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REPORT

KLONDYKE WATER STORAGE FACILITY
WATER STORAGE COMMISSIONING PLAN

Prepared for Rangitata Diversion Race Management Ltd

April 2018

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
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REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
1	09/11/2016	Draft for comment	SW	NF		SM
2	12/12/2016	Updated Draft	SW		PF	SM
3	8/3/2017	Final	SW	SW	SW	SW
4	March 2017	Consultation Draft	NF			
5	10/3/2018	Consultation Draft	SW	SW	SW	SW

Rangitata Diversion Race Management Ltd

Klondyke Water Storage Facility

Water Storage Commissioning Plan

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1 Scope

1.1 Objective

The objective of this document is to minimise the risks that could arise from the first filling of the Klondyke Water Storage Facility and to test the water storage facility to ensure it will operate in accordance with its design and the applicable regulations governing the design. Initial reservoir filling can be a critical condition for dams and adherence to set procedures is a requirement for dam safety.

This plan is being prepared in advance of construction of the pond and a number of details relevant to the plan, such as the personnel involved and the exact location of monitoring points are not yet known. This plan will be updated and finalised in accordance with the consent conditions prior to any construction work/activity commencing at the Klondyke Water Storage Facility (The Klondyke Pond).

1.2 Pond Description

Klondyke Pond is located approximately 40 km west of Ashburton, near the intersection of Shepherds Bush Rd and Ealing Montalto Rd. The reservoir is formed by a ring embankment and lined with a synthetic liner. Water will be transferred into the reservoir from the Rangitata Diversion Race (RDR) via a gate controlled intake structure. Water will be released from the reservoir via a low level outlet into the Mayfield Hinds Irrigation Scheme (MHIS) race. Occasional releases back to the Rangitata River can also be made via the spillway and sluice facilities, which discharge down a new channel formed in a natural drainage gully. The statistics of the reservoir are:

- Dam crest RL 362.5
- Full Supply Level (FSL) RL 361.0
- Minimum Operating Level (MOL) RL 337.5m
    - Total Storage 53 Mm^3
- Live Storage 52 Mm^3
- Max inflow = 40.7 m^3/s
- Max operational outflow = 17 m^3/s
- Spillway and Sluice Capacity = 40.7 m^3/s

The dam is categorised as High Potential Impact Classification (PIC) in terms of the New Zealand Society on Large Dams (NZSOLD) New Zealand Dam Safety Guidelines (DSG) (2015).

1.3 Commencement, Duration and Completion

Commissioning commences when instruction is given to deliver water to the reservoir from the RDR.

Commissioning is nominally complete one month after the reservoir reaches FSL, provided spillway trials are complete and readings at the monitoring points are stable.

Filling of the reservoir is expected to take 62 days at the maximum allowable commissioning inflow of 10 m^3/s.

2 Responsibilities

2.1 Actions

Action	Position Accountable
Commissioning, Monitoring and reporting	Contractors Representative
Events based monitoring and reporting	Contractors Representative
Receive monitoring reports and advise design director	Engineers Representative
Evaluate monitoring reports and instruct additional actions when necessary	Design Director
Liaison with technical specialists and peer reviewers as required	Design Director
Completion of commissioning report.	Design Director
Respond as required on advice of his/her technical advisors	Owners Representative

2.2 Communication Directory

Owner	Rangitata Diversion Race Management Ltd
Owners Representative	Ben Curry
Contractor	TBC
Contractors Representative	TBC
Designer	MWH New Zealand Ltd
Design Director	Peter Foster
Design Engineer	Steven Woods
Engineers Representative	William Waddell
Peer Reviewer	TBC

3 Pre-commissioning Requirements

The approval of the Design Director must be obtained before commissioning begins. This will require:

- The completion of all critical reservoir construction works.
- The satisfactory completion of the readiness checklist included in Appendix A.
- The availability of suitably trained personnel to resource the commissioning and monitoring processes.

All conditions of the project consents must be complied with, in particular, condition 16 of consent CRC170657:

16	The Consent Holder shall prepare a comprehensive Water Storage Commissioning Plan (WSCP) for the Dam. The objectives of the WSCP shall be to minimise risks from the initial filling and other commissioning of the Dam, in accordance with the Guidelines for a High PIC dam. The WSCP shall be certified by peer review input by an independent certifier in accordance with the Guidelines and condition 17. The WSCP shall include (but not be limited to) provisions for: a. definition of the physical works that must be completed before commissioning can commence. b. definition of all parties involved and their responsibilities, the names of key personnel including backup personnel, and all personnel contact details. c. confirmation that all statutory requirements have been and will be met during commissioning. d. requirements for Designer input including inspections and input if performance is not as anticipated. e. the rate of reservoir filling, reservoir level hold points and their duration, and criteria for the continuation of reservoir filling. f. recording a set of initial (baseline) measurements for all instrumentation and survey marks immediately prior to commissioning. g. the establishment of expected performance ranges for instrumentation by the Designer, to provide a guide for evaluating actual dam performance during and following commissioning.

	h. commissioning procedures including at prescribed frequencies and/or reservoir elevations: i. walkover inspections to check for any indications of unexpected changes. ii. identification and measurement of seepage flows and clarity and changes in seepage behaviour. iii. measurement of piezometric pressures and groundwater levels. iv. measurement of settlements and deformations. v. inspections and/or monitoring of the dam. vi. reservoir shoreline and rip rap stability at specified hold points. i. testing of installed plant and equipment critical to dam safety (e.g. diversion gates from the Rangitata Diversion Race and low-level outlet gates) over an appropriate head and flow range including flushing and irrigation releases. j. testing of spillway and energy dissipation structure performance including but not limited to reinforced concrete chutes, stilling basins, rock lined channels and interface areas over an appropriate range of flow magnitude and duration. k. The recording and communication of monitored data, interpreting the monitored data, and evaluating the performance of the Dam against acceptable performance criteria. l. actions to be taken in the event of a developing actual or potential dam safety emergency. m. the duration of commissioning and handover procedures. n. for a comprehensive Commissioning Report to be prepared by the Designer including interpretation of all surveillance data and confirmation that all surveillance data is in accordance with design expectations and/or discussion on the resolution of any matter that is outside of design expectations. The commissioning report shall be provided to the Canterbury Regional Council, Attention Regional Leader – Monitoring and Compliance not more than 20 working days following the Designer certifying completion of commissioning.

4 Commissioning Procedure

4.1 Commissioning Sequence

Once approval to proceed has been received, inflow to the reservoir shall be slowly ramped up to 10 m^3/s over the first hour. Once the water level has reached RL339 m the inflow shall be stopped to allow testing of the outlet gate under water. The outlet flow shall be ramped up to design flow of 16.5 m^3/s over a period of 8 hours and the gate tested to confirm it can be operated while under pressure. The outlet gate shall be re-tested in the same manner at RL 345, RL 350, RL 355 and RL 361m.

Once the reservoir reaches Full Supply Level (RL 361m) the inflow shall be stopped for a period of 3 days and the volume lost calculated and recorded. The maximum expected loss is 285 l/s or 75,000 m^3 over 72 hours. Data from the Winchmore weather station shall be used to correct for evaporation and rainfall during this period.

Following successful completion of the water loss test, the inflow to the reservoir shall be ramped back up to 10 m^3/s to induce spilling of the reservoir. The flow shall be increased in increments of 10 m^3/s per 15 minutes until the maximum inflow reaches 40.7 m^3/s (or the maximum flow allowed by the RDR consents at the time of the test). The flow shall be held at the maximum flow for 15 minutes.

Following successful completion of the spillway test the inflow shall be stopped and the pond returned to full supply level (RL361m). The outflow (to the Mayfield Hinds Irrigation Scheme) shall then be varied in increments of 2 m^3/s per hour and the ability of the control system to automatically adjust the inflow to keep the pond at RL361m verified.

The pond shall be held in the range of RL358 to RL361m for a period of one month following the above-mentioned activities to allow the system to stabilise. If no adverse observations are made during this period then the commissioning will be deemed successful and operation will transfer from the commissioning plan to the Dam Safety Management Plan. Adverse observations could include seepage flows that are discoloured, slumping on either the upstream or downstream slopes, cracking in the embankment or liner, movement of the rip rap erosion protection or operation of the gate and control systems outside their operating parameters. Refer to Section 5 of this document for additional information on performance criteria and conceivable problem areas.

4.2 Reservoir Filling

It is expected that the filling of the reservoir will take approximately 62 days at an inflow rate of 10 m^3/s. The timing of reservoir filling will depend on the construction programme and the demand for irrigation and generation water. Based on historical flow records the available RDR take from the Rangitata River is never less than 10 m^3/s at any time of the year. The anticipated time vs pond elevation relationship is shown on Figure 4-1. The graph is plotted assuming a constant inflow of 10 m^3/s. If the filling occurs at a time of the year that doesn't allow a constant flow into the pond eg during the irrigation season then the Designer will provide a revised filling curve.

The actual filling relationship shall be plotted against this graph during filling to give early warning of excessive seepage from the pond or an incorrect inflow rate.

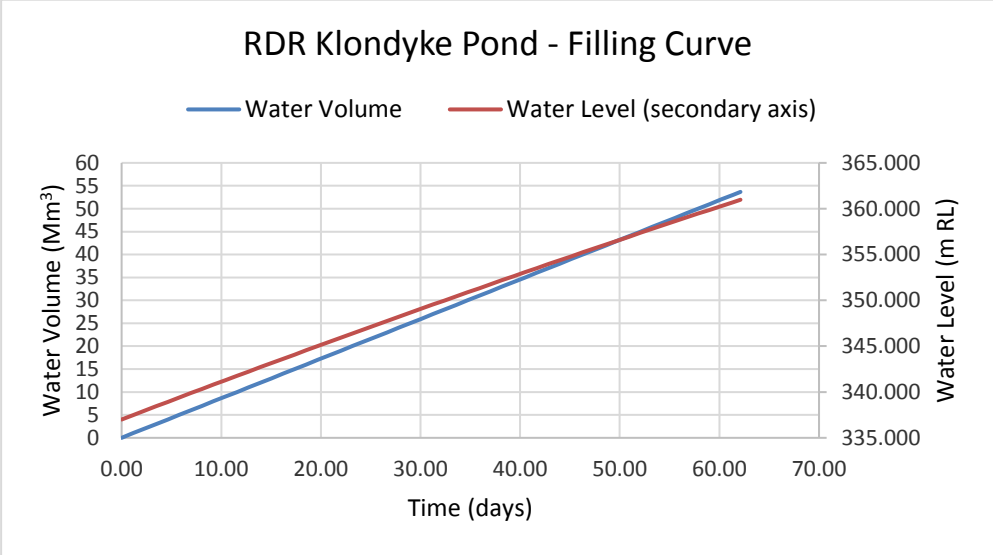

Figure 4-1: RDR Klondyke Storage – Reservoir Stage-Storage-Filling Time Curve

4.3 Observation and Monitoring Requirements

The contractor will be responsible for routine inspections during the commissioning process. Inspections are to be completed on a daily basis and shall consist of:

- Noting reservoir water level and rainfall and evaporation.
- Measuring toe drain flows.
- Inspection of dam face and abutments for seepage flows.
- Inspection of dam and abutment faces for slumps.
- Inspection around outlet pipelines for seepage flows.

All monitoring information shall be forwarded to the Engineers Representative within 24 hours. A format for the routine monitoring reports is included in Appendix B.

One week after the completion of reservoir filling the frequency of inspections can be reduced to twice weekly provided no adverse observations, as previously discussed, have been identified. If adverse or potentially adverse observations are made then the Designer will require either the daily observations to be maintained or a modified inspection frequency to be adopted.

As far as practicable the same inspector is to be used throughout the commissioning period. Personnel carrying out the work are to be nominated for the Design Directors approval and any changes notified in advance. They will be required to have attended a dam safety surveillance course such as those run by organisations such as NZSOLD, ANCOLD, USBR or USACE and will receive project specific training from the Designer. New personnel will require training to ensure adequate transfer of knowledge.

Additional inspections will be required following such trigger events as:

- Heavy rainfall in excess of approximately 80mm/day.
- Earthquake with felt intensity greater than MMV (refer Appendix C).
- Wind speeds in excess of 80 km/h.
- A significant seepage flow (in excess of 100 l/min) from toe drains or discolouration of a seepage flow, discovered in routine inspection.
- A rapid increase in flow from toe drains over a short period of time.
- Any flow from the drains along the outlet pipelines.
- Any slumping discovered in routine inspection.

Other unusual observations from routine monitoring as determined by the Design Director.

Piezometers shall be read on a daily basis and the results plotted in a graph format for review.

Levels on the monitoring points shall be taken on a weekly basis and the results plotted in graph format for review.

4.4 Gate Testing Requirements

4.4.1 Dry Commissioning

Prior to disestablishment of the temporary RDR diversion and commissioning of the RDR pond, dry commissioning of all of the new gates installed shall be undertaken. The dry commissioning process shall involve:

a) Non-destructive testing of welds and welded components.
b) Checks on mechanical assemblies and clearances.
c) Confirmation that all safety provisions, guards and equipment tags are in place.
d) Tightness of coupling bolts and locking arrangements checked and noted.
e) All terminations checked for tightness.
f) Stroking, rate of travel and operation and timing checks of all mechanical, electrical and control equipment and operating systems to prove correct operation.
g) Operation of all isolating gates, stoplogs, valves and trash screens.
h) Verification of water level or pressure measuring and flow metering equipment.
i) Checks and resistance measurements of the primary current carrying conductors and the earthing grids and earthing systems.
j) Insulation resistance checks on all power cables and motors.
k) Point to point wiring tests.
l) Proof of phasing and/or polarity of power supplies and circuits.
m) Functional and operational checks on plant, equipment, components and systems.
n) Demonstration of sensitivity and operation of all communications, data logging, metering, control, protection and alarm equipment.
o) Tests of all indications, displays and outputs.
p) Protective devices (moulded case breakers and fuses) checked for correct settings.
q) Operational tests of fire detection and protection systems.
r) Simulation and timing of power system trip, failover power systems and emergency operations.
s) Confirmation of correct operation of all shutdown circuits by simulating each and every plant protective trip event.
t) Tests reports on HV equipment from Electricity Ashburton.
u) Any other tests recommended by the supplier/manufacturer.

To complete the Dry Commissioning process a series of controls tests shall be performed by overriding sensors and manually entering inputs into the control system. These shall include at least the following tests as shown in Table 4-1:

Table 4-1: Gate Dry Commissioning Tests

System Input	Required Response
Klondyke Pond filling to commence	Pond inlet gate opens at designed opening rate. In-RDR gate closes in response to inlet gate. Trial at five flow splits between pond and RDR.
Klondyke Pond reaches full supply level.	Pond inlet closes and in-RDR gate opens in response. RDR entrance gate (i.e. RDR Rangitata intake) limits maximum inflow to scheme to 30.7 m^3/s.
Release of water to MHIS.	MHIS outlet gate opens at correct ramping speed and to correct position using five different input pond water levels.
Release water to sluice channel.	RDR entrance gate goes to maximum consented flow, RDR in-river gate closes, Pond inlet gate fully opens, sluice outlet gate opens at correct ramping speed.

If the desired response is not achieved, remedial works shall be carried out and dry commissioning repeated and successfully completed before moving to wet commissioning.

4.4.2 Wet Commissioning

Wet commissioning of the In-RDR and Pond Inlet gates shall be undertaken by pumping water from the RDR over the coffer dam so that they can be tested under non-flow conditions. Following successful completion of this test (based on visual observation of lack of leakage and structural stability of the gate and supporting structure) the in-RDR coffer dam can be removed with both gates fully closed and water spilling over the in-RDR spillway. Both gates shall be opened independently at increments of 20, 40, 60, 80 and 100% of their full opening. At each setting the flow is to be held for 15 minutes to allow observation of hydraulic performance and adequacy of downstream erosion protection.

The low level gates (MHIS outlet and sluice outlet) will be progressively tested as the reservoir fills as described in section 4.1.

5 Performance Criteria

5.1 Performance Criteria

Performance of the dam, during commissioning, is to be measured in the following categories. Maximum acceptable levels are in brackets.

- Combined toe drain flow (100 l/min).
- Flow from the drains along the outlet pipeline drain (none allowed).
- Seepage flows on downstream face of embankment (none allowed).
- Surface slumps (none allowed).
- Displacement of erosion protection during spillway trial (none allowed).
- Piezometers increase of more than 1 kPa per day or total of more than 30 kPa above baseline reading.
- Survey points movement of more than 3mm per week in vertical or horizontal direction.

The Engineers Representative is to be notified immediately if any of the acceptable levels are exceeded.

5.2 Performance Evaluation and Reporting

If readings taken during the daily inspections remain within the acceptable limits outlined above, then reporting to the Engineers Representative shall be on a weekly basis. The report shall include the following contents:

- Commissioning activities in the previous week (including progress against reservoir filling chart).
- Observations.
- Seepage Behaviour.
- Piezometer Behaviour.
- Deformation Behaviour.
- Appended inspection forms.
- Appended piezometer and survey graphs.

If readings taken during the daily inspections do not remain within the acceptable limits outlined above then the Designer will either require an increased frequency of monitoring, a stop to filling of the pond or dewatering of the pond (or a combination of these). If the Designer, Engineers Representative or inspector believes that the reading represents an actual or developing dam safety emergency then the Emergency Action Plan, as discussed in section 6 below shall be activated.

5.3 Conceivable Problem Areas

Water loss through seepage is anticipated for this dam (as is the case with all dams). The lining system is not totally impervious and some seepage is anticipated. In the event of a problem with the lining system (for example a poor seam joint) then more concentrated seepage flows are possible. The most likely path for seepage is tracking along the outlet pipelines and special attention should be paid to this.

Most seepage paths should be identifiable from the nature of the toe drain flows (if any occur). Seepage flows below the level of the embankments will likely not emerge at ground level. However, the possibility, which would be seen as springs or seeps in the surrounding ground, should be checked for. In particular the stormwater control channel beside the reservoir and the outlet channel to the Rangitata River should be checked.

It must be noted that uncontrolled seepage may develop into a piping issue, which is one type of failure modes of these types of dams. This will be indicated by discoloration of seepage water and particular attention should be paid to recording any colouration or change of colouration in seepage and toe drain flows.

Any movement or slumping of the cut or filled surfaces is an indication of problems, which could lead to disruption of the liner and seepage issues as discussed above. Any erosion of material during filling of the reservoir, as shown by physical signs of erosion or cloudiness of the water, could lead to difficulties with the lining system and should be checked for.

Strong winds, in particular at this site from the north-west direction, will create waves across the reservoir. These waves could displace the rip rap around the wave band or displace the liner below this level. Particular attention should be paid to the rip rap and liner following strong winds, particularly the south east corner where wave action is likely to be concentrated during north westerly wind events.

If observations during inspections identify one or more of these conceivable problem areas, then the Designer will either require an increased frequency of monitoring, a stop to filling of the pond or dewatering of the pond (or a combination of these). If the Designer, Engineers Representative or inspector believes that the observation represents an actual or developing dam safety emergency then the Emergency Action Plan, as discussed in section 6 below shall be activated.

6 Emergency Action Plan

A separate document titled “Emergency Action Plan” has been prepared and should be available to all personnel working on the site. The Emergency Action Plan can be activated by any member of the Owner, Designer or Contractor if an emergency situation develops.

The Emergency Action Plan provides a systematic means of:

- Defining and declaring Emergency Situations associated with Klondyke Pond.
- Ensuring effective actions are taken throughout any Emergency Situation.
- Avoiding loss of life and minimising damage should dam failure occur.

The responsibilities of organisations associated with the Emergency Action Plan are outlined in the plan. This includes The Contractor, The Designer, The Owner, Environment Canterbury, Civil Defence and NZ Police. An Emergency Situation is where a condition of a serious nature has developed that may endanger the integrity of the dam and/or downstream property or life and requires immediate action.

Emergency situations include but are not limited to:

- Breach of the dam (actual or imminent).
- Overtopping of the crest of the dam.
- Excessive and highly turbid seepage.

Action Plans for various Emergency Situations are given in the Emergency Action Plan but they can be summarised generically as:

1. Immediately implement the notification procedure.
2. Commence reservoir lowering.
3. Attempt to control the problem – if possible.

The greatest risk to life from dam failure is assessed as being residences located south of the reservoir.

Early notification is a key requirement of the Emergency Action Plan and a full notification procedure is given.

On observation of an emergency situation the most important first contact is the Police at Ashburton or **111**.

7 Commissioning Records

Comprehensive records of all site inspections and measurements are to be kept by both the Contractor and the Engineers Representative.

At the end of commissioning the Designer will compile a report summarising the commissioning process and providing recommendations to be carried forward into normal operation under the Dam Safety Management Plan. This report shall be in the format shown in Figure 3-2, Module 4 of the NZSOLD DSG.

8 Reference Documents

Construction Specification (not yet prepared)

Construction Drawings (not yet prepared)

Final Design Report (not yet prepared)

Resource Consent (not yet obtained)

New Zealand Dam Safety Guidelines, NZSOLD 2015

Appendices

Appendix A Readiness Checklist

Readiness Check List

Item	Description	Complete	Comment
1	Reservoir lining complete. All QA documentation sent to Engineer		
2	All cover and slope protection materials placed.		
3	Inlet spillway complete and marked with elevations (reduced levels) at 0.5m intervals.		
4	Inlet works complete and armouring in place.		
5	Subsoil drains around reservoir perimeter completed and accessible for monitoring		
6	Settlement monitoring points in place and baseline readings taken.		
7	Piezometers in place and baseline readings taken.		
8	Stormwater control channel completed		
9	Drainage channel rock protection placed and inspected.		
10	Dry commissioning of all gates and actuators completed.		
11	Dry commissioning of control system completed.		
12	All operating procedures in place and understood by Contractors Representative and commissioning personal.		
13	Commissioning procedures and Emergency Action Plan completed and understood by Contractors Representative and commissioning personal.		
14	Resources detailed in the commissioning plan of the Emergency Action Plan available on site.		
15	All consent conditions complied with.		
	Proposed to proceed with Commissioning	*Date*	
			Signature
	Accepted		*for Contractor*
			for Engineer

Appendix B Daily Inspection Form

Monitoring Checklist for Dam Commissioning

Inspected by:		**Date**	**/ /**
Weather Conditions and Rainfall (mm)		**Reservoir Water Level**	
During Inspection			
Prior to Inspection			

Inspect	✓ (done)	***Comment*** record detail on separate sketches if required
Downstream embankment face: surface erosion, slips, unusual growth, wet areas, seepage		
Upstream slope and rip rap: slips, displacement, settlement or deterioration		
Crest and abutments: settlement, cracks and displacement		
Overflow Spillway: displaced rip rap, erosion, slips, debris		
Inlet Structure and Channel cracking, erosion, slips, debris		
Stormwater control channel: displaced rip rap, erosion, slips, debris, seepages		
Upstream and Downstream of dam, (100 m each way) unusual growth, wet areas, seepage, springs		
Outlet Pipelines through dam: leakage, damage, seepage		
Reservoir surface debris or floating weed		

Measure Drain Flows	Weir Stage Height (mm) and/or Flow (litres /min)	Colour
Drain # 1		
Drain # 2		
Drain # 3		
Drain # 4		
Drain # 5		
Drain # 6		

Drain # 7		
Drain # 8		
Adjust to number of drainage points installed.		
Total		
Flow from outlet pipeline drains.	Weir Stage Height (mm) and/or Flow (litres /min)	Colour

Any Other Comments

Appendix C Modified Mercalli Seismic Intensity

Table 2-1 Modified Mercalli Intensity Scale of 1931

I	Not felt except by a very few under especially favorable circumstances
II	Felt by only a few persons at rest, especially on upper floors of buildings; delicately suspended objects may swing
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake; standing motor cars may rock slightly; vibration like passing of truck; duration estimated
IV	During the day felt indoors by many, outdoors by few; at night some awakened; dishes, windows, doors disturbed; walls make cracking sound; sensation like heavy truck striking building; standing motor cars rocked noticeably
V	Felt by nearly everyone, many awakened; some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned; disturbances of trees, piles, and other tall objects sometimes noticed; pendulum clocks may stop
VI	Felt by all, many frightened and run outdoors; some heavy furniture moved; a few instances of fallen plaster or damaged chimneys; damage slight
VII	Everybody runs outdoors; damage negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, considerable in poorly built or badly designed structures; some chimneys broken; noticed by persons driving motor cars
VIII	Damage slight in specially designed structures, considerable in ordinary substantial buildings, with partial collapse, great in poorly built structures; panel walls thrown out of frame structures; fall of chimneys, factory stacks, columns, monuments, walls; heavy furniture overturned; sand and mud ejected in small amounts; changes in well water; persons driving motor cars disturbed
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse; buildings shifted off foundations; ground cracked conspicuously; underground pipes broken
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked; rails bent; landslides considerable from river banks and steep slopes; shifted sand and mud; water splashed over banks
XI	Few, if any (masonry) structures remain standing; bridges destroyed; broad fissures in ground; underground pipelines completely out of service; earth slumps and land slips in soft ground; rails bent greatly
XII	Damage total; practically all works of contruction are damaged greatly or destroyed; waves seen on ground surface; lines of sight and level are distorted; objects thrown into the air

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