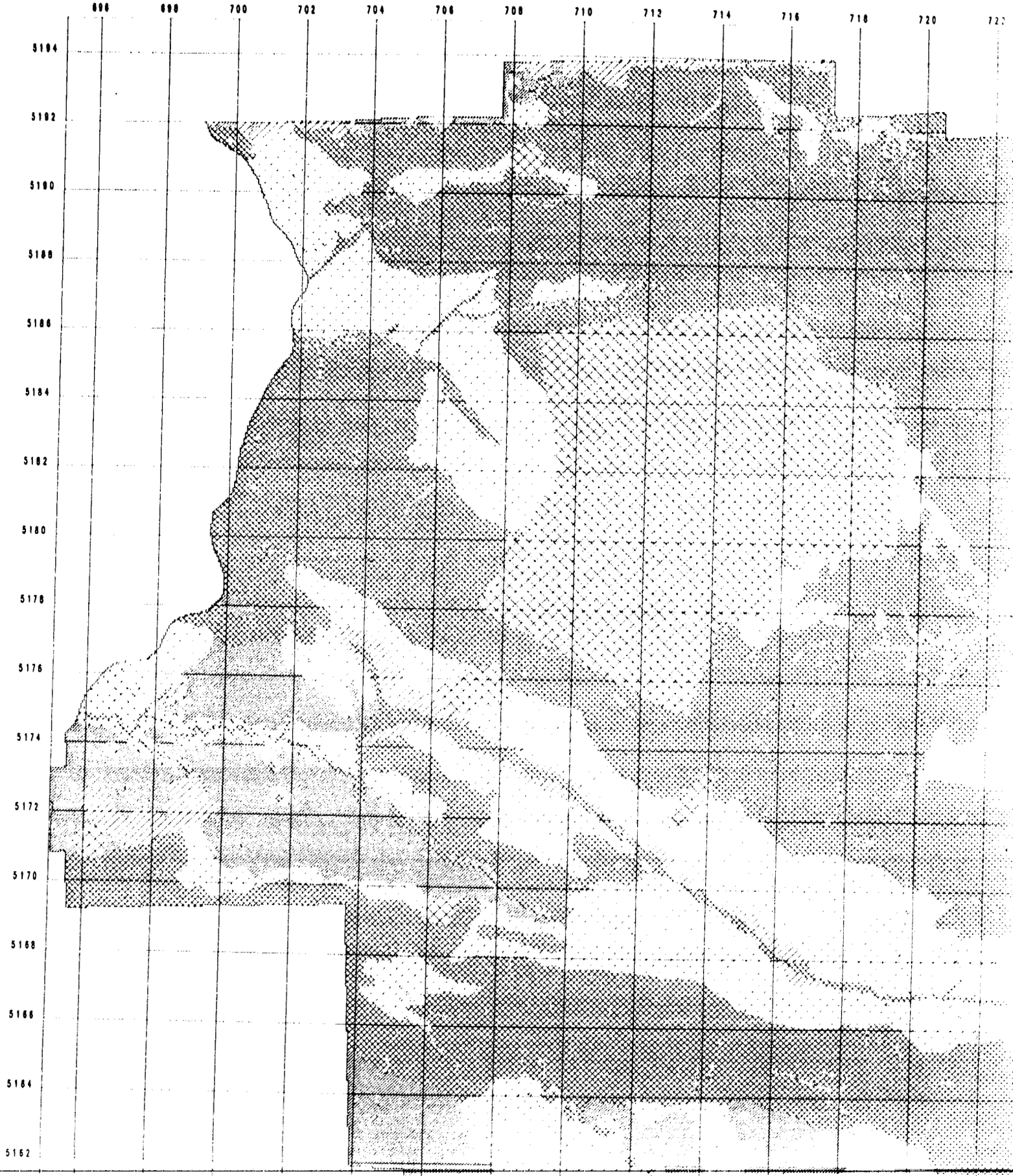
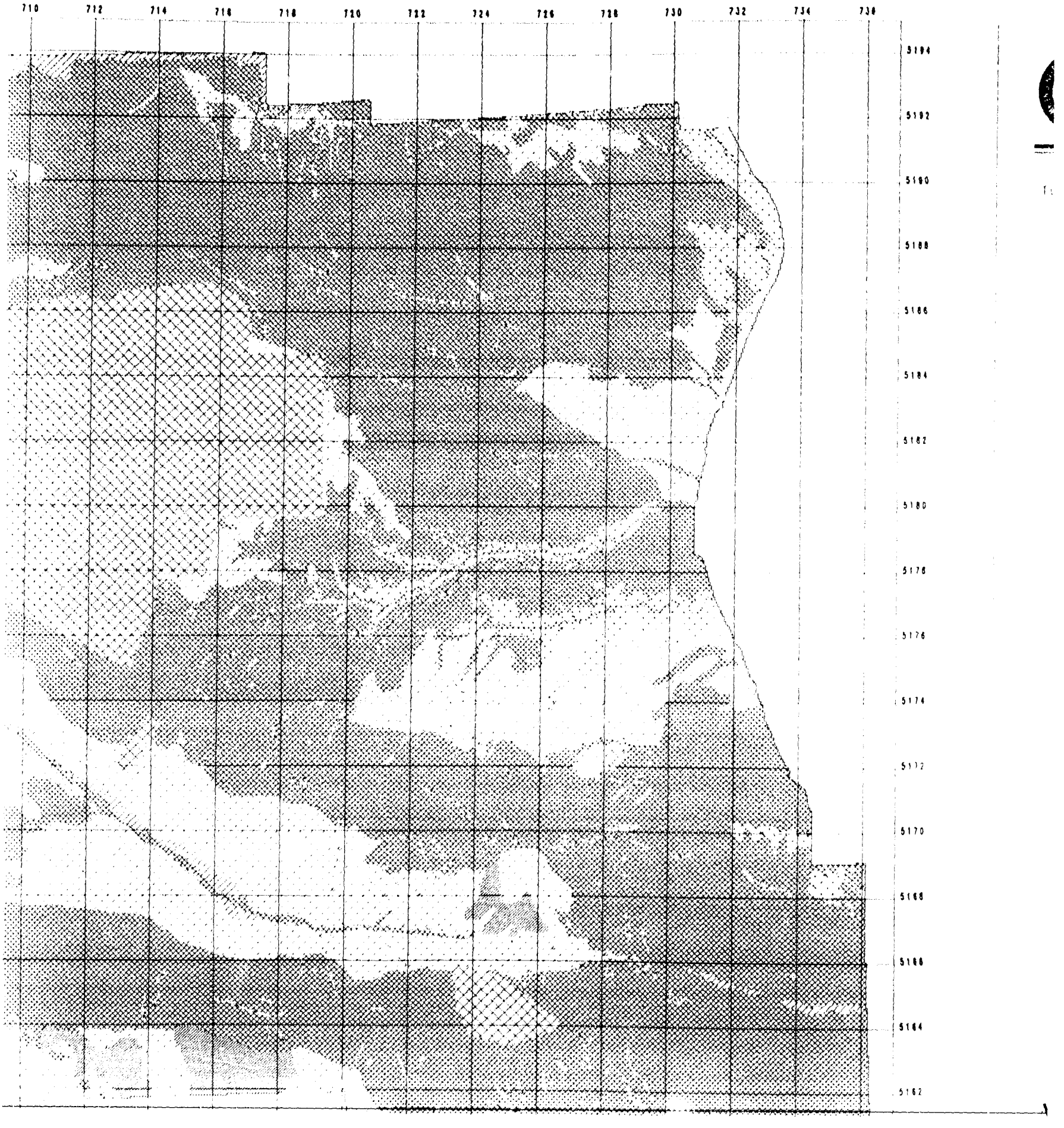


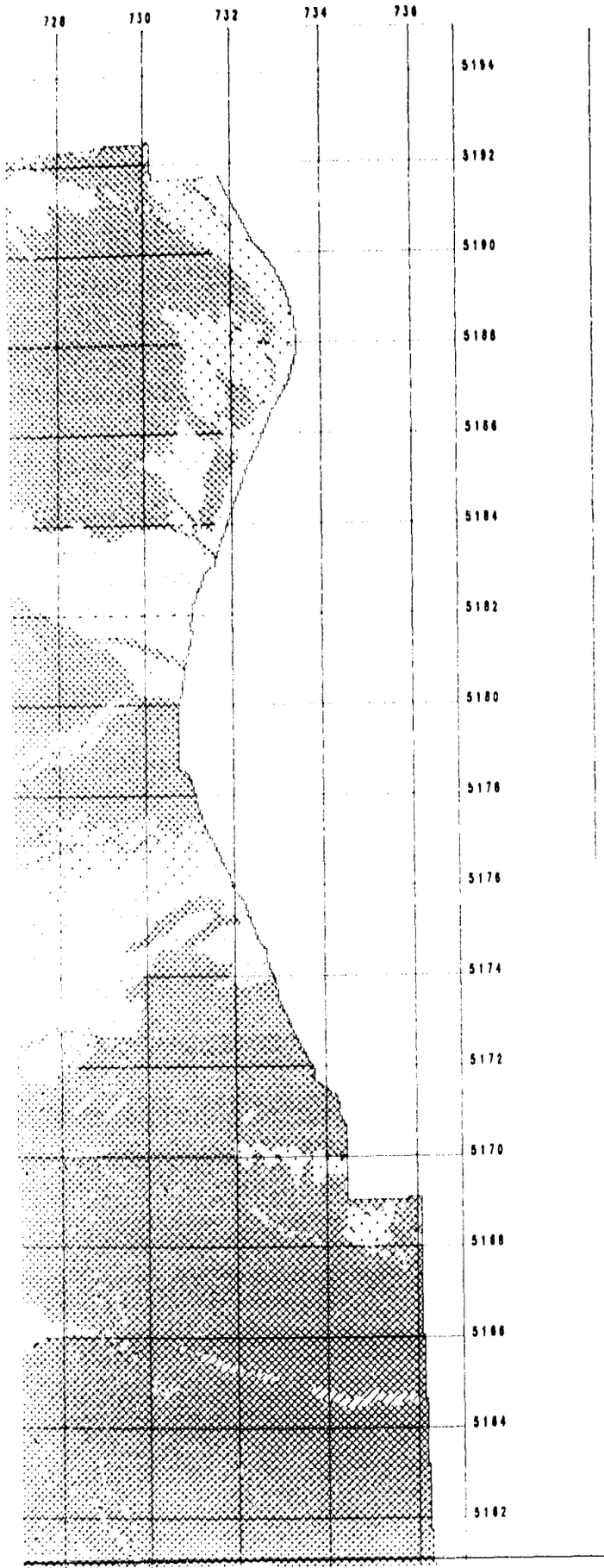
Plate 52. Soil erosion severity for 3-3-5 and 4-3-3 (HMMWV) force structures for fifty passes



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U. S. Army Corps of Engineers
Waterways
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Station

SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

3-3-5 FORCE STRUCTURE
1000 PASSES

METERS

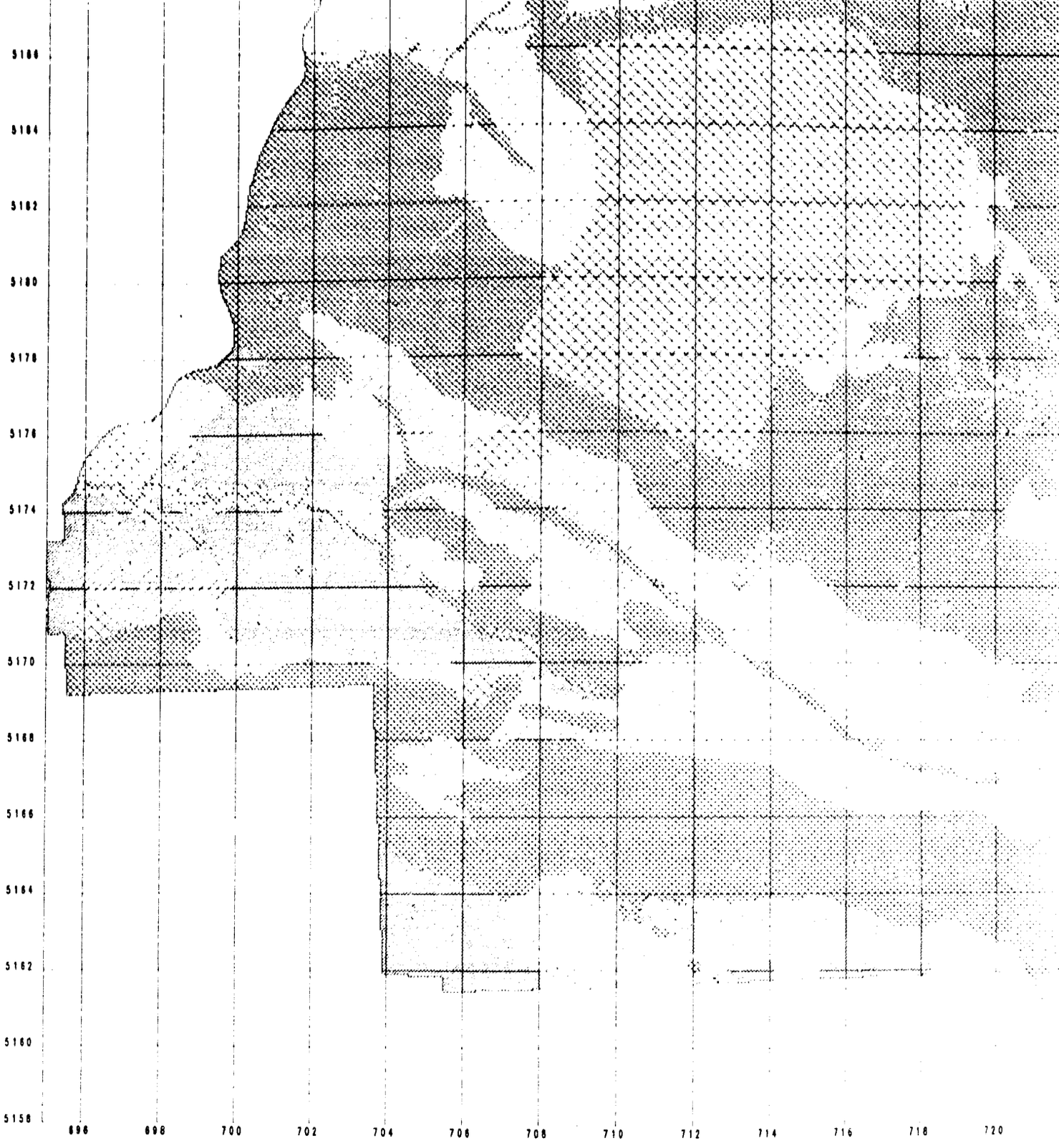


Plate 53. Soil erosion severity for 3-3-5 and

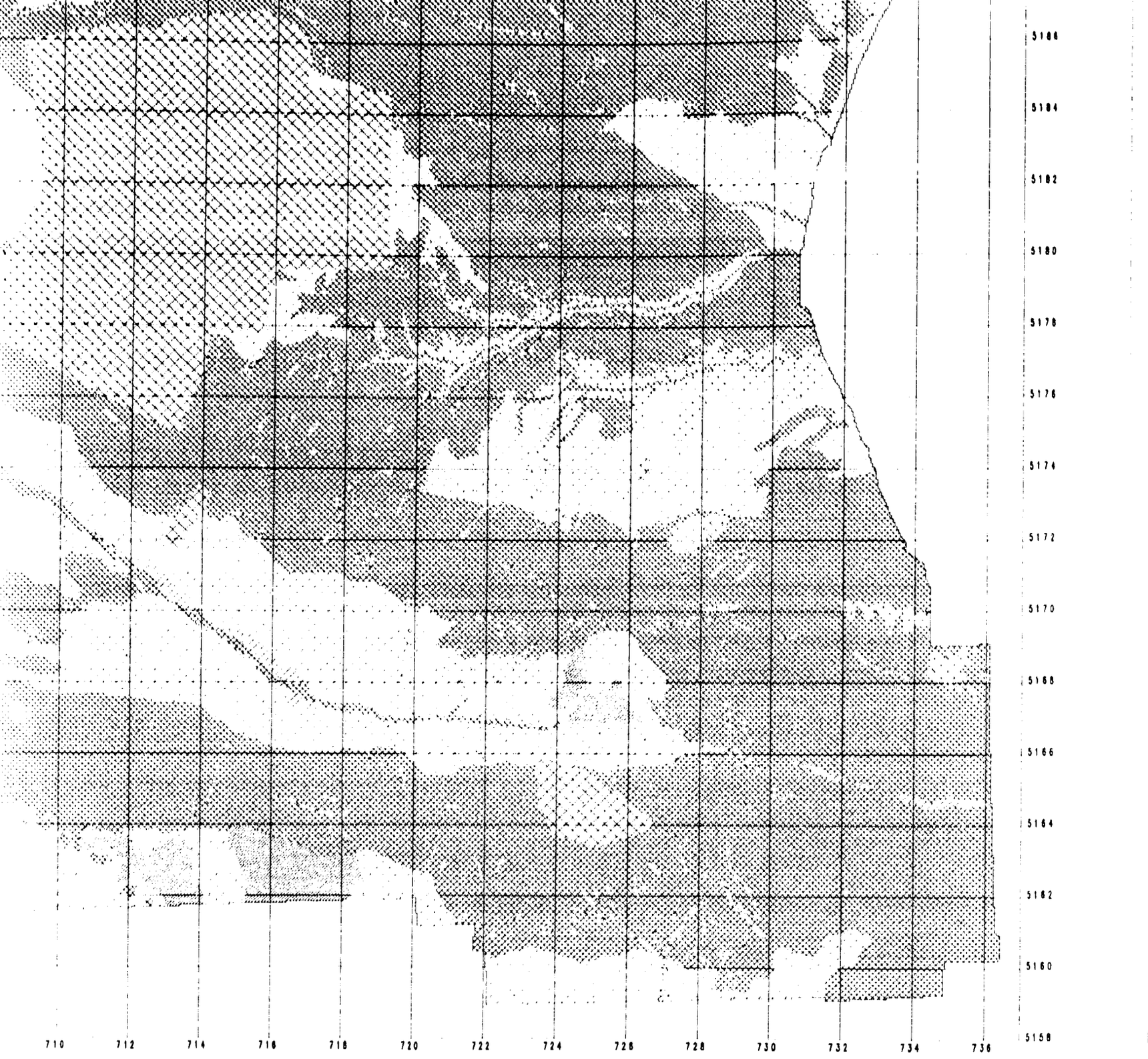
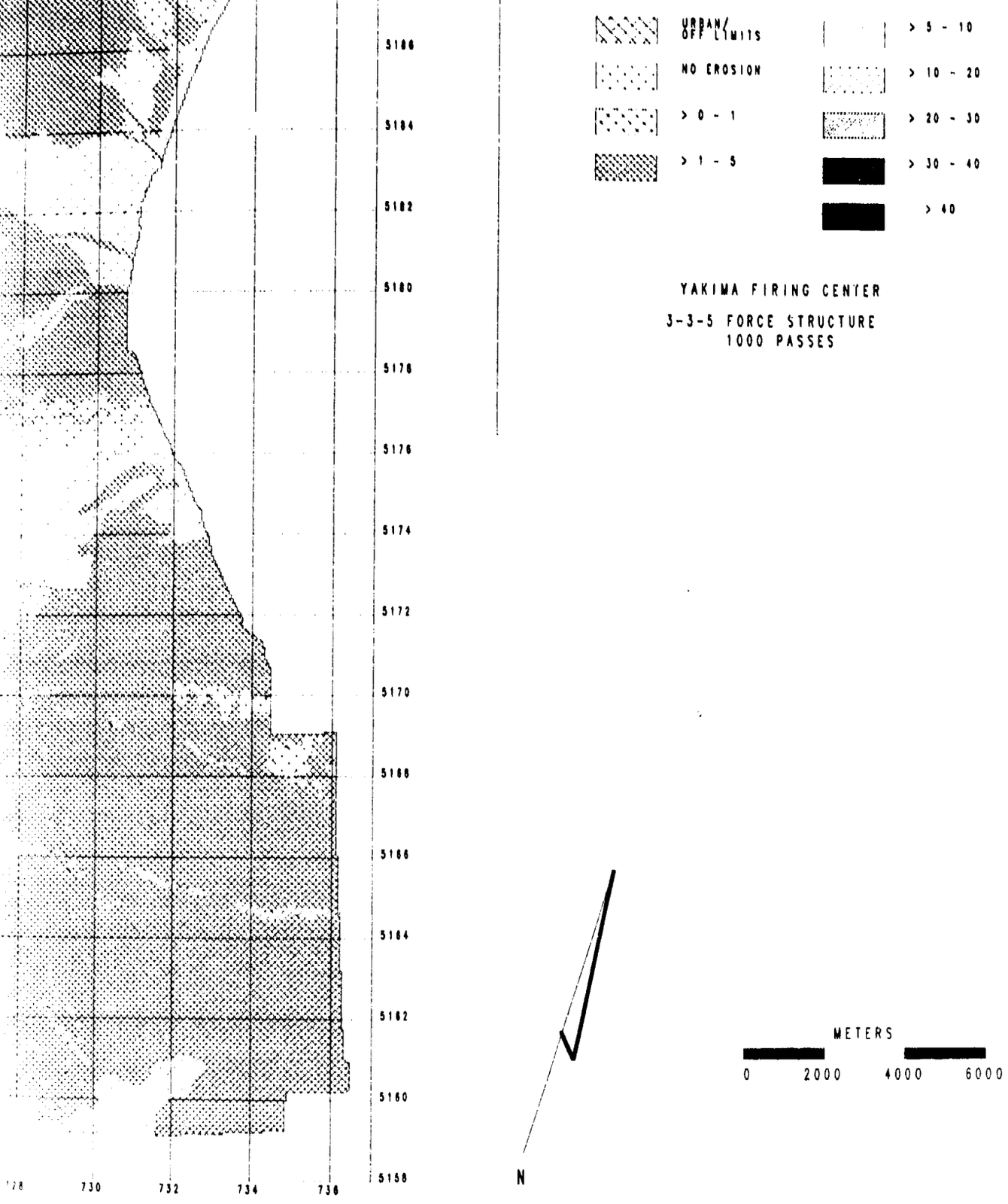
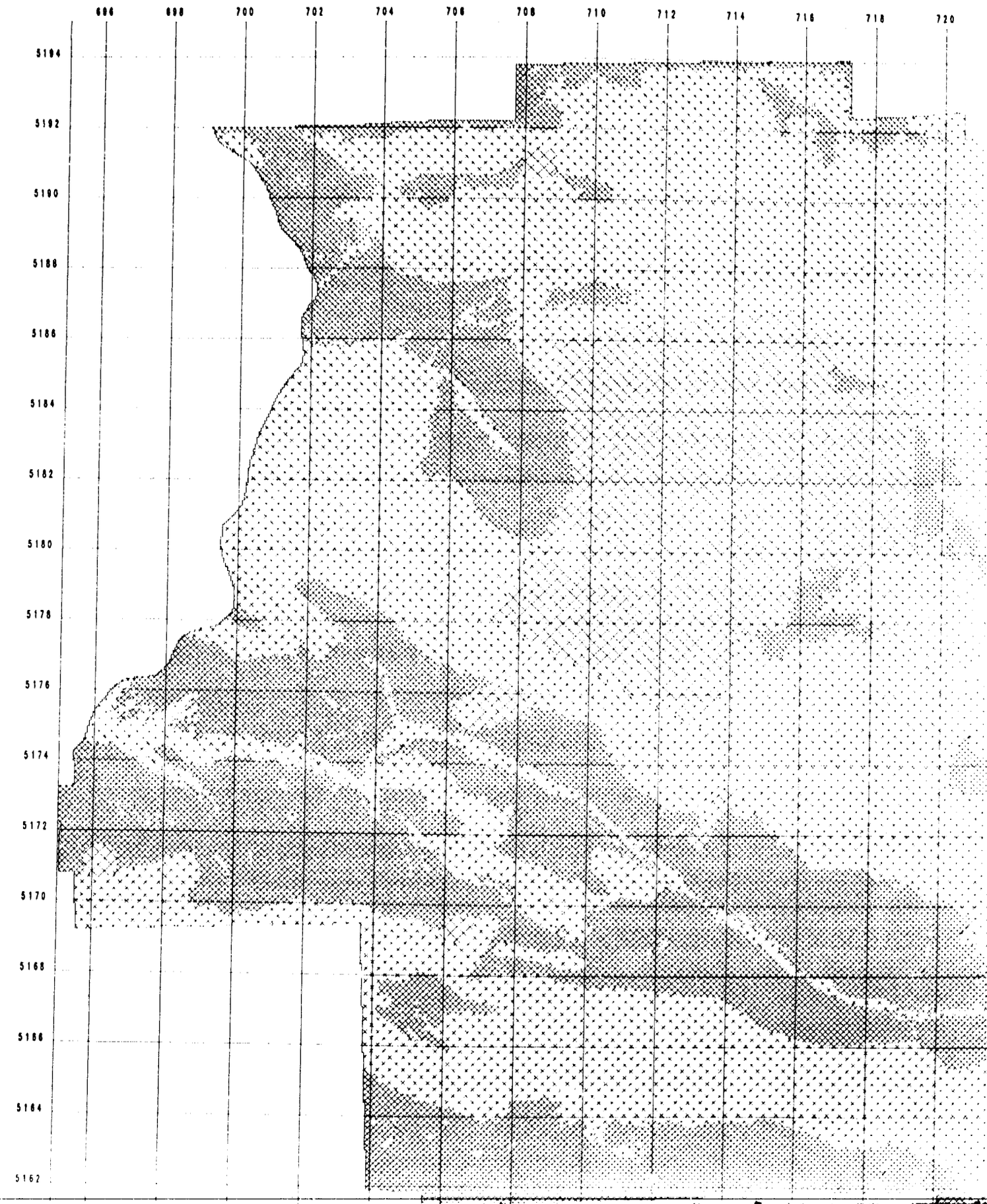
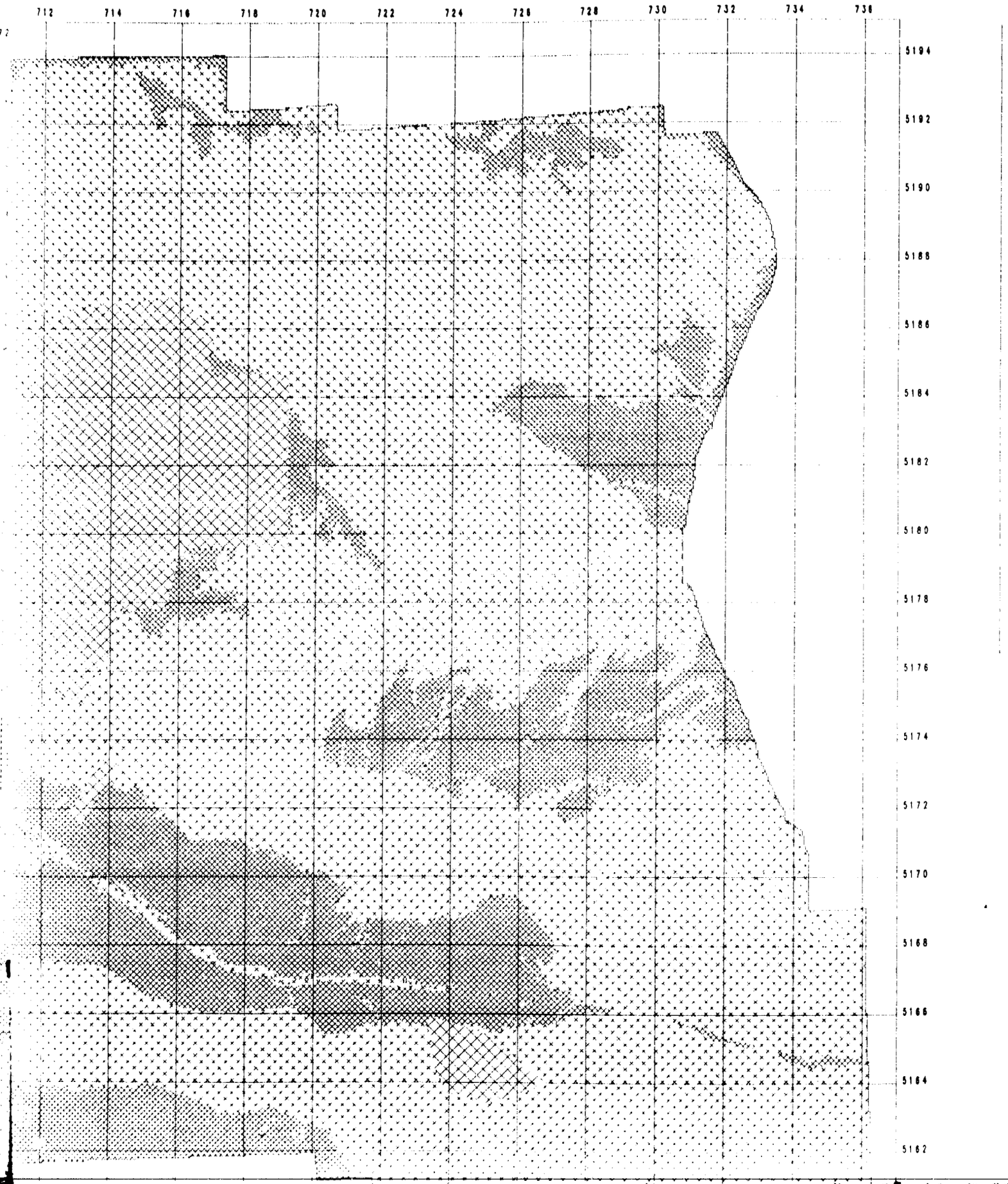


Plate 53. Soil erosion severity for 3-3-5 and 4-3-3 (HMMWV) force structures for one thousand passes

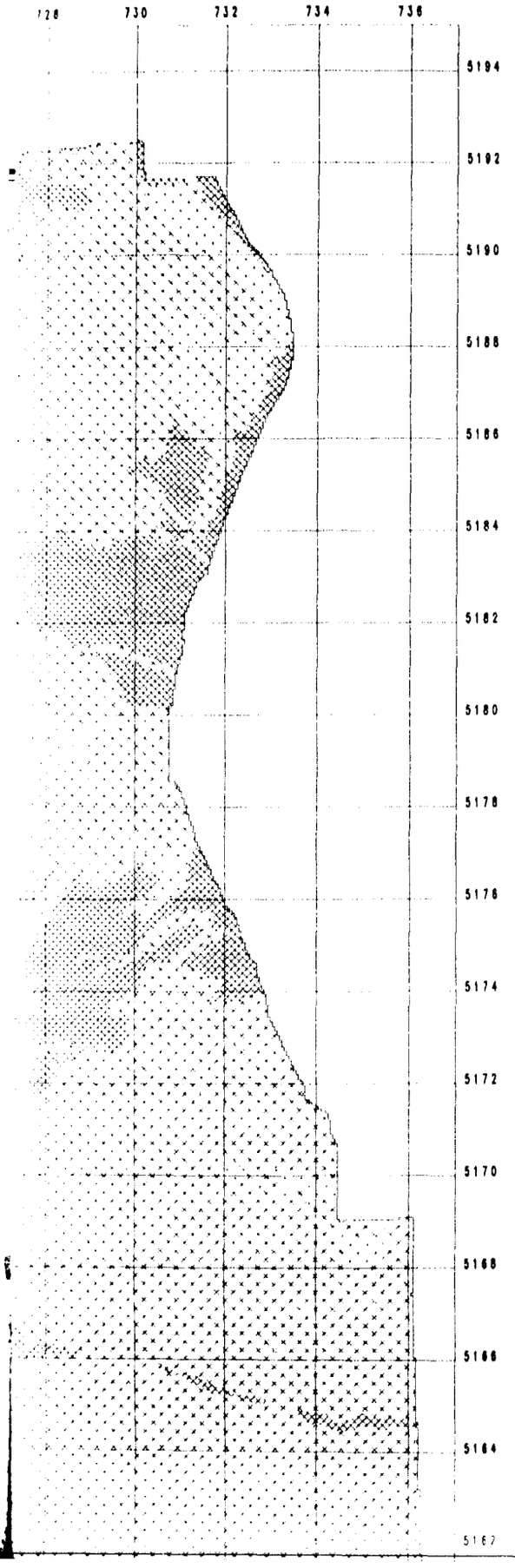


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TOTAL P



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SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
10 PASSES

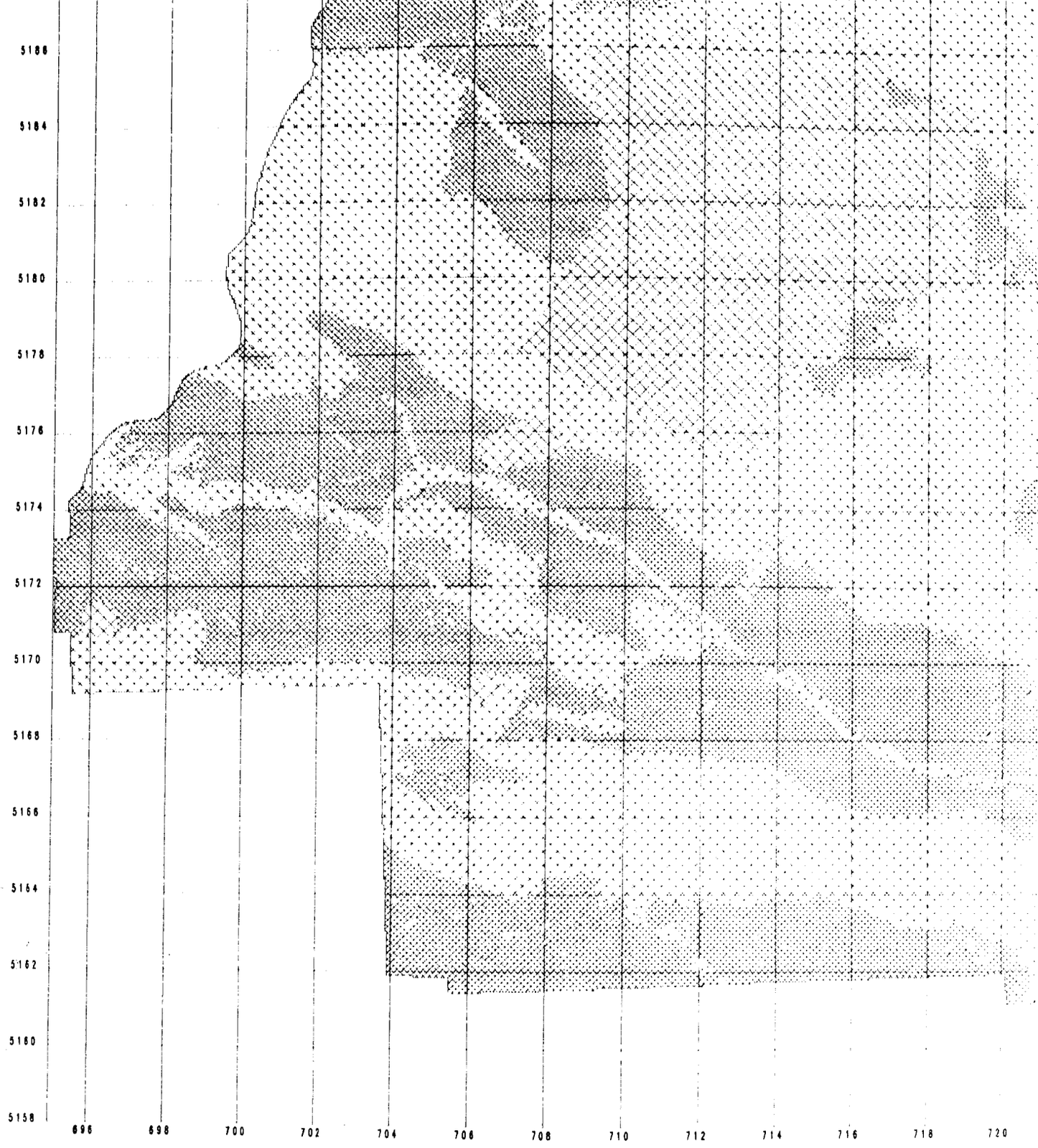


Plate 54. Soil erosion severit

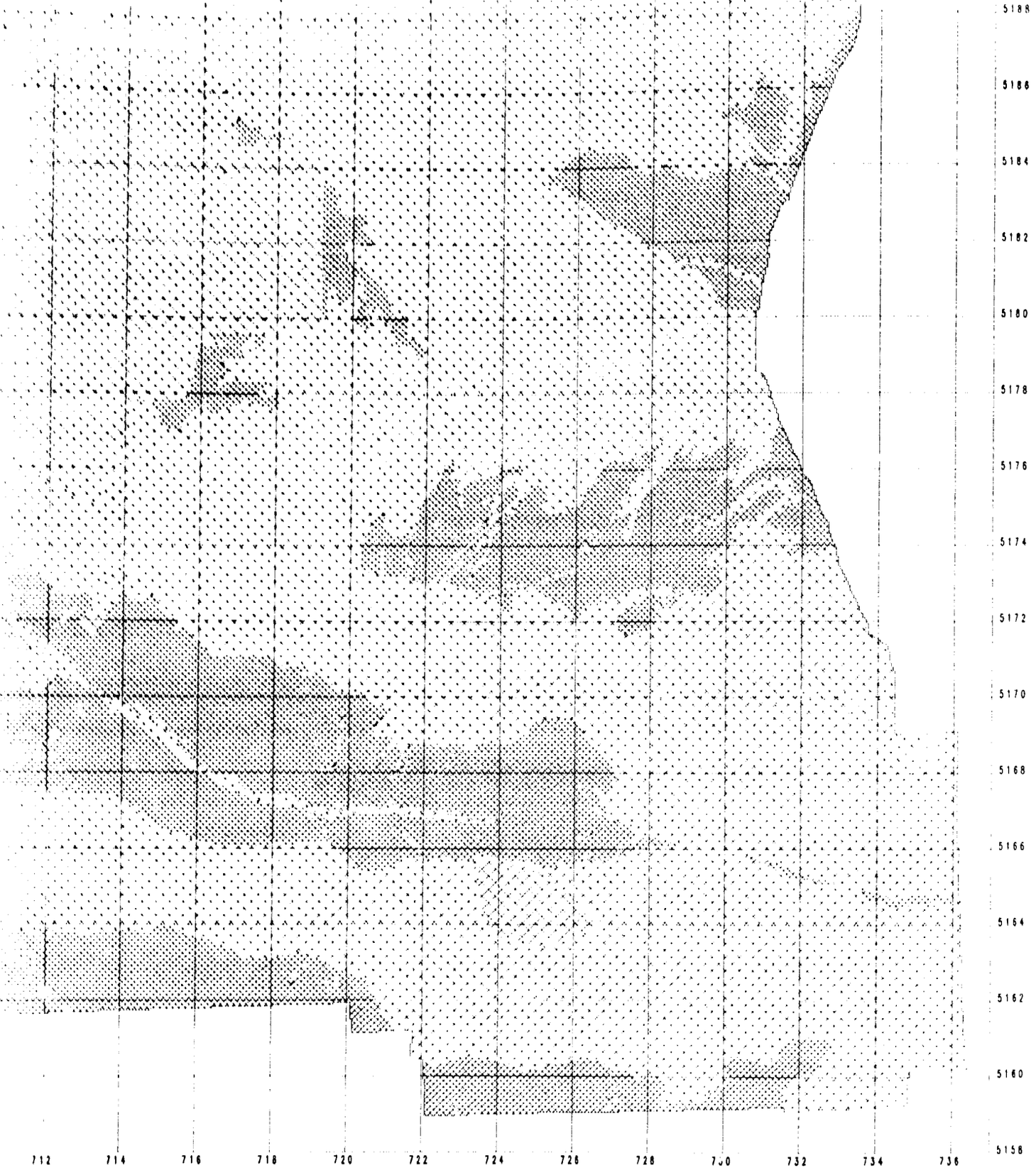
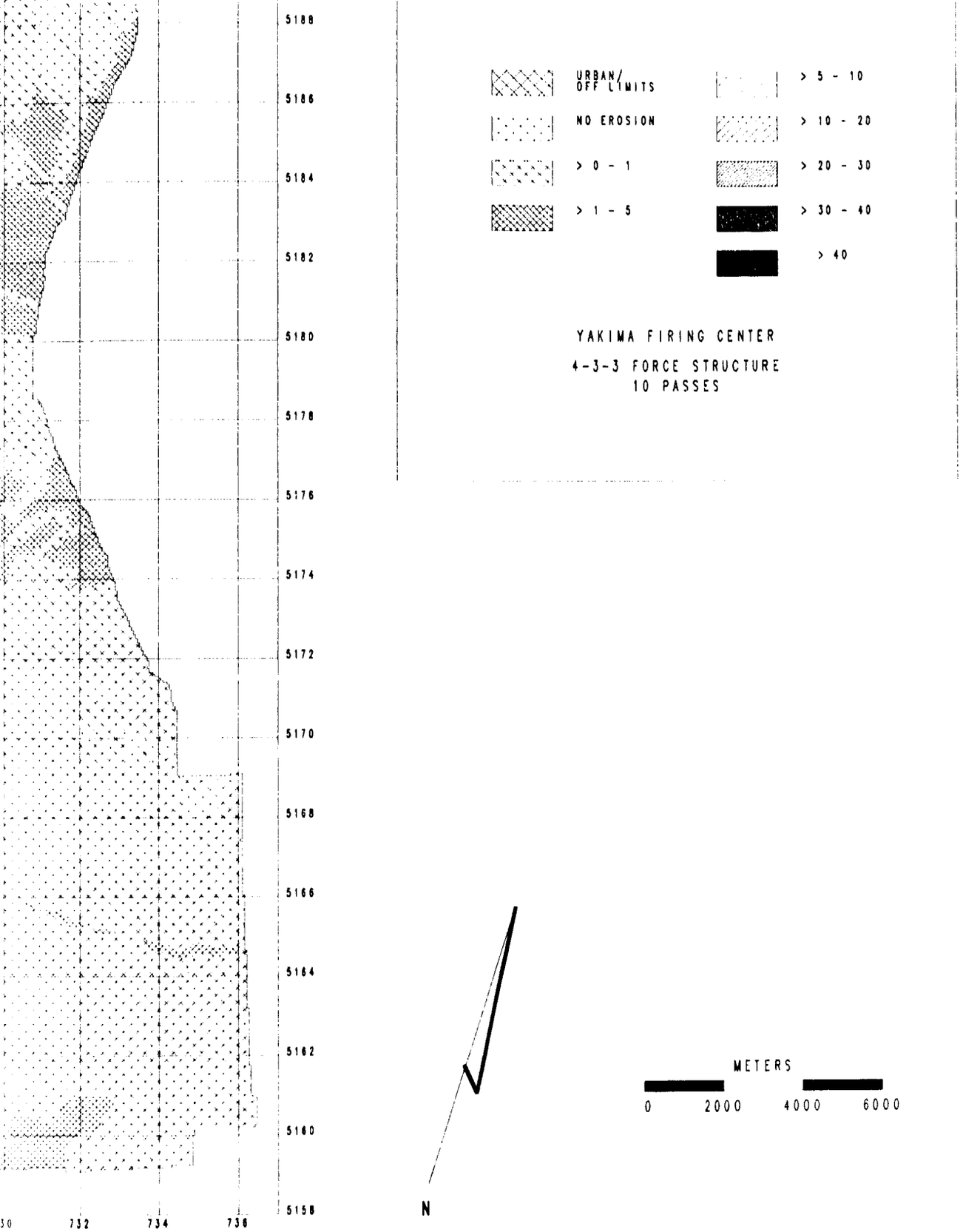
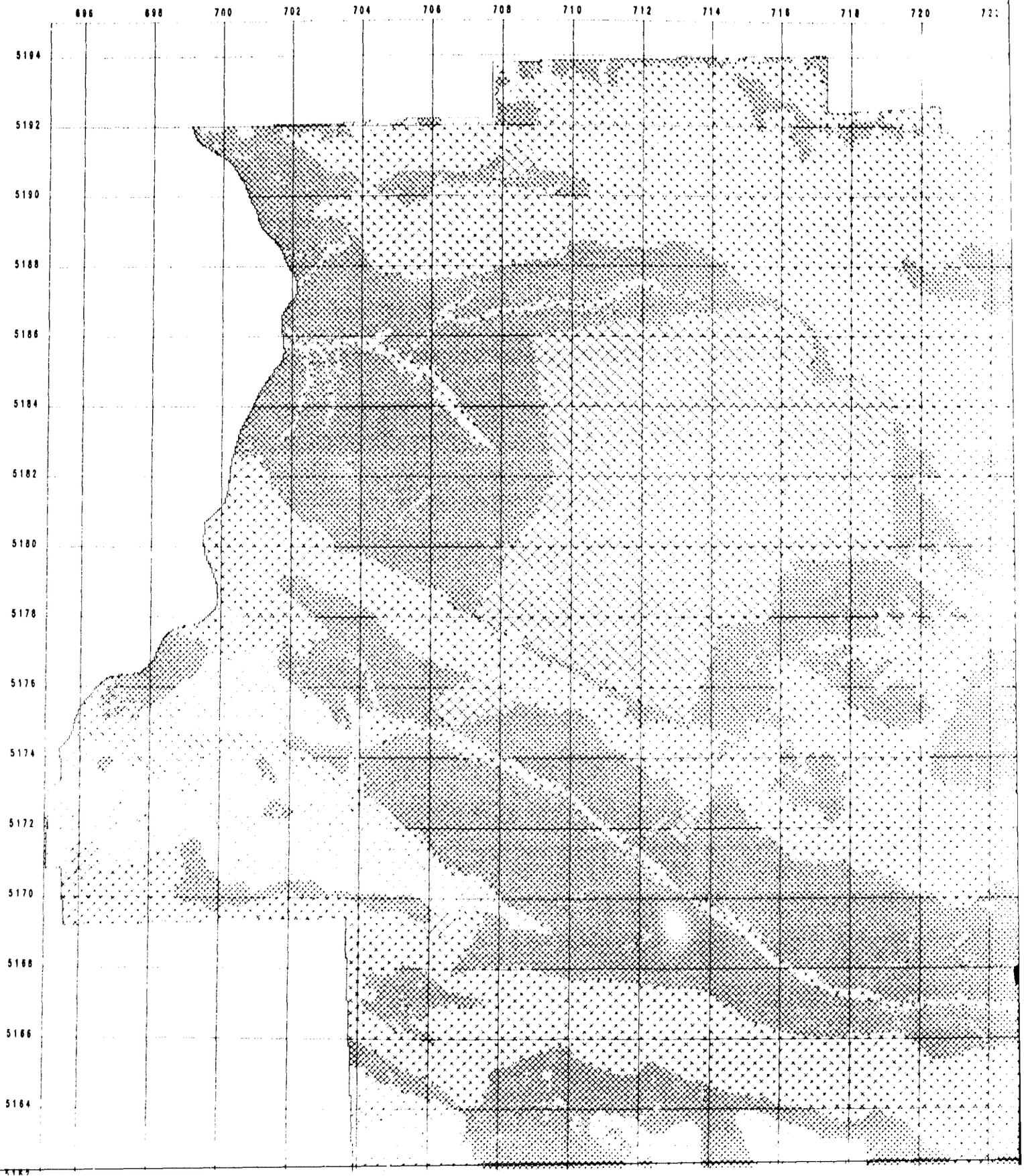
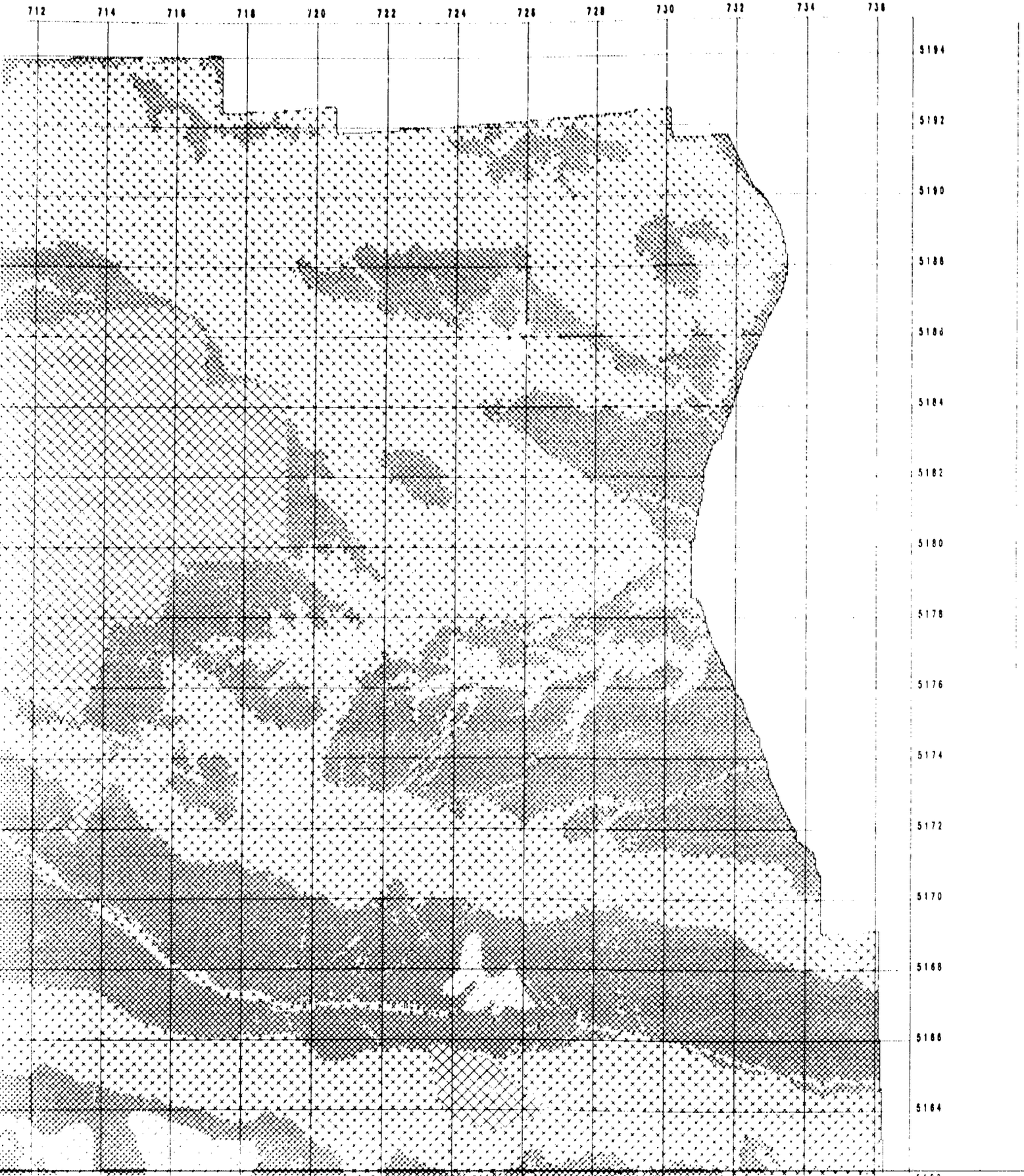


Plate 54. Soil erosion severity for 4-3-3 (8X8) force structure for ten passes

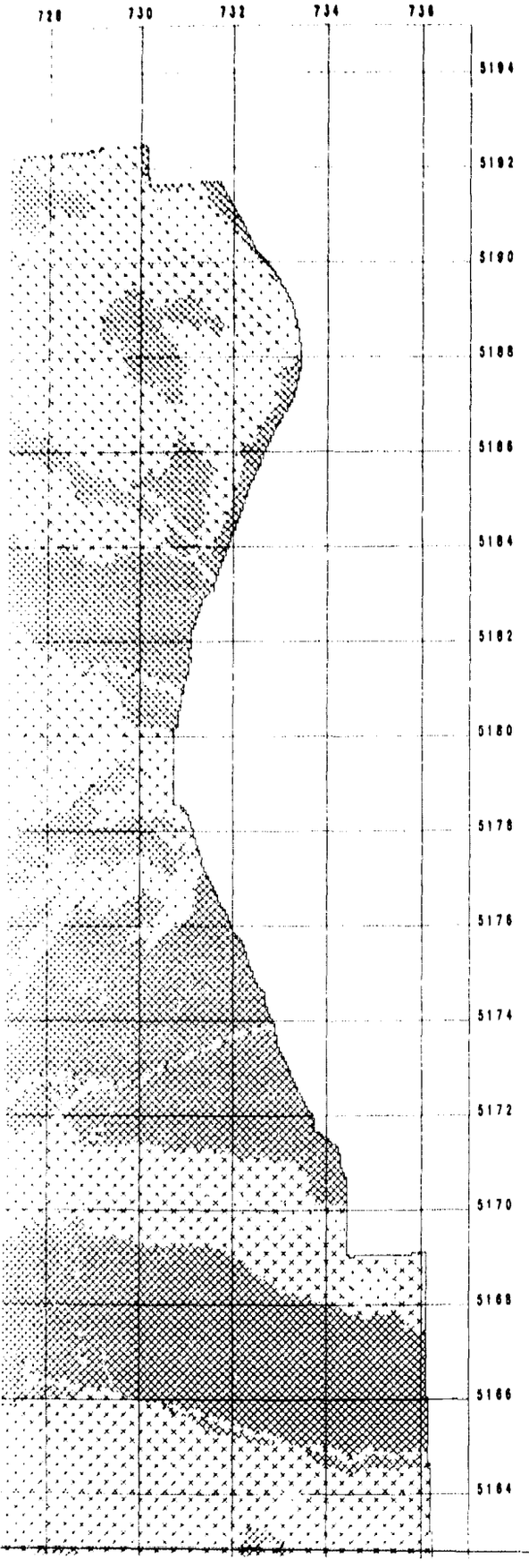


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TOTAL P



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SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
50 PASSES

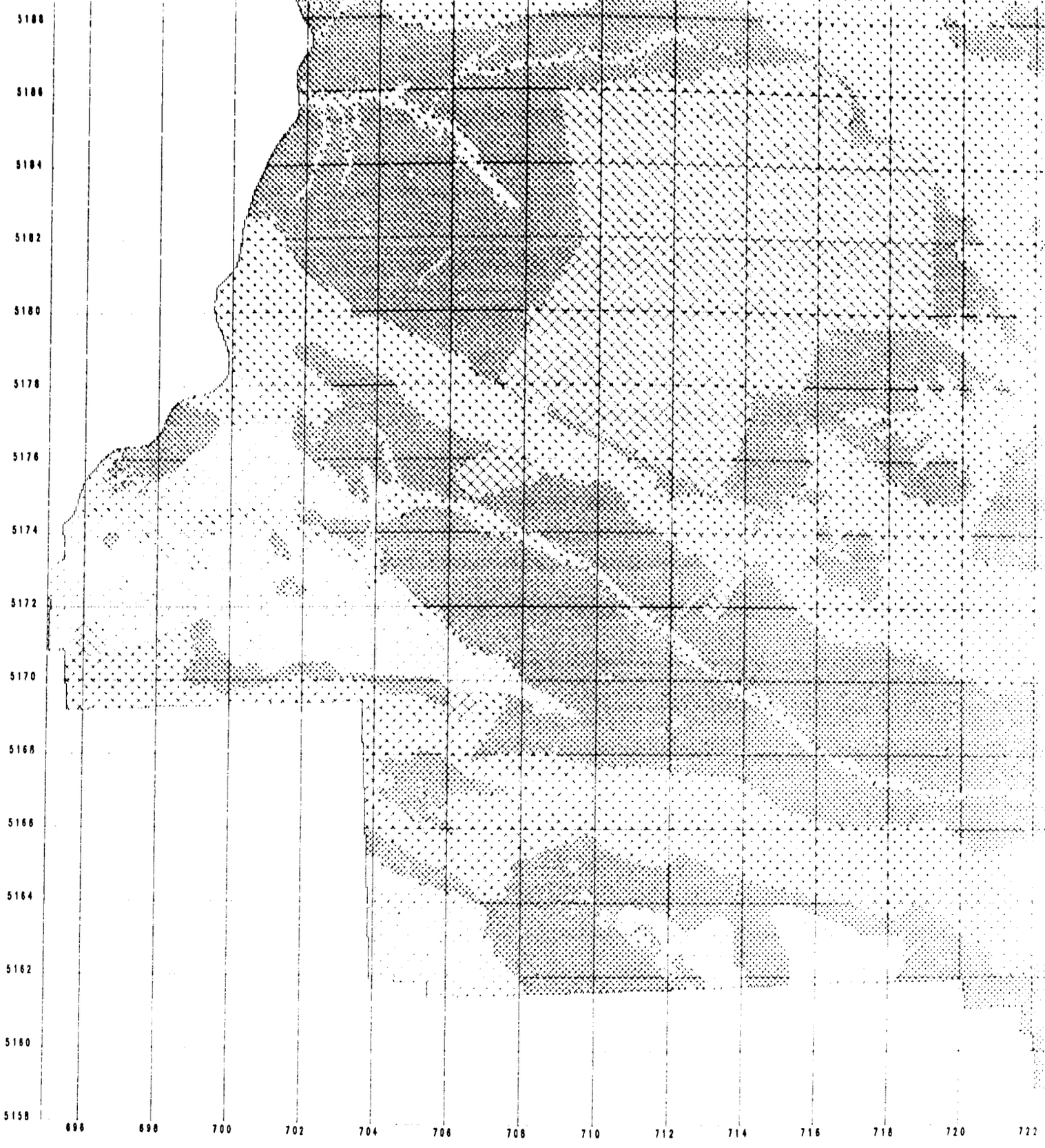


Plate 55. Soil erosion severity fo

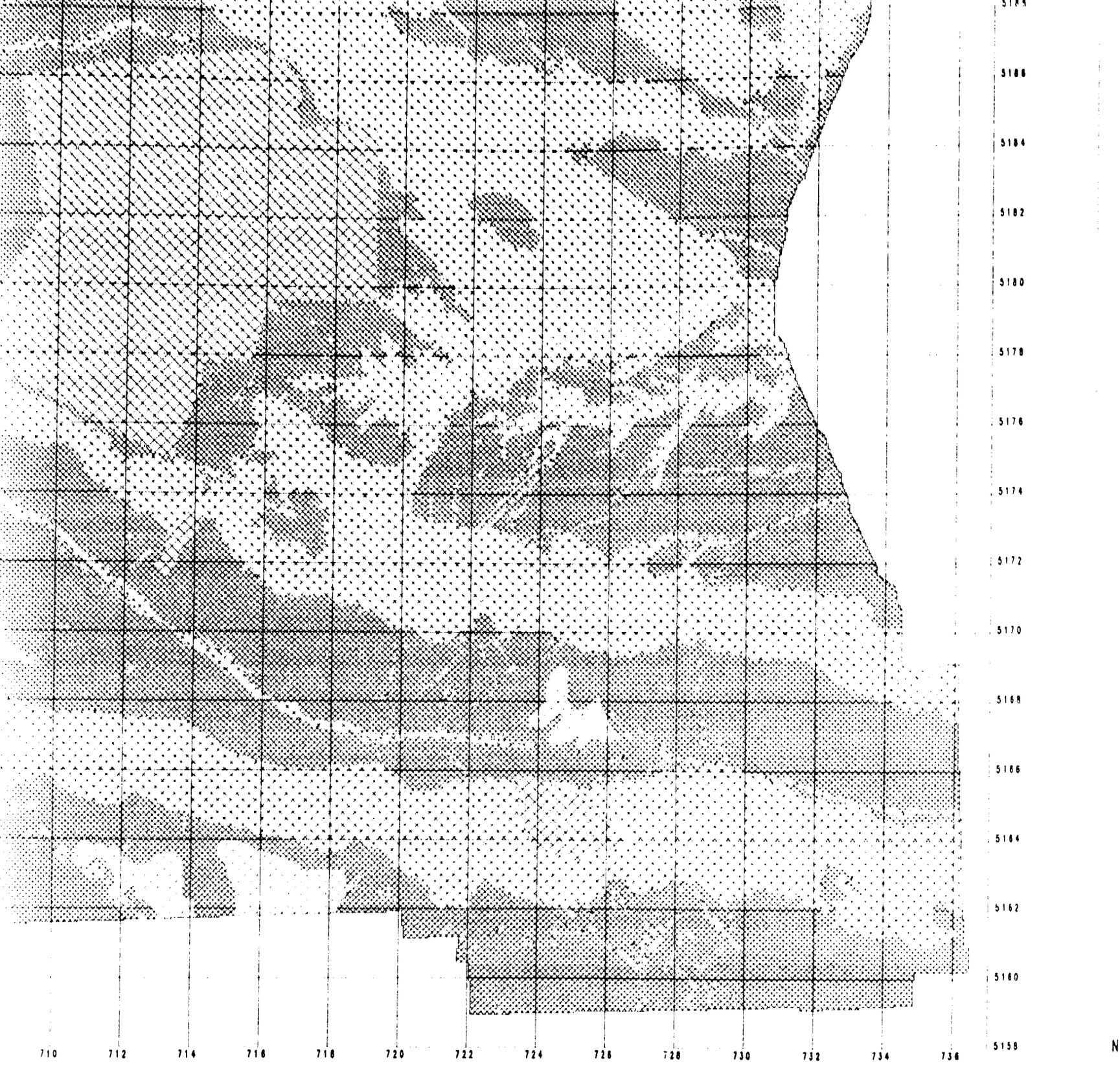
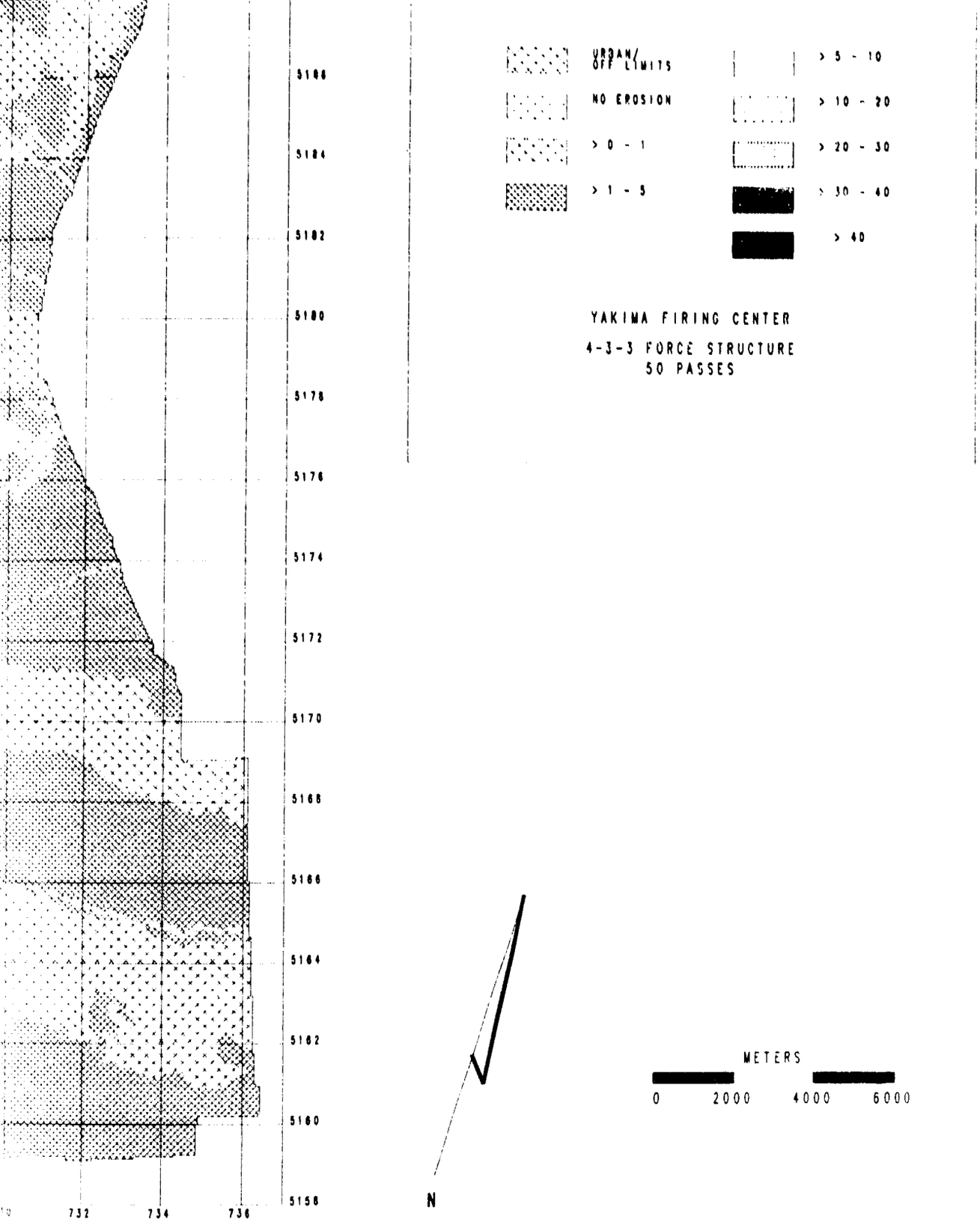
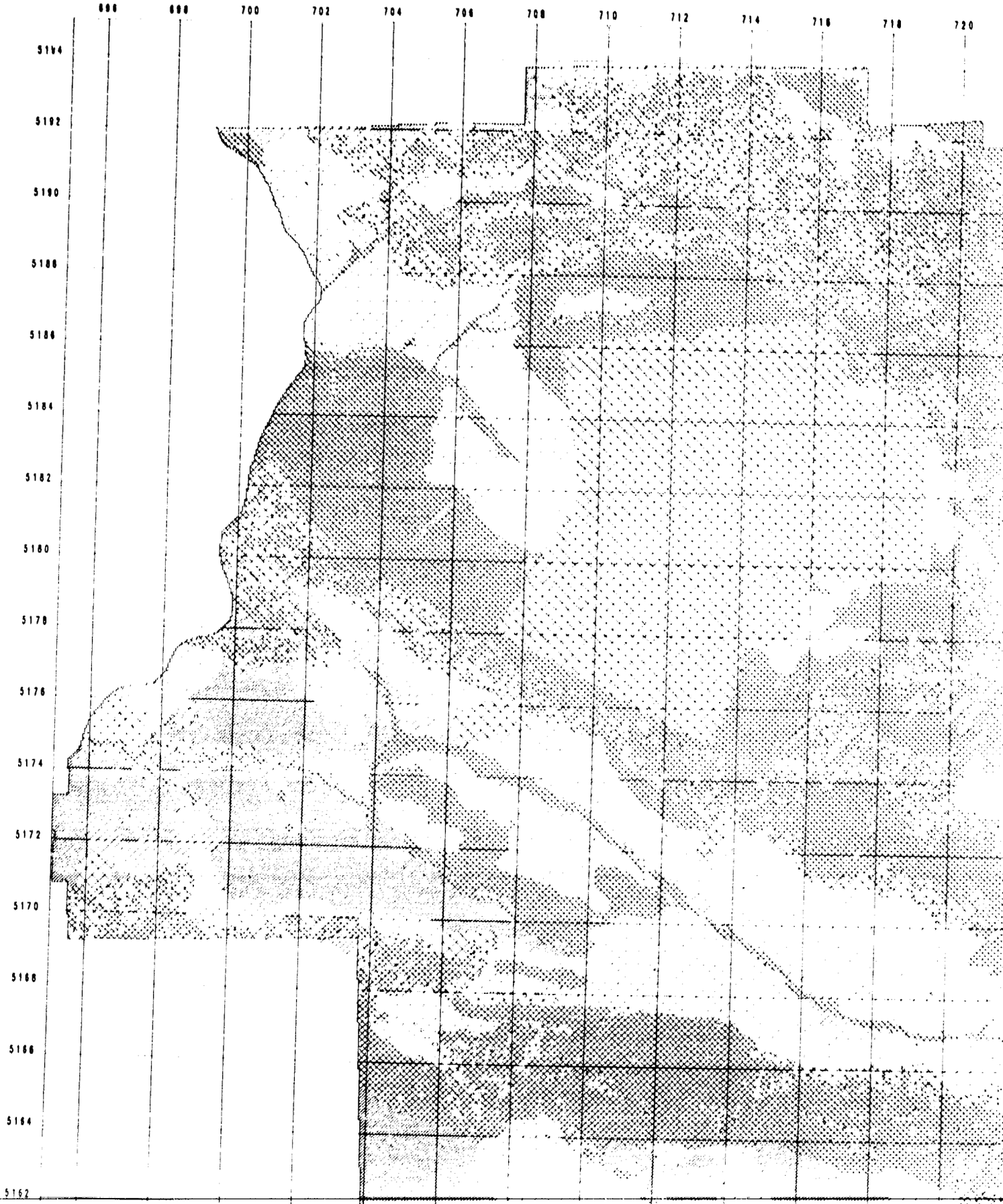
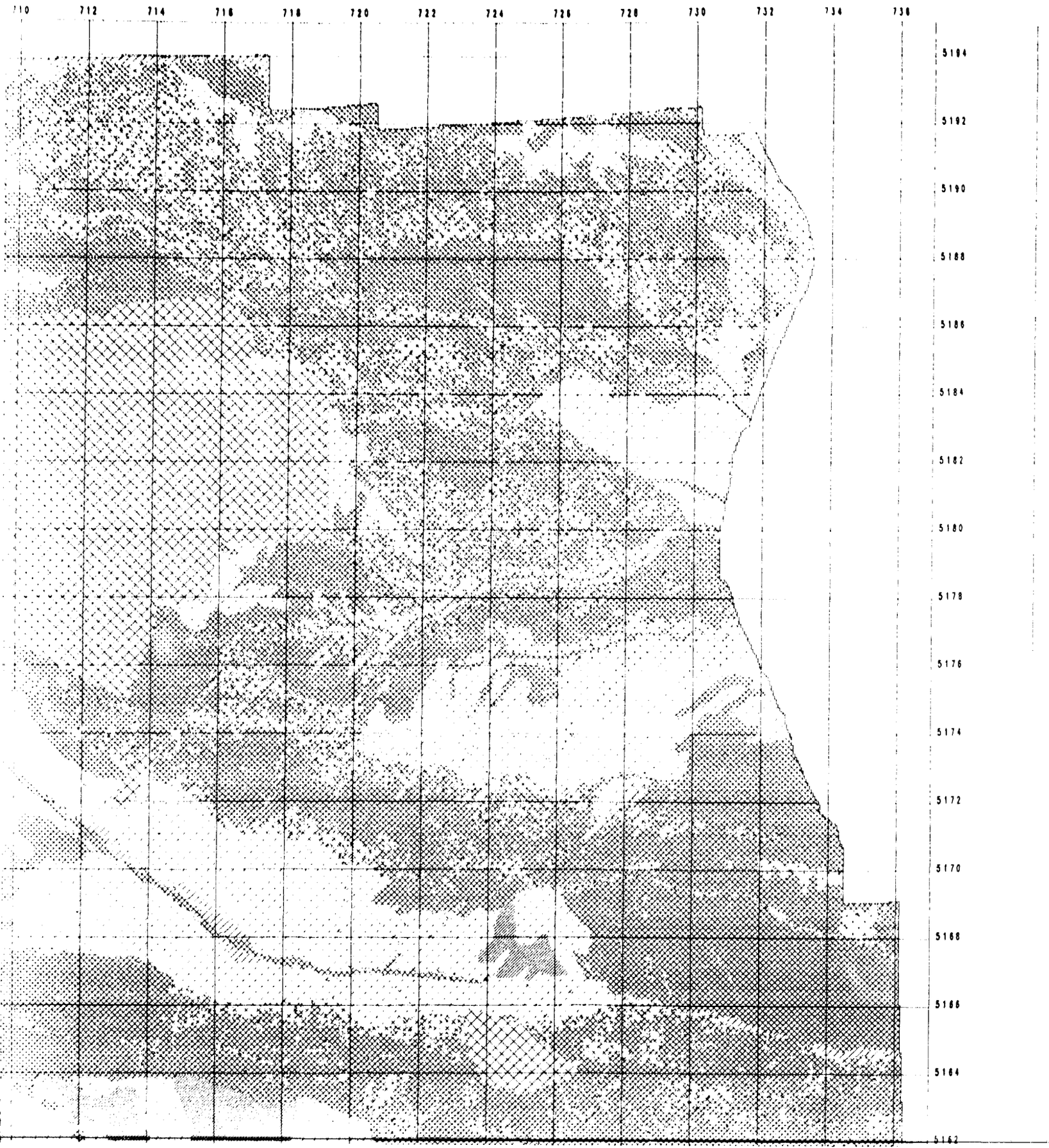


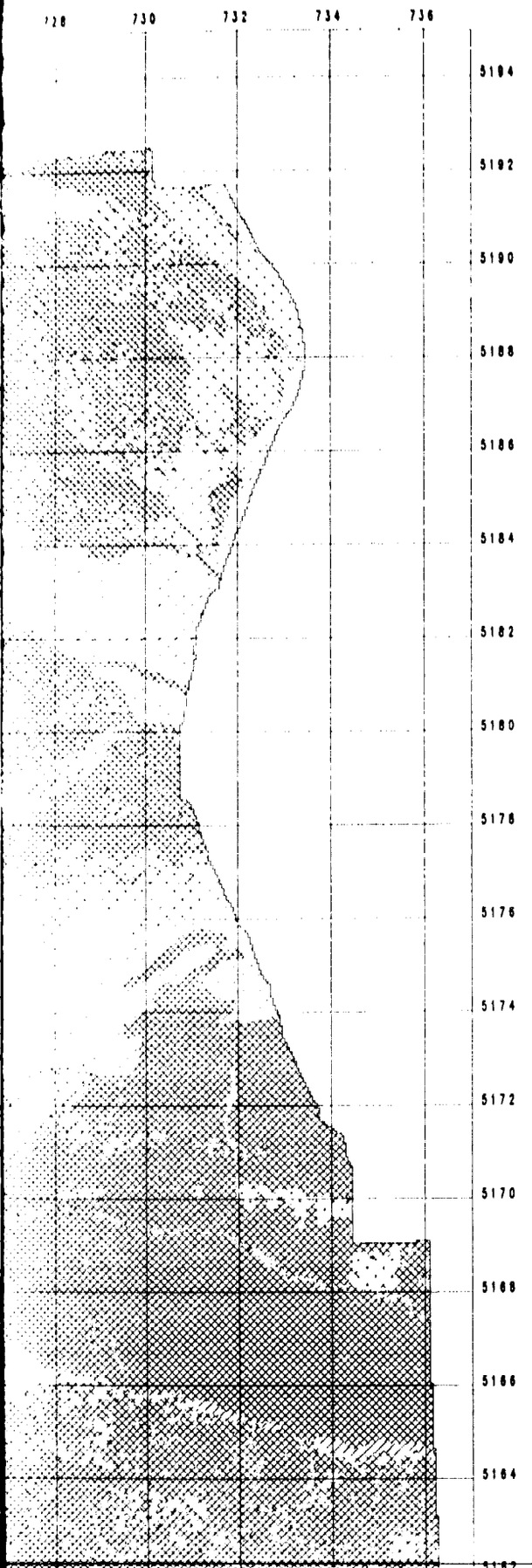
Plate 55. Soil erosion severity for 4-3-3 (8X8) force structure for fifty passes



for fifty passes


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SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/ OFF LIMITS	> 5 - 10
NO EROSION	> 10 - 20
> 0 - 1	> 20 - 30
> 1 - 5	> 30 - 40
	> 40

YAKIMA FIRING CENTER

4-3-3 FORCE STRUCTURE
1000 PASSES

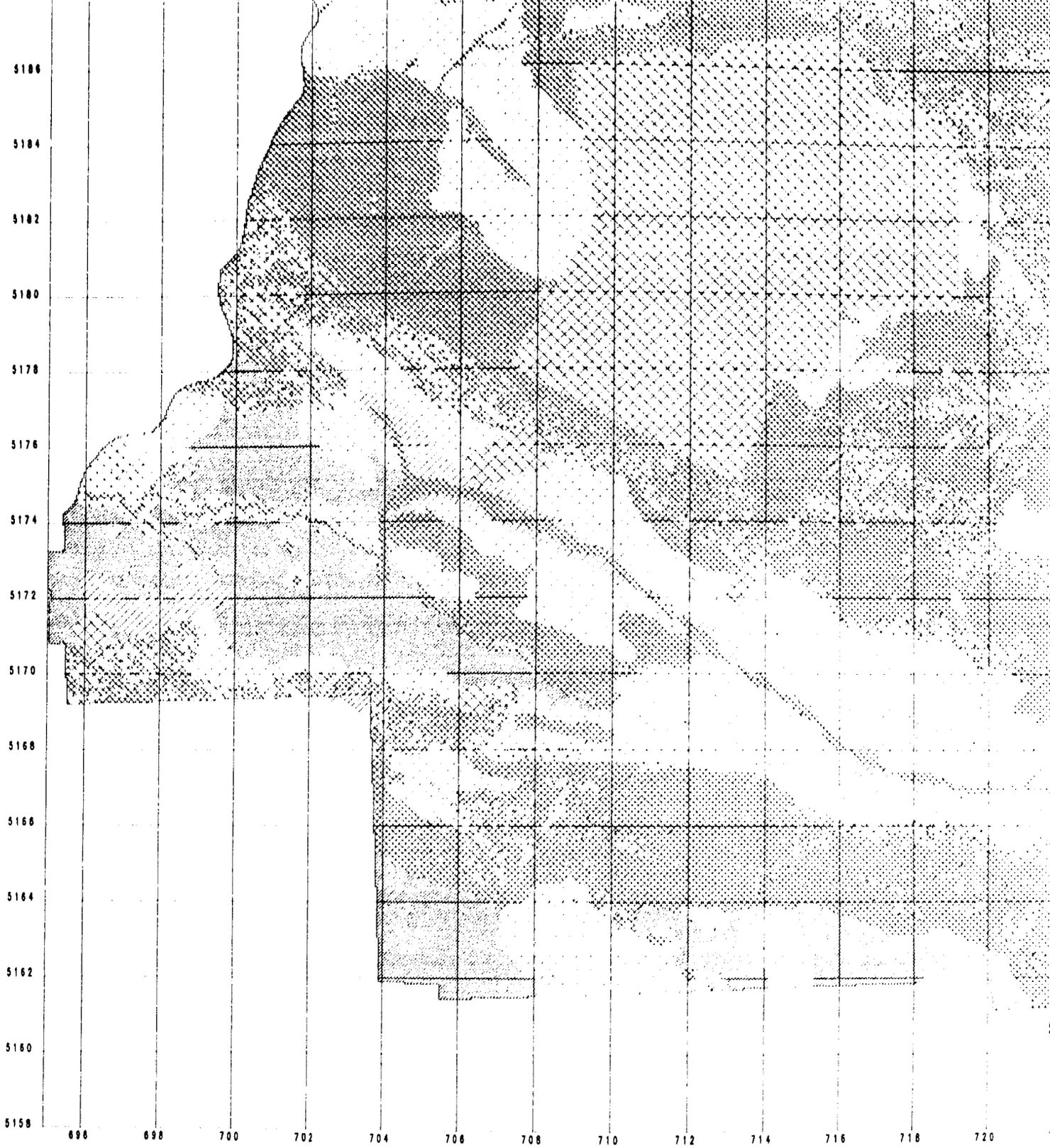


Plate 56. Soil erosion severity fo

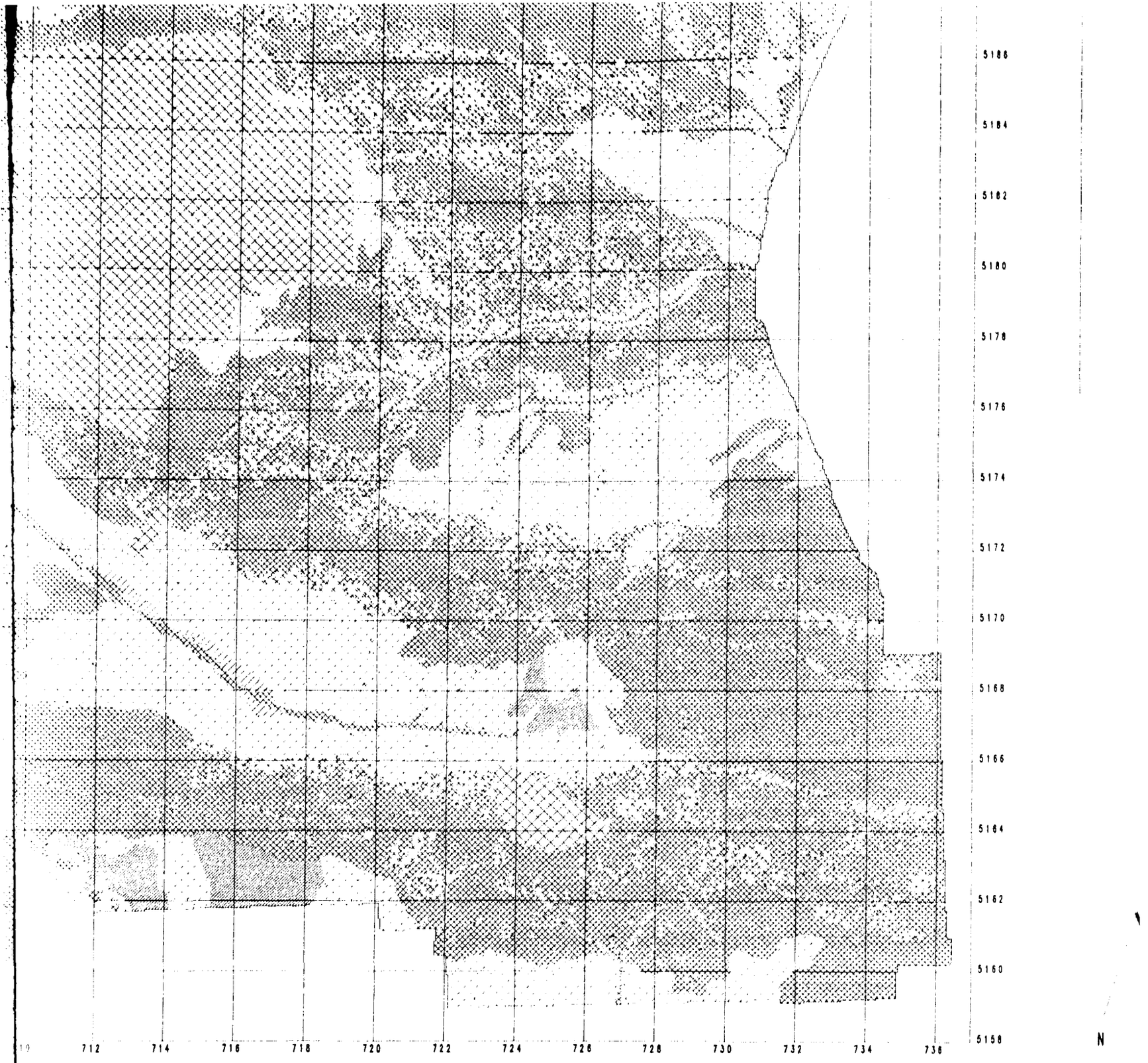
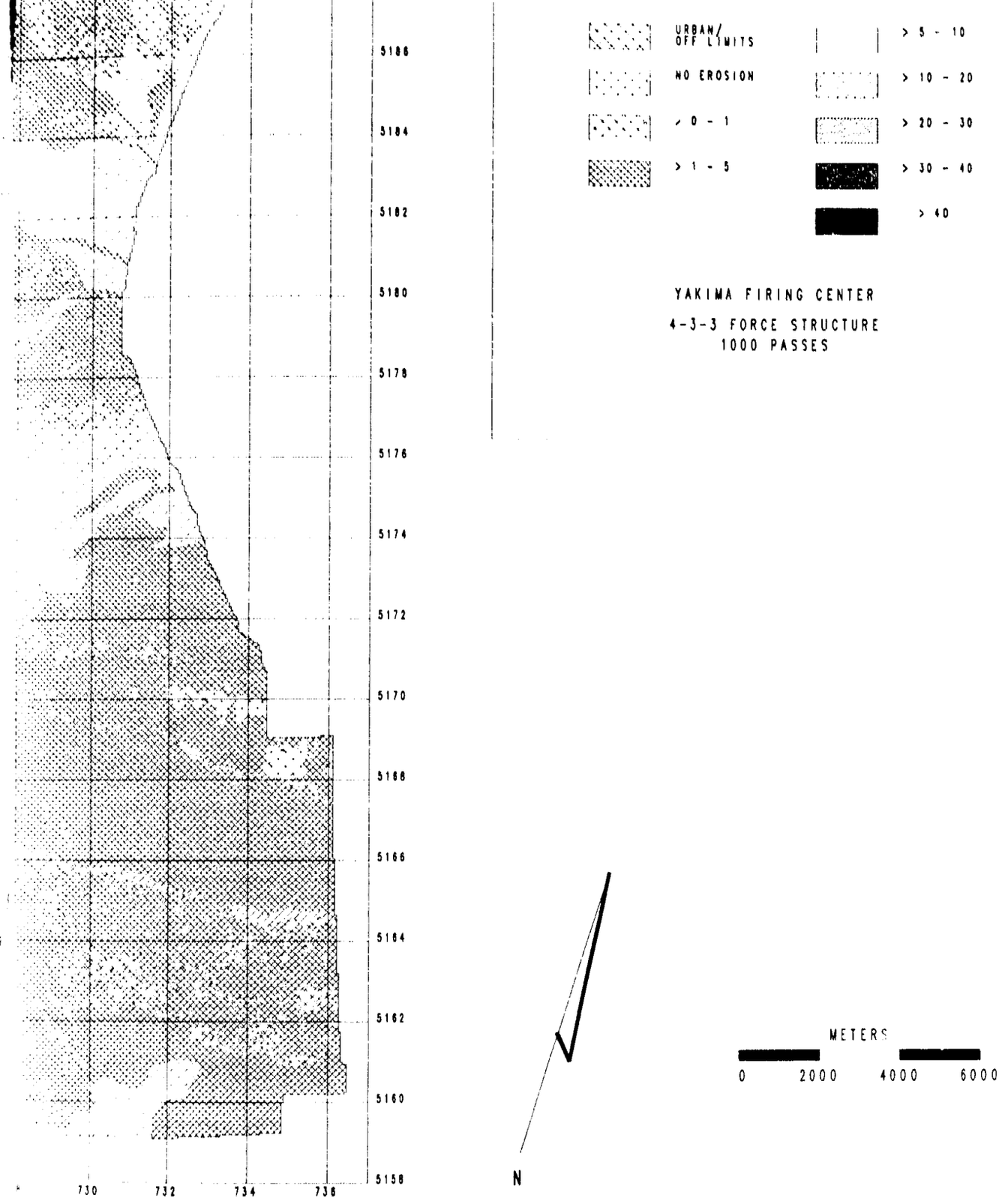
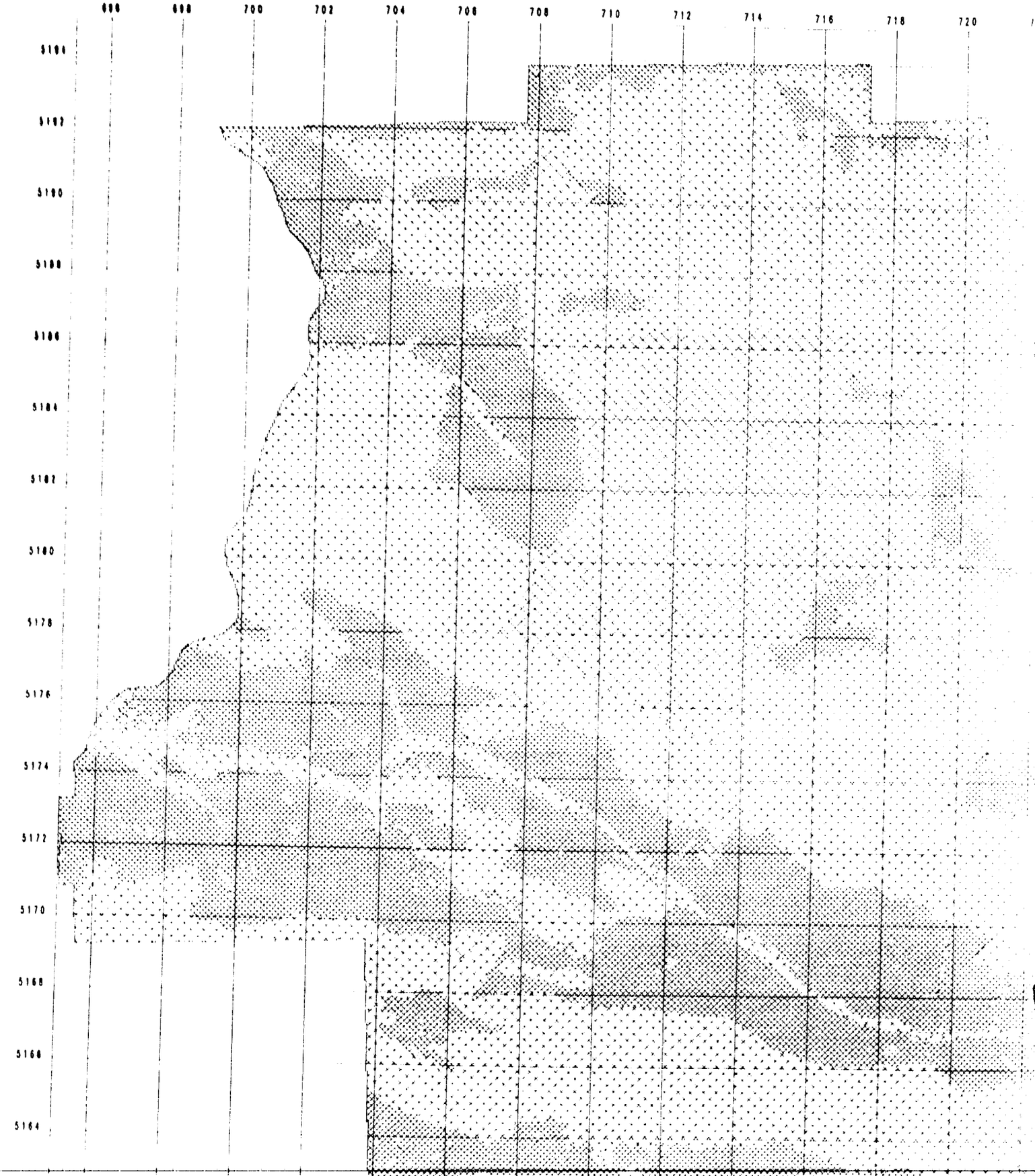
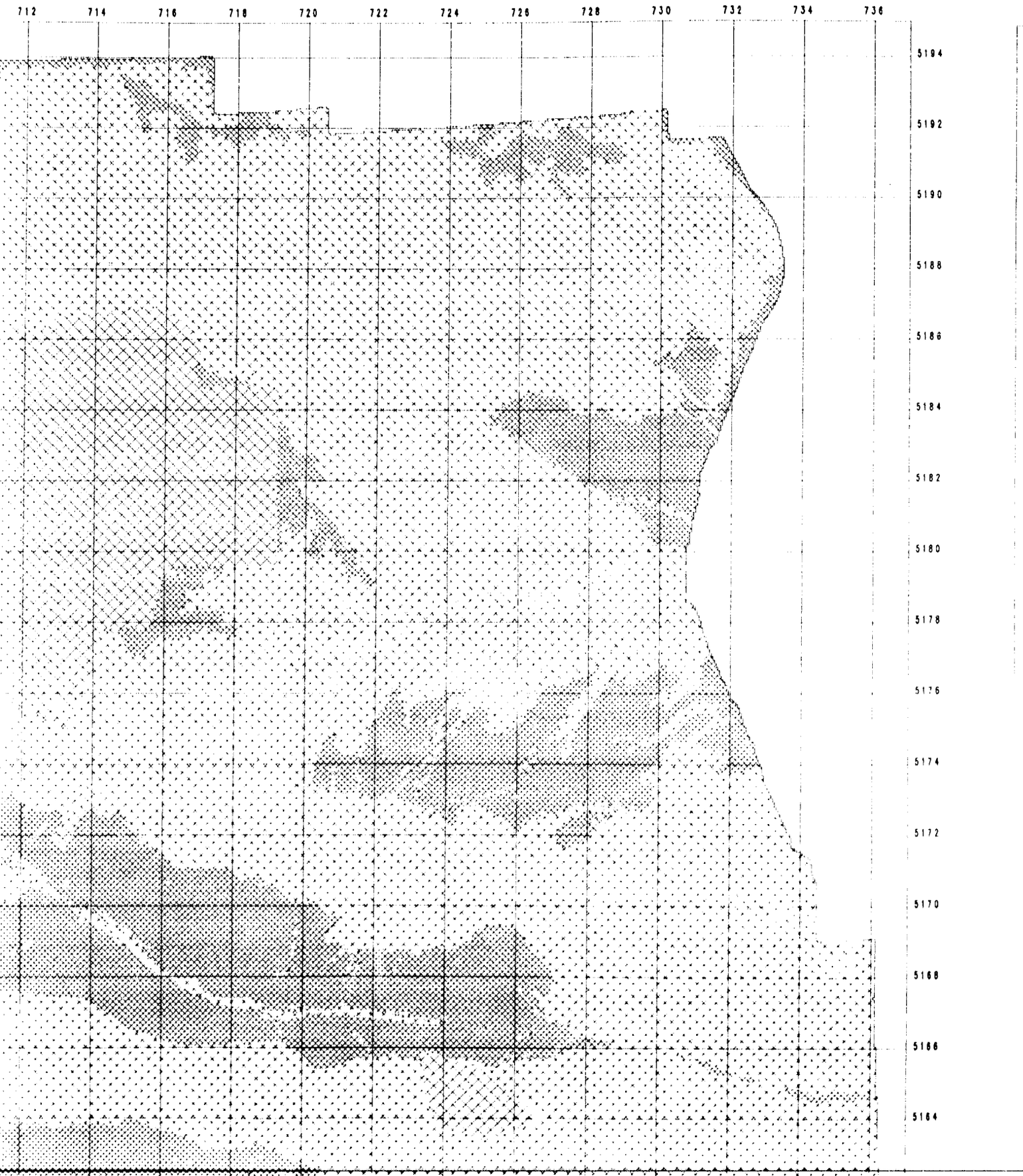


Plate 56. Soil erosion severity for 4-3-3 (8X8) force structure for one thousand passes

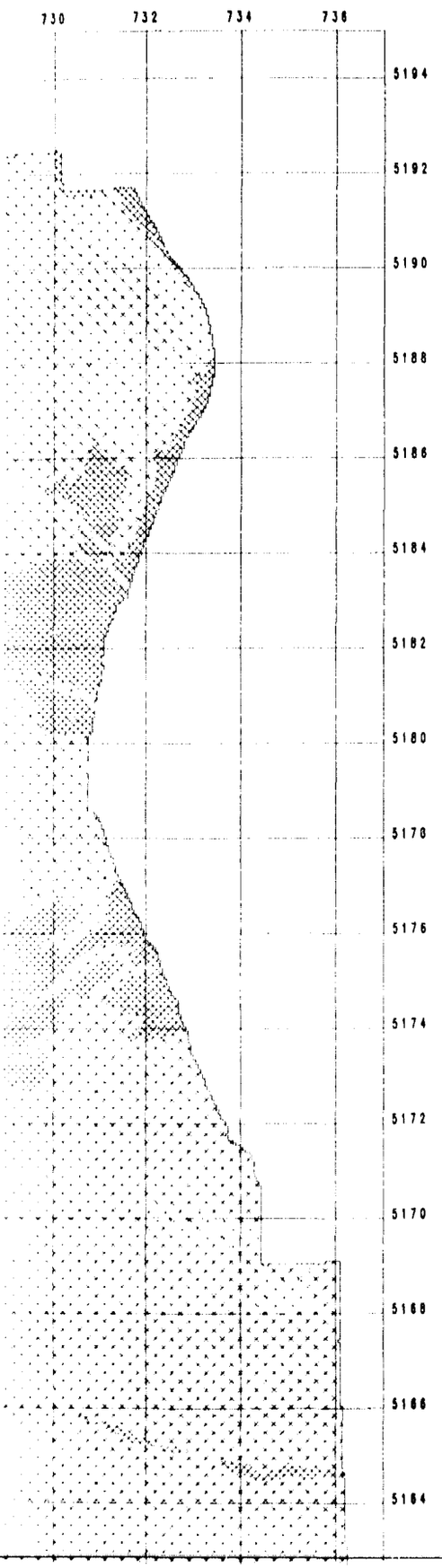


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TOTAL PO



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SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
10 PASSES

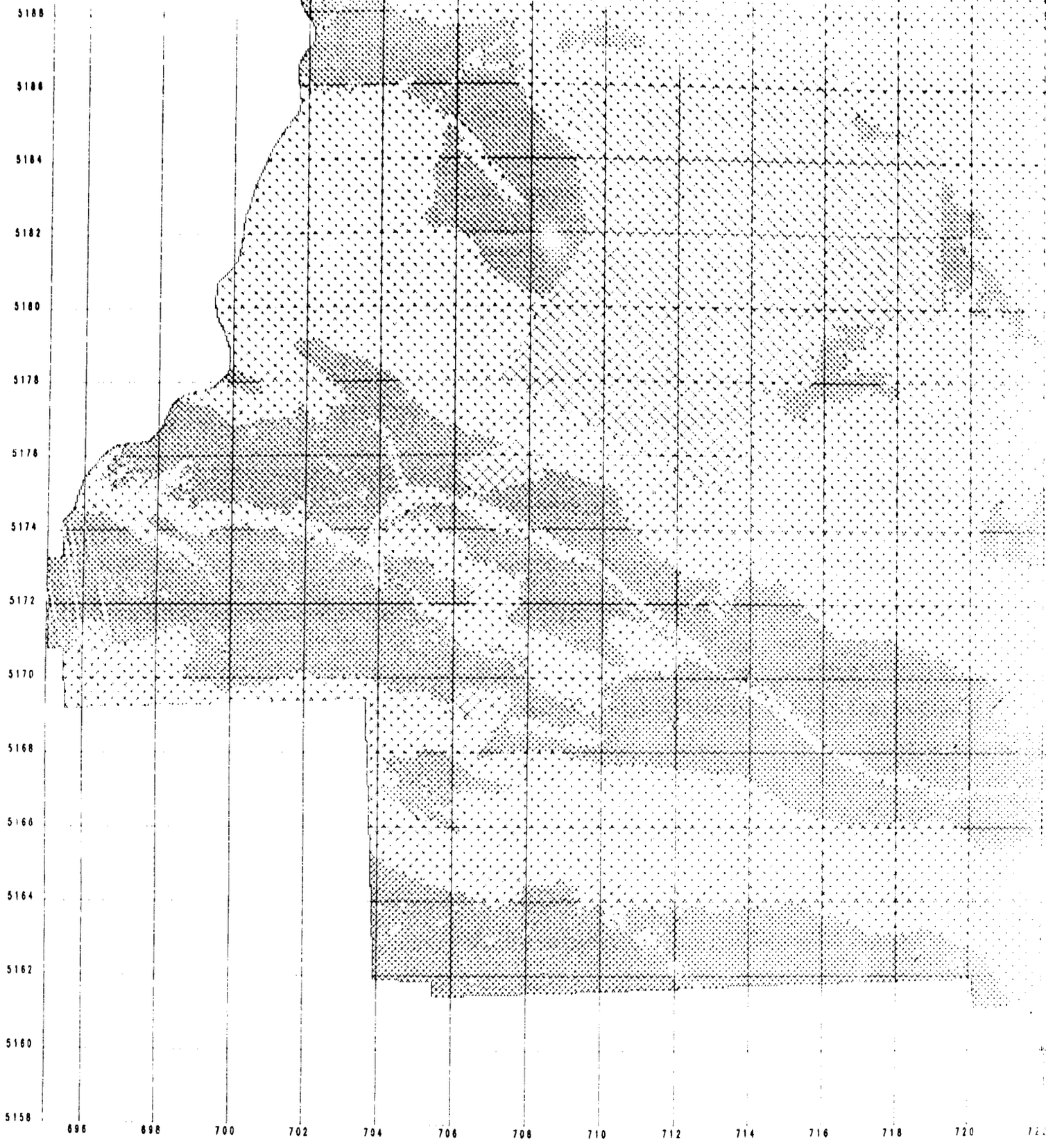


Plate 57. Soil erosion severity

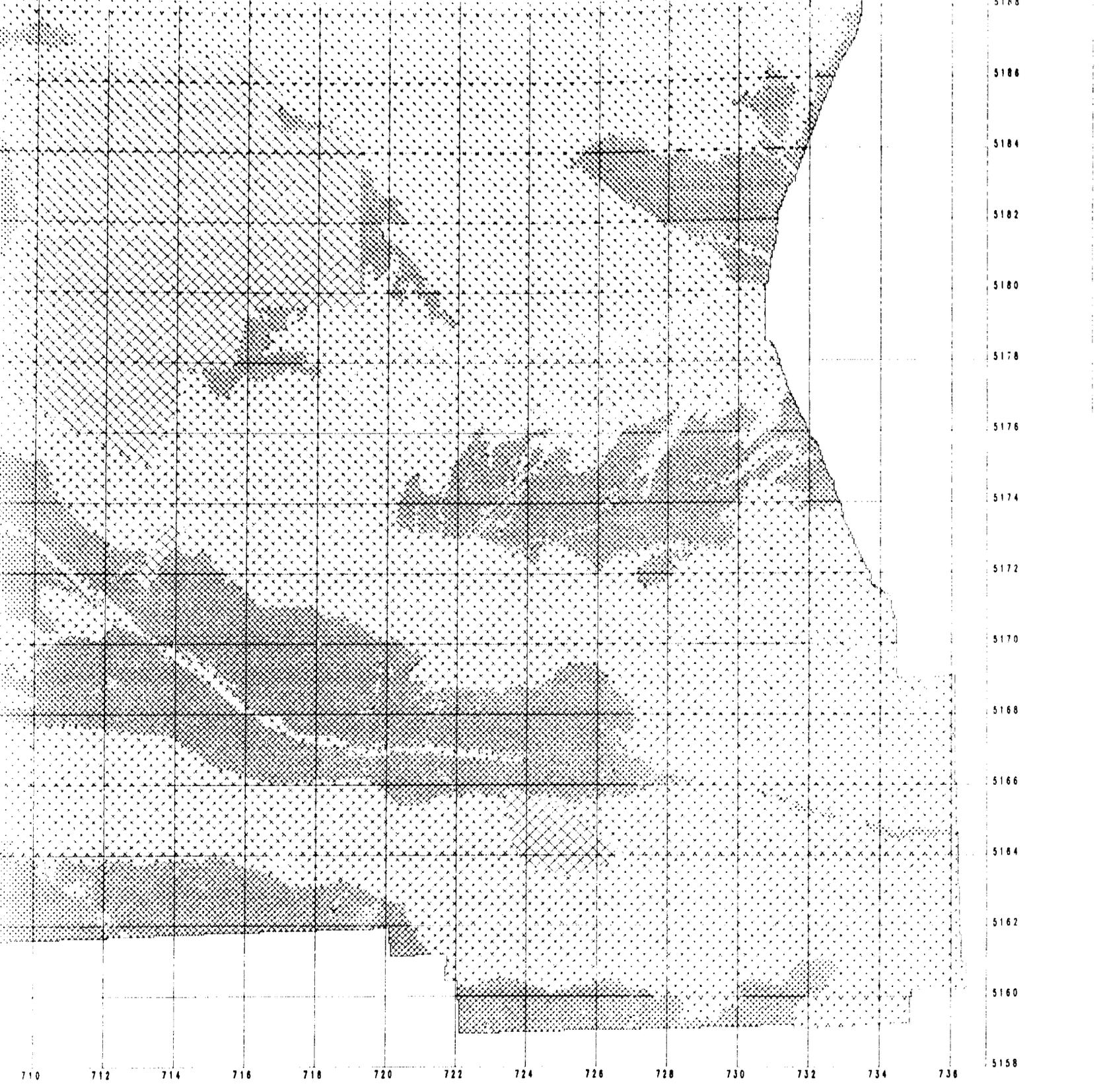
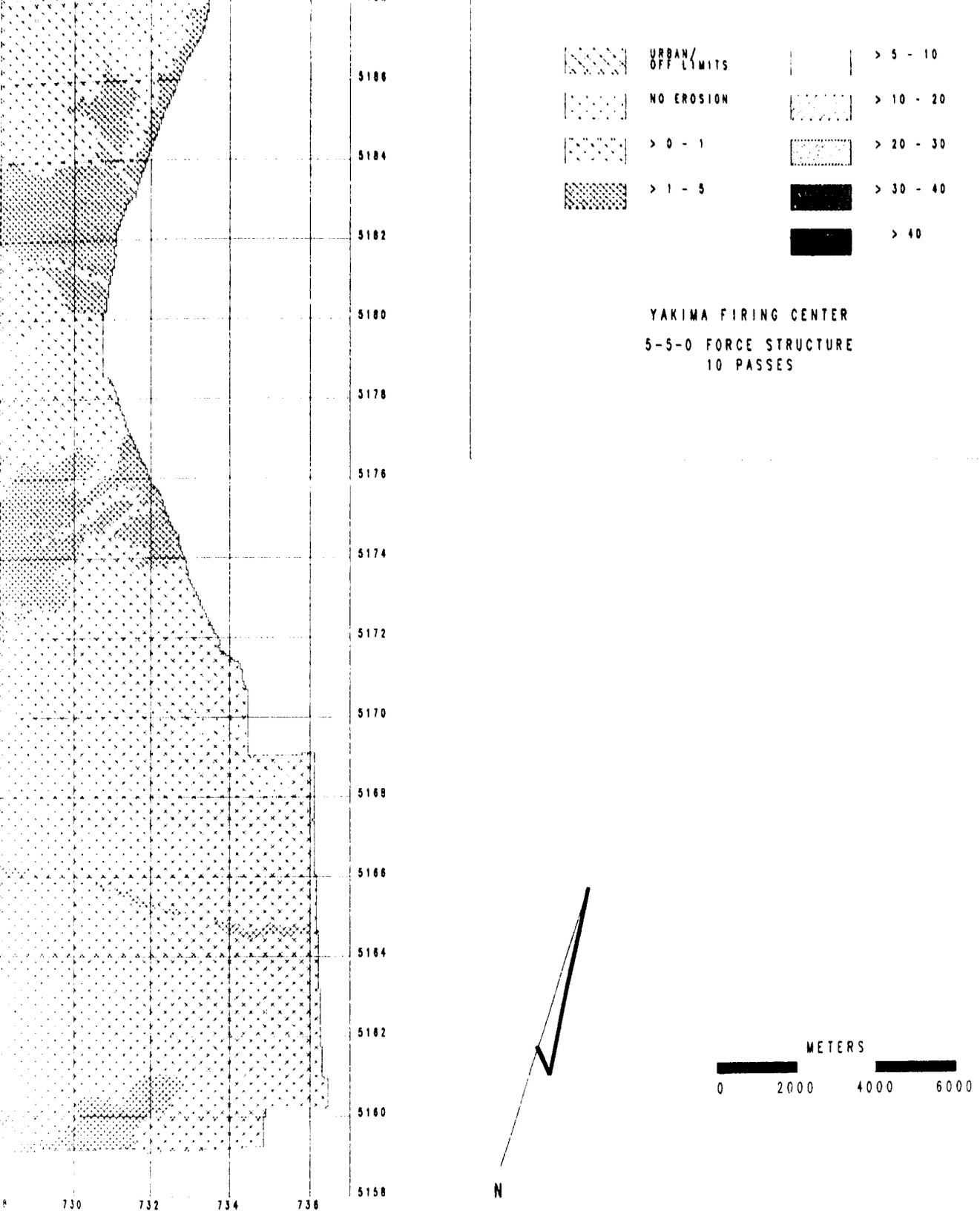
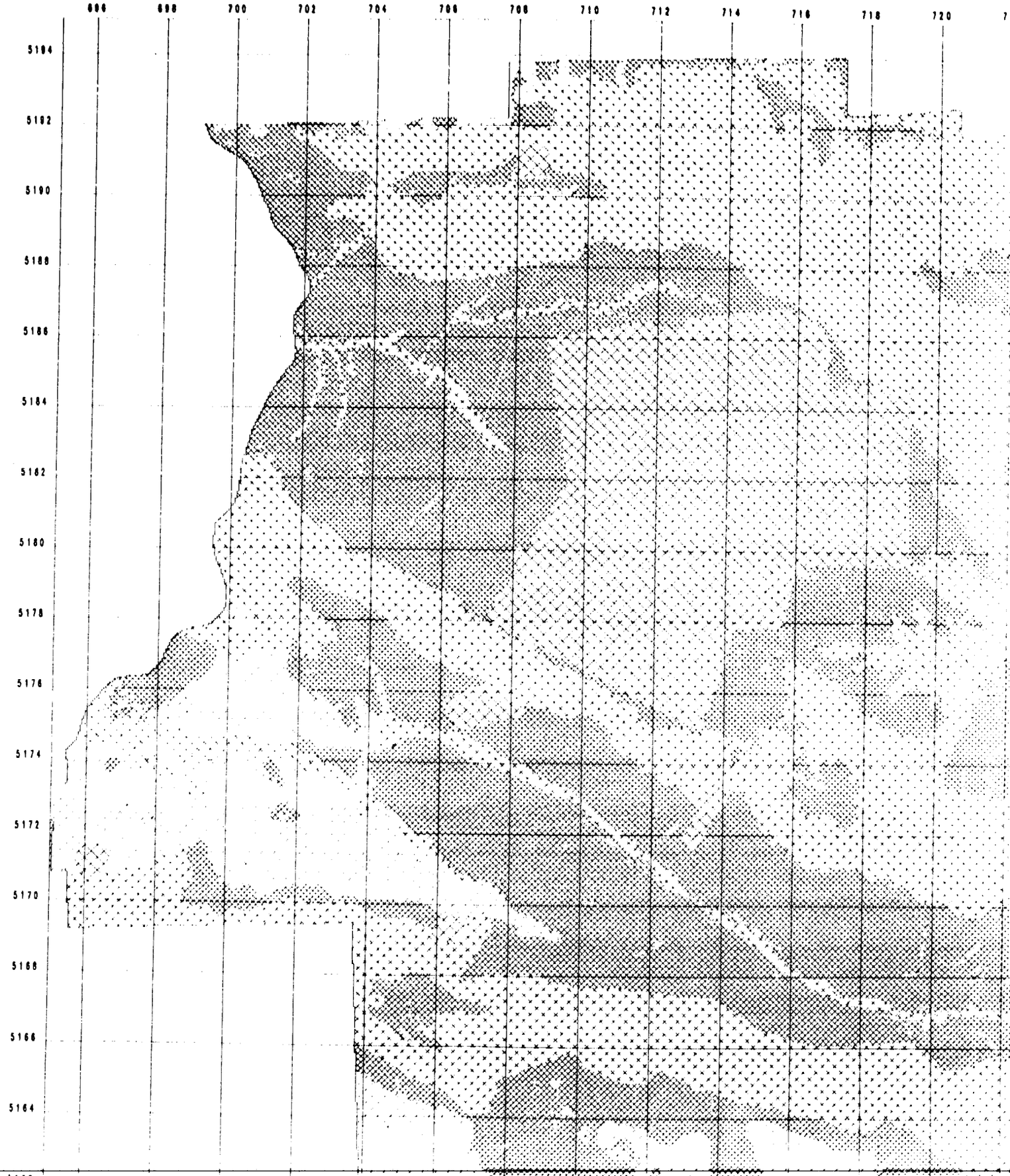
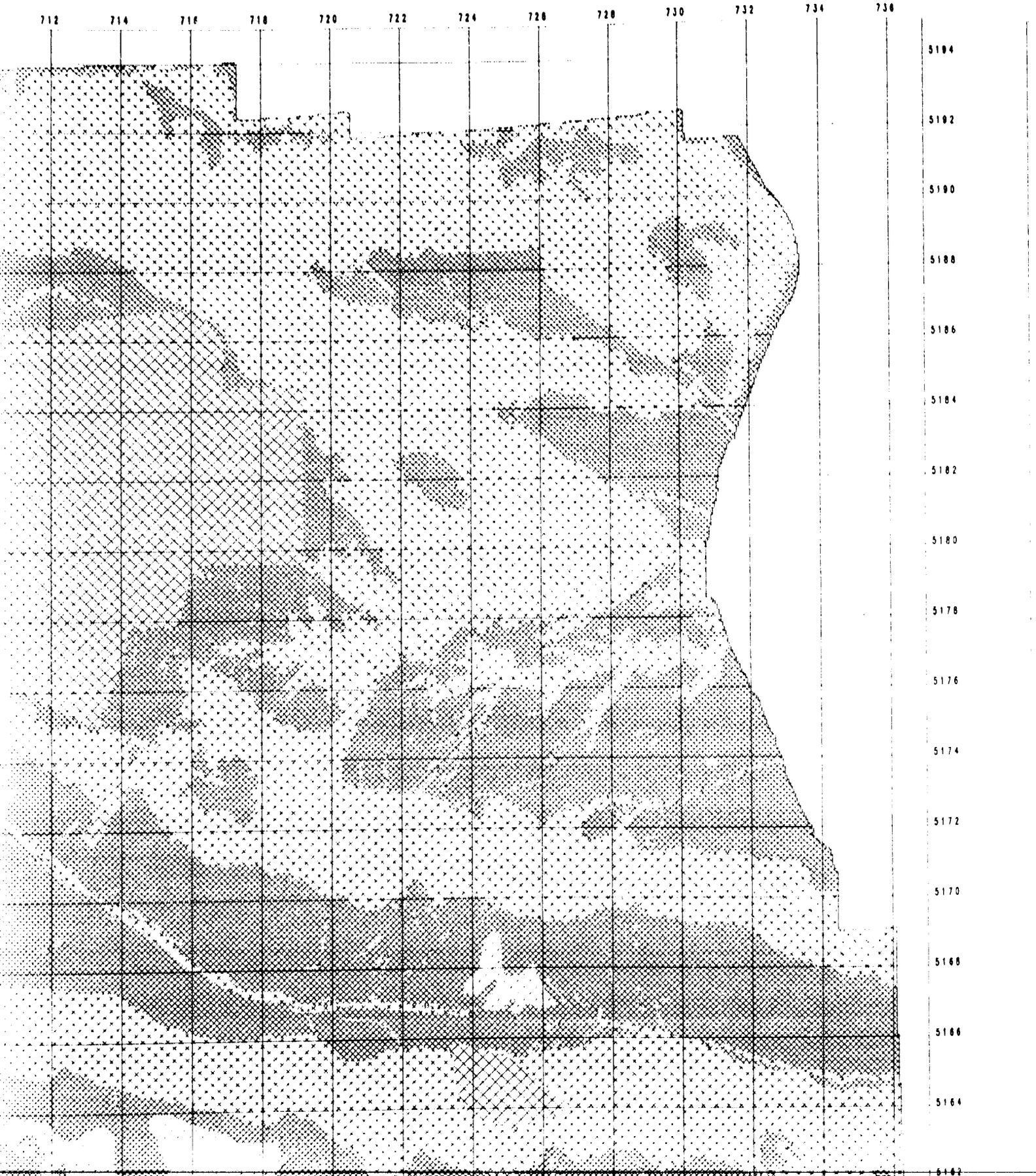


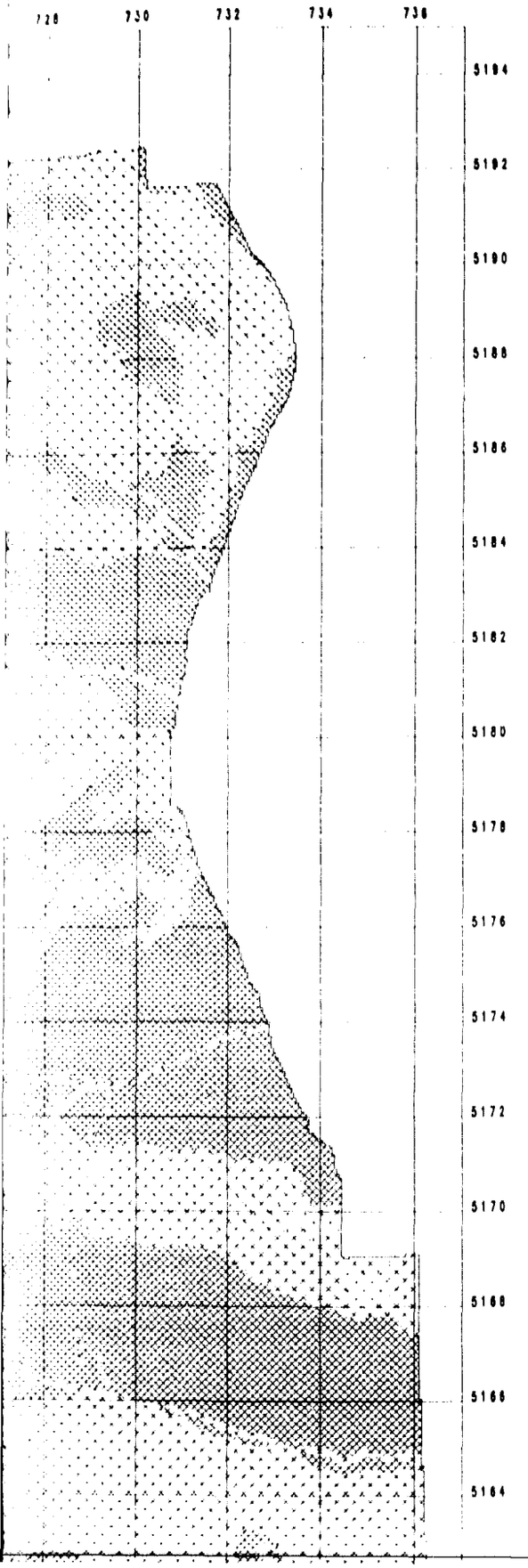
Plate 57. Soil erosion severity for 5-5-0 force structure for ten passes



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SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

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YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
50 PASSES

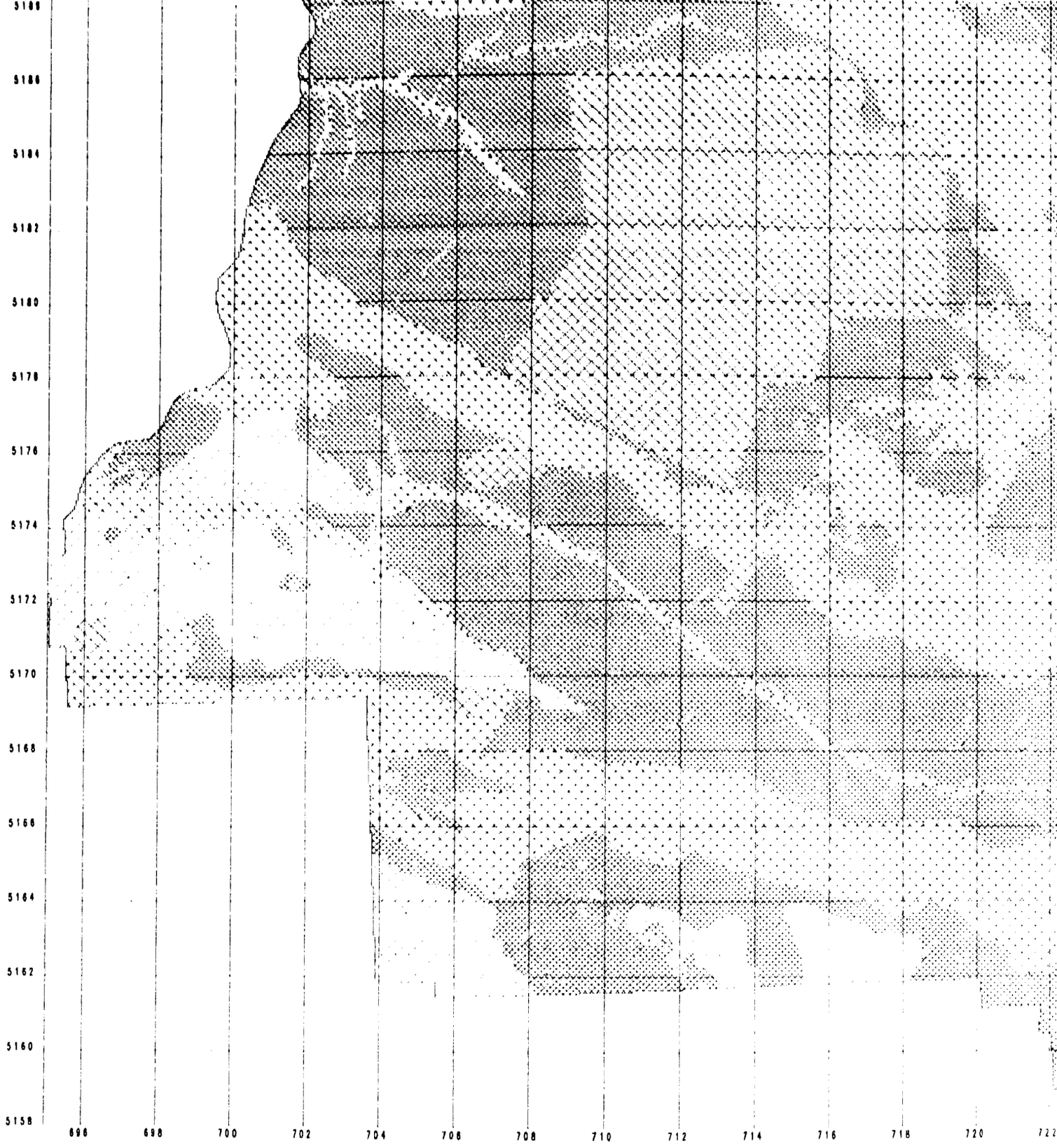


Plate 58. Soil erosion severit

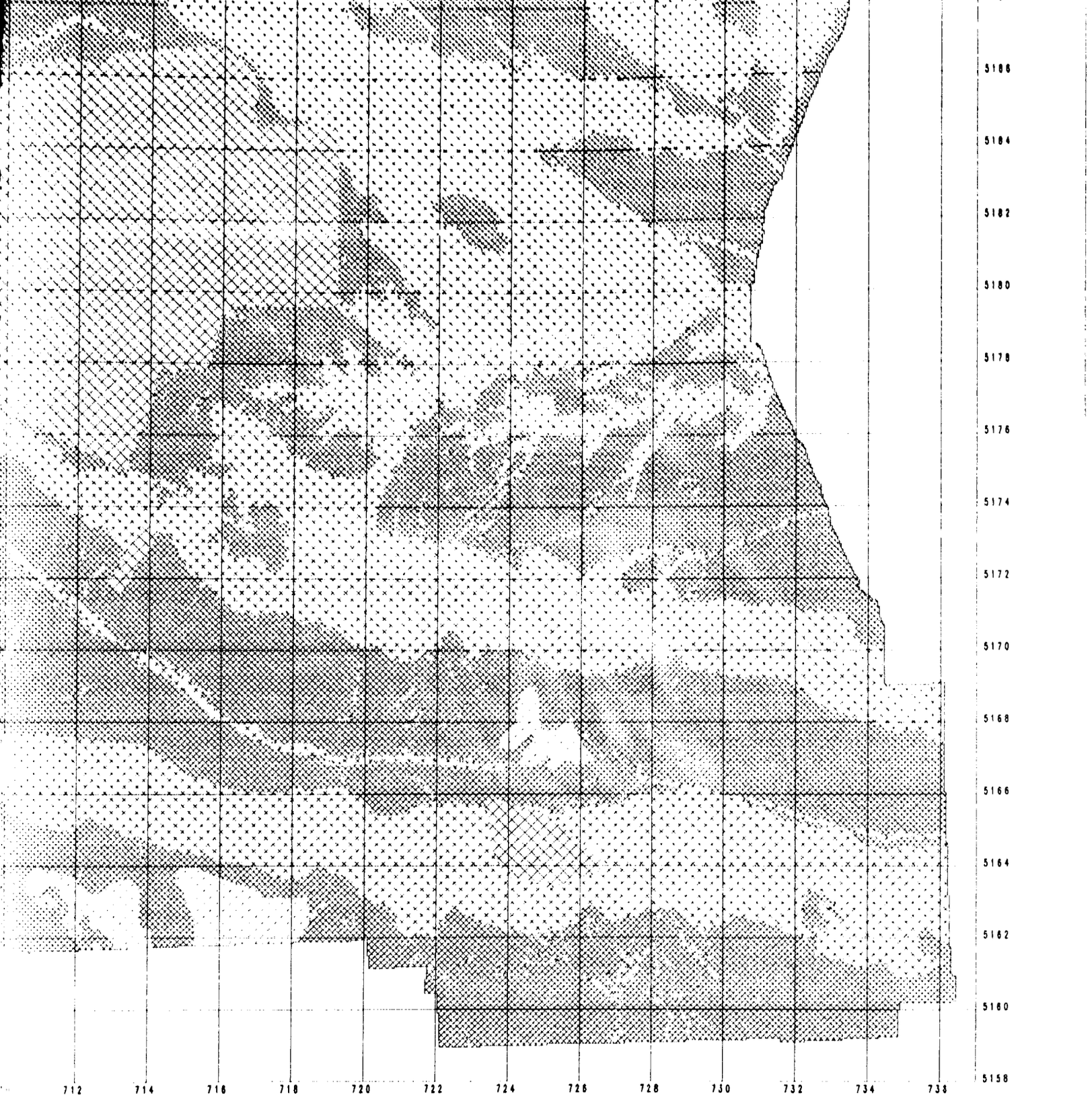
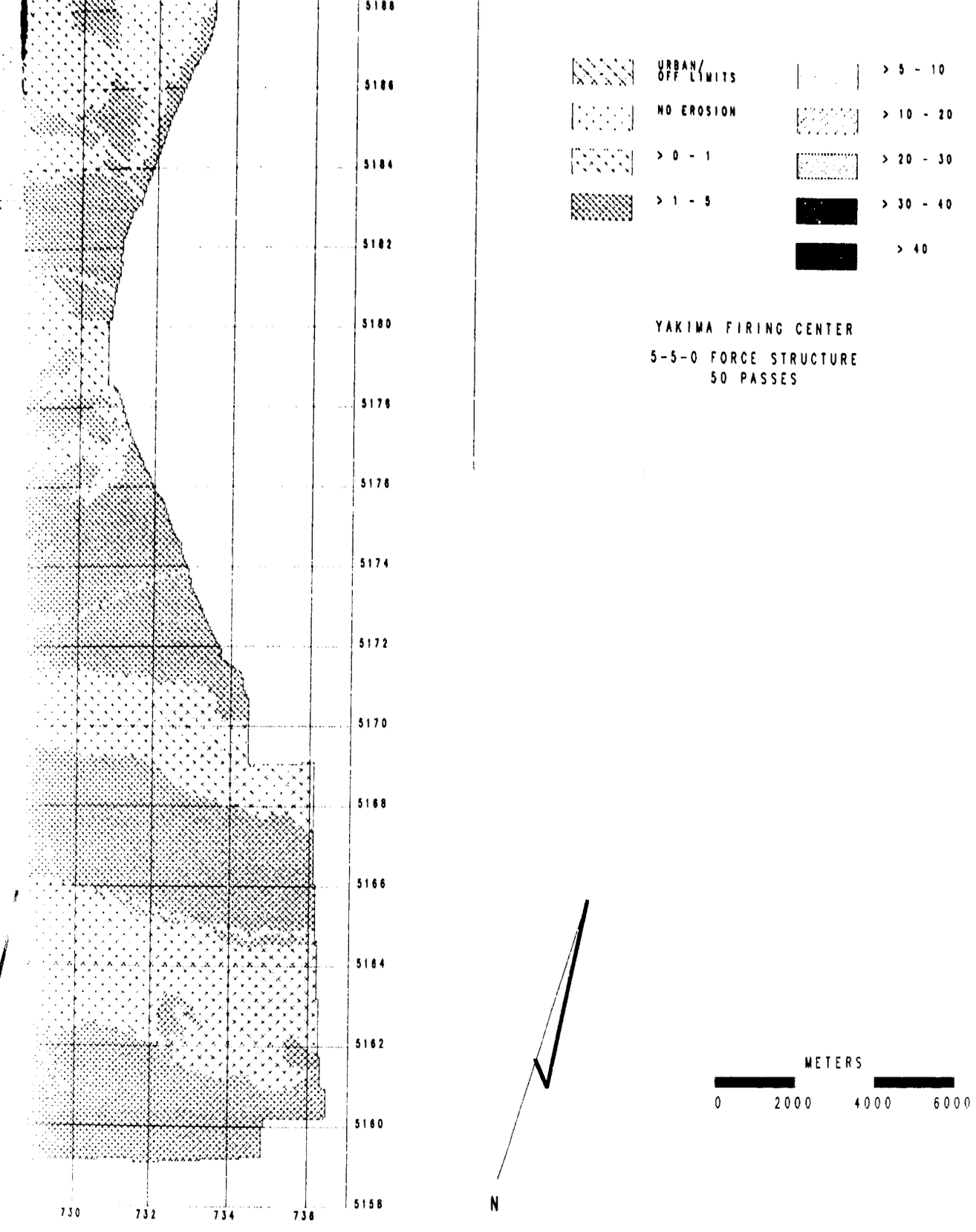
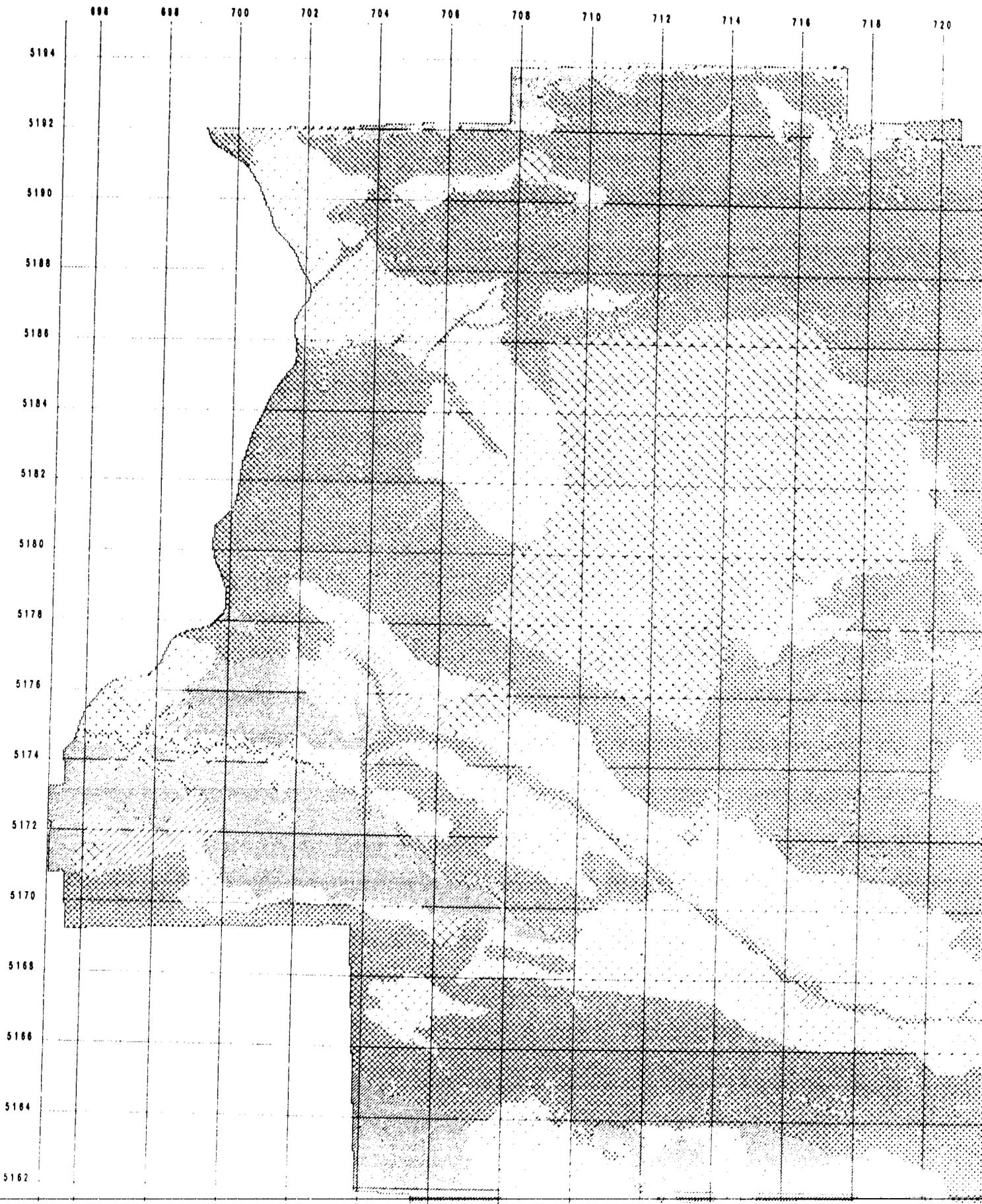
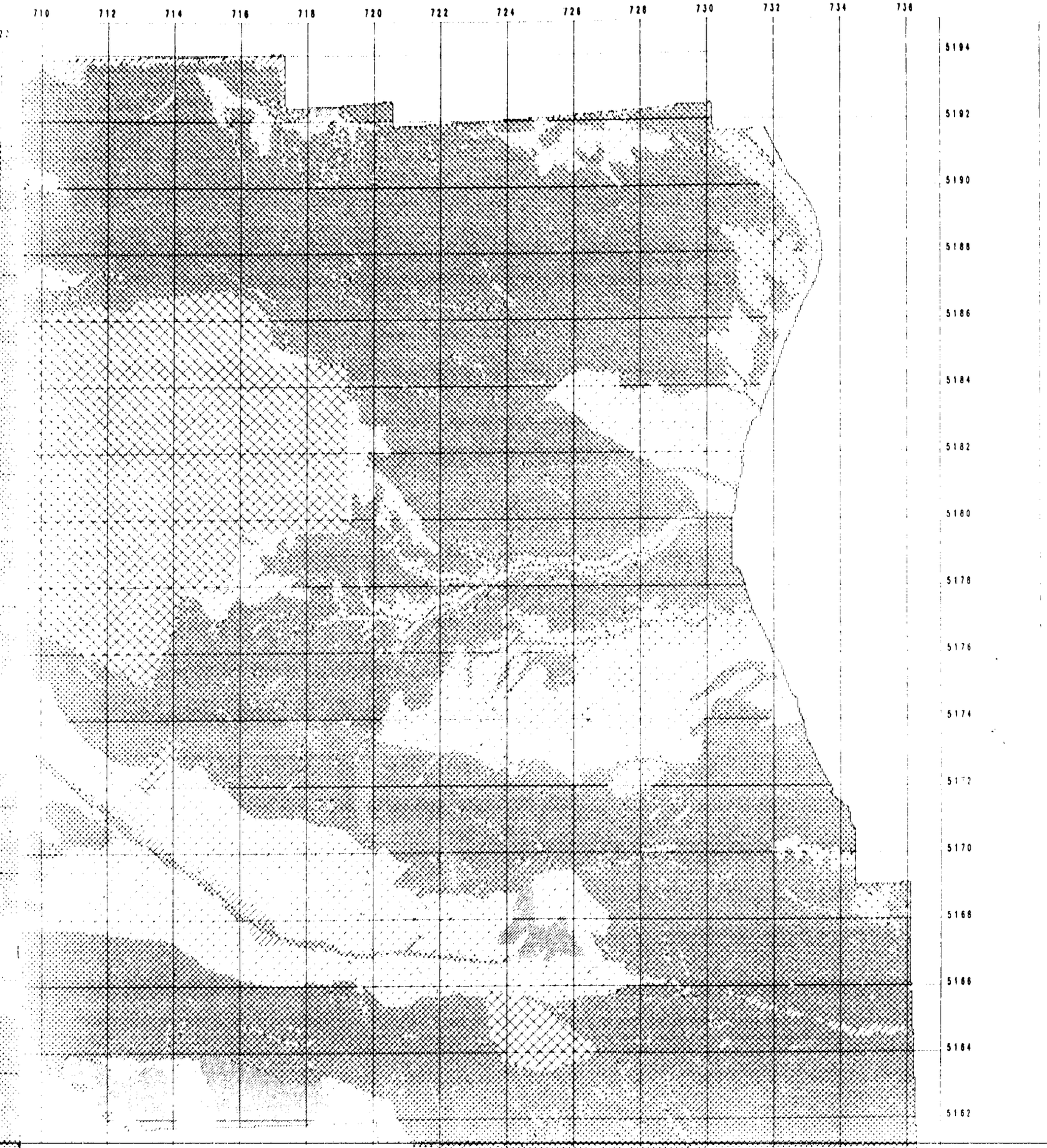


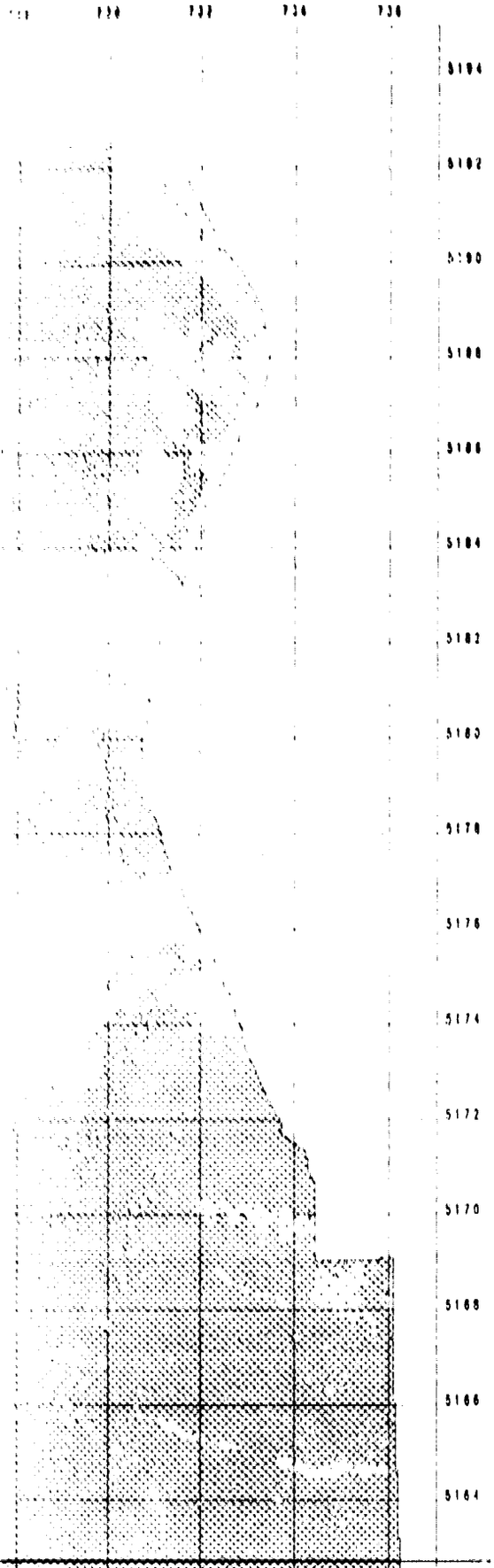
Plate 58. Soil erosion severity for 5-5-0 force structure for fifty passes



re for fifty passes


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U. S. Army Corps of Engineers
Waterways
Experiment
Station

SOIL EROSION SEVERITY
TOTAL POSSIBLE EROSION / SOIL GENERATION RATE

SCALE 1:100000

URBAN/
OFF LIMITS

NO EROSION

> 0 - 1

> 1 - 5

> 5 - 10

> 10 - 20

> 20 - 30

> 30 - 40

> 40

YAKIMA FIRING CENTER

5-5-0 FORCE STRUCTURE
1000 PASSES

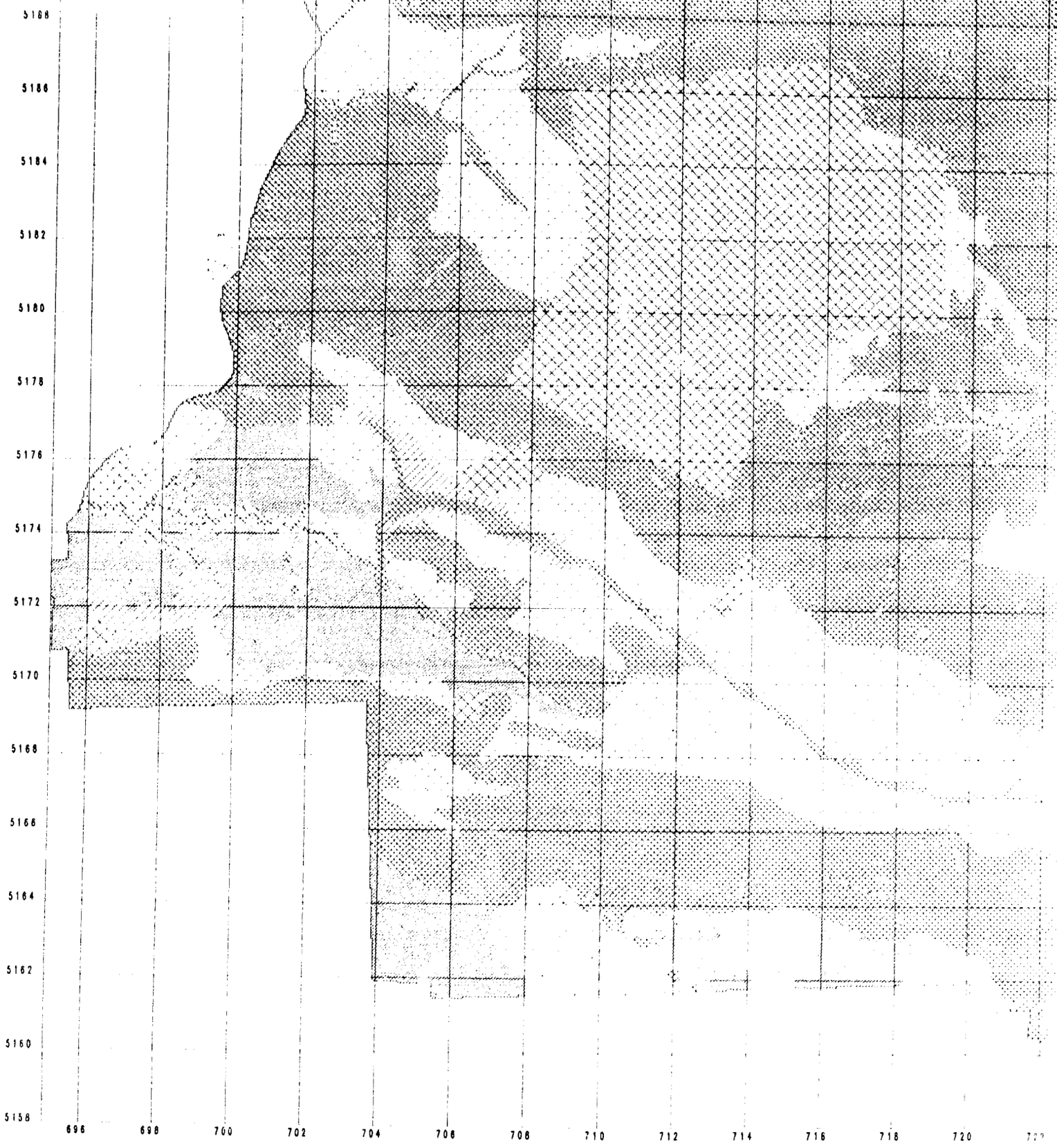


Plate 59. Soil erosion severity f

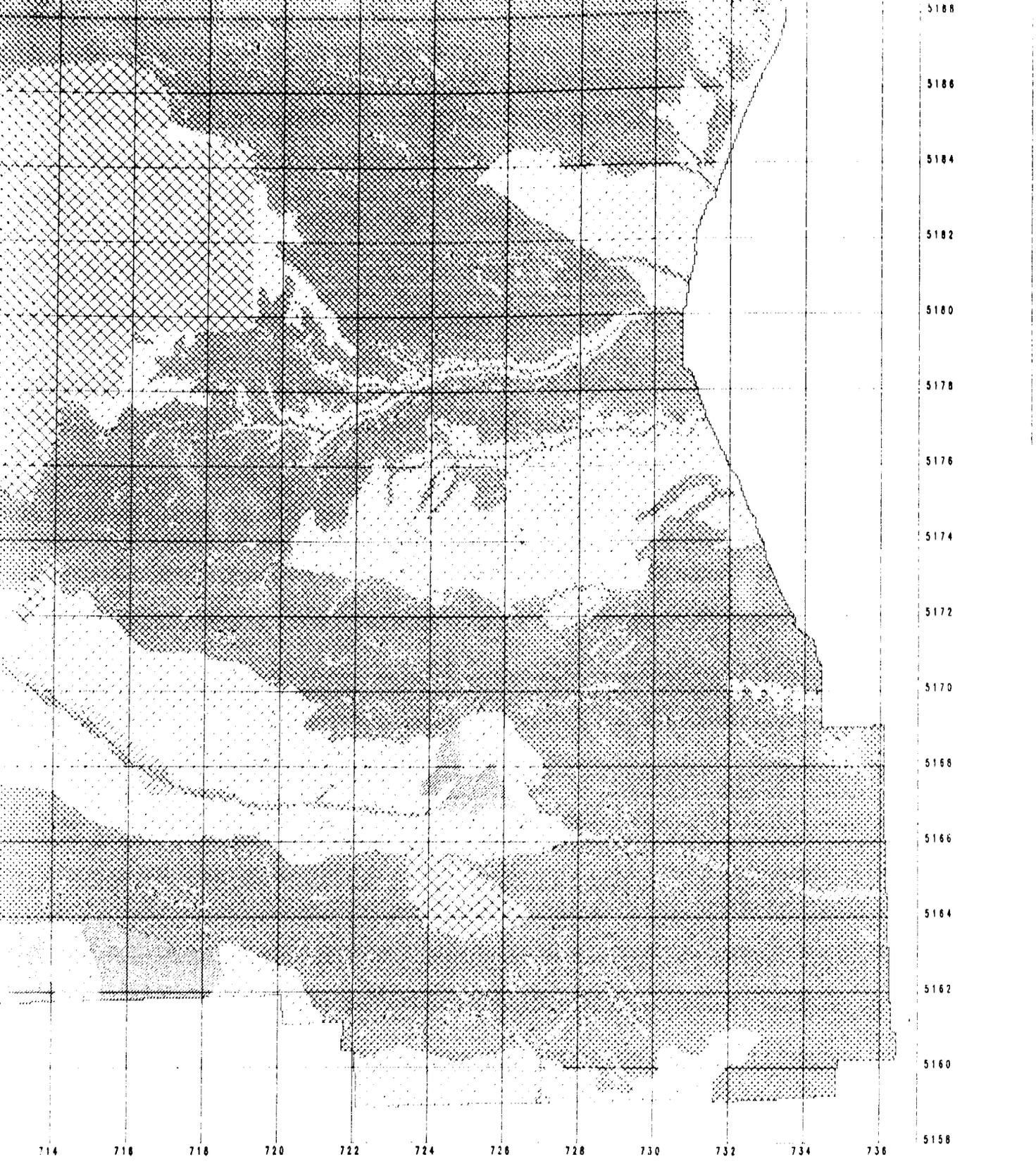
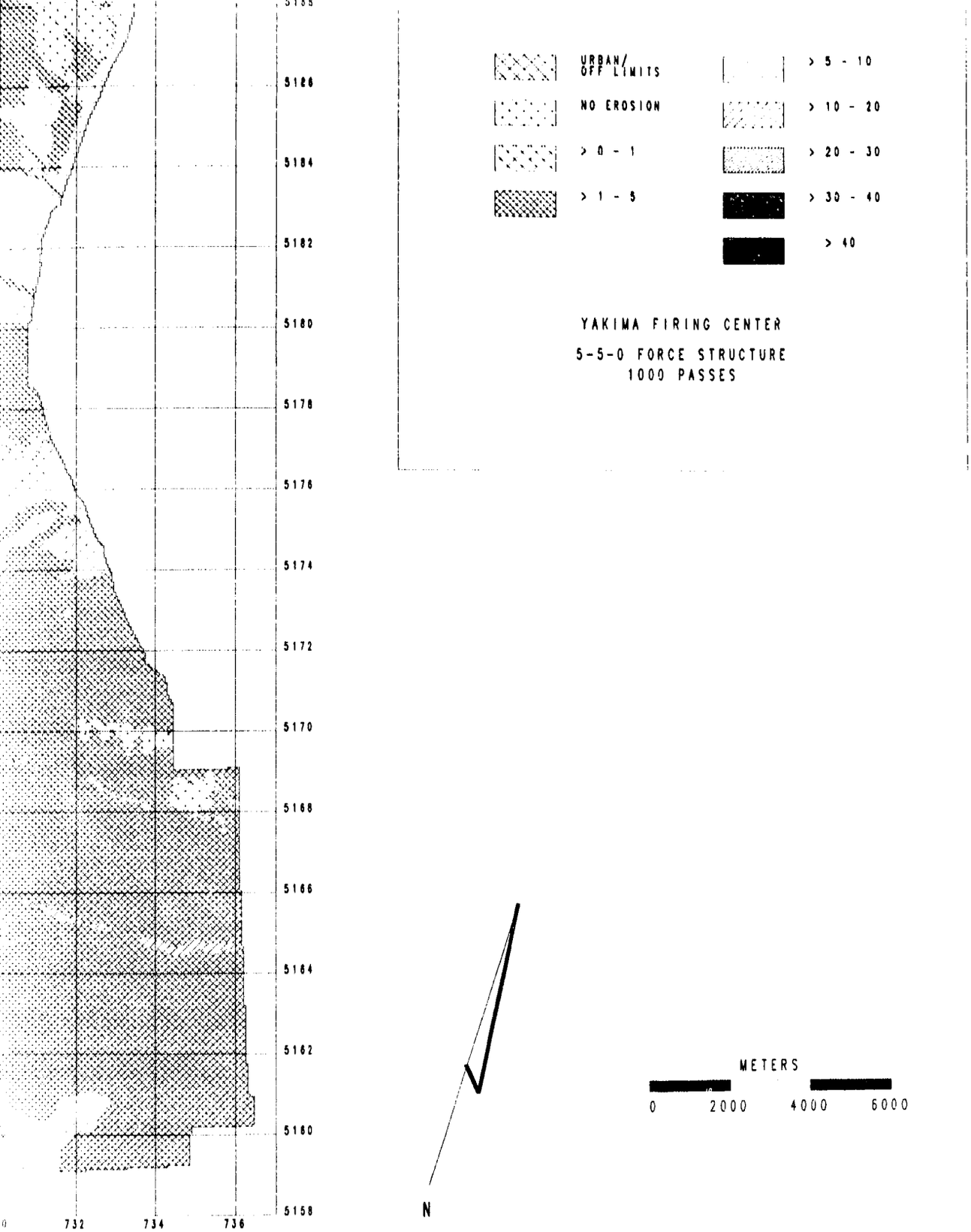
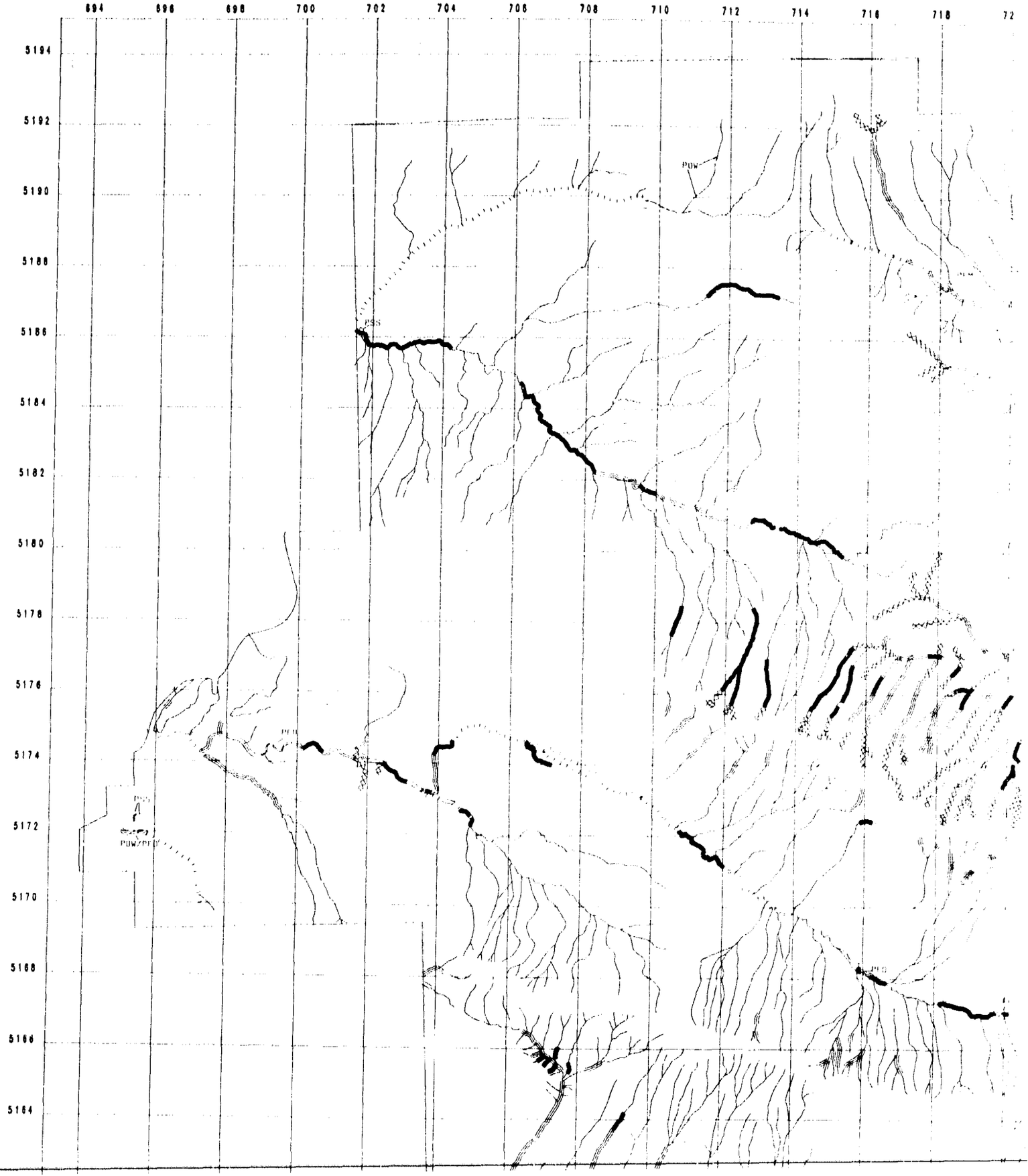
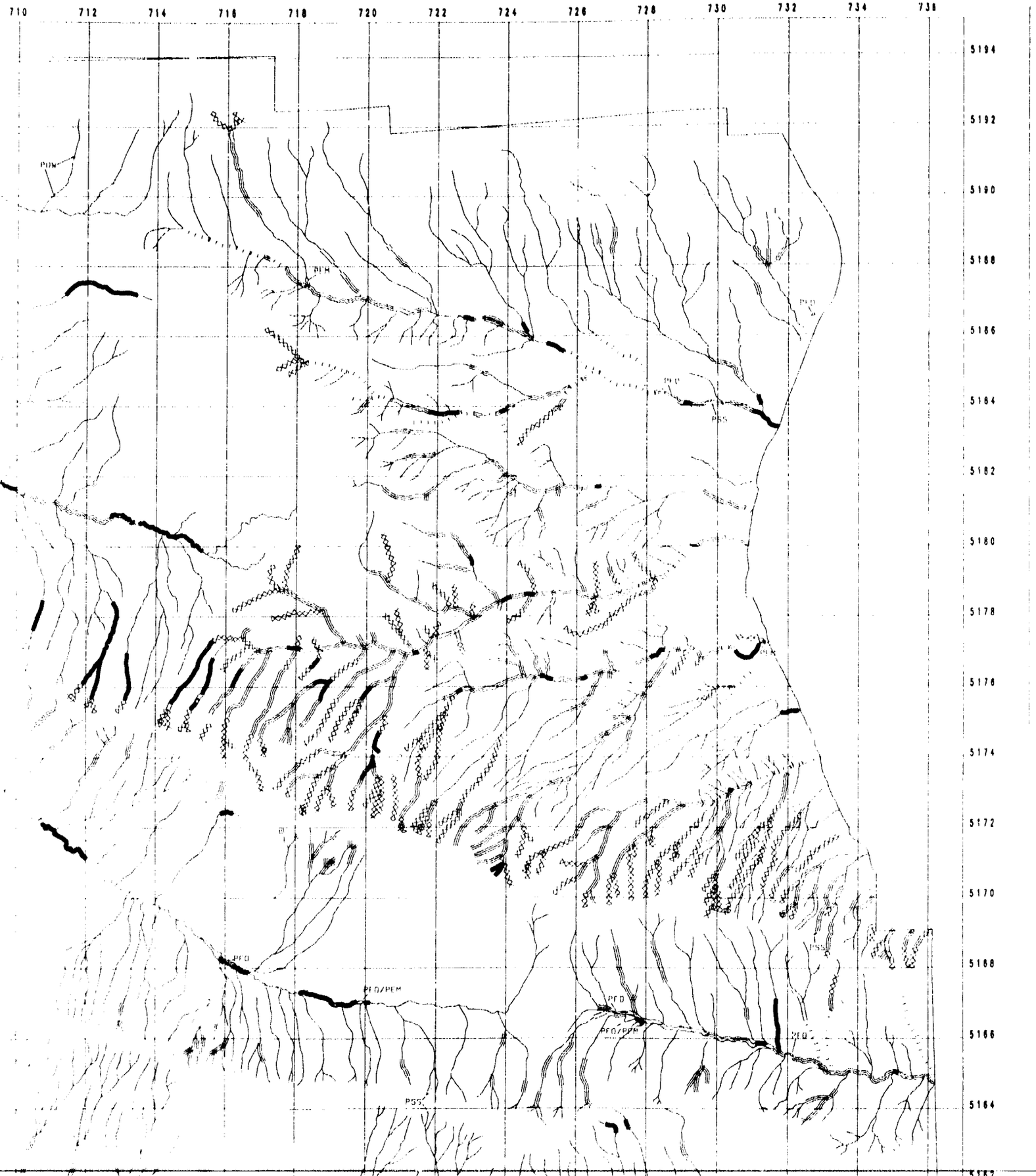


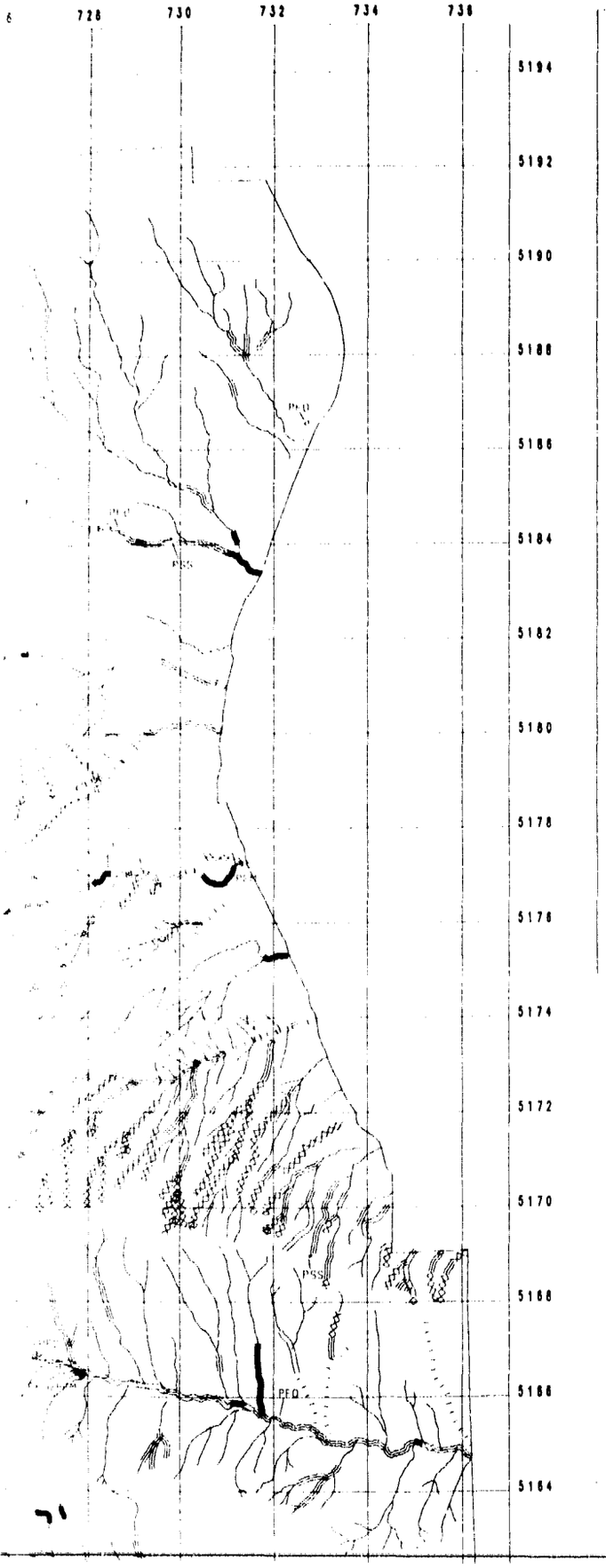
Plate 59. Soil erosion severity for 5-5-0 force structure for one thousand passes



one thousand passes


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PFO/PEM



U. S. Army Corps of Engineers
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RIPARIAN ZONE CLASSIFICATION

SCALE 1:100000

PALUSTRINE EMERGENT MARSH (PEM)

PALUSTRINE FORESTED WETLAND (PFO)

PALUSTRINE SCRUB/SHRUB WETLAND (PSS)

RIPARIAN STREAM BED - UNCLASSIFIED (RSB)

RIPARIAN STREAM BED - EXPOSED ROCK (RSBn)

RIPARIAN STREAM BED - UPLAND VEGETATION (RSBv)

RIPARIAN VEGETATION AREAS > 200 FEET WIDE

YAKIMA FIRING CENTER

YAKIMA, WASHINGTON

METERS

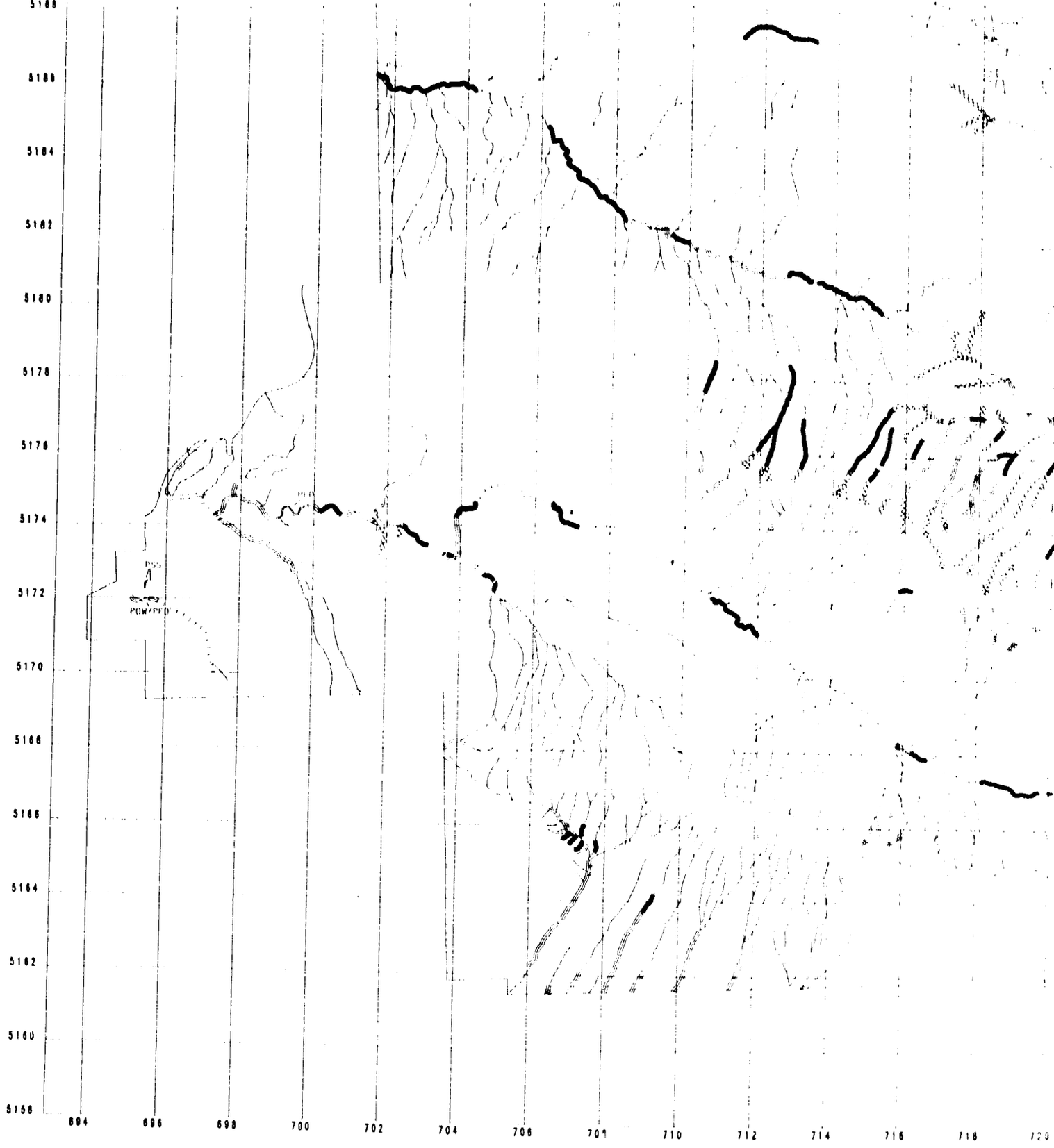

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Plate 60. R

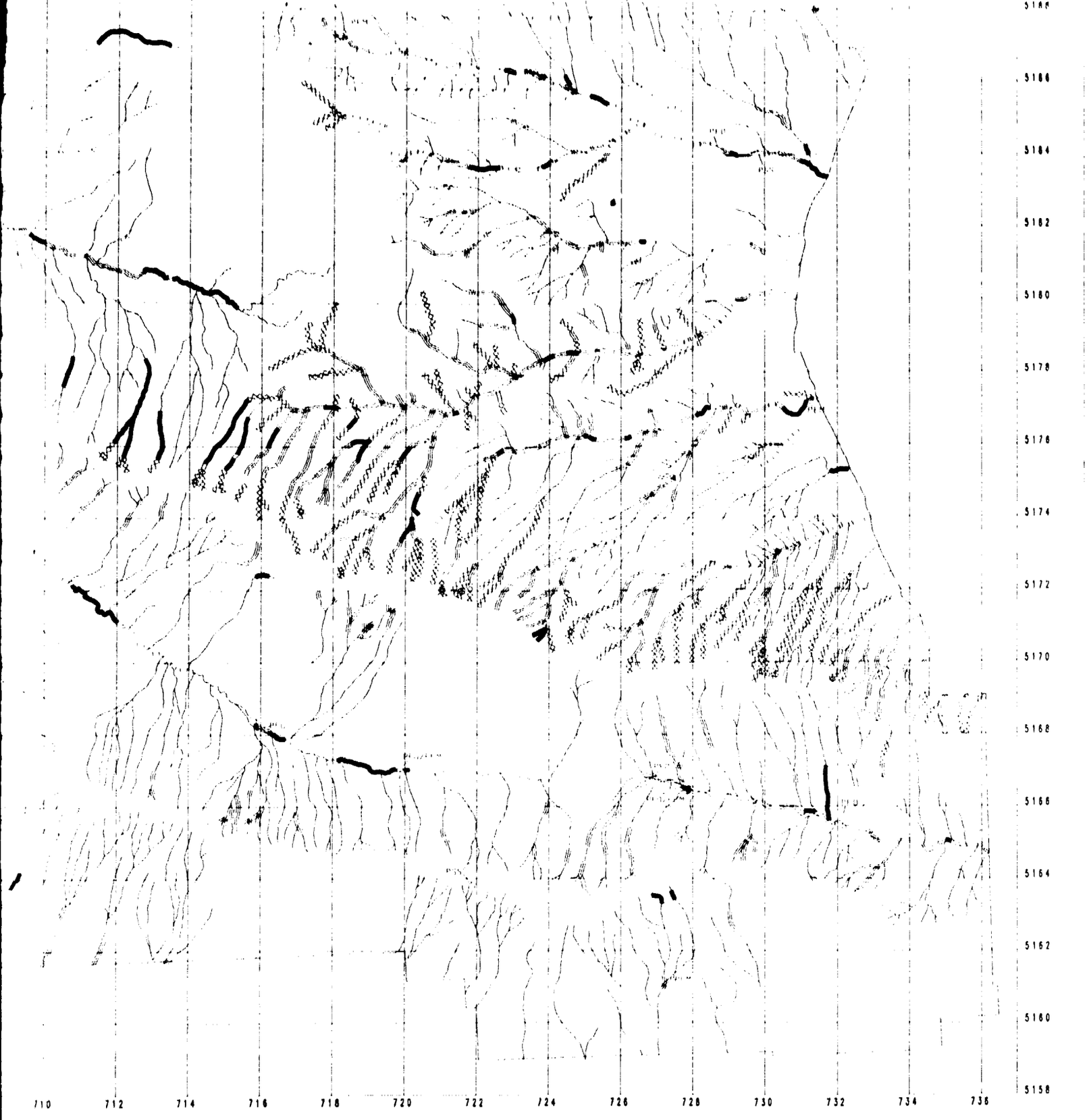
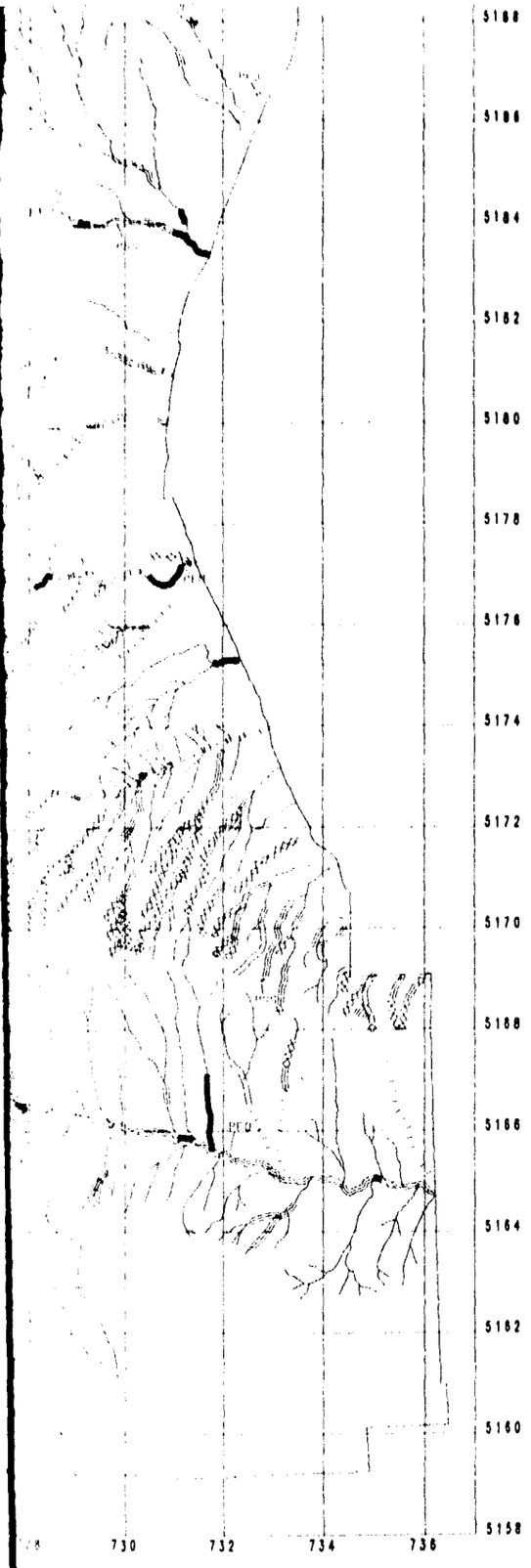


Plate 60. Riparian zone classifications



PALUSTRINE EMERGENT MARSH (PEM)

PALUSTRINE FORESTED WETLAND (PFO)

PALUSTRINE SCRUB/SHRUB WETLAND (PSS)

RIPARIAN STREAM BED - UNCLASSIFIED (RSB)

RIPARIAN STREAM BED - EXPOSED ROCK (RSBr)

RIPARIAN STREAM BED - UPLAND VEGETATION (RSBv)

RIPARIAN VEGETATION AREAS > 200 FEET WIDE

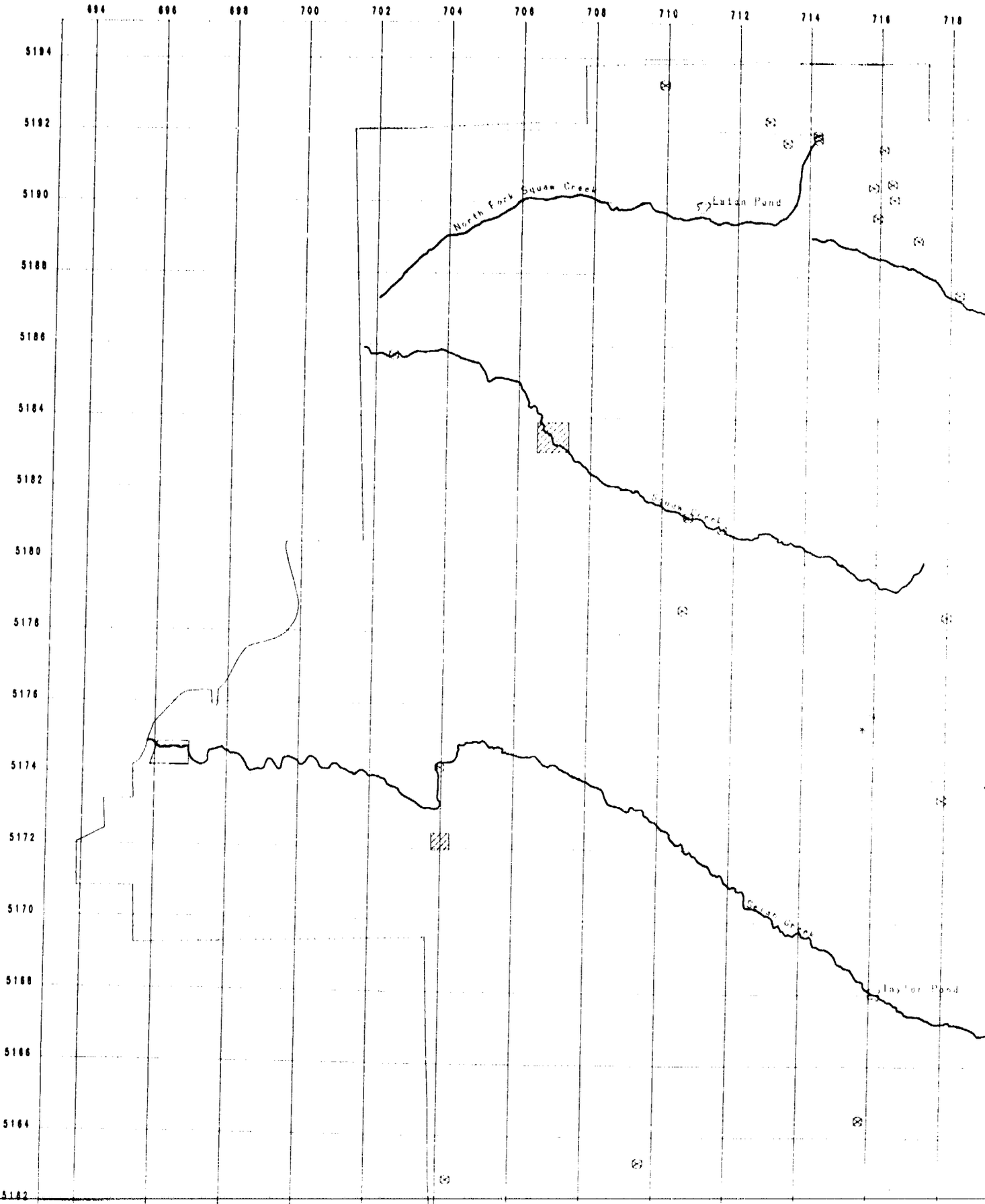
YAKIMA FIRING CENTER

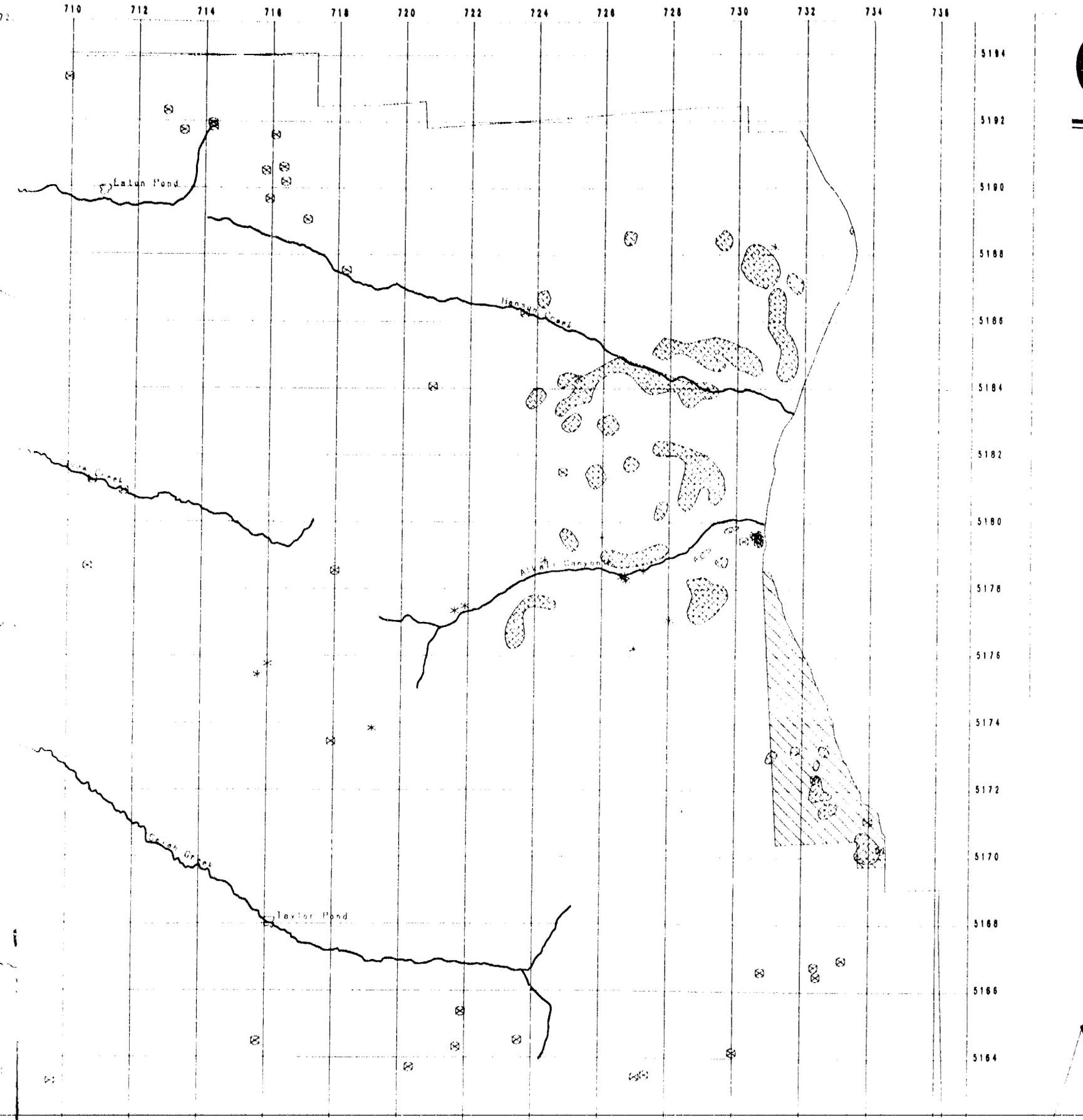
YAKIMA, WASHINGTON

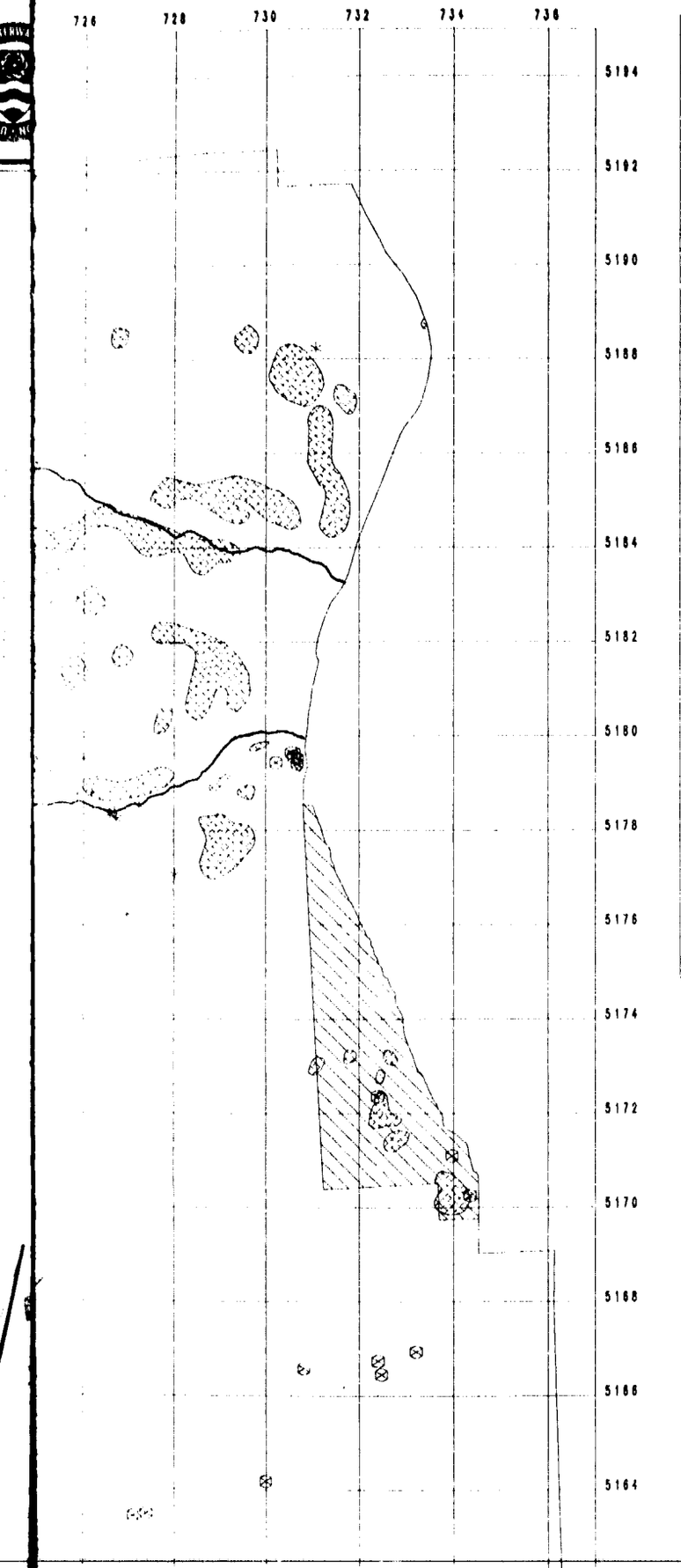
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North Fork Squaw Creek
Eaton Pond
Squaw Creek
Cedar Creek
Taylor Pond


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Laton Pond
Taylor Pond



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SPECIAL FEATURES - NATURAL

SCALE 1:100000

CONFIRMED SEEPS

SPRINGS

SAGE GROUSE LEK AREA

GOLDEN EAGLE NESTING AREA

COLUMBIA MILKVETCH
1979 SPECIAL FEATURES MAP

COLUMBIA MILKVETCH
1987 SPECIAL FEATURES MAP

YAKIMA FIRING CENTER

YAKIMA, WASHINGTON

METERS

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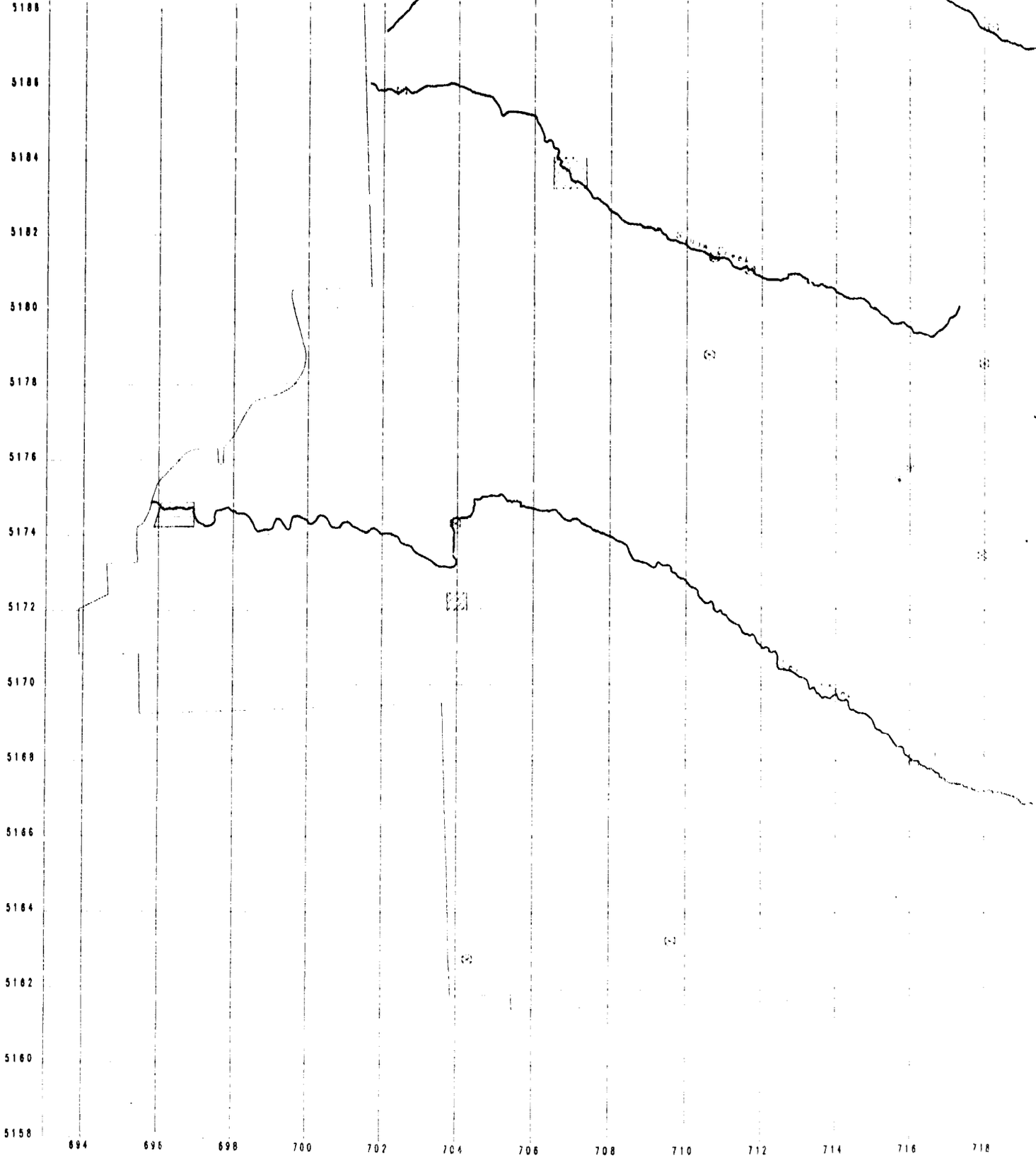

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Plate 61.

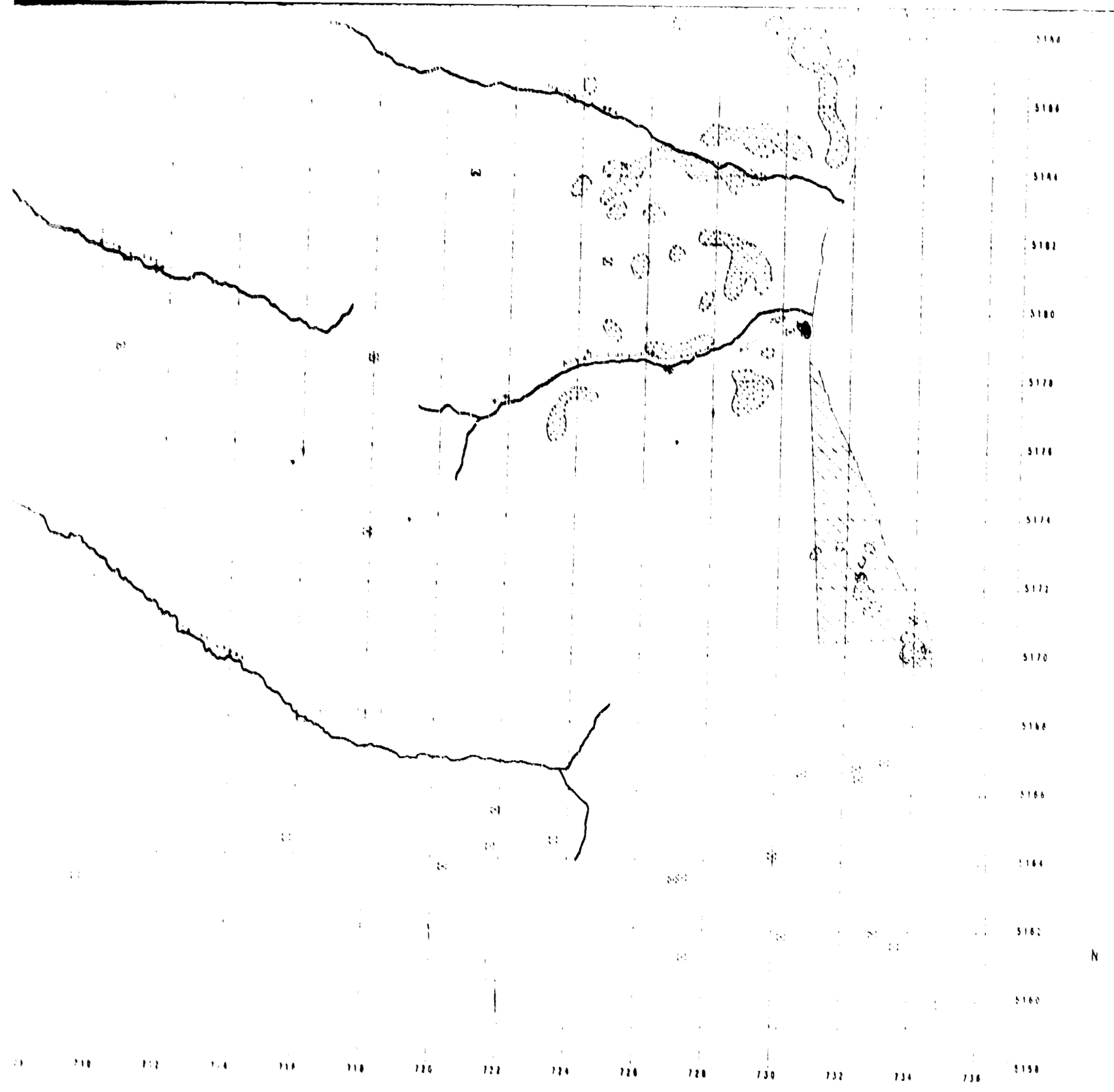
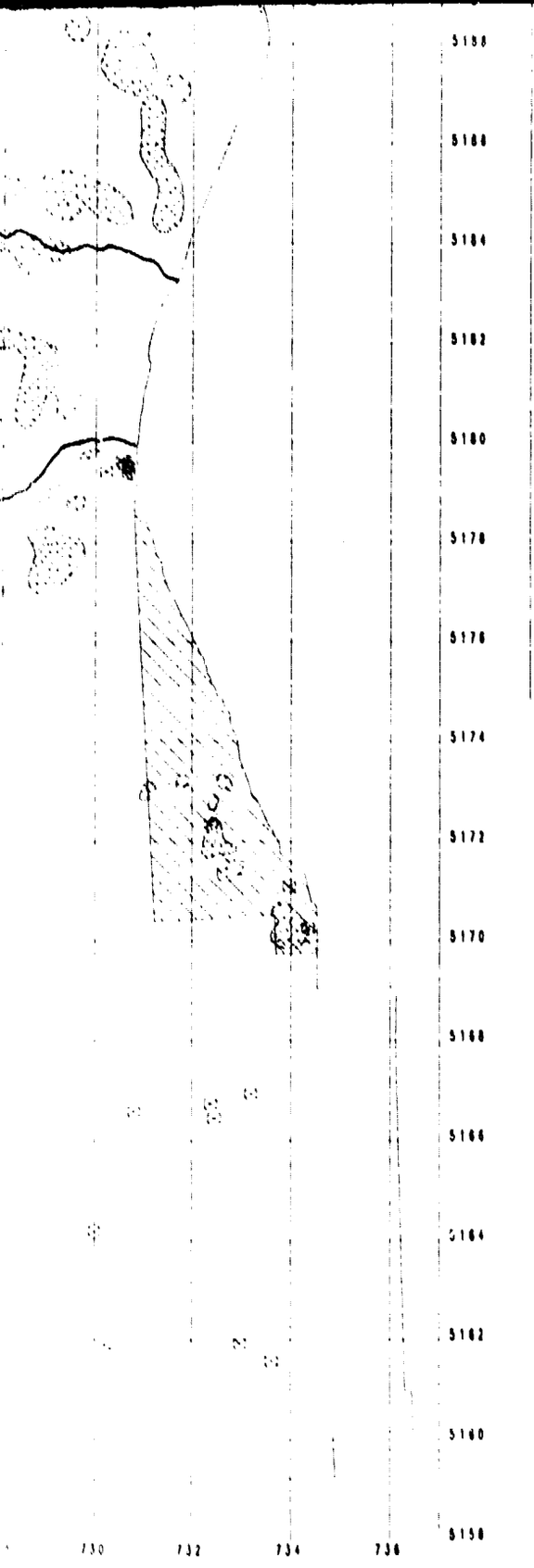


Plate 61. Special features - natural



CONFIRMED SEEPS

SPRINGS

SAGE GROUSE LEK AREA

GOLDEN EAGLE NESTING AREA

COLUMBIA MILKVETCH 1978 SPECIAL FEATURES MAP

COLUMBIA MILKVETCH 1987 SPECIAL FEATURES MAP

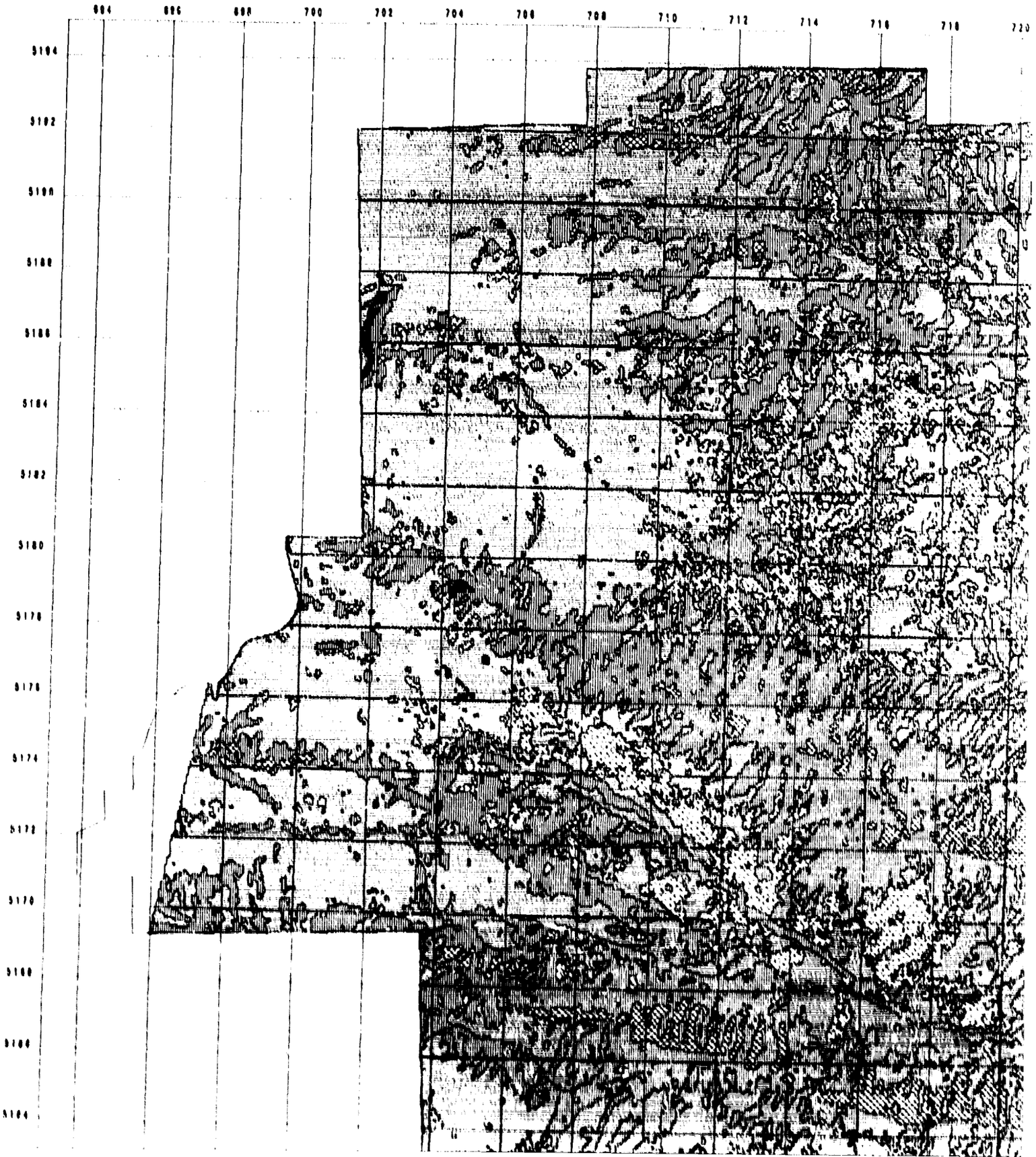
YAKIMA FIRING CENTER

YAKIMA, WASHINGTON

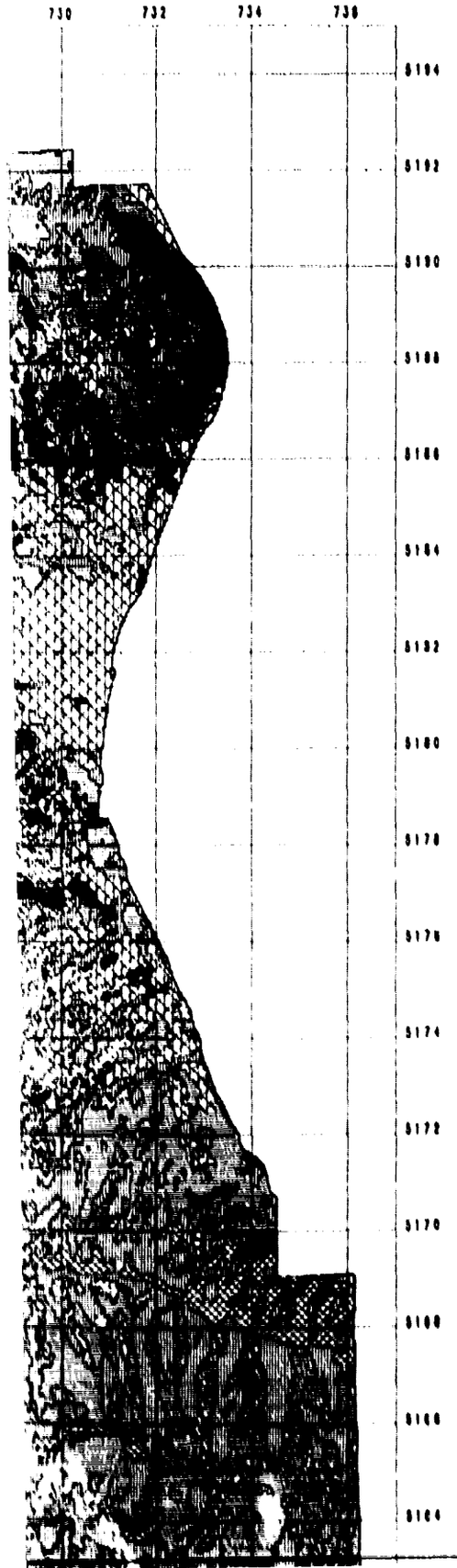
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U. S. Army Corps of Engineers
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LANDSAT CLASSIFICATION

SCALE 1:100000

- SHRUBS/WHEATGRASS/SANDBERG BLUEGRASS
- OPEN WATER
- EXPOSED ROCK
- WHEATGRASS/SANDBERG BLUEGRASS/CHEATGRASS
- CHEATGRASS
- SAND DUNES/SURFACE MINES
- BLUEBUNCH WHEATGRASS
- AGRICULTURAL/RIPARIAN
- SANDBERG BLUEGRASS/STIFF SAGE

YAKIMA FIRING CENTER

YAKIMA, WASHINGTON

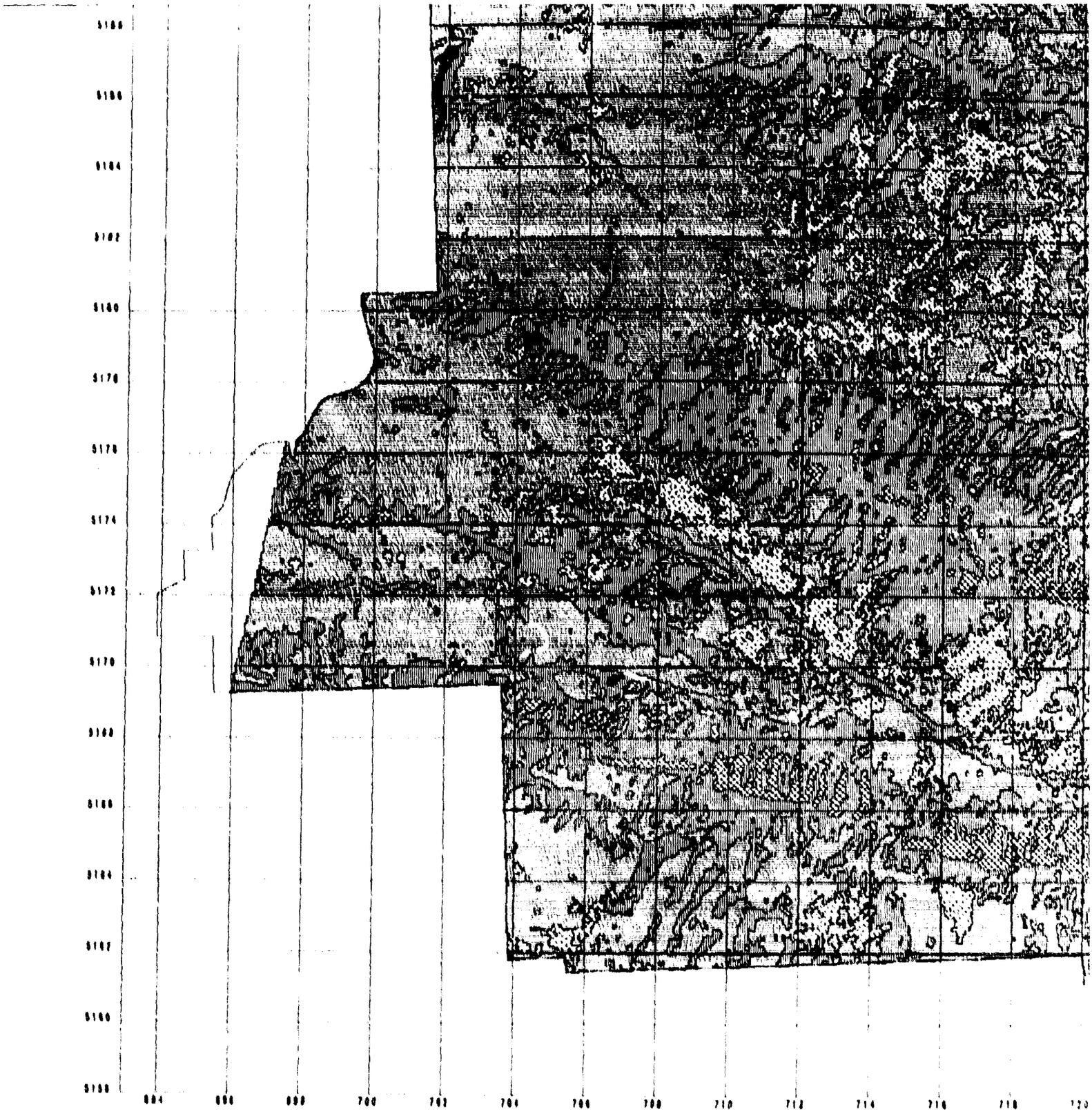
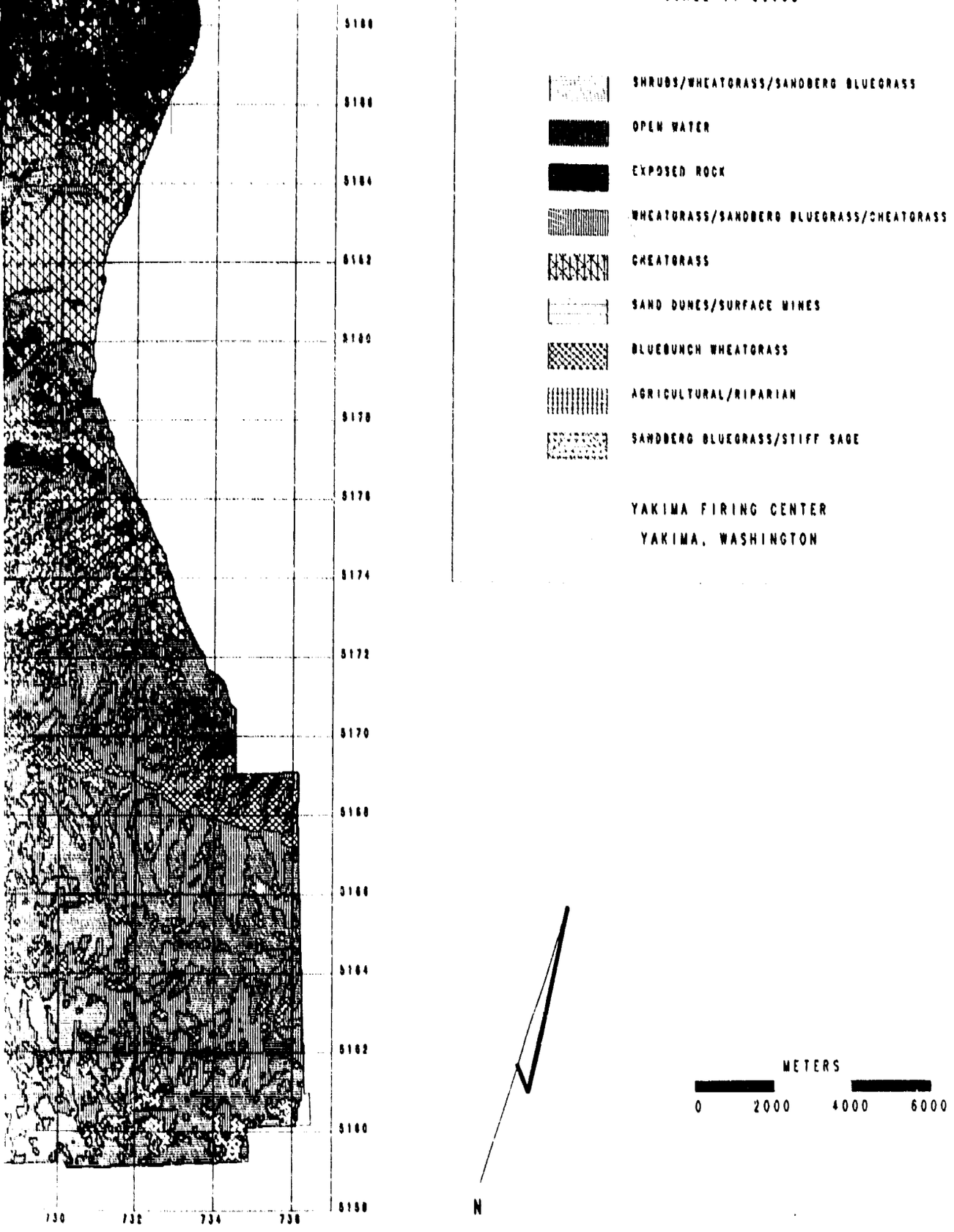


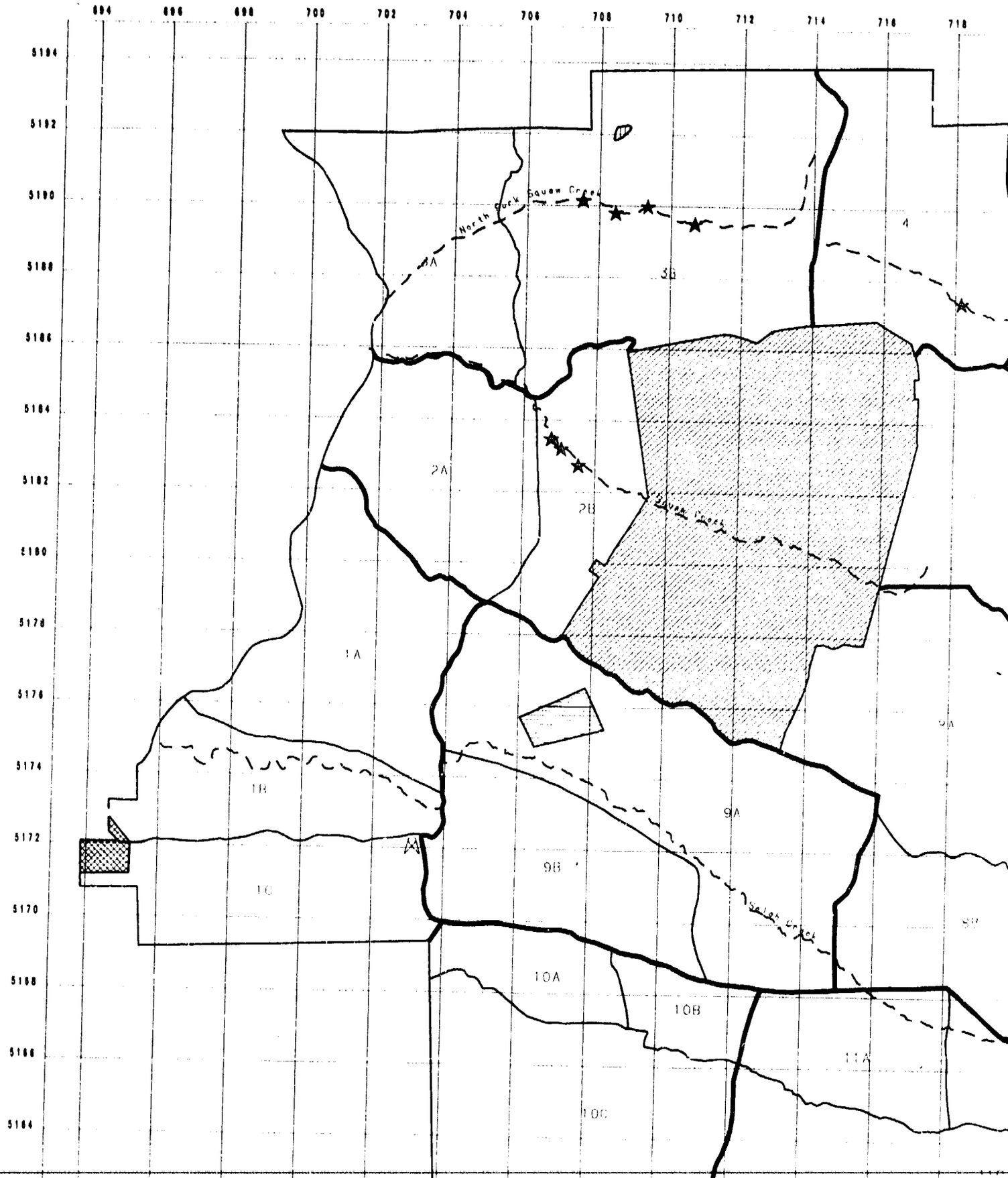
Plate 62. LANDSAT cl

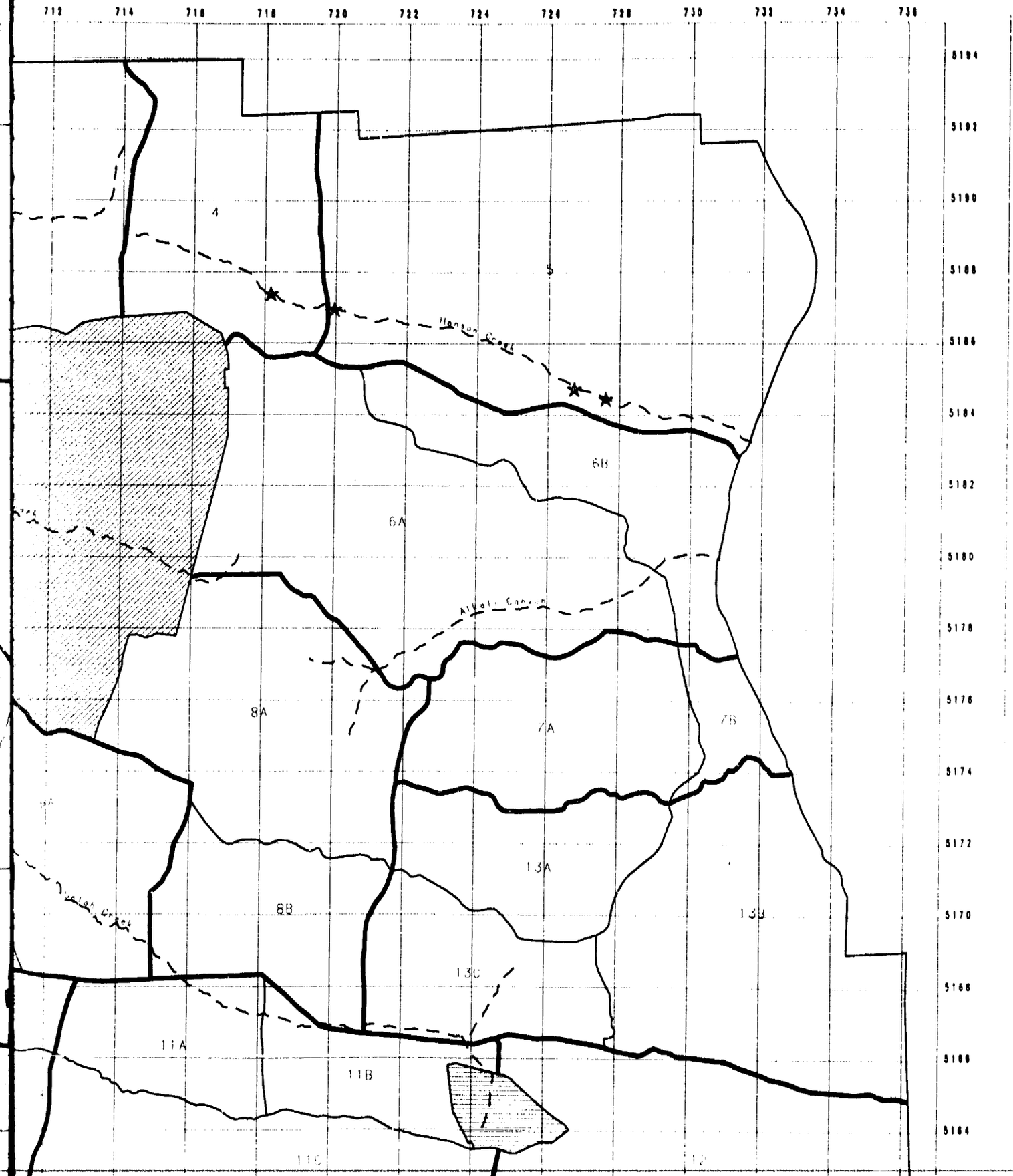


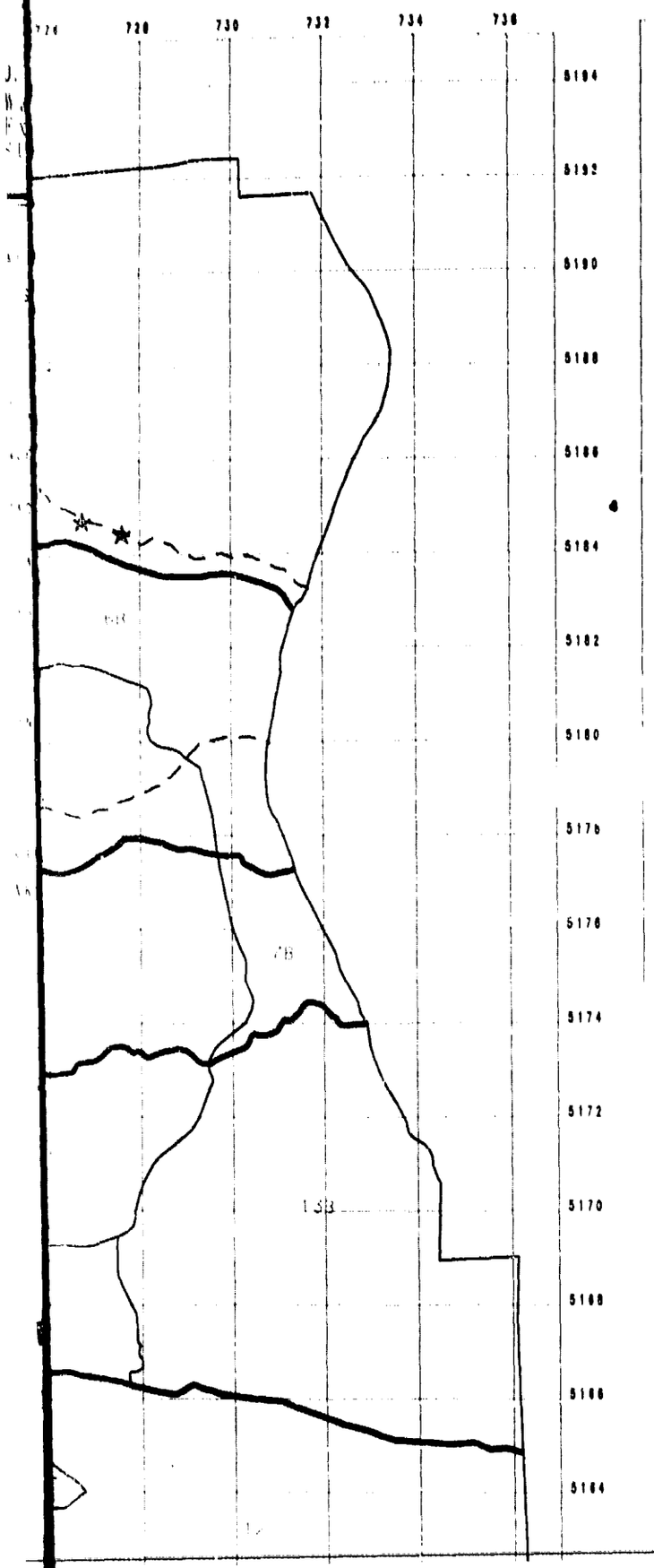
Plate 62. LANDSAT classifications (vegetation associations)


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SHRUBS/WHEATGRASS/SANDBERG BLUEGRASS
OPEN WATER
EXPOSED ROCK
WHEATGRASS/SANDBERG BLUEGRASS/CHEATGRASS
CHEATGRASS
SAND DUNES/SURFACE MINES
BLUEBUNCH WHEATGRASS
AGRICULTURAL/RIPARIAN
SANDBERG BLUEGRASS/STIFF SAGE
YAKIMA FIRING CENTER
YAKIMA, WASHINGTON
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13A
13B
13C
Hanson Creek
Alkali Canyon
SP
1A-13C



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SPECIAL FEATURES - MILITARY

SCALE 1:100000

FORD

RANGE CENTRAL

IMPACT AREA

DUD AREA

CANTONMENT

BIVOUAC SITE

TRAINING AREAS

1A-13C

YAKIMA FIRING CENTER

YAKIMA, WASHINGTON

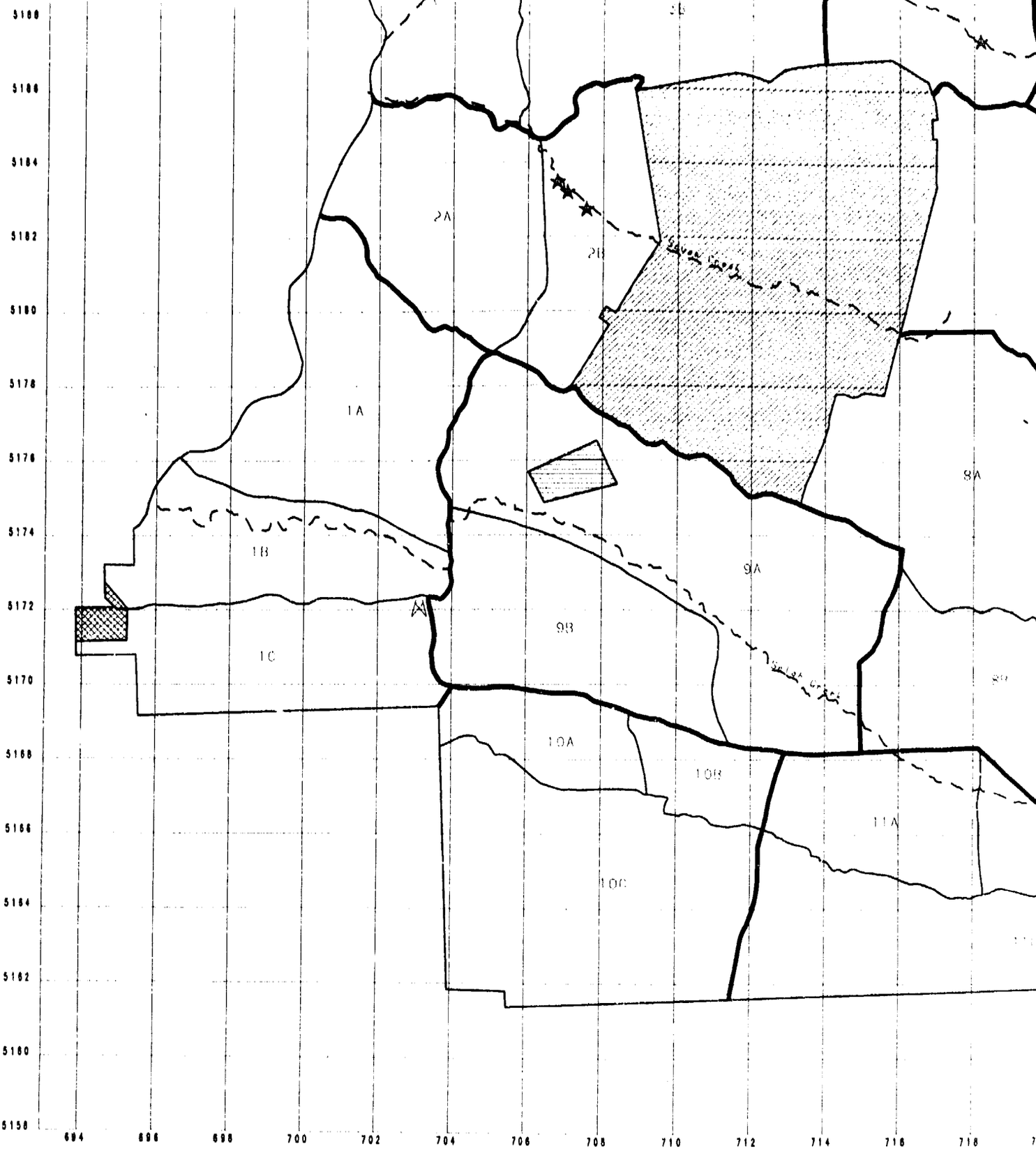

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Plate 63. S

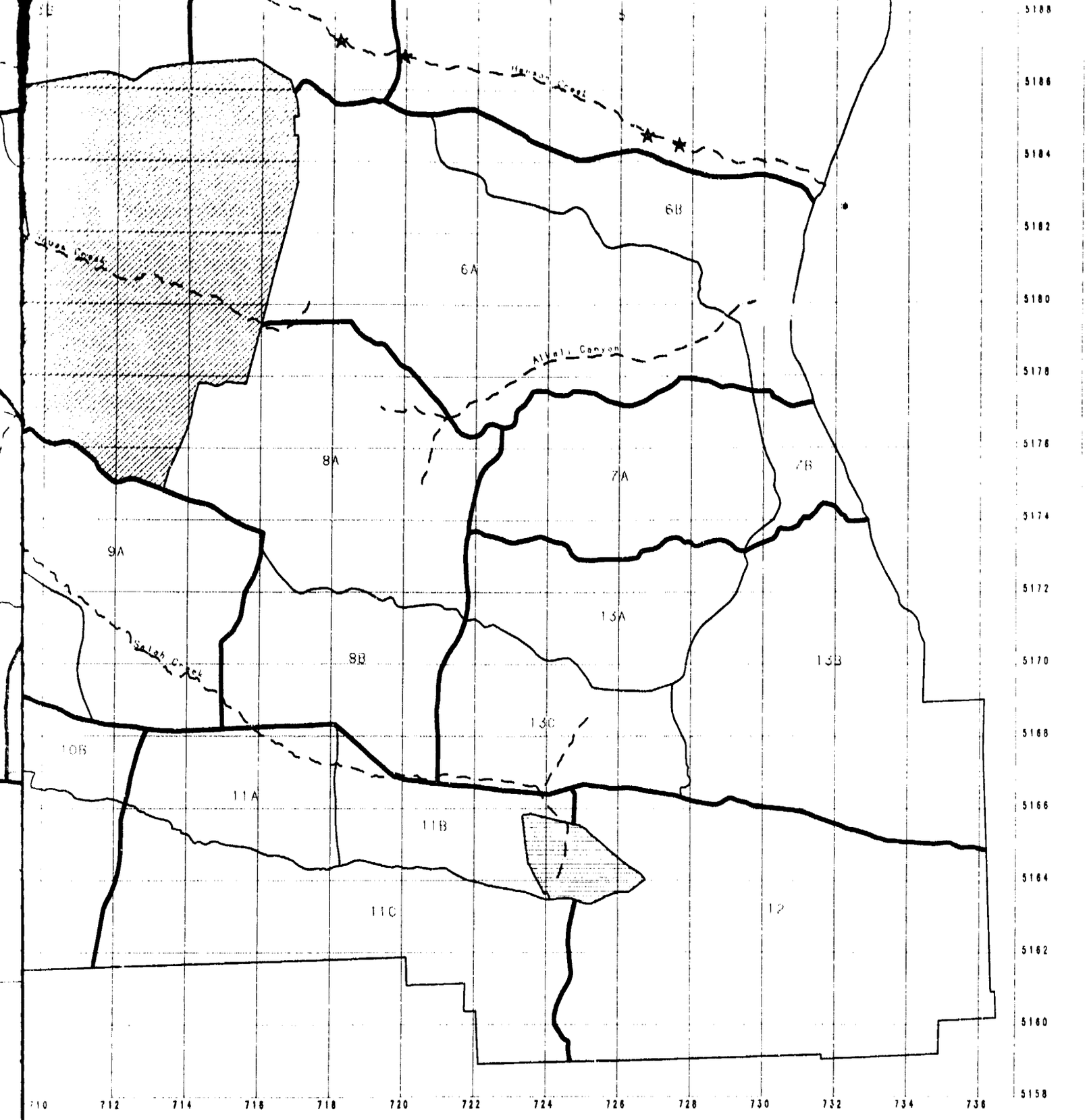
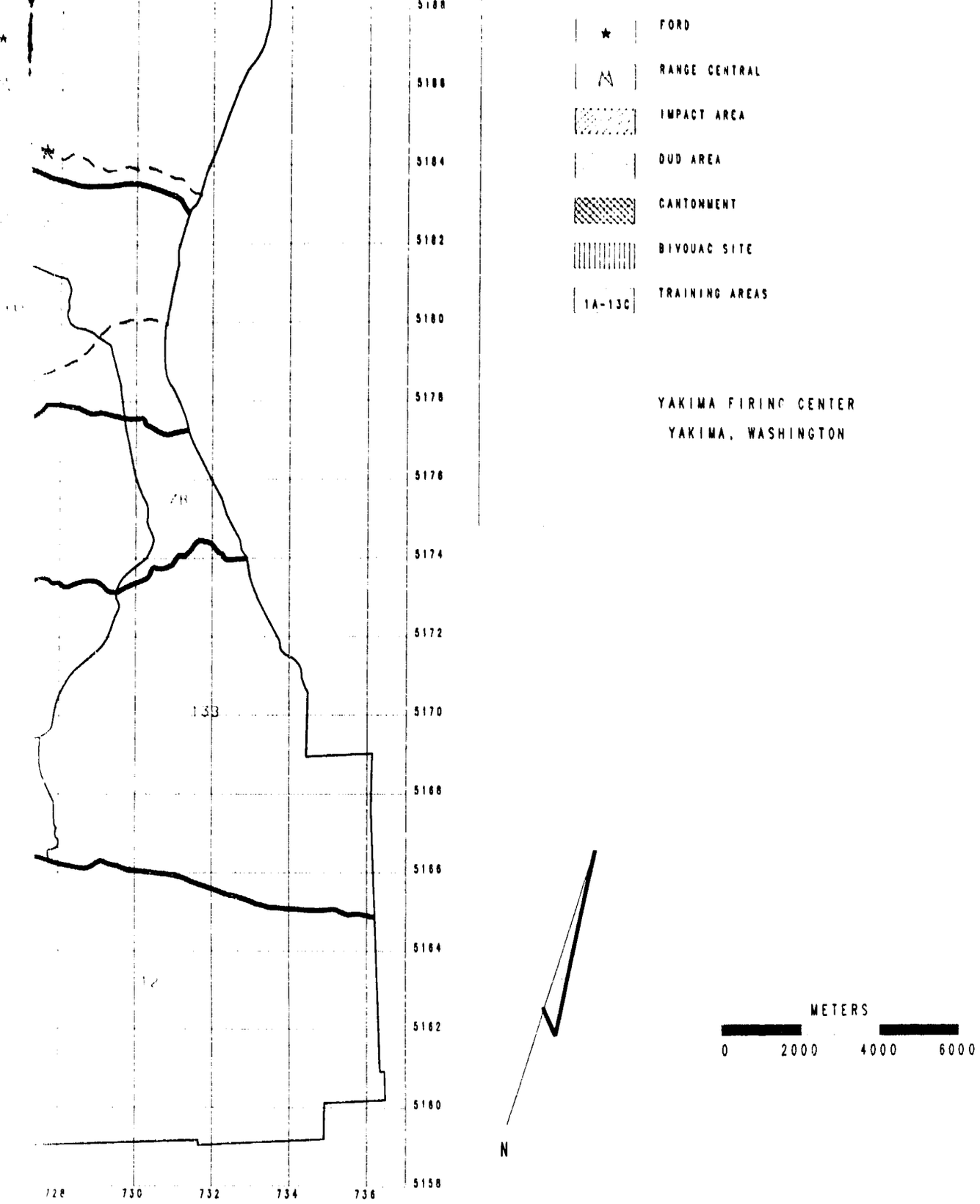
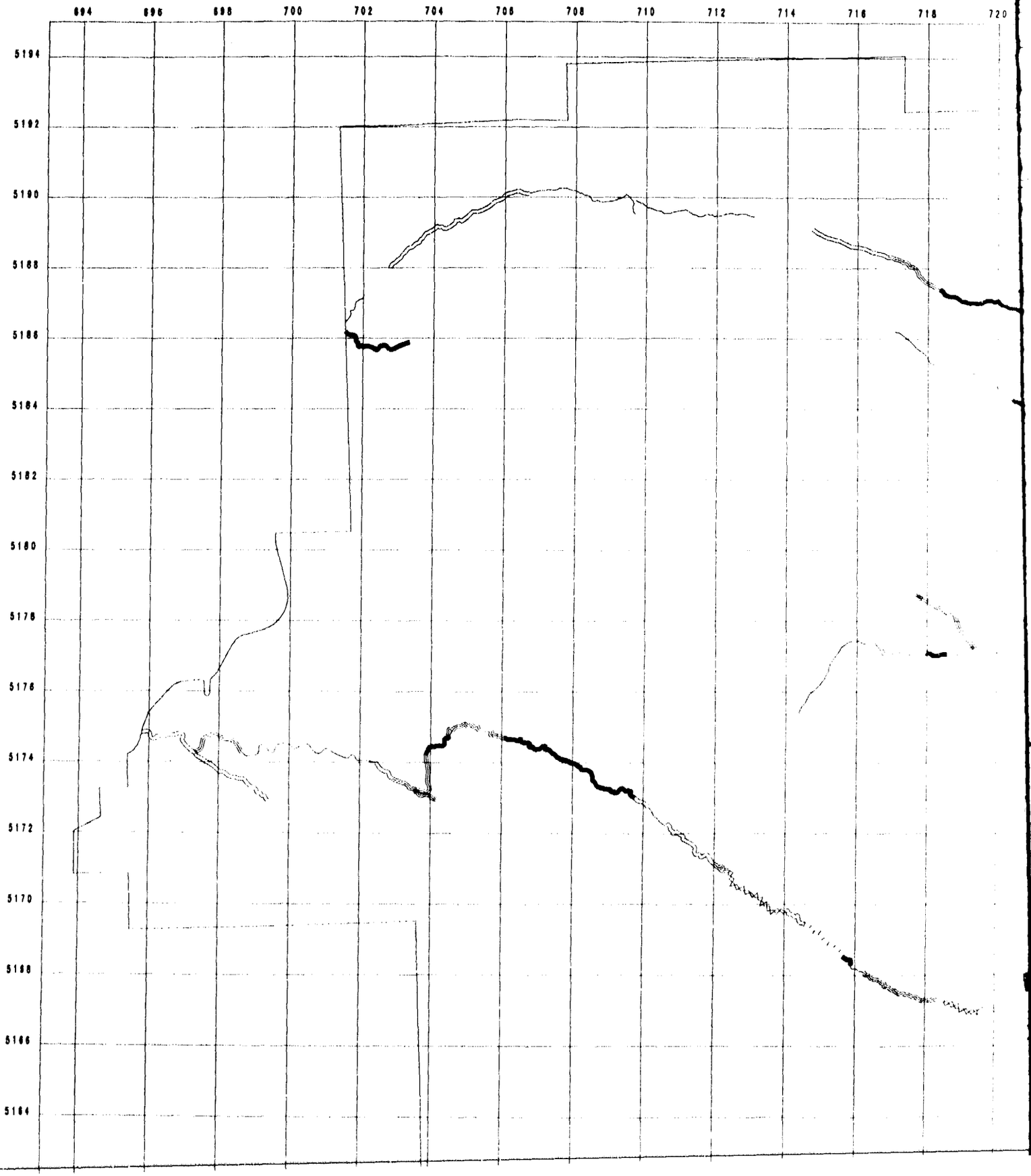
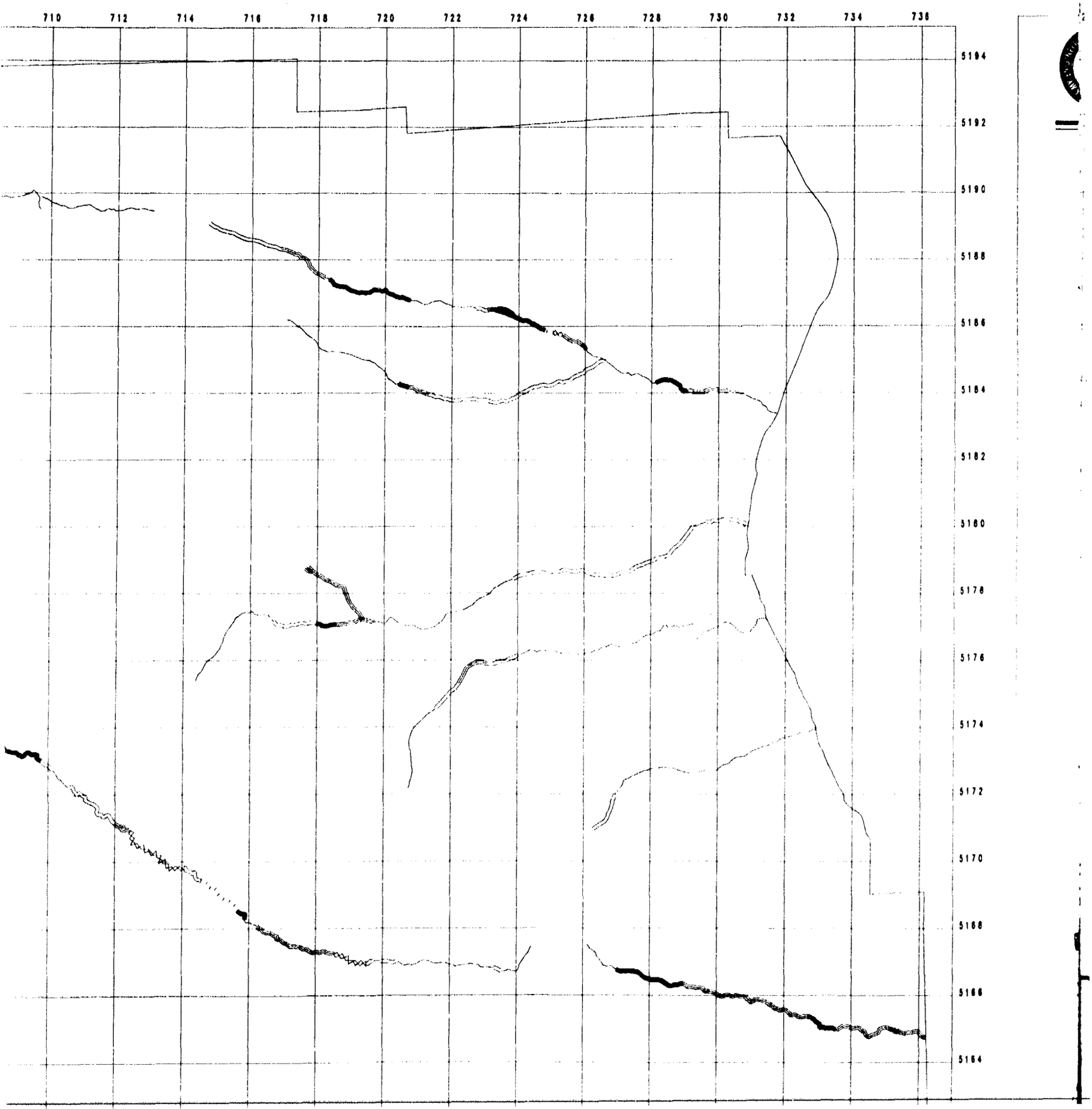
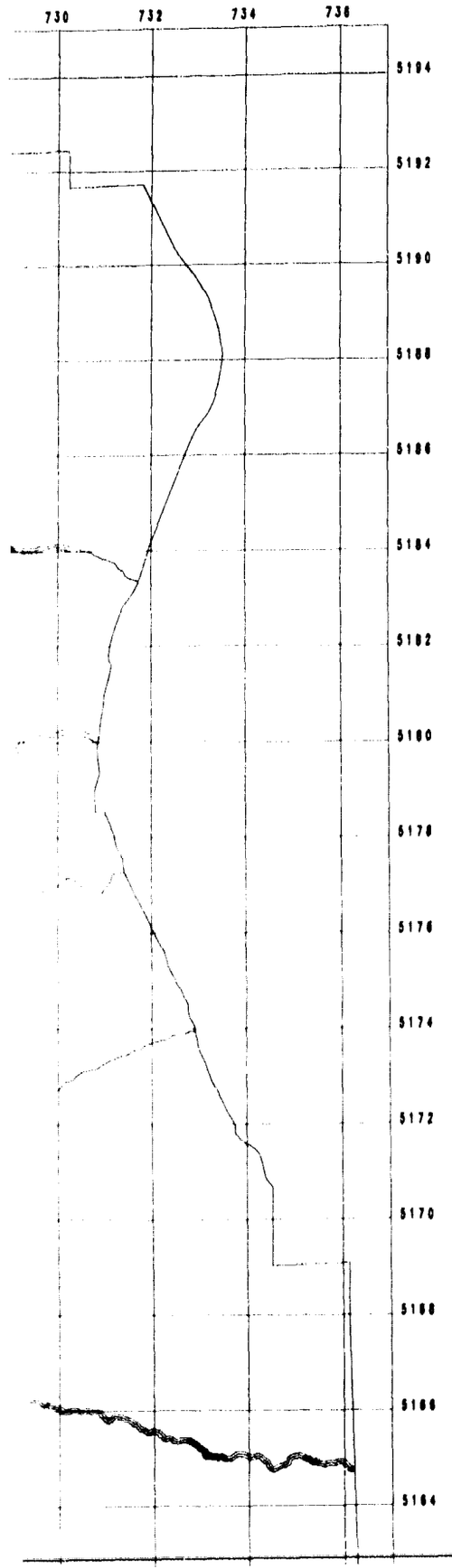


Plate 63. Special features - military


FORD
RANGE CENTRAL
IMPACT AREA
DUD AREA
CANTONMENT
BIVOUAC SITE
TRAINING AREAS
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YAKIMA FIRING CENTER
YAKIMA, WASHINGTON
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RIPARIAN ZONE -
CATEGORIES OF EROSION
SCALE 1:100000

EROSION DEPTH 0-2 FEET

EROSION DEPTH 2-6 FEET

EROSION DEPTH 2-6 FEET
WITH UNPAIRED TERRACES

EROSION DEPTH 6-12 FEET

EROSION DEPTH 6-12 FEET
WITH UNPAIRED TERRACES

EROSION DEPTH >12 FEET

YAKIMA FIRING CENTER

YAKIMA, WASHINGTON

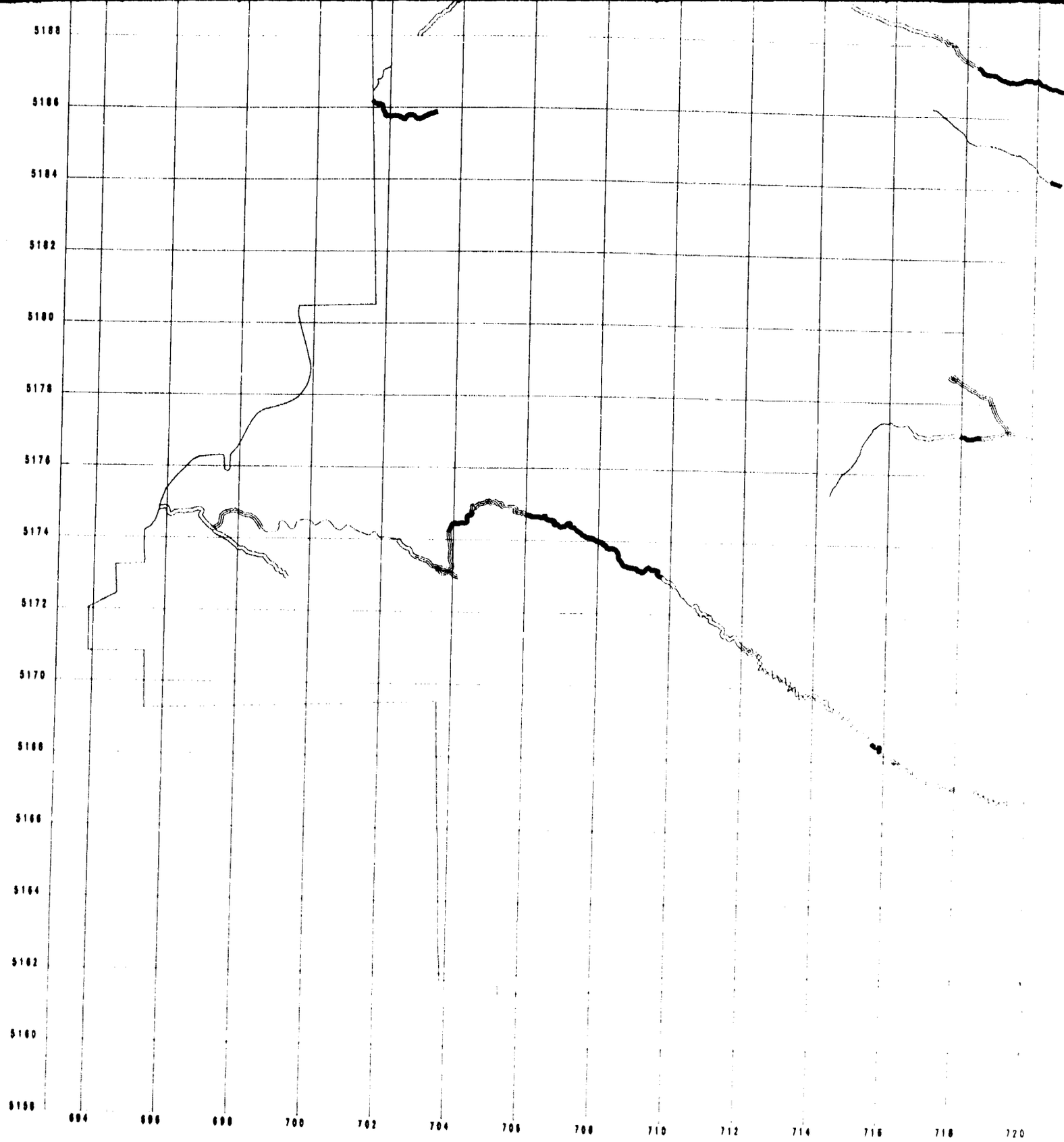


Plate 64. Riparian

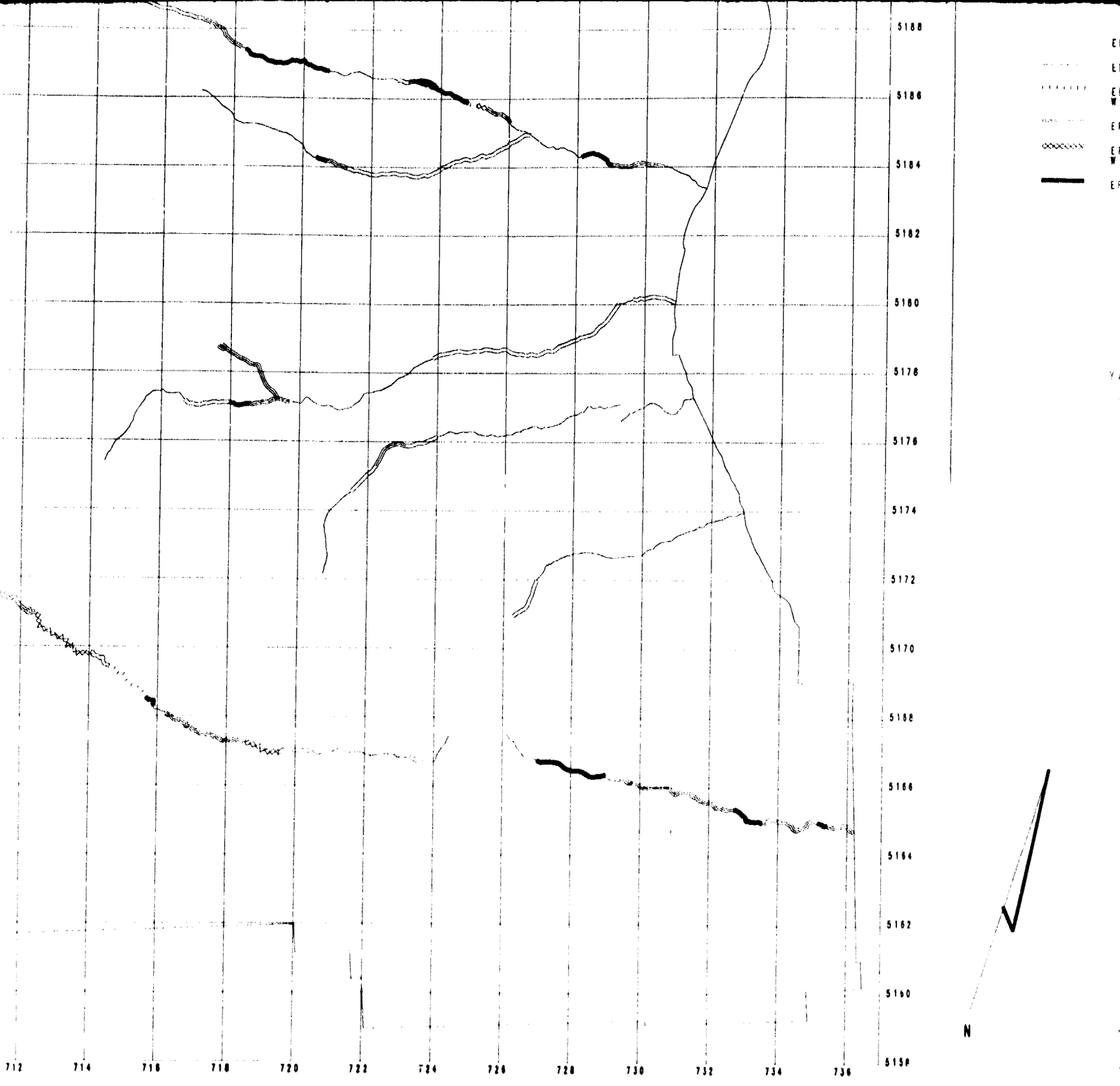
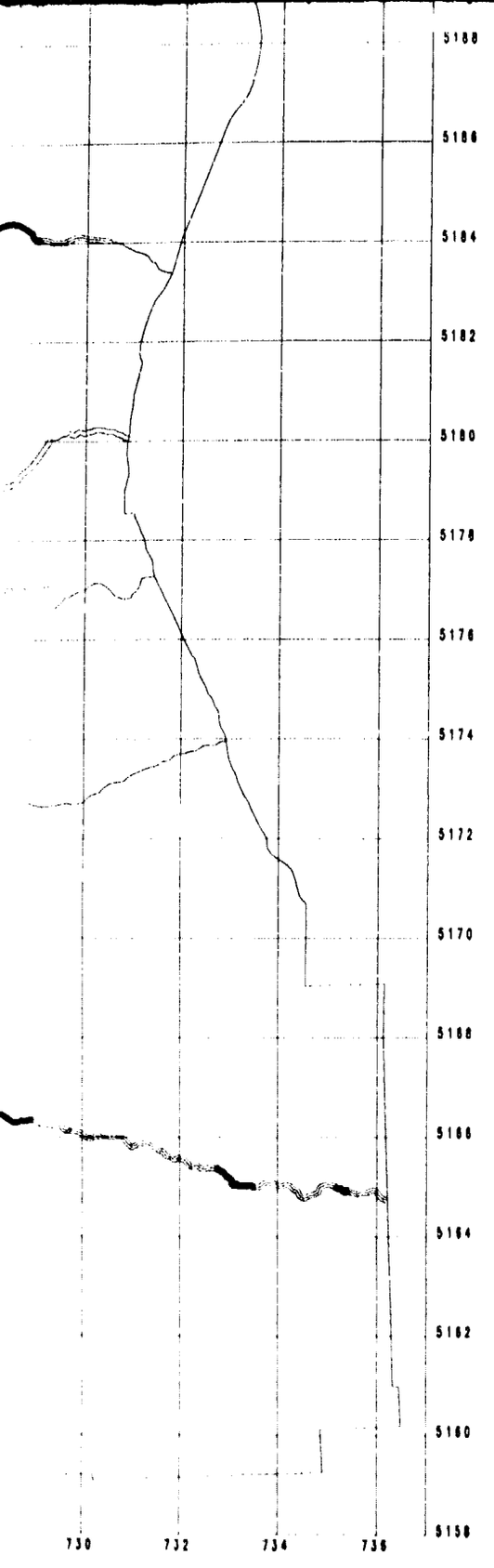


Plate 64. Riparian zone - categories of erosion



EROSION DEPTH 0-2 FEET

EROSION DEPTH 2-6 FEET

EROSION DEPTH 2-6 FEET WITH UNPAIRED TERRACES

EROSION DEPTH 6-12 FEET

EROSION DEPTH 6-12 FEET WITH UNPAIRED TERRACES

EROSION DEPTH >12 FEET

YAKIMA FIRING CENTER

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METERS

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