

4 Pierhead Street
Capital Waterside
Cardiff
CF10 4QP
Wales
www.arup.com

t +44 29 2047 3727
f +44 29 2047 2277
d +44 29 20266____

Project title	WAST Western Gateway	Job number
		213833/61
cc	Sergio Solera	File reference
Prepared by	David Lynesmith	Date
		15 November 2011
Subject	Preliminary Summary of Ground Investigation findings (following completion of the factual report for the ground investigation).	

1.0 Purpose of this summary

This summary is an update of the preliminary summary issued Thursday 10th March 2011, following the completion of the factual report by Ian Farmer Associates, the GI contractor who carried out the works. Exploratory hole logs and field test results have been confirmed and laboratory test results, long term ground water monitoring and survey information of the ground levels of the exploratory holes have become available.

Since issuing the preliminary summary in March 2011, the preferred option has changed to 'Option B', with the fire buildings moving from the site area west of the Afon Gwenfro river, to be incorporated with the Ambulance buildings east of the river.

2.0 The site

The site is an area of green field near Wrexham Maelor, Figure 1 (Site Location). The site is located at National Grid Reference SJ 320 502. The site is currently unoccupied. However, part of the site was occupied by travellers in the past.

The site is bounded by a car park associated with the hospital to the north and east with residential development to the south. Croesnewydd road is located to the west of the site past which are undeveloped fields. Afon Gwenfro runs through the site (dividing the site in two) and along the site's southern boundary. Afon Gwenfro has a protected 15m 'ecology corridor' along its entire. Access to the site can be gained via Croesnewydd Road to the west.

Figure 2 shows the part of the site to be developed. The topography of the site is relatively flat with the exception of three mounds up to 5m high approx. Two of these mounds are partially over the proposed Fire building, whereas the third one is located behind the proposed Fire Training house.

There are a number of trees within the site boundary and along the site perimeter.

2.0 Geology

Based on the 1:50,000 geological map, the geology consists of Alluvium and Glaciofluvial deposits over glacial till. The solid geology consists of the Pennine Lower Coal Measures.

The following assessment of the geology of the site and ground conditions in Table 1 below has been inferred from available information obtained from existing boreholes sunk prior to this investigation.

Stratum	Thickness (m)
Made Ground	1.5 -3.0 (up to 6.0 in mounds)
Alluvium and Glaciofluvial soils	3
Glacial Till	3-40
Pennine lower coal measures	>40m

Table 1 Thickness of geological strata

A report from the Coal Authority has confirmed that the coal 3 seams of coal were worked at 240m to 280m depth, last worked in 1932. Any ground movement from these coal workings should have stopped by now, as advised by the Coal Authority.

3.0 Ground investigation

Boreholes, window samples, dynamic probes, trial pits and hand TRL probes for CBR tests were undertaken at the site. Standpipe water/gas piezometers were installed at a number of locations. The factual information from the investigation is contained in the factual report by Ian Farmer Associates, June 2011. Figure 2 shows the location of the exploratory holes and the approximate locations of the proposed buildings.

4.0 Ground and groundwater conditions and preliminary foundation assessment

A geological section is shown in Figure 3.

Fire, Shared and Ambulance Buildings

As a result of this area being partially occupied by mounds up to 5m high, some of the exploratory holes (BHs, TPs, dynamic probes etc) were undertaken from the top of the mounds. It is also noted that the existing ground level at the site within the proximity of the Ambulance Building may need to be raised by 1m to 2m approximately, depending on the final levels chosen.

It has been noted that the presence of the mounds may have resulted in some improvement to the ground properties in these areas.

The exploratory hole logs indicate the ground conditions (within the footprint of the mounds) of the proposed Fire, Shared and Ambulance buildings consist of (based on BH01, for a made ground mound of 4.3m) in Table 2:

Stratum	Depth to top (m) below base of mound	Thickness (m)
Medium dense SAND	-	3.5
Firm Clay	3.5	2.2
Very dense GRAVELS with interbedded SILTS	5.7	7.1
Very stiff Glacial Till	12.8	Not proven

Table 2 Ground conditions under the Fire, Shared and Ambulance buildings: section within the existing mounds

Water was struck at 7.7m BGL in BH1, rising to 7.4m BGL in 20 minutes. Ground water monitoring was undertaken 2 weeks after sinking the borehole and recorded a water level of 11.65m BGL.

Outside the mounds, the ground conditions can be summarised as follows in Table 3 (Based on WS12 – WS18):

Stratum	Depth to top (m) below ground level	Thickness (m)
Made Ground	-	1.2 – 1.6
Very loose SAND/soft CLAY	1.4 to 1.6	0.2 – 0.4
Firm CLAY or loose to medium dense GRAVEL	2 – 2.3	1.7 – 3
Firm CLAY	4-5	Not proven

Table 3 Ground conditions under the Fire, Shared and Ambulance buildings: outside the mounds

Water was struck at generally struck a depth below 3m BGL, though a perched water table may exist in areas where granular deposits overlay cohesive soils as it was the case at WS10 where water was struck at 1.5m. Ground water monitoring undertaken 2 weeks after the exploratory holes were sunk recorded water levels of 3.5m BGL (WS16) to 5.98m BGL (WS13).

In situ SPTs undertaken in boreholes outside the footprint of the earth mounds are lower than those undertaken within the footprint. For instance, WS14 shows SPT N values are low as 3 to 5 blows/30mm to depths of around 4m.

Based on the observations made above, it recommended that a lower allowable bearing pressure of 50kPa be used, at a depth of approximately 2m. Although a higher bearing pressure may be permitted within the footprint of the mounds, this may lead to excessive differential settlement. If the bearing pressure results in very large bases, or the required excavation to reach the firm clay/loose gravel is excessive, a piled solution is feasible. This would consist of driven or bored piles to 10-15m depth, depending on the load requirements.

It is also recommended that any soft clays or very loose granular soils be removed and replaced by well compacted granular fill. In the area of the Shared and Ambulance buildings where the ground is low, it is recommended that made ground and soft clays/very loose deposits are removed and the ground level is raised up using well compacted granular fill.

Fire Training House at the far end of the site (in the proximity of the pumping station)

The ground conditions in this area are described as follows in Table 4 (based on BH3 and WS19 – WS20).

Stratum	Depth (m) below ground level	Thickness (m)
Made Ground	-	0.3
Loose/medium dense SAND and GRAVEL with interbedded clay layers	0.3	6.0
Very loose SAND/Very soft SILT	1.2	0.6 - 0.8
Firm/stiff CLAY with silt layer at the base	6.3	7.2
Dense SAND	13.5	Not Proven

Table 4 Ground conditions under the Fire Training House

Water was struck first at 1.8m, rising to 1.4m in 20 minutes. It was then struck at 2.7m, rising to 2.0m in 20 minutes. Ground water monitoring undertaken 2 weeks after the exploratory holes were sunk recorded water levels of 2.06m BGL (WS19) to 4.15m BGL (BH03).

Car park and access roads

It may be feasible to construct the car park and access road over the existing ground, provided that any soft clay, peat or very loose granular soils are removed. For CBR design, the results of the TRL's DCP undertaken on site indicate an equilibrium CBR of 3% should be used in the design of the car park and access roads.

Reusability of earth mounds

The earth mounds are formed from cohesive and granular soils. It may be possible to re-use this material as general fill, provided that any organic soils, domestic waste or any other soft or contaminated material are removed. It may also be feasible to grade the material in granular and cohesive, if it is economic to carry out the sorting on site using the appropriate sieves.

5.0 Contamination Assessment

Made ground was encountered during the 2011 ground investigations across the site with typical thickness of strata between 0.3m and 1.0m except for an area east of the ecological corridor. In this part of the site, spoil mounds are present with some 2m - 4m of made ground.

No evidence of significant subsurface contamination was noted. However in the area of spoil mounds domestic refuse (BH02), ash (WS11) and tarmac/tarmacadam (TP14, TP15 and TP17) were encountered. In addition, tarmac (TP04) and clinker (TP21) were noted in the remainder of the site.

Results of the laboratory tests undertaken on soil samples confirmed the field observations and indicated insignificant levels of soil contamination with concentrations lower than the applied assessment criteria in relation to human health (in commercial end use scenario). However, a full and detailed risk assessment in relation to potential impacts on site end users is required. In addition, no asbestos was encountered in analysed samples.

To assess potential risks to controlled waters from made ground and the potential for materials to be re-used on-site, selected soil samples (mainly obtained from the spoil mounds) were subjected to leachate effluent analysis and the results were compared with the Environmental Quality Standards (EQS). Generally, this has shown low concentrations of contaminants within the leachate effluent (except for minor exceedances of

applied EQS for copper and zinc) indicating low risk to controlled waters and therefore made ground present on site may be suitable for on-site reuse. Further sampling and testing is however required, particularly in area of BH02, where domestic refuse was encountered. Nonetheless, due to the sensitivity of the site location (the site is transected by a river) a full hydrogeological risk assessment is required. Therefore groundwater quality monitoring needs to be undertaken. This would include groundwater sampling from the existing instrumentation and laboratory testing.

Waste Acceptance Criteria (WAC) testing was undertaken on selected soil samples obtained from the encountered made ground materials, particularly from the spoil mounds. The results indicated that the analysed materials may be classified as inert waste for the purpose of off-site disposal. However, further investigation is required in the area of borehole BH02, where domestic refuse like materials were encountered.

Furthermore, the 2011 investigations included only one round of ground gas monitoring. Current guidance requires a minimum of six rounds of monitoring over a period of two to three months (for commercial development with low to medium generation potential of source). The results will form a basis for a ground gas risk assessment for the proposed development.

Also, the invasive plant Himalayan Balsam has been identified within the site. The prevention of the spread of invasive plants is required and therefore Himalayan Balsam should be removed prior to seeding and removed material containing seed should be disposed off appropriately.

6.0 Outstanding information

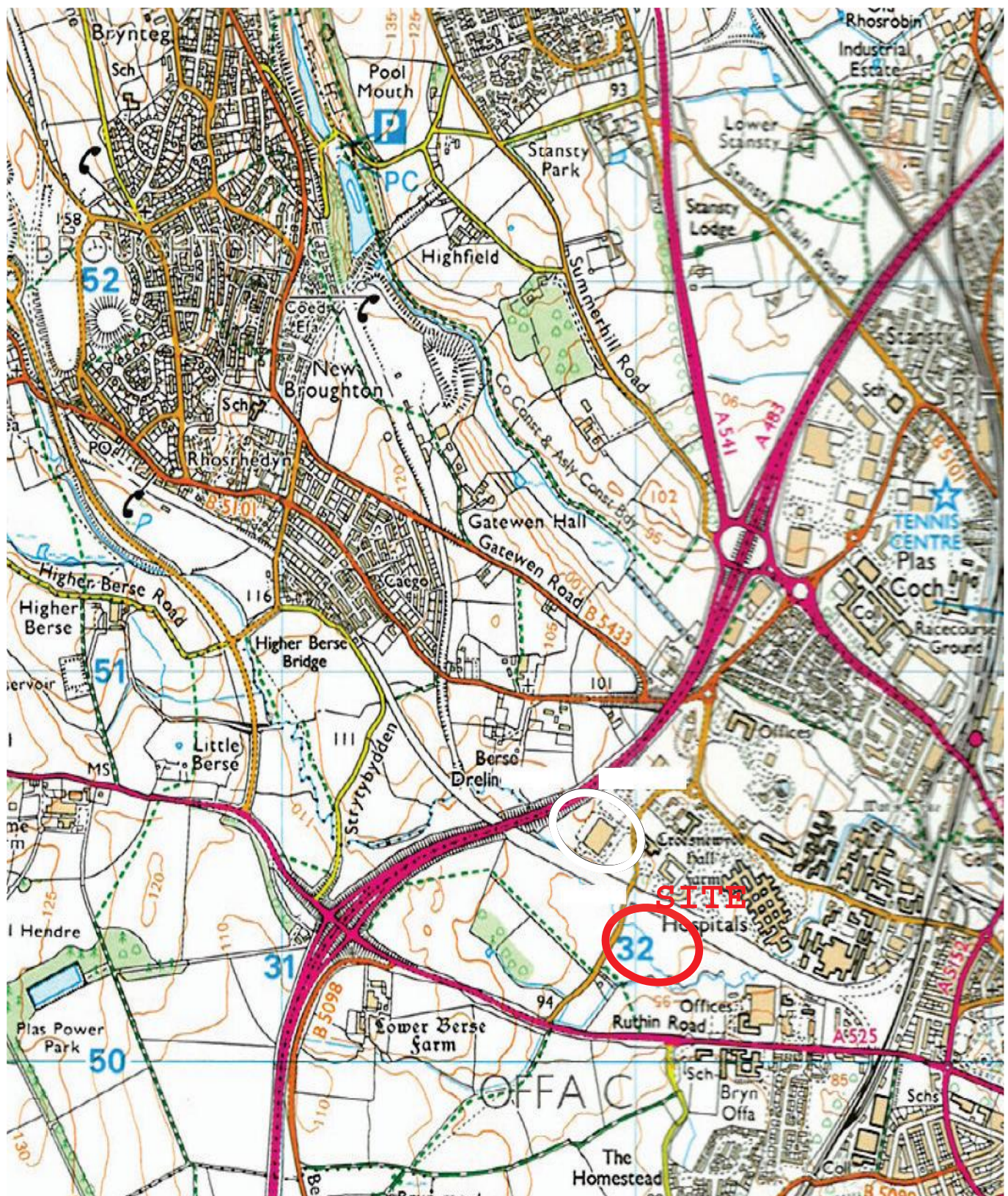
The following has not been assessed/will require further consideration:

- Human health detailed risk assessment,
- Groundwater quality monitoring and detailed hydrogeological assessment,
- Ground gas monitoring and detailed assessment,
- Additional testing and detailed assessment of the materials found in the mounds for re-usability or disposal
- Review of proposed structural loading against expected settlement for shallow foundations
- Review of proposed levels, to confirm that shallow foundations will not require excessive digging
- Review of possible depth to piling, depending on the proposed loads
- Additional Borehole to allow for new building location (Fire Building)

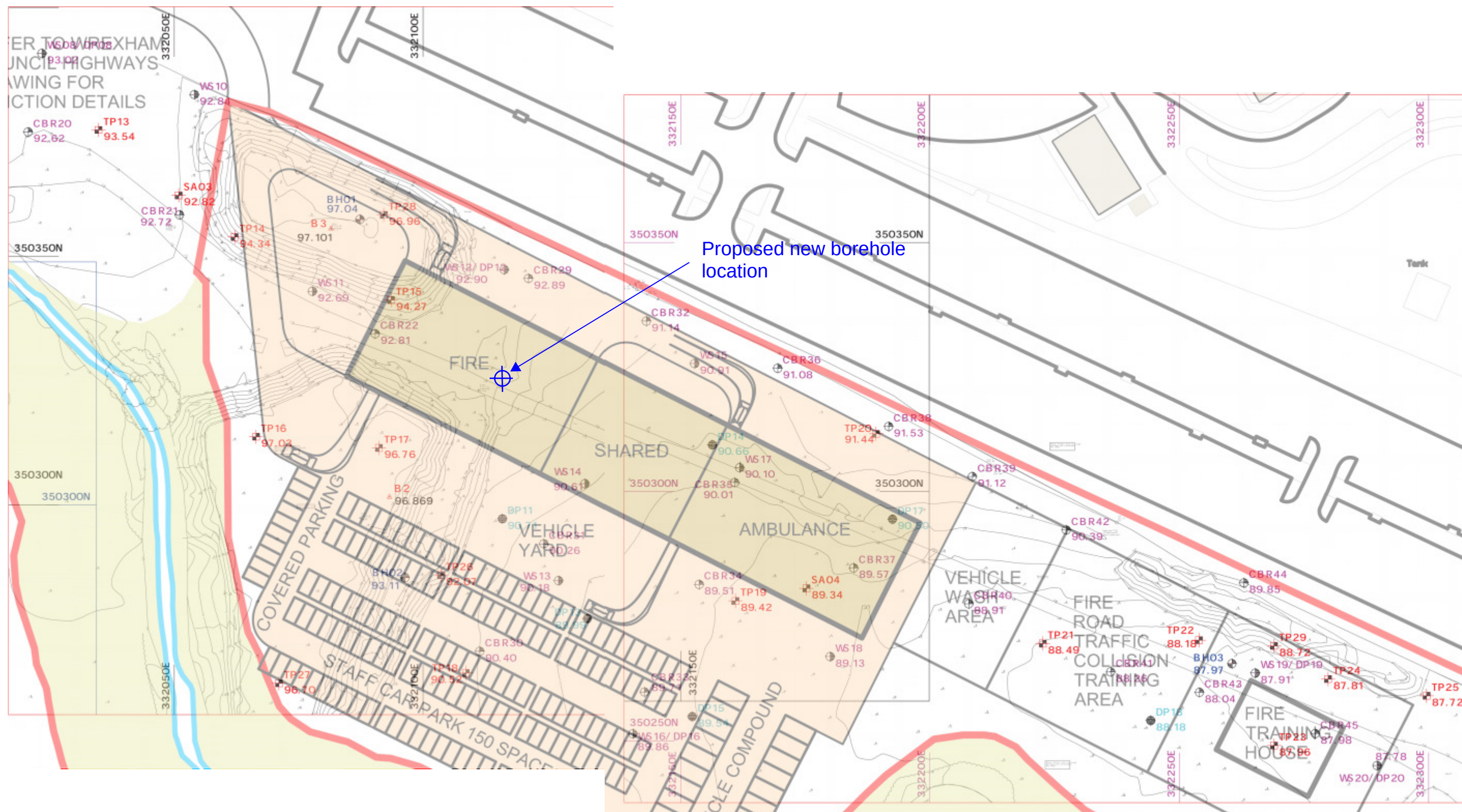
It should be noted that this summary should only be used as indicative.

DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	David Lynesmith	Sergio Solera	Daymon Brocklebank
Signature			



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50m (approx.)

Figure 2
WAST Western Gateway
Exploratory hole location plan

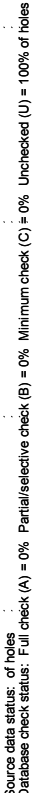


FIGURE 3