

*Inspection Guidelines for the Condition
 Assessment of Concrete and Steel Structures
 Using Remotely Piloted Aircrafts (RPA's)*

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**Inspection Guidelines for the Condition
 Assessment of Concrete and Steel Structures
 Using Remotely Piloted Aircrafts (RPA's)**

(Business Rules)

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I. FOREWORD

Inspection guidelines are prepared to ensure that the Water Corporation staff, consultants and contractors are informed as to the Corporation's requirement on the methodical approach to asset condition assessment. The Corporation's ultimate objective of this Guideline is to contribute toward ensuring the provision of safe and functional plant and equipment at minimum whole-of-life cost.

In the Corporation, high risk/specialist inspections are carried out by Inspection Service Providers (ISP's) by means of Scaffolds, Rope Access, Ladder Climbing Systems (LCS), and Elevated Work Platforms (EWP's). These activities carry inherent safety risk to the inspectors.

In order to minimise the risk and maximise efficiency, the use of Unmanned Aerial Vehicles (RPA's) for asset inspection was trialled in 2015 by , Assets Planning Group (APG). It is envisaged the benefits of RPA inspection are as follows:

- aligned with Corporation's achieving Zero Harm safety policy;
- less labour intensity process;
- the collection of higher-quality data in real time;
- inspection data can be analysed faster and remedial actions can be planned and carried out proactively to maintain the integrity of the asset; and
- as part of the on-going Corporation's Renewals Planning practice, learnings from RPA's inspections will be shared amongst other Australian water utilities for on-going asset management.

Suggestions and reviews to this document by Aroona Alliance and other stakeholders are gratefully acknowledged and referenced in this document. Experience and qualification documents requirement provided by consultants, inspection equipment manufacturers and suppliers are gratefully acknowledged.

The ISP's shall familiarise themselves with the Corporations "Safety Essentials" which are mandatory rules for our high risk activities that came into effect in January 2015 and can be found on the <http://www.watercorporation.com.au> webpage. All safety and environmental hazards shall be reported in Sentinel [Refer: <http://sentinel/Cintellate/jsf/main.jsp>]. The ISP's shall adhere to Corporation's privacy policy PCY252 at all times.

Users are invited to forward recommendations for continuous improvement to the Senior Materials and Corrosion Specialist or Section Manager, In-Service Assets (Metro), Water Corporation who will consider these for incorporation into future revisions.

Tino Galati
Section Manager
In-Service Assets (Metro)

II. DISCLAIMER

This Guideline is intended solely for inspection of Water and Wastewater infrastructure in operating areas in Western Australia where the Water Corporation has been licensed to provide water services subject to the terms and conditions of its Operating License.

This Guideline is provided for use only by a suitably qualified professional inspector, engineer or technician who shall apply the skill, knowledge and experience necessary to understand the risks involved and undertake all infrastructure condition assessment work.

Any interpretation of content in this Guideline that deviates from the requirements specified in the project design drawings and construction specifications shall be resolved by reference to and determination by the Design Engineer.

The Corporation accepts no liability for any loss or damage that arises from anything in the Guideline, including loss or damage that may arise due to the errors and omissions of any person.

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

Users should use and reference the current version of this document.

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IV. REFERENCES

- [1] Steel Structures Condition Assessment Guideline, AquaDoc No. 11051170.
- [2] Inspection Guidelines for Condition Assessment of Concrete Structures, AquaDoc No. 11520656.
- [3] S151 Prevention of Falls, AquaDoc No. 9220625.
- [4] Aerial drones: the future of asset inspection, <http://www.utilitymagazine.com.au/aerial-drones-the-future-of-asset-inspection/>
- [5] Drones at Melbourne Water <http://www.melbournewater.com.au/aboutus/news/Pages/Drones-soar-high-to-collect-data.aspx>, February 2015.
- [6] Civil Aviation Safety Authority (CASA) http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_90900.
- [7] Job Safety Environment Analysis (JSEA) forms, AquaDoc. 8092748.
- [8] Safety Essentials, Mandatory Rules for our High Risk Assets, published by Water Corporation, WA, <http://www.watercorporation.com.au/~media/files/suppliers/osh/wc%20safety%20essentials.pdf>
- [9] Water Corporation Privacy Policy PCY 252, *currently under discussion*, AquaDoc. No. 10579222.
- [10] <http://www.watercorporation.com.au/legal/privacy>, commonwealth Privacy Act, 1988, AquaDoc. No. 10574262
- [11] Western Australia Surveillance Devices Act 1998, AquaDoc. No. 12687221.
- [12] Water Environment Research Foundation (WERF), [http://www.werf.org/Condition Assessment & Asset Performance Guidelines](http://www.werf.org/Condition%20Assessment%20&%20Asset%20Performance%20Guidelines), Practice No.7, Water Supply & Sewerage, IPEWA, Australia, 2007.
- [13] Concrete and Steel Structures Inspection Services Providers List (ISP's), Asset Management Branch, AquaDoc No. 11380256.

V. AMENDMENT REGISTER

Section	Version/Revision	Date	Description of Amendment	Authoriser
All	1.0/0	24.03.15	New Version/Revision	SM
4.0	1.0/0	20.04.15	Western Australian Surveillance Devices Act 1998.	SM
Pages 2 & 3	1.0/1.1	21.03.16	Document Custodian	TG
All	2.0	25.01.18	New Version/Revision	TG

VI. GLOSSARY OF TERMS & ABBREVIATIONS

ACA means Asset Condition Assessment.

ACS means Asset Class Strategy – Specific to an asset class.

APG means Assets Planning Group.

ARA means Asset Risk Assessment.

Authorised Operation means an operation which is authorised to conduct Aerial Photography, Aerial Spotting and Aerial Surveying.

Authorised RPA means an operation using Multi Rotor and Fixed Wing type with restricted size and of smaller category.

CASA means Civil Aviation Safety Authority.

CASR 1988 means the Civil Aviation Safety Regulations 1998.

Chief Controller means the person appointed by the Certificate Holder as its Chief RPA Controller and whose appointment has been approved in writing by CASA.

Corporation means Water Corporation, Western Australia.

DST means Decision Support Tools.

GIS means Geographic Information System.

IPWEA means Institute of Public Works Engineering Australia.

ISP means Inspection Service Provider.

OH & S means Occupational Health and Safety.

Operator means the holder of RPA Operator's Certificate.

O & M means Operational and Maintenance Group.

RSL means Remaining Service Life.

RPA means Remotely Piloted Aircraft.

UAS means Unmanned Aerial Systems.

1.0 PURPOSE AND SCOPE

The purpose of this document is to provide guidance for Level 1 inspections as part of the hierarchy of Condition Assessment (CA) guidelines of high risk assets e.g. Egg Shaped Digester, Flue Stacks in Wastewater Treatment Plants, High Level Tanks, Reservoirs, Intake Towers in Dams, etc. using RPA's.

This guideline will assist Inspection Service Providers (ISP's), Operational Asset Managers (OAM)/Region/Alliance to conduct objective, consistent and reproducible Level 1 asset inspections in a cost effective and safe manner.

This document is also intended to assist ISP's in the scoping of appropriate testing and investigation works such that the output received will be of a high standard and be a positive contribution to the management of Corporation assets.

The guideline clarifies the qualification(s), responsibilities, accountabilities, inspection data capturing techniques and interpretation for ISP's.

The guideline will also aid the ISP's to prepare and deliver the inspection findings to an appropriate format so that Assets Planning Group (APG) can, where possible, determine the Remaining Service Life (RSL) of the asset and subsequently prioritise the renewal of the asset on the informed Asset Risk Assessment (ARA) and Decision Support Tools (DST's).

For more details on the steel and concrete structures condition assessment guidelines, references shall be made to Aqua Docs 11051170 and 11520656 [1, 2].

This document should be read in conjunction with S151 Prevention of Falls [3].

2.0 CAUTION

It is important to define the Scope of Work and inspection location as it dictates flight path and safety/privacy of the general public.

Weather plays a major role during the RPA inspections. The stability of the RPA hovering on the tightly spaced areas i.e. under the bridge, high level tanks will pose major problems. If the weather is cloudy, dark with gusty winds, then the imagery obtained will not be clear and the asset details may not be captured which will render the quality to poor.

3.0 BACKGROUND

Asset Condition Assessment (ACA) is vital as infrastructure ages [4]. ACA's are used to determine the condition of assets and RSL to enable the Corporation to prevent premature asset failures that result in service interruptions and significant damage. Assets should be regularly inspected to detect any issues as early as possible.

Assets Planning Group (APG) proactively identifies assets for inspection by means of Asset Risk Assessment (ARA) and various DST's thereby calculating RSL. It is well known that inspecting assets manually is a time-consuming and labor intensive process. It also comprises a significant percentage of a utility's operating costs each year. In some cases, manual inspection such as use of EWP's, Rope Access, and Cherry Pickers etc. of certain assets can also be high risk resulting in injuries and fatality.

Recently, RPA's are employed for asset inspection by a growing number of utilities throughout the world. Using RPA's for asset inspection provides a number of substantial improvements over traditional inspection methods, including safety, efficiency and data quality [4]. However, developments in Unmanned Aerial Systems (UAS) and RPA look set to streamline and enhance the asset inspection process. As a result, RPA inspections are being trialed and adopted by a growing number of utilities [5].

Employing a RPA to inspect assets means that staff can stay at a safe distance removing the need for working at heights, thus reducing the likelihood of injury. Also, RPA inspections offer higher quality, more accurate and usable data, as well as improving safety efficiency and reducing costs.

It is also important that all images captured and anomalies recorded by the RPA's may be spatially tagged and therefore incorporated readily into the Corporation's Geographic Information System (GIS). The ability to record the size and dimension of anomalies also means that they can be compared after each subsequent inspection to detect and measure any changes that may have occurred.

In-Service Assets undertook trials in highly trafficable areas and demonstrated that staffs were not in direct contact with operational hazards such as working at heights, working with or near high voltage assets, biological hazards and large bodies of water.

Appendix A, illustrates in photographs 1- 6 some of the high risk assets in the Corporation's water and wastewater environment and the traditional techniques used by the ISP's to undertake asset condition inspections.

3.1 Conventional RPA

A Remotely Piloted Aircraft System (RPA), commonly known as an Unmanned Aerial Vehicle or Unpiloted Aerial Vehicle (UAV) or drone, is an aircraft without a human pilot aboard. Its flight is controlled either autonomously by on-board computers or by the remote control of a pilot on the ground or in another vehicle.



Photo 1 – Various components of RPA.

3.2 Caged RPA

The purpose of the caged RPA is to get a baseline (Level 1 inspection) of the asset condition and potential danger(s) in the confined space where conventional RPA cannot be used. Caged RPA is a collision-tolerant drone, utilizing a rotating spherical outer cage that means it can be used safely in close proximity with people and structures. It is designed to enter confined space environments such as tunnels, digester tanks, restricted areas, and transmit RGB and infrared images.

The caged material is made of ABS, carbon steel, and carbon fiber. It can crash, tumble, race and roll with complete control [<https://www.flyability.com/>]. The use of the caged RPA assists in understanding the potential issues in the asset by obtaining a base line (Level 1 inspection) data prior putting personnel in the confined space. It can also be operated easily without risking personnel in the confined space.

4.0 QUALIFICATIONS

The RPA operator shall possess valid certificate issued by Civil Aviation Safety Authority (CASA) under Civil Aviation Act 1988 [6]. The operator shall produce valid certificate upon Corporation's request.

The RPA operator should be able to recognise basic understanding in identifying various types of structural failures.

RPA will be piloted by individuals who are properly trained and competent to operate the vehicle or its systems.

RPA flights shall be conducted only after a thorough assessment of risks associated with the activity is completed. Also, Water Corporation's Job Safety Environment Analysis (JSEA) forms shall be filled and endorsed by the relevant Operational & Maintenance Group (O&M) [7].

The RPA operator shall fully understand the Safety Essentials, Mandatroy Rules for our High Risk Assets, publihsed by Water Corporation [8]. The RPA operator shall fully understand the Water Corporation's Privacy Policy PCY 252 [9], and also Commonwealth Privacy Act, 1988 [10].

The RPA operator shall fully understand the Western Australian Surveillance Devices Act 1998, AquaDoc. No. 12687221 [11].

5.0 CONDITION RATING INTERPRETATION

5.1 WERF – Why This Approach?

Prior to 2014, various condition rating systems were used in the Corporation to assess the civil structures. They were all so called industry practice and/or based on the “hearsay”. Also, the assessments were qualitative, debateable and hence inconsistent rating.

The main purpose of rating the tank is to evaluate the condition in an objective approach and its effective RSL. The assessment will assist further decision-making about the Level of Service (LOS) provided by the tanks. It is well known that deterioration of material range from 0% to 100%. Currently, the best deterioration model readily fits to this approach is Water Environment & Reuse Foundation (WERF).

The WERF model approach is either “aged based” or “condition based”. If no prior inspection or condition data is available, then the service life of the asset will be based on the age and will take the precedence over the condition and vice versa.

Corporation’s inspection experience and condition assessment of the asset clearly proved only certain levels of inspection (Level 1 – Visual, Level 2 – Formal and Level 3 – Destructive) is warranted. It is well known that the asset failure leading to physical mortality is not uniform and at certain point it is unserviceable and beyond economic repair. Also, Capacity, Level of Service and Finance factors play major role in the renewals planning decision[3]. So, after any inspection activity the condition rating should be within the margin of “Serviceable and Unserviceable”. If this concept is not followed, the rating in 5 scale will also provide a huge margin of error when compared to the 10 rating. In simple words, for a rating 4 in 5 scale, the deterioration is 80%, because each scale will equate to 20% deterioration; whereas the same 80% deterioration equates to a condition rating of 8 in a 10 scale.

For the past 3 years, Level 2 inspection of water and wastewater assets clearly showed that the steel structures are still within the serviceable range. The asset condition rating of 10 scale provides a pragmatic maintenance repair works on the assets individual components. Most importantly, Corporation follows Capital Program which is of 5 years plan for repairs and replace approach. Hence, asset with 30% deterioration which is rated as 3 in a ten point scale can be repaired in 3 to 5 years.

5.2 Condition Rating System

For the condition assessment of tanks, In-Service Assets utilises TDST model [Refer: Figure 1]. The condition rating is based on 1 to 10 scales and the outcome is summarised as below [3].

Guideline for the use of Remotely Piloted Aircrafts (RPA's)

- ☑ **Excellent condition** - Observable deterioration is none. Less than 10% physical life is consumed.
- ☑ **Very Good condition** - Observable deterioration is insignificant. No adverse service reports. 30% physical life is consumed.
- ☑ **Good condition** - Observation and/or testing indicate that the asset is meeting all service requirements. Sound Physical condition. Minor deterioration/minor defects observed. 50% physical life is consumed.
- ☑ **Fair condition** - Moderate deterioration evident. Minor components or isolated sections of the asset need replacement or repair now but not affecting short term structural integrity. 70% physical life is consumed.
- ☑ **Poor condition** - Serious/Significant deterioration evident and affecting structural integrity. Asset is now moving into zone of failure. 90% physical life is consumed.
- ☑ **Very Poor** - Failed or failure imminent. Immediate need to replace most or the entire asset. 100% physical life is consumed.

Asset Condition Rating		
Asset Condition Rating	Asset Condition Rating Outcome	Priority for Repair Works
1	Excellent	5+ years
3	Very Good	3-5 years
5	Good	2-3 years
7	Fair	within 1 year
9	Poor	Immediate
10	Very Poor	Retire

Figure 1 – Asset Condition Rating based on TDST model.

Note: A series of charts published by the AS/NZS engineering standards, Standard Practices (SP) published by NACE, ASTM standards and IPWEA can also be used to make an informed decision on the condition rating of the asset for Level 2 and Level 3 inspections.

6.0 OVERVIEW OF LEVEL 1 ASSET CONDITION INSPECTION

In-Service Assets, APG propose on all the Water Corporation steel and concrete structures that the condition assessment is undertaken at three levels [15]:

6.1 Level 1 – Routine Operation and Maintenance Inspection

Level 1 inspection is carried out as part of routine operational budgets and activities. Level 1 inspection will assist in assessment of the overall safety and performance of the steel tank structure. A Level 1 inspection can be carried out by Water Corporation employees including treatment plant operators, chemical dosing plant supervisors, asset maintainers, asset planners, service delivery representative and diving contractors. Relevant inspection data is captured as part of the on-going operation and maintenance process.

If corrosion defects are a threat to the structural integrity of the tank, then an Asset Deficiency Report (ADR) must be created by the asset inspector. The Asset Manager or responsible person must also use the Asset Risk Assessment (ARA) system and verify the likelihood and consequence of failure i.e. risk rating for the steel tank.

In-Service Assets, APG recommends all the asset owners to complete ARA which can be found on the APG website in the Water Corporation intranet <http://waternet.watercorporation.com.au>.

In-Service Assets, APG will then validate the risk assessment and also use the Tank Decision Support Tool (TDST) to calculate the indicative Remaining Service Life (RSL) from the Level 1 assessment. Where the indicative RSL is calculated to be within 5 years, a Level 2 inspection may be initiated and planned in the appropriate year for condition assessment.

Level 1 inspection is carried out as part of routine operational budgets and activities. Refer **Appendix A** inspection checklist for Level 1 inspection by Water Corporation employees and external Inspection Service Providers (ISP's).

Recently the Corporation has conducted some Level 1 inspections using RPAs. Images obtained during these inspections are shown in **Photos 10 – 19**.



Photo 10 –Elevated tank roof and platform.



Photo 11 – Underside of tank platform.



Photo 12 – Tank inlet pipe.



Photo 13 - Tank external wall and handrails.

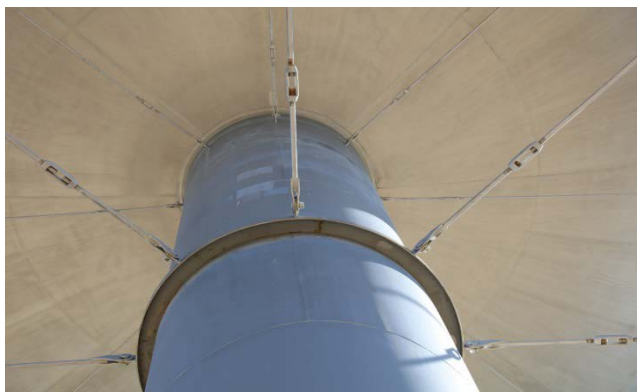


Photo 14 - Underside of tank and central column



Photo 15 - Overview of satellite tank

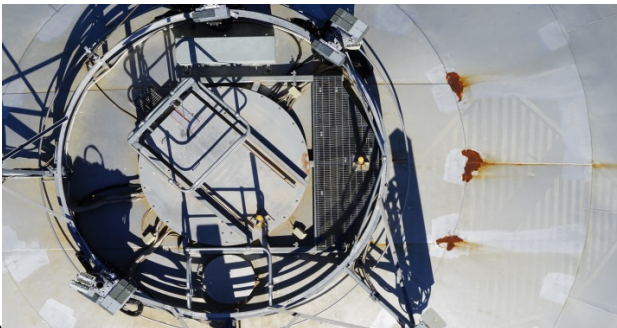


Photo 16 – Top view of satellite tank showing hatch

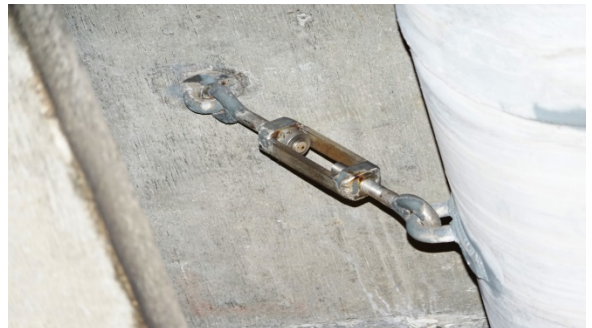


Photo 17 - Pipe hangers



Photo 18 - Inside of an odor scrubber using a caged RPA



Photo 19 - Inspection of a tunnel using a caged RPA

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For Level 2 and Level 3 inspection references shall be made to relevant Steel Tanks and Concrete structures guidelines [1, 2].

For example, an overview of the Corporation's ACA process on steel tanks is shown in Figure 2.

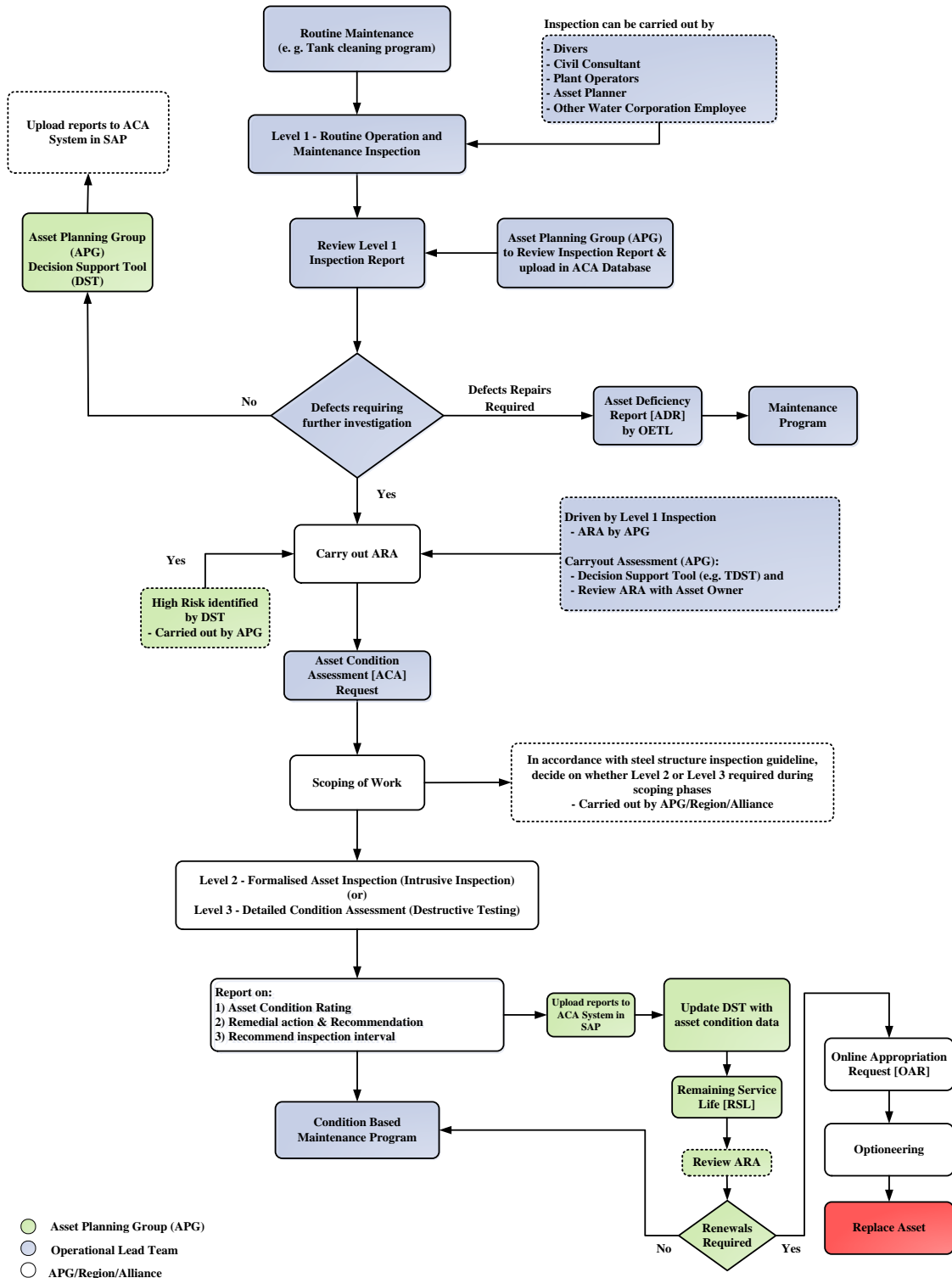


Figure 2 – Overview of Corporation's steel tank ACA process.

7.0 ASSET INSPECTION PROCEDURE

Prior to conducting any inspection, the Authorised Operation must fully understand the condition assessment and data capture process. They must also be familiar with the criterion (condition rating & priority repair works) used to assess the asset condition. Relevant permits shall be obtained from the Asset Manager/Responsible Person prior to start of inspection.

Any inspector undertaking on-site condition assessments shall be appropriately qualified and competent for the task. The data collection and reports will provide valuable information not only on the asset RSL but also assists in understanding the risk and current performance of the asset.

The inspector should ensure that the assessment is complete with appropriate levels of detail for each relevant component of the asset with a rated condition. The corrosion assessments must be made with degree of reasonable accuracy. The data collected should adhere to the criteria provided to enable consistency between surveys.

All inspecting personnel shall hold appropriate site safety inductions both general and site specific. If the asset is deemed to be confined space and/or working at heights, then appropriate valid certification shall be possessed by the in-house personnel and ISP's. The certificates shall be available to the Corporation for at least 10 working days prior to the inspection.

After completion of inspections, the report should be sent to the inspection initiator whom should then forward to the Asset Manager or Responsible Person and Renewals Planning. The inspection data must then be updated and analysed in the DST database. The inspection documents will be saved in Aqua and linked to ACA database.

7.1 Roles and Responsibilities

Activities	Role(s)*	Responsible Branch*
Level 1	Visual Inspection using RPA's	Authorised Operation
Level 2	External & Internal Inspection	ISP [†]
Level 3	Detailed & Laboratory Assessment	External Consultants [♦]
ARA	Regional/Alliance Civil Asset Planners and Maintainers	Region/Alliance Partners/APG
Inspection data review	Level 1 by OAM & Region/Alliance Partners. Level 2 and 3 inspection data analysis by Renewals team.	APG
Inspection data update in Database	Analyst in Renewals team	APG

Table 1 – Roles and Responsibilities Matrix for RPA inspection.

* Changes in Roles and Responsibilities matrix shall only be approved by Section Manager, In-Service Assets.

[†] Approved External Contractors – Refer ACA Panel, [AquaDoc. No. 16729525].

[♦] Approved Materials Testing and Corrosion Specialists - Refer ACA Panel, [AquaDoc. No. 16729525]

7.2 Defects Notification

During Level 1 inspection, corrosion related failures may be identified by the Authorised Operation and/or ISP's that requires urgent attention shall be notified to the OAM/Region/Alliance. The defects recognised needs to be addressed as soon as practicable, so that the asset can be brought back to operation. Some of the common issues that may require immediate notification include:

- 1) Safety compliance issues.
- 2) Security issues.
- 3) A defect that will have detrimental effect on the asset if not rectified.
- 4) A defect that is adversely affecting the service being provided by the asset.

7.3 Inspection Data Interpretation

Persons responsible for identifying and recording defects, service conditions and construction features for preparing reports and operating equipment shall hold a suitable qualification for various levels of inspection and is discussed in Section 7.1.

APG is responsible for analysing the asset inspection data (Level 2 & Level 3) provided by Authorised Operation and/or ISP's and shall be competent in the following:

- 1) Interpreting information contained in the inspection reports.
- 2) Identifying and coding of defects and other features.
- 3) Verifying the inspection scoring/grading system.
- 4) Recording the inspection scoring/grading system in DST tools.
- 5) Recognising corrosion related defects and the likely parameter contributing to the defects.
- 6) Recognising poor quality inspection videos and camera inspection.

8.0 APPENDIX A - HIGH RISK ASSETS IN CORPORATION'S WATER AND WASTEWATER ENVIRONMENT

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Photo 1 – Elevated steel tank.



Photo 2 – Elevated steel tank.

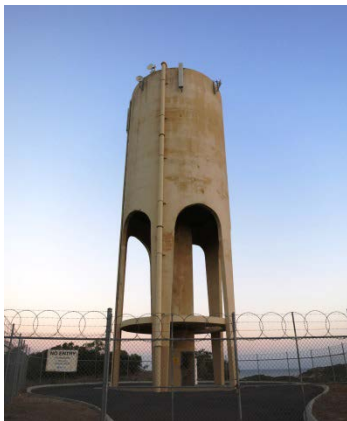


Photo 3 – Elevated Concrete Tank.



Photo 4 – Pipeline under the bridge.



Photo 5 – Inspection of Intake tower in the Dam by conventional inspection approach.









Photo 6 – Sacrificial Anode inspection on the intake tower.







9.0 APPENDIX B - ASSET CONDITION RATING

Guideline for the use of Remotely Piloted Aircrafts (RPA's)

9.1 Tek Screws






ACA Rating	ACA Outcome	Description	Descriptive Photograph
1 or 2	Excellent	<ul style="list-style-type: none"> No or very minor defects 	
3 or 4	Very Good	<ul style="list-style-type: none"> Minor corrosion/deterioration to Tek Screws Light surface rust to Tek Screws Light surface rust to thread portion of the Tek Screws 	
5 or 6	Good	<ul style="list-style-type: none"> Moderate corrosion/deterioration to Tek Screws Moderate surface rust to Tek Screws Early signs of Necking surface rust to thread portion of the Tek Screws 	
7 or 8	Fair	<ul style="list-style-type: none"> Severe corrosion/necking to Tek Screws Severe surface rust to Tek Screws Severe signs of localised thinning or Necking rust to thread portion of the Tek Screws 	
9	Poor	<ul style="list-style-type: none"> Severe corrosion/necking to Tek Screws Imminent failure to Tek Screws Severe signs of Necking surface rust to thread portion of the Tek Screws 	
10	Very Poor	<ul style="list-style-type: none"> Tek Screw broken or disconnected from the roof sheeting 	

9.2 Roof - External

ACA Rating	ACA Outcome	Description	Descriptive Photograph
1 or 2	Excellent	<ul style="list-style-type: none"> No or very minor defects 	
3 or 4	Very Good	<ul style="list-style-type: none"> Minor corrosion/deterioration observed on the roof sheet 	
5 or 6	Good	<ul style="list-style-type: none"> Moderate corrosion/deterioration observed on the roof sheet Moderate surface rust to Tek Screws At times, random holes are observed on the roof sheet 	
7 or 8	Fair	<ul style="list-style-type: none"> Severe corrosion/necking to the internal roof sheet support structures Sagging of roof sheet observed 	
9	Poor	<ul style="list-style-type: none"> Imminent failure to roof sheet collapsing inside the tank High velocity wind may lift the roof sheeting off from the structure 	
10	Very Poor	<ul style="list-style-type: none"> Tek Screw broken or disconnected from the roof sheeting 	

Guideline for the use of Remotely Piloted Aircrafts (RPA's)

9.3 Wall - External

ACA Rating	ACA Outcome	Description	Descriptive Photograph
1 or 2	Excellent	<ul style="list-style-type: none"> No or very minor defects 	
3 or 4	Very Good	<ul style="list-style-type: none"> Minor corrosion/deterioration to wall coating Light surface rust to steel substrate 	
5 or 6	Good	<ul style="list-style-type: none"> Moderate corrosion/deterioration to wall coating Light surface rust to steel substrate Showing signs of hot dip galvanising (zinc) reaction with the environment 	
7 or 8	Fair	<ul style="list-style-type: none"> Severe corrosion due to hot dip galvanising coating deterioration Severe surface rust noted on large areas 	
9	Poor	<ul style="list-style-type: none"> Coating delamination and failure of protective coating 	
10	Very Poor	<ul style="list-style-type: none"> Severe corrosion/ on the wall Severe signs corrosion build up on most of the wall surfaces Imminent leak due to steel corrosion 	