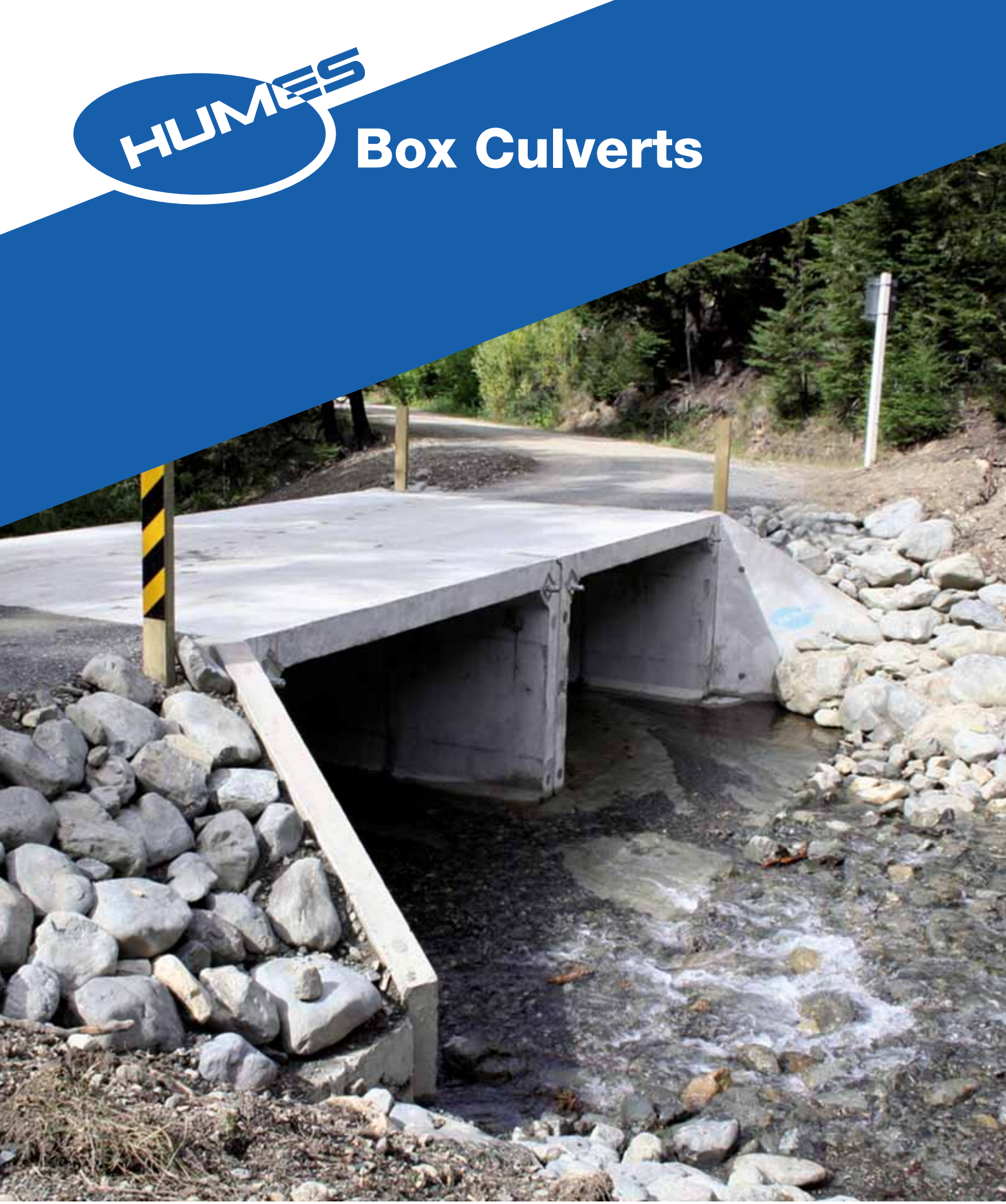
Box Culverts



Designers and manufacturers of
engineered box culvert solutions

Introduction

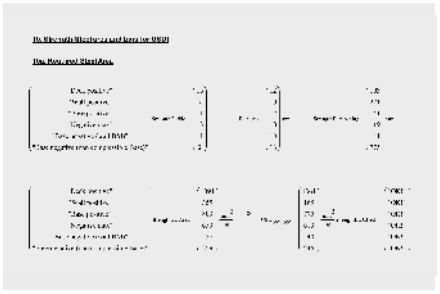
Humes are the leading manufacturer of concrete pipe and pre-cast products in New Zealand. While large diameter pipe have traditionally provided a solution for culverts, pre-cast box culverts have become more and more popular due to their ability to provide a more adaptable solution and profile.

The benefit of box culverts is that they can be engineered in a way that requires a minimum amount of cover in contrast with pipes which deliver a structural solution with a universal overall strength. Box culverts can be engineered to provide the strength exactly where the need is rather than across the whole unit. They are also able to be configured in ways that assist in speeding up the construction process by post tensioning boxes together in the factory and lifting several sections into place at one time.

In the past couple of years, Humes have invested significantly in box culvert mould capacity and now have the largest number of box culvert moulds available in New Zealand. This means we can deal with your requirements no matter how big or where in New Zealand or the South Pacific.

Humes has the capability to produce up to eight boxes a day at any of its production locations in Auckland, Hamilton, Hastings, Nelson, Christchurch, Greymouth and Alexandra. This means that the manufacture of boxes for even the largest projects can be completed in a short period of time. This capability allows boxes to be produced from 1x1m to 5x3m as a standard configuration and larger sizes or customized solutions as designed. Humes new VT plant also has the ability to produce box culverts and they can be manufactured up to 2x2m in excess of 30 units a day. This means with a production facility close to most project locations we can minimise freight costs.

Humes box culverts have been independently tested by Holmes Solutions Ltd and meet the NZS 3101 Part1:2006 and Transit Bridge Manual. Humes are able to provide specialised designs to meet any unique specification requirements.



Humes Technical team are equipped with a design software “BOX ‘C’, which has the capability to generate box culvert designs in minutes along with full calculations. Humes can provide you with drawings and full calculations which can then be presented to the project consultants.

When it comes to technical knowledge, flexibility, quality, value, speed and reliability make Humes your first option for your box culvert requirements.

Types of Box Culverts

Humes provide a standard range of full box culvert designs ranging from 1x1m units to 5x3m units with fill heights between 0 and 2000. Units to other specific designs or standards can be accommodated.

Optional details and features

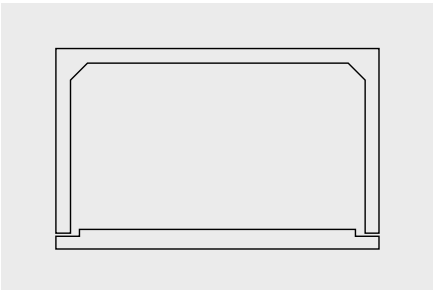
- Corner duct holes for site stressing or coupling via tie rods
- Cast in starter bars to tie into insitu wingwalls or apron slabs
- Provision of precast wingwalls and headwalls
- Cast in concrete inserts, unistrut and fixing plates to enable welded connection across joints
- Cut-outs for pipe access, manhole access, doors, etc

Full box

Full boxes consist of a complete box culvert cell, integrally cast. This type of unit provides maximum onsite construction savings by eliminating the need to pour an insitu base. Moulds can be changed to make portals and ducts.

Types of Box Culverts (continued)

Portal and base



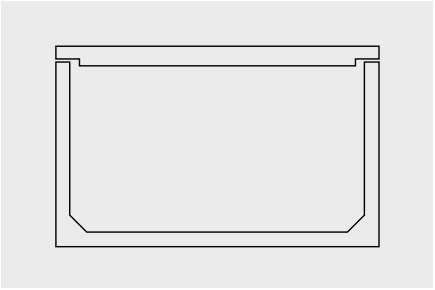
This structural form is used:

- To reduce transport and handling mass of a full box
- To permit the use of an insitu base, to give continuity over poor foundations
- To provide a shaped invert using insitu concrete to give improved low flow hydraulics
- To provide box culvert heights of less than1000mm

Portal culvert bases, precast or insitu, must have rebates to prevent the legs being forced inwards by consolidation of the fill material beside the culvert. The recommended rebate depth for spans over 1500 is 25 mm. In determining width and location of rebates, adequate allowance must be made for dimensional tolerances, particularly span and leg width tolerances.

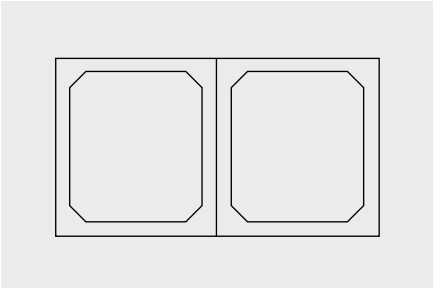
Large duct and lid

This type is the invert of the portal and base. It is normally used in sizes of less than 1000 x 1000 mm, but can be specified for large ducts where future access by lid removal is required.

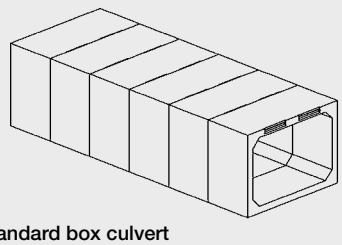


Twin cell structure

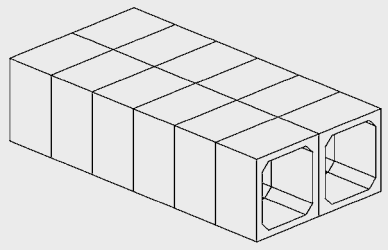
This unit is commonly formed by installing two individual units side by side.



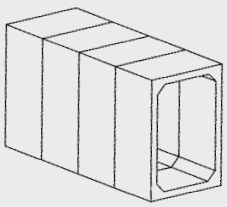
Box Culvert Configurations



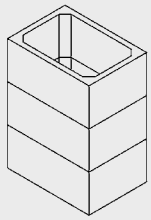
Standard box culvert or rural stock underpass



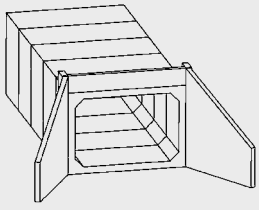
Twin cell box culverts



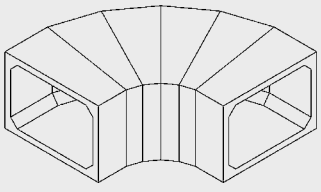
High headroom box culverts



Vertical box culverts for chamber applications



Box culvert with optional precast wingwall and headwall panel



Box culvert with splay (note: splay to one end of box unit only)

Box Culvert Installations

Handling

It is important to use the swift lifts and the correct rigging to ensure safe handling. With portal culverts over 1500 span, slings must not be placed around the toes such that large bending movements are induced in the legs. Slings should not be used under the centre of the top slab of the unit. Lateral sliding of box culverts should always be avoided.

Culverts should be lifted clear of the ground, not dragged, to avoid any lateral forces at the bottom of the legs. If portal culverts are to be stored on site, supports should be placed under the legs. In the case of full boxes uniform support should be provided to the base slab.

Laying

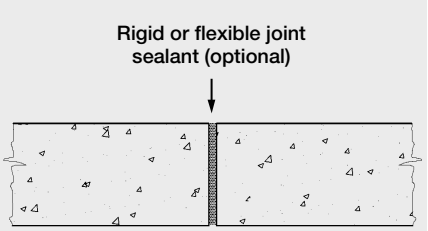
Precast bases, ducts and full boxes should be laid on prepared bedding. The bedding material can be compacted sand, cement, stabilising sand or granular material. The compacted thickness of the bedding can range from 100mm for earth foundations to 150mm for rock foundation.

When placing portals on bases or lids on ducts, the surface of the bearing area should be cleaned and covered with mortar or damp proof course to ensure uniform bearing. In culverts over 1500 span, any gap between the inside at the leg and recess should be grouted. This will prevent the legs moving due to horizontal loads. Portal on base or lid on duct joints should be aligned to avoid stresses caused by differential settlement. Backfilling and compaction to units should be carried out in even layers on both side simultaneously. Care must be taken to prevent wedge action against surfaces. This is especially important for large box culverts and long leg lengths, to ensure the units are not displaced or overloaded during backfilling.

Heavy earth moving or construction equipment should not run close to or over the culverts without first checking that the units can take the loading that results. The foundation below the prepared bedding must be capable of providing a minimum safe bearing capacity (SBC) of 100 kPa.

Jointing

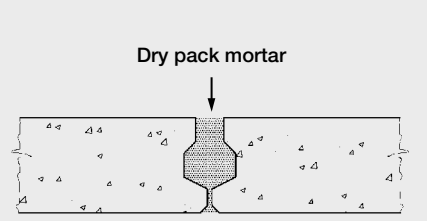
Joints between box culverts used in stormwater drainage conditions do not normally require sealing. Box culverts are usually made with plain ends giving a butt joint. The joint gap is so small that grouting is unnecessary, however it is recommended that a geotextile or similar measure is employed to prevent the ingress of fines through the joint.



Butt joint

For special applications such as pedestrian tunnels, ducting systems and vertical applications a variety of rigid or flexible joint fillers can be applied to the butt joint.

- Deck shear keys are used in low fill cover situations to transfer wheel loads across the joint and must be filled with dry pack mortar.
- Plain butt joints are normally associated with higher fill covers and good foundations. Sealants may be incorporated
- Units can also be cast with post-tensioning ducts and subsequently tensioned in the longitudinal direction to provide a closed joint and longitudinal integrity.



Shear key joint

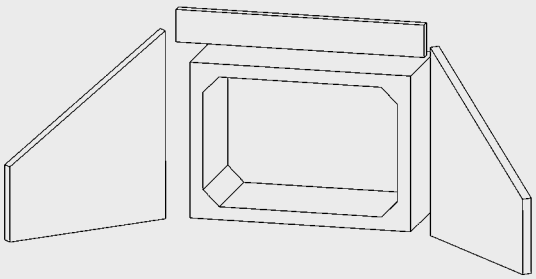
Alternatively, tie rods may be pulled up in the ducts to provide nominal longitudinal integrity. We recommend that all duct holes be grouted back to ensure integrity and durability.

Culvert Inlet/Outlet Arrangements

Headwalls and wingwalls can be either precast or insitu concrete.

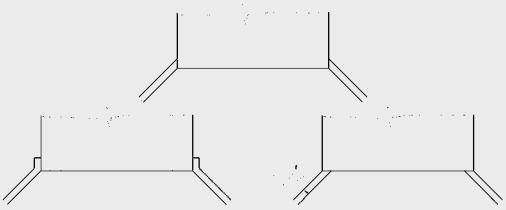
Options include:

- Parallel sided precast wingwalls, made from the box culvert mould, with either stepped or tapered wingwall top surfaces.
- Wingwalls formed from precast L shape units, tied together with insitu concrete.
- For smaller boxes fully precast units.
- Wingwalls formed from precast flat slab units, tied together with insitu concrete. (Note: Apron slab design must provide strength and stability to precast cantilever wingwall).
- Splay of wingwall can vary according to specific applications.

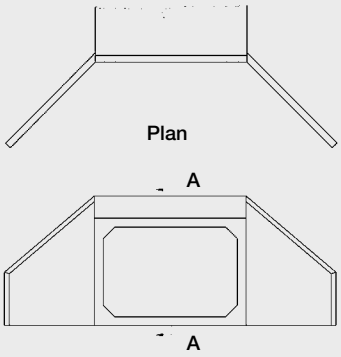


3D view

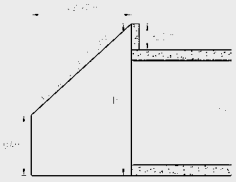
Note: Starter steel from wingwall and/or end box unit must be incorporated into the design of the apron slab to provide strength and stability.



Different types of end connections of wing walls



Elevation



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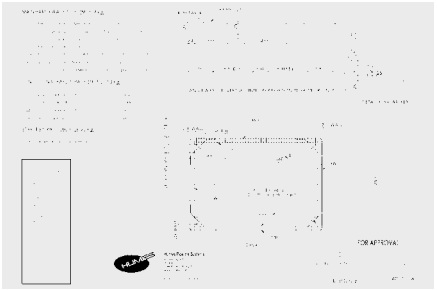
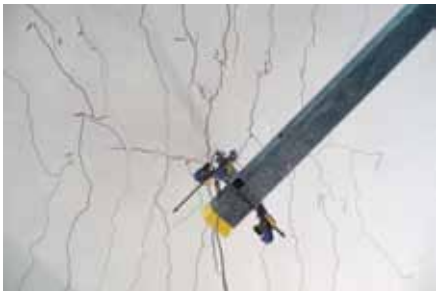
Box Design

The Humes Technical Team has over 200 years of engineering experience in precast and specifically the design and manufacture of box culverts. This covers design, reinforcing options, concrete specification, testing and construction methodologies. Humes Technical Team is available to provide detailed design and construction advice and drawings as part of our project support services.

Humes has recently completed the most comprehensive engineering review of box culverts undertaken in New Zealand. This included design and performance modeling, structural and load testing including over 1.5 million cycles of fatigue loading. This independent testing has provided Humes with the only test data available in New Zealand, enabling improved and more accurate design options for box culverts. Testing was done at the Holmes Solutions Laboratory (HSL) in Christchurch.





Box Culvert Case Studies

Bridge 48, KiwiRail Wairarapa

Design	3x2m box culverts designed to specific KiwiRail standards with additional strength and to withstand loading and impact.
Manufacture	Manufacturing began in late February to make sixteen box culvert units that needed to be delivered in early April.
Logistics	There were specific time frames in place to meet track downtimes, that could not be changed. To save double craneage costs and install on the same day as delivery, the contractor requested that all sixteen units be delivered over 36 hours. Given the size of the units, this meant only one box culvert per truck and trailer. Eight truck and trailers made the eight hour return delivery to enable the remaining eight units to be delivered the following day.
Projects outcome	All deadlines were met to the satisfaction of the contractor. The detail and quality of workmanship contributed to a successful installation with tricky methodology.

Bridge 7, KiwiRail Wellington

Design	4x2m box culverts designed to specific KiwiRail standards however using stainless steel as the reinforcing material.
Manufacture	Extremely tight time frames to meet KiwiRail's expectations were challenged by long supply lead times for stainless steel reinforcing from Europe. A total team effort and partnering with all external suppliers resulted in deadlines being met. Seven day manufacturing (producing four boxes a day), innovation around mix design and curing methods were used to speed up delivery.
Logistics	Box culverts were manufactured in Hamilton and delivered to the site in Wellington. A detailed logistics plan was put in place to deliver six box culverts per day (one 2IT box per truck and trailer) to site during the construction period.
Projects outcome	Humes ability to meet the tight deadlines ensured that the contractor had a continual supply of product during the construction period.

Box Culvert Case Studies

Palmerston North City Council

Design	2x1.5m box culverts
Manufacture	120 boxes to a tight time schedule
Logistics	Manufactured in Hastings and delivered to site to allow eight boxes a day to be installed during the construction period. Due to construction delays the entire production volume of 120 boxes were delivered in three days.
Projects outcome	Not only was the tender price the most competitive quote received by the customer but it provided the best added value, design and support features. The Palmerston North City Council and the contractor were extremely happy with the product, support and additional effort in accommodating a new delivery schedule.

Farm underpasses for stock off roads programme

Design	Standard 4x2m box culverts or variations to Transit specification. Customisation where required for vehicles access heights or utilities. Designs, drawings, specifications were able to be provided within 48 hours.
Manufacture	Manufactured to order in Papakura, Hamilton, Hastings, Nelson, Christchurch, Greymouth and Alexandra using a standardised mould suite. A logistics plan was put in place to deliver the box culverts to the agreed contractor schedules.
Projects outcome	Humes is recognised as a main supplier of box culvert underpasses in New Zealand and has the reputation for quality, design, affordability and on time delivery.

Wakelin Station Stormwater Culvert

Design	10 units of 4x2m boxes, specifically designed by Humes technical team to both withstand the construction loads with zero cover and cope with high volume of water that flow through at certain times of the year.
Manufacture	All the boxes were manufactured in Papakura to required timeframes.
Projects outcome	To start stage 2 of Wakelin Station, a Landcorp block, they needed a road through the farmland and over an old farm bridge. This bridge was not wide enough or strong enough to handle the stress and weight of construction vehicles. Engineers were considering using larger diameter pipes to replace the old bridge. However, the stream bed has several small springs, which would have made it very difficult to install pipes. After discussing the constraint, Humes box culverts were specified for the job. contractors and Engineers were pleased with the support they received from Humes Technical team in offering a solution which met their needs.

Manufacturing Standards

Humes Box Culverts have been independently tested to NZS 3101 Part1:2006 and Transit Bridge Manual. Precast manufacture is to NZS 3109:1997 with surface finishes to NZS 3114:1987.

Humes Sales Centres

Whangarei	09 459 6935	**Tauranga**	07 578 6114	**Kapiti**	04 298 2860	**Timaru**	03 688 2079
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